to intense lateral pressure. The conscientious and detailed paper by Messrs. Marr and Nicholson¹ on the Stockdale Shales of the Lake District, in the November Number of the same publication, has brought home to British geologists, in an equally convincing manner, the untenability of the views of those few surviving stratigraphists who still hesitate to acknowledge the paramount value of the Graptolites in the elucidation of complicated questions of stratigraphy and correlation among the Lower Palæozoic rocks.

In these two typical papers the *zonal* and detailed method of stratigraphy, as opposed to the *regional* and generalized method, has been consistently followed throughout, and it is to the adoption of this method I believe that they owe their reliability and their success. This zonal method, which has always been employed by myself in my work among the convoluted rocks of the Scottish Uplands, has thus quietly entered upon what may be regarded as the accepted or orthodox stage. With the new interest springing up among British geologists respecting the natural sequence and the proper classification of the Lower Palæozoic rocks, it may be regarded as certain that the complicated region of the Scottish Uplands will now be studied in fuller detail by geologists acquainted with the new methods, and that such differences of opinion as still exist among geologists respecting these rocks will soon find their natural solution and harmony, as in the cases of the Lake District and the N.W. Highlands, in a careful and detailed investigation of all the actual facts.

(To be concluded.)

V.—ON A NEW SPECIES OF THE GENUS *PROTASTER* (*P. BRISINGOIDES*),
FROM THE UPPER SILURIAN OF VICTORIA, AUSTRALIA.

By J. WALTER GREGORY, F.G.S., F.Z.S.,
of the British Museum (Natural History).

SO little is as yet known of the Palæozoic Ophiuroidea, that the discovery of some specimens that represent a new species of *Protaster* in the Upper Silurian rocks of Victoria is of interest. Some of the specimens were forwarded to Dr. Woodward by Mr. Frederick McKnight, of 60, Hawke Street, West, Melbourne, Victoria, some time ago, but they were too fragmentary to be of much service; several better examples having been received from the same source, Dr. Woodward has kindly entrusted them to me for description.

Protaster brisingoides, n.sp.

Disk obscurely indicated: apparently of medium size and pentagonal in shape, each face being concave owing to the disk extending slightly along the arms. It is seen only in one specimen, and in this but faintly.

The arms are at least twice as long as the diameter of the disk, and probably considerably more, the full length not being known.

The mouth-frames are homologous with the ambulacral ossicles of

¹ Quart. Journ. Geol. Soc. (read May 9), 1888, vol. xlv.

the arms; they are about three times as long as broad and somewhat spindle-shaped, being more bulging in the middle than in *P. leptosoma*, which is the nearest ally of this species; the margins are entire and not notched as in that species. The adambulacral elements in the "oral pentagons" probably represent the jaw and jaw-plate; the former is long and narrow, about four times as long as broad, and slightly curved at the inner end (Fig. 3, *b*); the jaw-plate, which unites the jaw to that of the adjoining radius, is short and thick; its inner surface is concave, as the two free corners extend somewhat towards the centre of the disk (Fig. 4, *c*). Neither buccal nor dental papillæ nor teeth are shown.

Each arm consists of a series of pairs of ambulacral ossicles (Fig. 2, *ao*) and adambulacral plates (Fig. 2, *l*) on each side of a median ridge, seen on the abactinal surface (Fig. 2, *d*): the first apparently represent the unfused halves of the ambulacral or vertebral ossicles of Ophiuroids; the second, the lateral or adambulacral shields: the nature of the median ridge is doubtful; it may possibly represent upgrowths from the ambulacral ossicles comparable to those in *Brisinga*, or it may have some connection with the dorsal shields, which are not otherwise indicated. Seen from the abactinal aspect, the ambulacral ossicles appear thick and bluntly oval, with the longer axis in the direction of the arm, and placed alternately in the concavities of the sinuous median ridge; they are distinctly

DIMENSIONS.—Diameter of disk	12 mm.
Diameter to the extremities of the oral pentagons	7 mm.
Width of arm	2 mm.
Length of ambulacral ossicles	1 mm.

EXPLANATION OF THE FIGURES.

Fig. 1. Specimen of *Protaster brisingoides*, abactinal aspect; nat size.¹ Fig. 2. Part of an arm from the same specimen, that which is uppermost in Fig. 1; *d*, median ridge; *ao* ambulacral ossicle, *l*, adambulacral plate: $\times 4$ diam. Fig. 3. The oral apparatus from another specimen in which the disk is not shown; *b*, jaw, *c*, mouth-frame; $\times 4$ diam. Fig. 4. A jaw-plate and distal ends of a pair of jaws; $\times 8$ diam.

¹ The faint indication of a disk is not shown in the figure, but can be detected in one or two of the interradial.

alternate in the arms, but in the disk, which includes the first three pairs, they are merely subalternate. The ambulacral ossicles are much thicker than those of other species of *Protaster*, and they are consequently less numerous. They are separated by double concave spaces, which served for the passage of the tube feet (or of the ampullæ, if, as is not improbable, the tube feet were arranged on the Asteroid type). The adambulacral plates are long and quadrangular, running parallel to the arms, each slightly longer than the corresponding ambulacral ossicle.

The actinal aspect of the arms is not well exposed in any of the specimens; in one, however, the end faces of the adambulacral plates are seen, as at their aboral extremities they curve actinally.

Neither the articular facets of the ambulacral ossicles nor the arm spines are shown.

Locality and stratigraphical position.—The specimens were found in the so-called "Mayhill Sandstone" of Moonee Ponds, Flemington, near Melbourne; they are Upper Silurian in age, but there seems no sufficient reason for regarding the beds from which they have been derived as in any way the equivalent of our Mayhill Sandstone.

The rock is a yellowish, fine-grained, micaceous sandstone, from which all calcareous matter has been dissolved, so that the fossils occur only as casts and impressions coloured by iron oxide.

Affinities of the species.—The only species of *Protaster* for which this could be mistaken is *P. leptosoma*, Salter, from the Leintwardine Flags of Ludlow; from this, however, it may be readily distinguished by the shape of the mouth-frames and of the ambulacral ossicles.

In a list of fossils from the Upper Silurian rocks of Victoria, published by F. M'Coy in 1874,¹ the MS. name of *Tæniaster australis* is recorded from the Upper Yarra. This may refer to the species here described, which at first sight, in specimens that do not show the disk, is not unlike a *Tæniaster*; in the absence of any description of M'Coy's species, it is quite impossible to say whether such is the case, and as the specimens do not come from the same locality, though some of the Asteroids recorded are from Moonee Ponds, it would not be safe to adopt M'Coy's manuscript name. It serves, however, to remind us of the differences of opinion as to the relations of *Tæniaster* and *Protaster*, which Hall² maintained were very closely allied, if not identical, attributing the supposed differences between them to errors in description by Salter.³ According to the original description by Billings,⁴ *Tæniaster* differed from *Protaster* in the absence of a disk, in the development of the oral plates from the adambulacral plates and not from the ambulacral elements, and in that the pores pass through the spaces between the

¹ R. B. Smyth, Progress Reports, Geol. Survey, Victoria, No. 1, Melbourne, 1874, p. 34.

² J. Hall, 20th Regents Report, Albany, 1867, pp. 293-4 and 300-1.

³ J. W. Salter, On some new Palæozoic Starfishes, Ann. and Mag. Nat. Hist. ser. 2, vol. xx, 1857, pp. 330-2, pl. ix. figs. 4 and 5; and Additional Notes on some new Palæozoic Starfishes, ser. 3, vol. viii, 1861, pp. 484-6, pl. xviii. figs. 9, 10, and 11.

⁴ E. Billings, On the Asteriadae of the Lower Silurian Rocks of Canada, Canadian Org. Remains, dec. iii, Montreal, 1858, p. 80-1, pl. x. figs. 3 and 4.

ambulacral ossicles and the two adjoining adambulacral plates, and not through the body of the ambulacral ossicle itself. Hall has claimed to have discovered traces of a disc in Billings's type specimens of *Teniaster*, and if so, this distinction falls to the ground; but, in regard to the two other points, the collection of specimens of *P. Miltoni* in the British Museum Collection confirm the correctness of Salter's views. The differences are, therefore, valid ones, and both genera must be retained, as has been done by Zittel. This new species differs from *Teniaster* in the presence of the disk, though, as we have seen, this distinction may possibly not hold good, and in the structure of both arms and oral pentagon. It undoubtedly differs from the other species of *Protaster* in many important points of structure, and herein agrees more closely with *Brisinga* than does any *Protophiuroid* yet described; to mark this resemblance the specific name has been given. But the other species of *Protaster* differ among themselves in equally important points, and the genus is apparently constituted by a group of species which careful revision and further knowledge of their structure would probably relegate to more than two distinct genera. The necessity for such a revision has been recently urged by Sturtz,¹ and to this with a discussion of some questions in their anatomy and the significance of some points in the structure of *P. brisingoides*, I hope subsequently to return. Till such has been done, it seems advisable to include this species in the comprehensive genus *Protaster*.

VI. — NOTE ON THE GENERA *TRISTYCHIUS* AND *PTYCHACANTHUS*, AGASSIZ.

By Dr. R. H. TRAQUAIR, F.R.S., F.G.S.

SOME years ago,² in showing that the spines supposed by Hancock and Atthey to be dorsal spines of *Gyracanthus* were merely young and unworn specimens of lateral spines of the same genus, I called attention to the general fact that young examples of Selachian spines could not be expected to represent the older ones in miniature, and *vice versa*.

For as the spine increases in size by growth at the base, the young one is consequently represented only by the distal portion of the adult. And as in the process of growth, differences in sculpture and proportions may supervene, the general characters may be so altered, that if the distal portion be lost by attrition, the old and young individuals may be with difficulty recognizable even as belonging to the same genus.

Such an instance may, I think, be found in the spines named by Agassiz respectively *Tristychius arcuatus* and *Ptychacanthus sublaevis*, both from the Lower Carboniferous rocks of Central Scotland.

In very young specimens of the former the surface of the exerted portion is entirely covered with longitudinal ridges and sulci, and

¹ B. Sturtz, Beitrag zur Kenntniss paläozoischer Seesterne, Palaeontographica, vol. xxxii. Stuttgart, 1886, p. 79.

² Ann. and Mag. Nat. Hist. ser. 5, vol. xiii. 1884, p. 37.