

8. *The TRIASSIC CRINOIDS from NEW ZEALAND, collected by*  
Dr. C. T. TRECHMANN. By FRANCIS ARTHUR BATHER,  
M.A., D.Sc., F.R.S., F.G.S. (Read February 7th, 1917.)

DR. TRECHMANN has kindly presented to the British Museum (Natural History) a stem-fragment and a piece of calcareous sandstone containing imprints of various columnals, and has asked me to furnish some notes on them. Since these are the first Triassic crinoids to be described from New Zealand, their adequate description seems warranted, despite their fragmentary condition. All are believed to represent new species.

In 1909 most of the Triassic crinoids known up to date were discussed by me in 'Triassic Echinoderms of Bakony,'<sup>1</sup> and the terminology here employed is explained in that memoir. Since then the only professedly new forms made known are those contained in Clark & Twitchell, 1915, 'The Mesozoic & Cenozoic Echinodermata of the United States' (U.S. Geol. Surv. Monogr. liv). These, therefore, are discussed here at greater length than the better-known European species, and for one of them a new specific name is proposed.

[Mr. G. C. Martin, in a paper on 'Triassic Rocks of Alaska,' published December 1916 (Bull. Geol. Soc. Amer. vol. xxvii, pp. 685-718), but not received here until June 1917, records specimens of '*Pentacrinus*.' These, which belong to two new species of *Isocrinus*, are also described and compared.]

*ENTROCHUS UNDATUS*, sp. nov. (Figs. 1 & 2, p. 248.)

Diagnosis.—Trochitæ with smooth, faintly convex side-faces; ratio of height to diameter circa 0·18; joint-face with about 25 coarse ill-developed ridges, radiating from the centre about halfway to the periphery, where they merge into a few broad, irregular waves.

Locality.—Eighty-Eight Valley, Nelson, (N.Z.).

Horizon.—Kaihiku Beds, Ladino-Carnic.

Material.—A stem-fragment consisting of 24 columnals or portions of columnals, broken cleanly across at the joint-face, between the 5th and 6th, and worn all down one side, especially towards the other end of the fragment. British Museum, Geological Department, E 22185.

Description.—Cylindrical.

Length of fragment=38 mm.

Average height of columnal, as calculated=1·58 mm.

Greatest height of a columnal, as measured=1·8 mm.

Least height of a columnal, as measured=1·5 mm.

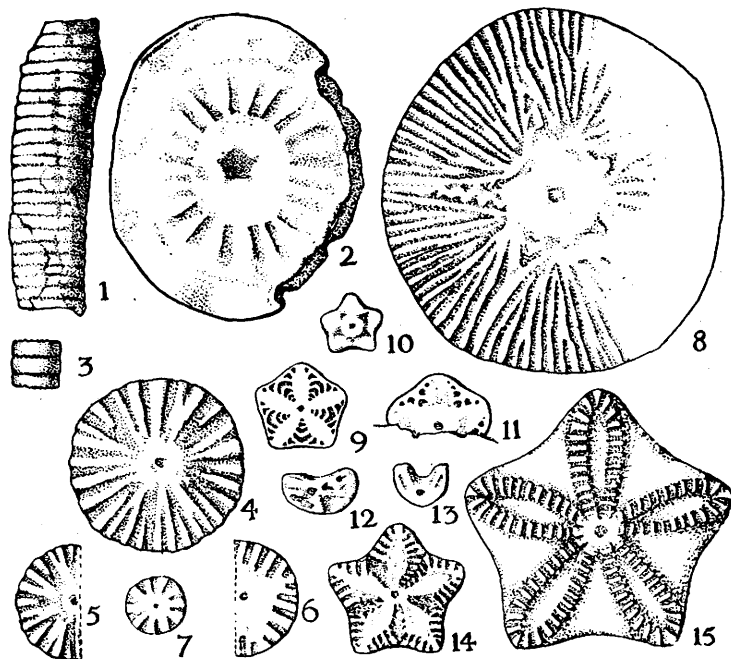
Diameter=8·2 mm. at the more imperfect end; =10 mm. at the other.

Ratio of height to diameter=0·18.

Diameter of lumen=about 0·8 mm.

<sup>1</sup> 'Result. Wissensch. Erforsch. des Balatonsees' vol. i, Pal. Anhang.

*Entrochi and Pentacrini from New Zealand and North America.*



[Figs. 1 and 3 are of the natural size. All the rest are enlarged 4 diameters.  
Drawn by Miss Margaret Tempest.]

*Entrochus undatus.* (Pp. 247-49.)

- Fig. 1. Holotype. Side view; the thicker suture-line, fifth from the top, represents the division between the two fragments. [E 22185.]  
2. Holotype. Joint-face at the top of the larger fragment.

*Entrochus ternio.* (P. 249-52.)

- Fig. 3. Holotype. Side view. [E 22186.]  
4. Holotype. Joint-face.  
5. Group B. Joint-face with the characters of the holotype.  
6. Group B. Joint-face with ridges pentamerously fasciculated.  
7. Group C. Joint-face of young.

*Encrinurus hyatti* W. B. Clark. (P. 251.)

- Fig. 8. Joint-face. [E 6481.]

*Isocrinus trechmanni.* (Pp. 252-53.)

- Fig. 9. Normal joint-face. In this example there is a marked peripheral rim, and the radial ridge-groups are gable-shaped. [E 22186.]  
10. Joint-face of a small epizygial with no ridges. [E 22187.]  
11. Syzygial joint-face with traces of ridges. [E 22187.]  
12. A wide asymmetrical brachial. [E 22187.]  
13. A pinnular, or a symmetrical brachial from the distal region. [E 22187.]

*Isocrinus cupreus.* (Pp. 255-56.)

- Fig. 14. Normal joint-face. In this the secondary or accidental radial depressions are less marked than in most. [E 22178.]

*Isocrinus gravinae.* (P. 256.)

- Fig. 15. Normal joint-face. [E 22181.]

Sides smooth, faintly convex, rising about 0.1 mm. above the suture-line.

Suture-lines broadly and irregularly waved, not crenulate in the ordinary sense.

The joint-face shows faint traces of radiating ridges in the central area, but at about halfway to the periphery these die away with varying rapidity. The number of these ridges is estimated at 25; it is not possible to see whether they are grouped by fives to any extent. The ridges and grooves are of equal size. The peripheral half of the joint-face is almost smooth; but in places there can be detected the traces of the radiate ridges, also faint concentric grooves. The whole surface is thrown into very slight broad waves, 5 or 6 in all, which bear no obvious relation to the ridges.

The lumen is obscurely pentagonal, and is indicated in the fossil by a calcite infilling of darker colour. Within this, at all four places where it is exposed there is visible a structure with a light border, which may be interpreted as probably an axial vessel, possibly with five chambers (compare Bather, 1909, pp. 41, 42).

Relations of the species.—The circular section, smooth exterior, apparent absence of cirri, small lumen, and radiating ridges on the joint-face: all these are characters of the *Encrinus* stem, and to that genus the present specimen probably belongs. None the less, in the absence of evidence from the crown, and in view of the distinctive characters of the joint-face, it is safer to give the specimen for the present the non-committal name *Entrochus*.

From all known species of *Encrinus*, and from all *Entrochi* as yet described from Triassic rocks, the *Entrochus* here described differs in the substitution of broad irregular waves for the radiating ridges in the peripheral area of the joint-face, resulting in a waved non-crenulate suture-line. Hence the trivial name, *undatus*, waved.

*ENTROCHUS TERNIO*, sp. nov. (Figs. 3–7, p. 248.)

Diagnosis.—Trochitæ with smooth, faintly convex side-faces; ratio of height to diameter=0.35 (more in young); suture depressed, crenulate; joint-face with a raised central area, and from 20 to 30 well-marked ridges, of which two-thirds tend to constitute forked pairs starting from the centre, and one-third to be shorter ridges intercalated between the pairs.

Locality.—Caroline Cutting, Hokonui Hills, Southland (N.Z.).

Horizon.—Kaihiku Beds, Ladino-Carnic.

Material.—Various imprints of columnals on a fragment of calcareous sandy matrix with iron-stained imprints and internal casts of *Spiriferina fragilis*, *Dielasma* cf. *himalayana*, *Mentzeliopsis*, and *Isocrinus*. British Museum, Geological Department, E 22186. The imprints of columnals may be grouped under three headings. (A) A stem-fragment consisting of 3 columnals,

and showing the clear impression of one joint-face. This, which is believed to represent the adult stage, is fixed on as the holotype. (B) Three smaller separated columnals, visible in rather imperfect imprints, not far from the holotype. (C) Two small united columnals, and, at 16 mm. distance from them, the imprint of a small joint-face. These three sets will now be described in order.

Description of A, the holotype (figs. 3 & 4, p. 248).—Cylindrical.

Length of fragment = 5·8 mm.

Diameter = 5·7 mm.

Height of a columnal, as measured = 2 mm. Ratio to diameter = 0·35.

Diameter of lumen = circa 0·4 mm. (not more).

Sides smooth, faintly convex; suture depressed.

Suture-lines with large, rounded, well-marked crenellæ.

The joint-face shows a raised area round the lumen, and outside this about 28 radiating ridges, which tend to be arranged so that about a third start from the central area and fork, while the remaining 9 are intercalated between these pairs. It is this arrangement by threes that has suggested the trivial name *ternio*, a number containing threes.

Description of Group B (figs. 5 & 6, p. 248).—The three columnals are all of about equal size, with the following approximate measurements:—

Diameter = 3·7 mm.

Height = 1·8 mm. Ratio to diameter = 0·48.

Diameter of lumen = 0·25 mm.

In the best-preserved joint-face (fig. 5) there are about 22 ridges, arranged in pairs with a shorter one intercalated, as in the holotype.

The joint-face of the adjacent imprint (fig. 6) has a smooth and flat central area, at a level slightly below the ridges. This area is larger than in the other cases, so that the ridges are shorter. Their number is estimated at not less than 22, and they appear to lie in five fascicles of 4 or 5, those in each fascicle being parallel to the median line of that fascicle.

These smaller columnals are ranked with the holotype, as probably belonging to the same species. The characters in which they differ from the holotype are, on the whole, those of youth. With this the relatively greater height of the columnals is consistent, though perhaps rather more than might have been expected on that interpretation. I have previously suggested (1909, p. 9) that the pentamerous fasciculation of the ridges is a frequent, possibly universal, characteristic of youth in the genus *Eucrinus*. It may, however, be manifested in certain regions of the stem and absent from others. In some species the character passes into the adult stage, and in genera of later origin becomes a normal feature (1909, p. 249). See p. 251, under 'Relations.'

Description of Group C (fig. 7, p. 248).—The stem-fragment composed of two columnals is cylindrical.

Diameter of columnal=2.3 mm.

Height of columnal=1.25 mm. Ratio to diameter=0.54.

Diameter of lumen=0.25 mm.

Sides smooth, very faintly convex, almost straight.

Suture-lines with large, rounded, well-marked crenellæ.

The joint-face shows a raised area round the lumen, with a diameter of about 0.6 mm., and outside this are 10 radiating ridges, rapidly broadening.

The other imprint also has 10 ridges. Its diameter is 1.6 mm.

These specimens may represent a still younger stage. If from the holotype's total of 28 we were to eliminate the shorter intercalated ridges, there would be left about 10 pairs of bifurcating ridges, and each of those pairs would in its early stage appear as a single rapidly broadening ridge.

Relations of the species.—At first sight the characters of these imprints seem of so indifferent or uncritical a nature as not to warrant the establishment of a new species. I have, however, worked through the descriptions of published species without finding any that agree with the diagnosis here presented. Perhaps one would not expect to find the same species in the European or even in the American province; but neither is there anything of the kind in the Triassic material from Timor that Prof. J. Wanner has kindly entrusted to me for description. Among European species similar joint-faces are found in the Carnic rocks rather than in the Ladinic, where the sharply-cut cog-wheel type, familiar in *Encrinus liliiformis*, is dominant.

A tendency to bifurcation and intercalation of ridges on the same plan as in *Entrochus ternio* is observable in *Entrochus insignis* Toulà. Specimens of this from the type-locality in Bulgaria were most kindly sent to me by Dr. P. Bakalow (Brit. Mus., Geol. Dept., E 14076), who has proved their Triassic age [probably Raiblian]. This species shows a far more marked pentamerous fasciculation of the ridges than anything hinted at in *E. ternio*, together with a beginning of petals and radial ridge-groups.

An earlier stage of that development is found in *Encrinus hyatti* W. B. Clark (1915), from the Upper Trias of California. Clark lays stress on the bifurcating striations (which, by the way, are scarcely shown in his figure); but he has not observed other important characters. In a specimen (fig. 8, p. 248) which Prof. Clark was so good as to give me many years ago (now Brit. Mus., Geol. Dept., E 6481) there are shorter intercalated ridges as in *E. insignis*, not so regular as in *E. ternio*. Further, the ridges are clearly gathered in 5 fascicles surrounding a relatively large, raised, central area, which thrusts out 5 wedges between the fascicles, each wedge splitting (as it were) one of the ridges and compressing the other ridges into a fan as it forces the limbs of

the split one asunder. These split ridges may be the beginning of either the radial ridge-groups or the petals; their relations to the lumen are obscure, but they coincide with the angles of the periphery, which is irregularly and faintly pentagonal. The ridges of *Encrinus hyatti* are coarser than those of *Entrochus insignis*, finer than those of *E. ternio*. The characters observed are confirmed by squeezes (Brit. Mus., Geol. Dept., E 21819) very kindly made by Prof. Bassler from specimens studied by Prof. Clark and now in the U.S. National Museum.

ISOCRINUS TRECHMANNI, sp. nov. (Figs. 9-13, p. 248.)

**Diagnosis.**—Transverse section normally a rounded pentagon, at the syzygy a rounded star. Height less than one-third of the diameter. Side-faces smooth, straight. Suture-line flush, faintly or not at all crenelate. Normal joint-face with lumen minute; central area raised, smooth, narrow, continuous with the radial crenellæ; petal-floors raised generally to the level of the crenellæ, smooth, narrow, long; radial ridge-groups about 3, inosculating more often than gable-shaped, the distal pair meeting at an angle of about 90°; peripheral crenellæ 6 to 8, passing from the inter-radius towards the periphery at an angle which gradually increases to a right angle in the more acentral ridges; all confluent on the periphery.

**Locality.**—Caroline Cutting, Hokonui Hills, Southland (N.Z.).

**Horizon.**—Kaihiku Beds, Ladino-Carnic.

**Material.**—Various imprints of columnals on the same rock-fragment as *Entrochus ternio*. British Museum, Geol. Dept., E 22186, E 22187. The holotype is the imprint of a normal joint-face on the latter piece, not the example drawn in fig. 9.

**Description.**—The transverse section of a normal internodal is a pentagon, usually rounded, with sides sometimes slightly convex. A few that show signs of excavation of the sides probably lay just above the nodes, and received the cirri in their hollowed sides. One such is almost a pentapetalon. Measurements of normal internodals are:—

Diameter=2 mm., 2·3 mm., 2·8 mm.

Height=0·75 mm.; ratio to diameter=0·27.

Side-faces straight and unornamented.

Suture-lines flush, noncrenulate in normal internodals; perhaps obscurely crenelate at or near syzygies.

**Joint-faces.**—Normal internodal (fig. 9, p. 248): lumen minute, say 0·1 mm., its section not distinct; central area raised, smooth, narrow, continuous with the radial crenellæ; petal-floors raised generally to the level of the crenellæ, smooth, narrow, long; radial ridge-groups about 3, inosculating more often than gable-shaped, the acentral pair tending to fuse with the central area, the acentral meeting at an angle of about 90°; peripheral crenellæ 3 or 5 in small ossicles, from 6 to 8 in full-sized ones (9 in the

pentapetalon), passing from the interradius towards the periphery at an angle which gradually increases to a right angle in the more acentral ridges: all confluent on the periphery.

Syzygial face (seen in one imprint, fig. 11, whether epi- or hypozygial uncertain): sides of rounded pentagon faintly excavate; lumen and central area larger than in the normal face, the area slightly raised; petal-floors wide, and flush or slightly depressed; perradial ridge-groups 2, the acentral one a mere granule, the acentral one lambdoid with the stem broadening to form part of the peripheral rim; peripheral crenellæ restricted to one on each side of the lambdoid stem, but the rim is continuous, though faint, and a couple of slight swellings on it represent the interradian crenellæ.

There is one small imprint (fig. 10) that appears to be of an epizygial, but it is not very clear. It is a rounded star, with diameter = 1.8 mm.; IR = 1 mm.;  $r = 0.5$  mm.; lumen minute, but distinct, relatively large, apparently pentagonal; ridges invisible; petal-floors slightly depressed; rim indistinct. The side-faces of this columnar were vertically concave, and apparently bore a depressed, elliptical cirrus-facet.

Cirrals appear to be represented by imprints of a few small canaliculate ossicles.

Brachials.—There are a few scattered imprints of articular faces, which probably represent brachials of this species. There are wide brachials from the proximal region (fig. 12), narrower and more elevated ones from the distal region (fig. 13); one wide brachial shows a syzygial face. All have the axial canal well developed, and in this respect resemble the brachial from the Raiblian *Cardita-Oolite* of Rammelsbach, figured in 'Triassic Echinoderms of Bakony' (1909, pl. v, fig. 122) rather than the brachial from the Cassian Beds of Cserhát (*op. cit.* pl. v, fig. 127).

Relations of the species.—The joint-faces of three European Triassic species (*I. propinquus*, *I. hercyniæ*, *I. bavaricus*) are distinguished from *I. trechmanni* by the presence of a radial triangle. The absence of a rim and the consequent crenelation of the suture-line distinguish *I. tyrolensis*, *I. scipio*, and *I. sceptrum*. *I. amœnus* is further characterized by the marked ornament of its side-faces, and *I. candelabrum* by the long curved ridges of its joint-face. In *I. dubius* (Goldfuss) the crenellæ are confluent with the periphery, but that species, to judge from the original figures, has wider petal-floors than *I. trechmanni*, with a greater distinction between the radial ridge-groups and the peripheral ridges. *I. dubius* needs careful redescription on the basis of the original material; meanwhile, it is with it and similar forms that *I. trechmanni* should be associated.

Turning to the Triassic species of North America, the characters of which have lately been sketched by Prof. W. B. Clark (1915), we find three species, which may be discussed briefly.

*Isocrinus smithi*, from the Lower Trias, is represented by weathered columnals. The section in the specimen as figured is a Q. J. G. S. No. 291.



rounded star, with diameter = 2.85 mm. (the text says 0.5 to 2 mm.) and height = 0.8 mm. (the text says 0.33 to 1 mm.). Ratio of height to diameter = 0.28 (the text would make it 0.6 to 0.5). The lumen is said to be 'small,' but as drawn has a diameter of 0.35 mm. No other characters of the joint-face are either figured or described, although the drawing suggests that the side-faces were transversely ridged. This feature and the general outline distinguish *I. smithi* from *I. trechmanni*.

*Isocrinus californicus*, from the Upper Trias, is represented by well-preserved columnals. The section as drawn is a rounded star, with a diameter = 3.75 mm. (the text says 2 to 5 mm.); height = nearly 0.8 mm. (the text says 0.5 to 1 mm.). Ratio of height to diameter = from about 0.25 to 0.2. The lumen is said to be 'large and well-marked,' but as drawn has a diameter of 0.14 mm., which (as compared with *I. smithi*) would be even minute. The petals are 'narrow' and 'sharply terminated'; from the drawing it appears that the ridges are short and not confluent at the periphery, but the side-view shows no trace of crenellæ, which is curious. The side-faces appear from both drawing and photograph to be gently convex at the IR angles and sharply so at the reëntrant *r* angles, so that in the angle the sides are transversely ridged. The photograph shows rather clearly a cirral, with section circular, joint-face rimmed, central area raised, lumen minute. The scalariform sides of *I. californicus* are enough to distinguish it from *I. trechmanni*, whatever its other characters may really be.

The third species is a form recorded in 1877 by Hall & Whitfield<sup>1</sup> from limestone of Middle Triassic age in Nevada. They referred it with doubt to the Jurassic *Pentacrinus asteriscus* Meek & Hayden. That, however, appears to be a *Pentacrinus* sensu stricto, whereas the Triassic species is rightly referred by Prof. Clark to *Isocrinus*. Unfortunately, he neither describes nor names it. The specimen is said by him, as formerly by Whitfield in his 'List of Types,' to be in the U.S. National Museum; but Dr. Bassler, who has kindly searched, tells me that it cannot now be found. The original figure, however, is quite clear enough to serve as the basis of a diagnosis and a name. The following are therefore submitted:—

*ISOCRINUS ARGENTUS*, sp. nov. Transverse section a slightly rounded star. Joint-face with radial triangle; lumen relatively large and quinquelobate with radial lobes; petals lanceolate, but not narrow; radial ridge-groups about 3, remainder of ridges about 15, but of these only 2 or 3 at the distal end of the petal reach the periphery. Diameter, may 'exceed one-fourth of an inch' (say 7 mm.).

Holotype.—The specimen figured as *Pentacrinites asteriscus*? by Hall & Whitfield, 1877.

<sup>1</sup> U.S. Geol. Explor. 40th Parall., Final Rep. vol. iv, p. 280 & pl. vi, fig. 16.



[I am indebted to the Director of the United States Geological Survey for several sets of squeezes taken from the best specimens found in Alaska (G. C. Martin, 1916). It is inferred from these squeezes that the original specimens are in their natural relief. Plaster casts have therefore been taken from the squeezes in the Geological Department of the British Museum, and form the basis of the following descriptions :—

*ISOCRINUS CUPREUS*, sp. nov. (Fig. 14, p. 248.)

Transverse section a rounded star, with the sides of the inter-radial angles slightly convex. Normal joint-face with lumen minute (under 0.25 mm.) and central area raised in a rim round it; petals broadly lanceolate, floors flush with the ridges or but slightly lower; radial ridge-groups about 4, their crenellæ inosculating, and apparently fragile, merging into peripheral crenellæ, which are 8 or 9, non-confluent. Suture crenelate all round.

Approximate measurements :—IR = 2.5 mm.;  $r$  = 1.5 mm.; reëntrant angle = 0.5 mm.; making diameter = 4.5 mm.

Locality.—Jumbo Creek, near Bonanza Mine, Copper River region, Alaska. U.S. Geol. Surv. Loc. 4809.

Horizon.—Upper Trias, Chitistone Limestone, supposed to be Middle or Upper Carnic, therefore comparable with Raiblian (see G. C. Martin, 1916, p. 692).

Material.—Squeezes in various substances from specimens in the collection of the U.S. Geological Survey, and plaster casts taken therefrom in the British Museum, Geological Department. Registered E 21915–21918, E 22178–22180.

Holotype. — Plaster cast E 22178 and its original at Washington.

Relations.—The most striking feature in the fossils (as interpreted from the squeezes) is the hollow that in nearly every radius of every specimen occupies the position of the radial ridge-groups. At first, this suggests a radial triangle; but closer inspection shows that crenellæ exist all round the periphery, and in rare cases, as in the right upper radius of fig. 14, the radial ridge-groups still remain. It appears as though these structures were of looser texture than usual, and so were easily worn or broken away, leaving as a rule obscure traces or even a mere hollow, as in the left upper radius of fig. 14. This last appearance seems (on the evidence of the squeezes) to be the most characteristic, and though it is not in the strict zoological sense a diagnostic character, it may be regarded as distinguishing what Prof. H. S. Williams (October 1917) has called a 'metamorphic species.'<sup>1</sup> The visible character of such a species is directly due to certain physical, mechanical, or chemical conditions of fossilization or metamorphism; but for it to have any systematic value, it must be indirectly due to some feature in the gross or minute anatomy. That feature may have been invisible until made visible by the extraneous forces, which act as do the differentiating reagents of the laboratory.

<sup>1</sup> 'Nuculites from the Silurian, &c.' Proc. U.S. Nat. Mus. vol. liv, pp. 27–58.

Apart from this peculiar character, the species differs from other known Triassic species. Those which resemble it in the crenelation of the suture and in the absence of a radial triangle have petal-floors depressed, and not flush as here. In *I. trechmanni*, which has flush petal-floors, the peripheral crenellæ are fewer and are generally confluent.

*ISOCRINUS GRAVINÆ*, sp. nov. (Fig. 15, p. 248.)

Transverse section a slightly excavate star with rounded angles. Normal joint-face with lumen small (obscure, say 0.5 mm.); central area merging into adradial crenellæ; petals narrow (4.4 mm. long, 1.6 mm. at greatest width, giving ratio of 0.36), their floors depressed, with a greatest width approximately one-third of the width of the petal (actually 0.6 mm.); adradial crenellæ, after the obscurely formed adcentral crenellæ, are about 10 on each side, regularly corresponding, 0.5 mm. long; peripheral crenellæ estimated at 5 (the ends of petals are broken); a well-marked radial triangle with surface rising gently towards the radius in its outer (acentral) region.

Approximate measurements:—IR = 4.9 mm.;  $r = 3.1$  mm.; reëtrant angle = 0.7 mm.; making diameter = 8.7 mm.

Locality.—Cove 3 miles north of Dall Head, Gravina Island (S.E. Alaska).

Horizon.—Upper Trias, supposed to be Lower Noric (see G. C. Martin, 1916, p. 700).

Material.—Squeezes in various substances from specimens in the collection of the U.S. Geological Survey, and plaster casts taken therefrom in the British Museum, Geological Department. Registered E 21913, E 22181–22182. An obscure squeeze, E 21914, indicates that a more broadly petaloid *Isocrinus* occurs in the southern arm of this cove.

Holotype. — Plaster cast, E 22181 and its original at Washington.

Relations.—A very distinct form. In the large radial triangle and narrow petals it approaches a true *Pentacrinus* much more closely than does *Isocrinus argenteus*, and, unlike that species, it has no radial ridge-groups.]

A radial triangle is slightly developed in *Isocrinus propinquus* and is well marked in an undescribed *Isocrinus* in Dr. Wanner's material from the Upper Trias of Timor. All these species are thereby distinguished from *I. trechmanni*.

There seems no doubt, then, as to the specific independence of these New Zealand fragments, and I can find no name more fitting to be associated with them than that of their collector, who has thrown so much light on the real and alleged Triassic deposits of New Zealand.