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Preliminary Account of the Palaeontology and Palaeoecology of the Eldon Group Formations of the Zeehan Area, Tasmania

By

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(Communicated by Prof. S. W. Carey)

WITH 4 TEXT FIGURES AND 1 PLATE

The lithological units (formations) of the Eldon Group rocks of the Zeehan area have been defined in an accompanying paper (Gill and Banks), and the purpose of the present communication is to (1) give some account of the sedimentation by which these formations came into being, (2) outline their palaeontology, (3) indicate something of the palaeoecology from the fossils and their relationship to the enclosing sediments, (4) discuss the age of the beds and their correlation, and (5) set out the systematic palaeontology concerned, concluding with due acknowledgments and a list of reference works.

1. SEDIMENTATION

Sedimentational Rhythm

Three-quarters of the world's land surface consists of sedimentary rocks, and the percentage is even higher in the area studied. The sedimentary rocks were originally deposited in the southern part of the Tasman Geosyncline (*vide* Browne, 1947, and references; Gill, 1950*a*, for Lower Devonian palaeogeographic map) as free sediments which were subsequently compacted, metasomatized, and regionally metamorphosed.

Treating the formations as wholes, one can observe a definite oscillation in the types of sediment deposited, as summarized in fig. 1. The following points emerge:—

(*a*) There is an alternation of sediment type, but the heaviest sediments are in the lowest formation of the series, and there is a progressive reduction in the contrast between contiguous sedimentary types. There is an overall reduction in the grain size of the arenaceous components. The generalized curve representing the sedimentary types (taken as groups) is therefore a damped harmonic curve (fig. 1).

(*b*) The rudite-arenite formations exceed the lutite group in thickness by 900 feet, which is about 10 per cent of the whole. The whole suite of sediments is a siliceous one, even the lutite formations being formed from fine siliceous silts. There are no claystones in the series.

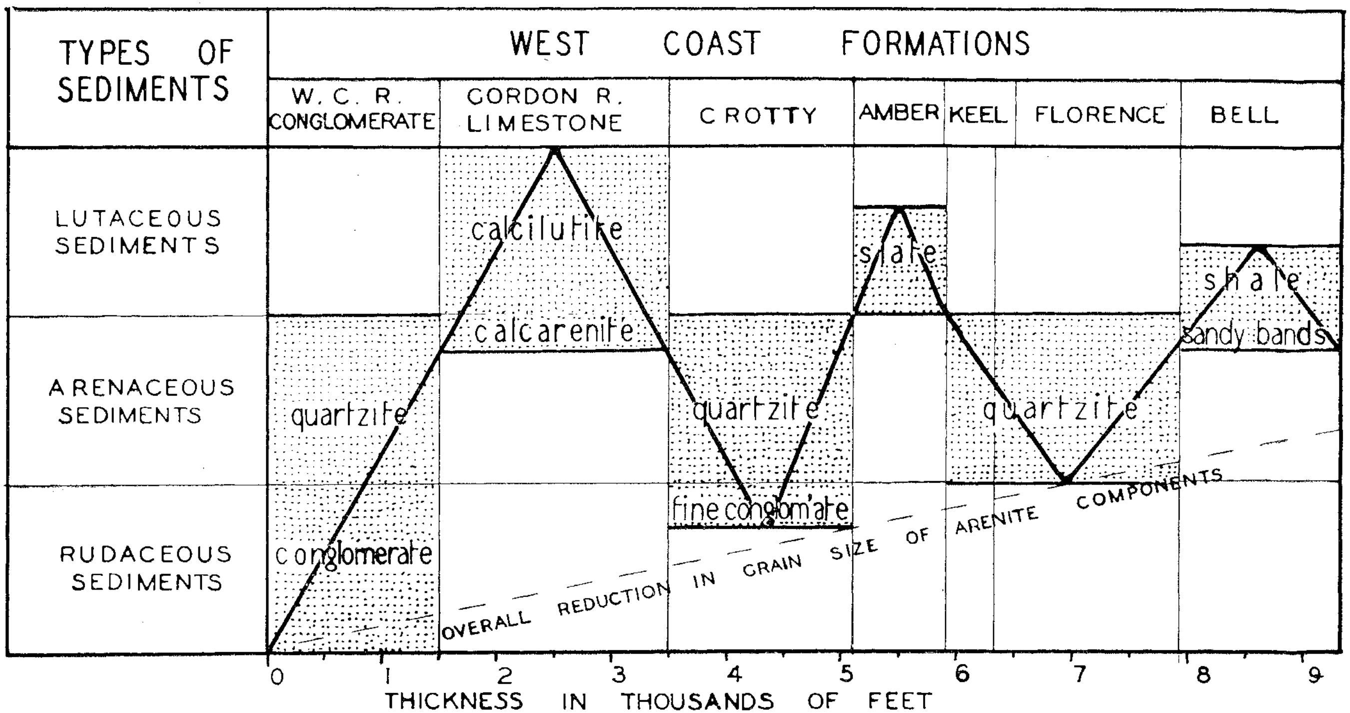

FIG. 1.—Damped harmonic curve representing the sedimentational rhythm recognized when the formations are taken as wholes. The stippled areas indicate in each formation the range of sedimentary types present.

(*c*) The alternation of sediment type involves considerable thicknesses of rocks, and holds over a large area; it is therefore not an expression of local coastal changes, but a function of geosynclinal movement.

(*d*) The alternation of sediment type is the fundamental reason for the varied topography, which aids photo-geology.

(*e*) The alternation is also a help in field geology, especially in the highly faulted areas. For example, if a lutaceous formation is encountered, it can be but one of three. The Gordon River Limestone is calcareous and so easily recognized; this reduces the possibilities to two, which can be distinguished in that the Amber Slate is a very homogeneous formation, while the Bell Shale is characterized by quartzitic bands.

(*f*) The different types of sediments produced different ecological facies, so that changing faunal characters are correlated with changing sedimentary types.

The alternation just discussed emerges from treating the formations as wholes. As this paper deals particularly with the Eldon Group formations, these are now examined more closely, and the relative information is represented diagrammatically in fig. 2. The graph line shows the rudaceous zone in the middle of the

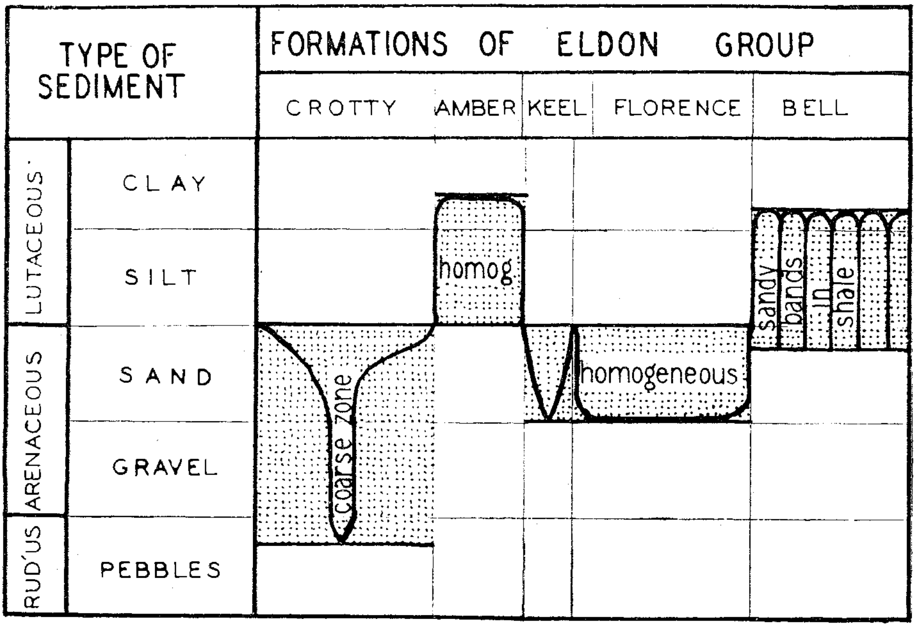

FIG. 2.—Diagrammatic representation of the sedimentational oscillation in the Eldon Group formations, taking into account variation within them. The stippled areas indicate in each formation the range of sedimentary types present.

Crotty Quartzite, the homogeneity of the Amber Slate and Florence Quartzite, that the Keel Quartzite has less arenaceous parts at the top and bottom, and that in the Bell Shale there is some oscillation of conditions with occasional arenaceous bands separating masses of shale or slate.

Probable Disconformity

One of the problems set for study was whether the Crotty Quartzite should be included in the Junee Group with the West Coast Range Conglomerate and Gordon River Limestone, or in the Eldon Group. The writer thinks it should be included in the Eldon Group because:—

(a) There is a probable disconformity between the Gordon River Limestone and the Crotty Quartzite. Fossils so far described from the former are all Ordovician types such as *Tetradium* (Chapman, 1919, Hill and Edwards, 1941), Piloceroid cephalopods (Teichert, 1947), and Asaphid trilobites (Etheridge, 1896, Nye and Blake, 1938). Some of these forms may range into the Silurian, but in spite of wide collecting accomplished in recent years, no Silurian index fossil has been found. On the other hand, a large *Camarotoechia* is herein described from a zone below the median grit band of the Crotty Quartzite. By reason of the coarse matrix and leaching, it is very difficult to obtain recognizable fossils, but in the Eden area (loc. 69), lamellibranchs believed to be *Palaeoneilo* were collected. This genus is recorded widely from the Silurian and Devonian beds of Victoria. On the track to the powerhouse at the Smelters' works on the Crotty Quartzite near Zeehan, a cephalopod was found *non in situ* but undoubtedly belonging to that location; this was identified by Dr. C. Teichert as *Ormoceras* sp., which he states is not an Ordovician type but comparable with Silurian-Devonian forms.

There is thus, apparently, a disconformity between the Ordovician Gordon River Limestone and the Crotty Quartzite which seems to be not older than Upper Silurian. For a demonstration of this disconformity and its extent, fossils will need to be collected in the type area at the top of the limestone.

(b) The Crotty Quartzite introduces a new cycle of erosion and sedimentation. The period of time in which the Gordon River limestone was laid down was one of quiescence. The silts and sands that came from the land mass of the time were limited in quantity, most of the sedimentary materials being calcareous and of organic origin. That the latter should exceed the quantity of terrigenous sediment indicates conditions of relative stability. Occasional arenaceous and lutaceous horizons indicate minor changes in conditions, but the formation as a whole is calcilutaceous judging by the outcrops seen and its physiographic expression. Then there came a change and great quantities of siliceous sand covered the limestone-forming sediments. The movement thus initiated increased in severity, so that coarse sediments of a polymictic type were thrown into the sea, represented now by the grits and fine conglomerate of the Crotty Quartzite formation. They occur at about the middle of the formation, as can be seen both in the Eden and Smelters' sections, dividing it into three members. As described in the accompanying paper (Gill and Banks), the rock is a mixedstone consisting of roundstones (derived from a previous sedimentary cycle) and sharpstones (newly derived), and consisting of clear quartz, milky quartz (pebbles up to 1½" long in the conglomerate), heavy minerals, and pebbles to finer fractions of siltstones (cf. Shrock, 1948, Pettijohn, 1949). This indicates a terrain suffering overall denudation by a new cycle of erosion.

2. Palaeontology

There is a great deal of variation in the amount of recorded life in the formations in the area studied, this is represented diagrammatically in fig. 3. No fossils apart from the tubicolar annelid have been found in the West Coast Range Conglomerate. The Gordon River Limestone is poorly fossiliferous in the type area (where seen), but at the Smelters' Quarry near Zeehan there is a very rich fauna, represented by a rise in the graph. The Crotty Quartzite is likewise poorly fossiliferous, most outcrops yielding no fossils. However, in spite of preservation being poor, there is a rich palaeontological zone just under the median grit of this formation, both in the Eden area and on the Smelters' ridge near Zeehan, and this is represented by a rise in the graph. Most of the Amber Slate is unfossiliferous, but a couple of rich horizons were found in the railway cuttings south of Zeehan. No fossils were found in the Keel Quartzite in the Eden area, but some were found near Zeehan in quartzite doubtfully referred to this formation on account of its faulted relationships. The Florence Quartzite and Bell Shale are both extremely rich in fossils. Some beds are so rich that the whole face of the rock is covered with fossils, so that originally the layer must have been a coquina.

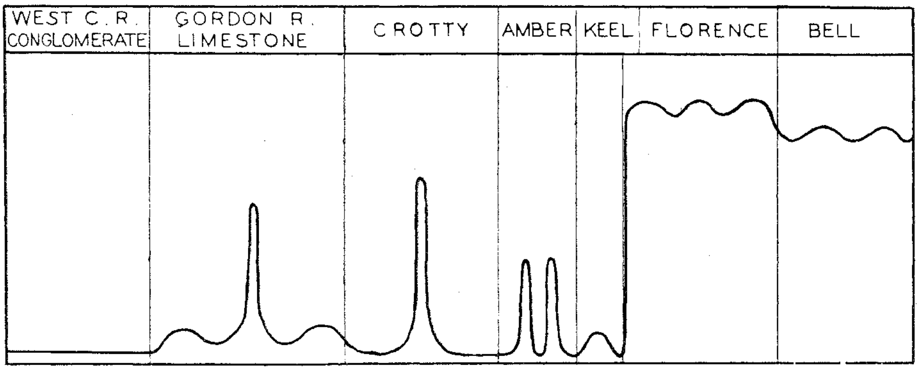

FIG. 3.—Graph representing relative abundance of recorded life in West Coast formations.

Paucity of recorded life does not mean necessarily poverty of life at the time concerned. After describing the activities of various marine scavengers, Dapples (1938) wrote: 'It is shown that these forms constantly ingest such quantities of bottom material that benthonic life may be considered a very active agent in diagenesis . . . Fossiliferous strata are believed to be due to sudden annihilation or rapid burial of benthonic life, whereas many unfossiliferous beds are thought to have been deposited under optimum conditions for animal life.' It is clear that the analogy of modern seas supports this view, and the writer has noted that often fossils can be found in so-called unfossiliferous beds by examining the base of a change in sedimentation. If Dapples' thesis be accepted, then the lower formations are to be regarded as belonging to times of comparatively even sedimentation, while those at the top are to be interpreted as belonging to times of erratic sedimentation.

Crotty Palaeontology

Under the grit band in the Eden area (locs. 68 and 69), numerous remains of lamellibranchs, brachiopods, crinoids, and tubicolar structures were found, but the coarse matrix and strong leaching made decipherment difficult. Undeterminable fossils were found at locs. 65 and 66. However, on the top of the ridge behind the Smelters' works near Zeehan is a richly fossiliferous zone with

Camarotoechia synchoneua as the dominant fossil, and associated with it are occasional toothed lamellibranchs and planospiral gasteropods. Characteristic also is crinoid columnal 1 (Pl. I, fig. 40), which is useful in the field because limited to that formation and it occurs when no other fossils are present. Crushed *Camarotoechia*, lamellibranchs and crinoid columnals occur in the railway cutting at loc. 49. At loc. 48 in the same section are poorly preserved brachiopods, lamellibranchs, and crinoid columnals.

Amber Palaeontology

In the Eden section, the Amber Slate formation is covered with the notorious type of rain forest called 'horizontal', which makes access extremely difficult. Traverses proved the homogeneity of the slates, and a few fossils were found at locs. 63 and 64. The Zeehan-Strahan railway traverses chiefly the Amber Slate and Gordon River Limestone because these are the two formations of the suite which have a low relief physiography. The railway follows the Amber Slate for about 1½ miles N.E. of the 22¾-mile point, and the cuttings there were examined. Most of the exposures proved unfossiliferous, but fossils were found at the following localities. At loc. 47 rhynchonellids, *Loxonema*, bryozoa, and crinoid columnals were collected, and at loc. 41 occurs a band crowded with ostracods. An interesting horizon appears at loc. 42 where a fine sandy band is packed with a fine *Tentaculites* 8 mm. long, and a brachiopod which is probably *Rhenorensselaria*. The brachiopods have suffered badly from crushing, but reconstruction indicates fairly thick shells, i.e., strongly biconvex, of elongate oval outline but sometimes shorter and more rounded. The surface is costellate, about 10 costellae per cm. occurring at the anterior margin, and becoming finer towards the umbo. The full-grown shells are of the order of 2 cm. long and 13 mm. wide, precise measurements being out of the question in the slate. Internally the ventral valve has well-developed teeth and slender dental plates 4-5 mm. long. The dorsal interior has a median septum about 4 mm. long. There are two hingeplates each about 4 mm. wide at widest, separated by a concave crural trough. The steinkern shows the anterior tips of the plates extending anteriorly as fine crura. The cardinal process is ill defined.

Rhenorensselaria occurs in the Lower Devonian of Europe (the genotype comes from the Lower Devonian of Germany) and possibly of South Africa (Cloud, 1942).

At loc. 38 more ostracod bands were noted and *Beyrichia* was identified in a dark grey slate with fine mica.

About 10 miles E. of Queenstown, the Hobart road crosses a ridge west of the Princess River called the Princess Ridge. The rocks consist of finely cleaved slates whose age was unknown but were thought to be probably Pieman (pre-Cambrian). Mr. J. Bradley of the University of Tasmania Geology Department advised Mr. M. R. Banks and myself of the probable occurrence of fossils on the west side of this ridge, and so the outcrops were investigated and some poor fossils collected. I have since examined them and found crinoid columnals of small diameter, the ostracod *Beyrichia (non sensu stricto)*, and rhynchonellid brachiopods—all much distorted by the regional metamorphism the sediments have suffered. These fossils can be fairly closely matched with those occurring at loc. 47 in the Amber Slate in the Eden area, thus establishing a probability that the Princess Ridge slates are of the same age as the Amber Slate.

Florence Palaeontology

The prolific faunules of this formation contrast strongly with the almost unfossiliferous condition of the underlying Keel Quartzite. Both vertically and horizontally the Florence Quartzite is rich in fossils, and hence the large number of localities for this formation. *Notoconchidium florencensis*, *Protoleptostrophia plateia*, and *Eatonia (Eatonia) pleonecta* are index fossils for this formation, being limited to it as far as present knowledge goes.

Bell Palaeontology

This richly fossiliferous formation is characterized by the incoming of a variety of new forms. This is partly due to its variety of facies, resulting from small oscillations of relative sea level presumed to be due to the onset of the orogeny which concluded Bell sedimentation. *Notanoplia*, *Plectodonta*, *Leptocoelia*, *Meristella*, *Eospirifer*, and *Proetus* are examples of genera which appear for the first time in the Bell Shale, judging by the collecting done so far. These forms and crinoid columnal 2 (Pl. I, fig. 41) are index fossils of the formation. Some of the genera named have facies limitations, but *Notanoplia* is found in Victoria in matrices varying from the finest siltstones to coarse grits, representing a wide variety of facies. Its incoming in the Bell Shale is therefore probably a function of time and not of facies.

3. Palaeoecology

The Eldon Group as a whole presents an arenaceous facies suggesting the dominance of near-shore conditions. All the fossil localities examined presented thanatocoenoses—places where those forms of life were buried and not where they lived, for once marine animals die they become sedimentary materials. Common to all the formations are the crinoids, although nothing more than columnals and an occasional plate were found. There appears to be some correlation between thickness of the column or stem and the coarseness of the sediment. Fine-stemmed forms occur in the Amber Slate where thick columns are entirely absent. The medium sized columns occur in the shales and quartzites of the Florence and Bell formations. The very thick columns as represented by crinoid columnal 1 occur only in the coarse zone of the Crotty Quartzite. The coarse sediments and strong cross-bedding indicate fast currents, and strong columns were needed, while the converse held for the quiescent conditions of the Amber Slate.

It is interesting to note in the fine sedimentation of the Amber Slate the coming of a brachiopod of Rhenish facies like *?Rhenorensselaria* once sandy conditions prevailed, even though for a short time. Swarms of water-fleas (Ostracoda) teemed in the Amber seas, and changes in conditions resulted in their burial in countless numbers. Three such ostracod bands were noted in the traverse along the Zeehan-Strahan railway north of the 22-mile post.

The abundant fossils of the Florence Quartzite prove seas teaming with life. There are beds consisting of little but masses of crinoid columnals of about $\frac{1}{8}''$ diameter. There are such millions of them that they present a picture of a sandy sea-floor covered with a waving garden of sea-lilies (Crinoidea). The matrix proves the nature of the sea-floor and the cross-bedding shows the water was fast moving. In some beds there are just crinoid columnals and a rhynchonellid, so that the latter may have lived attached to the crinoid stems. Other zones again are full of branching bryozoa, indicating that as the dominant form of life, and calling up a picture of a 'coral' sea. Yet other strata are packed with brachiopods. Lamellibranchs are few, but a large actinopterid growing up to three or four inches across is a common fossil, but always broken. It is curious that there should be so few lamellibranchs since they constitute a characteristic phase of the Rhenish facies. Another negative feature worthy of comment is the poverty of trilobites in the Eldon formations of this area. Brachiopods, crinoids, and bryozoa appear to have been the dominant forms of life. Graded bedding was recognized in some places in the Florence Quartzite, and proved useful in indicating the top and bottom relationships in overturned beds (cf. Shrock, 1948).

In the Bell Shale, oscillation of sedimentary type brought oscillation of ecological conditions with amazing variety in faunules. It is possible to walk across country at right angles to the strike and encounter succeeding faunules which are almost mutually exclusive. If these zones can be proved to be at all extensive, they will admit of fine and accurate subdivision in the formation. This would be instructive palaeoecologically and useful to mining companies. Brachiopods dominate in this as in the other formations, and although lamellibranchs are commoner, they are still relatively rare. Crinoids are common, but do not occur in great masses as they do in the Florence Quartzite. Vascular land plants indicate that there was a thin vegetative cover on at least part of the land surface of the time. Berry (1945) regards these early plants as a bog flora.

4. Age and Correlation

As there is some difference of opinion as to where the Siluro-Devonian boundary should be drawn, I should state that I follow Stamp (1923*a*, 1923*b*) in regarding the base of the Lower Devonian as the base of the Ludlow Bone Bed of the Welsh Borderland, which in turn is considered the equivalent of the base of the Gedinnian on the Continent. White (1950) has recently provided new evidence and discussed the Siluro-Devonian in the type area, arriving also at the conclusion that the Bone Bed is the best base for the Devonian, a view moreover 'strongly advocated on the Continent'. The North American equivalent of the Siluro-Devonian junction is apparently the base of the Helderberg Stage. The Lower Devonian in North America comprises the Helderberg, Oriskany, and Onandaga according to Cooper *et al.* (1942).

The Bell Shale contains *Plectodonta bipartita* and *Chonetes* aff. *ruddockensis* which are index species of the lower part of the Yeringian Group (Lower Devonian) of Victoria (Gill, 1945). These forms, with *Notanoplia*, *Notoleptaena*, *Proetus euryceps*, *Pleurodictym megastomum*, and '*Lindstroemia ampla*' constitute a fauna which is characteristic of the Kinglake West District of Victoria. *Parmorthis allani* is a species from the Lower Devonian of New Zealand. *Maoristrophia*, known only from the Lower Devonian of New Zealand and Australia, *Meristella*, and *Leptocoelia* also indicate a Devonian age. The palaeontology has not been studied in sufficient detail yet for close correlations to be proved, but the general correlation with the Yeringian of Victoria is indubitable.

The Florence Quartzite is also classified as Lower Devonian because it contains *Notoconchidium*, a genus which is an index fossil of the Lower Devonian Mt. Ida Beds of the Heathcote District of Victoria (Thomas, 1937), and proves now to be also an index fossil of the formation named. *Protoleptostrophia*, *Maoristrophia*, and *Eatonia (s.s.)* also occur and these are Devonian genera.

	Formations	*Index Fossils*
LOWER DEVONIAN	BELL SHALE	*Notanoplia pherista*, gen. et sp. nov. *Plectodonta bipartita* (Chapman) *Leptocoelia polyspera*, sp. nov. *Meristella bellensis*, sp. nov. *Eospirifer parahentius*, sp. nov. *Proetus euryceps* (McCoy) Crinoid columnal 2 Land plants
	FLORENCE QUARTZITE	*Notoconchidium florencensis*, sp. nov. *Protoleptostrophia plateia* Gill *Eatonia pleonecta*, sp. nov. Massed crinoid columnals
SILURO-DEVONIAN	KEEL QUARTZITE	?Unfossiliferous
	AMBER SLATE	?*Rhenorensselaria*-*Tentaculites* association Ostracod bands
	CROTTY QUARTZITE	Tubicolar structures *Camarotoechia synchoneua*, sp. nov. Crinoid columnal 1

FIG. 4.—Age and index fossils of the Eldon formations in the Zeehan area, Tasmania.

Through lack of decisive evidence, the age-determination of the three underlying formations is left in abeyance. If the occurrence of the genus *Rhenorensselaria* is confirmed in the Amber Slate, then both the Amber Slate and the Keel Quartzite are Devonian.

5. Systematic Palaeontology

Plantae

In an indurated siltstone at locality 16, beside the Little Henty River near Zeehan, there occur numerous fragments, generally only $\frac{1}{8}''$ to $\frac{1}{4}''$ long, of carbonized plant stems which show evidence of vascular tissue (N.M.V.* 14825). A similar bed was found on the track to the Sunshine Mine. These fragments are interpreted as land plants, and are probably of the type recorded from Warrentinna in Tasmania (Cookson, 1937), and from Victoria (Lang and Cookson, 1935, Cookson, 1935, 1945, 1950).

Marine fossils occur in the same stratum with the land plants, and so the latter must have been washed into the sea. This suggests that there was a Lower Devonian river in this vicinity.

Echinoderma

Crinoid Columnal 1

Pl. I, fig. 40

Circular in outline, 16 mm. in diameter and 4 mm. thick. The central canal is 5·5 mm. in diameter. Natural sections show that a cross-section along a diameter has a planate-oval outline, i.e., the dorsal and ventral surfaces of each columnal are curved. The central canal in such a section has a biconvex outline.

Formation. Crotty Quartzite.

Comment. The figured specimen is N.M.V. 14843 and comes from locality 19, which is the Smelters' sand quarry, near Zeehan. The form is abundant and a characteristic fossil of that formation.

Crinoid Columnal 2

Pl. I, fig. 41

Circular in outline, 9 mm. in diameter and about 1 mm. thick. Perimeter scalloped. Central canal a little less than 1 mm. in diameter; appears to be subpentagonal in outline. Around the canal is a circle of very short radial fine ridges about 1 mm. from the centre of the columnal. Around the perimeter of the columnal are 20 radial ridges about 1·5 mm. long. (N.M.V. 14822.)

Formation. Bell Shale.

Comment. In the field these columnals were found to be useful as a Bell index fossil because they occur sometimes when other fossils are absent.

* N.M.V. = National Museum of Victoria, Melbourne.

Coelenterata

'Lindstroemia ampla' Chapman

Some difficulty has been experienced in dealing with the fossil corals referred by Chapman (1925) to *Lindstroemia*. In practice, we have distinguished in the Yeringian beds of Victoria two kinds, the first having an elongate corallum which we have called *L. yeringae* and a second with a comparatively short broad corralum which we have called *L. ampla*. The corals are preserved only as casts and determination is difficult. However, the recognition of the two types of corallum is easy, but whether these two groups are true species and how closely they correspond with Chapman's species has yet to be determined. In the sense of the above form diagnosis, *L. ampla* occurs at localities 1 and 5 at Zeehan.

Genus **Pleurodictyum** Goldfuss, 1829

Pleurodictyum megastomum Dun

Pl. I, fig. 37

See Gill, 1942, for synonymy to that date.

Pleurodictyum megastomum Hill, 1942, p. 8, Pl. 2, fig. 5.

Pleurodictyum megastomum Gill, 1948, p. 66, Pl. VIII, fig. 13.

Locality. Right bank of the Little Henty River, about one mile S.E. of Zeehan, locality 16. The localities mentioned in this paper are to be seen on the map in the accompanying paper by Mr. M. R. Banks and the writer.

Formation. Bell Shale.

Comment. *Pleurodictyum megastomum* is a characteristic fossil of the Bell Shale at Zeehan. Dr. Dorothy Hill (1942) described this species from an unknown locality in Tasmania, and commented that Etheridge (1896) figured a coral from Zeehan which might well be this species. The specimens described were in a blue-grey shale, which is a characteristic lithological type of the Bell Shale formation. *P. megastomum* has also been collected from near the top of the Florence Quartzite at Zeehan (loc. 12), and from localities 1, 5, 6 in the Bell Shale.

Thomas (1947, p. 36), in commenting on West Coast stratigraphy, said that 'Some of the forms, however, e.g., *Pleurodictyum*, would indicate a higher horizon than the authors would give their "Silurian" beds which may thus extend into the Lower Devonian and would be comparable with the Yeringian of Victoria'. He thus regarded *Pleurodictyum* as a probable index of Devonian age, as also did Hill (1943, p. 58), who in discussing Australian Palaeozoic stratigraphy, referred to the presence of *Pleurodictyum* at Zeehan, and stated, 'The age of the Zeehan shale is thus probably Lower Devonian, though a Ludlovian horizon is still possible'.

The figured specimen is N.M.V. 14813.

Annelida

The Tasmanian geological literature is steeped in references to 'tubicolar sandstone'. The writer has seen the structures referred to in the West Coast Range Conglomerate, in an outcrop of quartzite in the Gordon River Limestone (loc. 55), and in the Crotty Quartzite in a number of localities (e.g., loc. 69). Bryozoan, crinoidal, and other structures apparently have been confused at times with true annelid remains, some at any rate of which appear to belong to the genus *Sabellarifex* Richter. These fossils require proper study, but a few relevant comments will be made here.

Professor Richter wrote three interesting and valuable papers (1920, 1921, 1927) drawing attention to large, flat-topped reefs in shallow North Sea waters off the coast of Schleswig-Holstein consisting of masses of straight, vertically disposed, arenaceous tubes built by the annelid *Sabellaria alveolata* Linn. (see also Galeine and Houlbert, 1922), and indicating their close similarity to fossil worm tubes in rocks from Cambrian to Devonian age. *S. alveolata* builds closely-packed vertical tubes (locally known as sand-coral) cemented enough to form pebbles when broken up. It grows only on sandy bottoms free from mud, and other macroscopic forms of life are usually absent. A related species has loosely intertwined tubes. Richter has drawn the parallel in Palaeozoic rocks with *Scolithus* whose simple tubes are very straight, unbranching, vertical to the old sea-floor, crowded, and limited to nearly pure sandstones devoid of other fossils. Prof. Richter set out a taxonomy for fossil annelid remains, and split off from *Scolithus* a new genus *Sabellarifex* to accommodate the forms which show slight undulations and less strictly parallel growth and a tendency to be less crowded. He described a new species, *Sabellarifex eifliensis*, from the Lower Devonion Koblenzquartzit of Germany (Richter, 1920). These annelids therefore range in age from Cambrian to Devonian. Richter's papers contain much of ecological value, and a précis of them has been published in English by Bucher (1928).

Brachiopoda

Genus **Notoconchidium** Gill, 1950

Notoconchidium florencensis, sp. nov.

Pl. I, figs 7-9

Type Material. 1. HOLOTYPE consisting of a dorsal valve preserved as a steinkern (N.M.V. 14799) and an external mould (N.M.V. 14798) in a whitish quartzite with a little yellowish-brown iron stain. This is a typical surface lithology of the Florence Quartzite formation. The type specimens are from the cutting on the east side of the Silver Bell railway station yard (loc. 15), near Zeehan, about 230 feet south of the centre of the road crossing the railway at the north end of the station.

Formation. Florence Quartzite.

Description. HOLOTYPE dorsal valve sub-triangular in outline, strongly convex, the midline profile rising about 1 cm. above the plane joining the posterior and anterior margins. The sides of the valve are deflected at right angles to the above plane, as is typical of this genus. Length in plan 1·9 cm., but following the profile 2·8 cm.; greatest width 2 cm. Hingeline narrow and beak blunt. Anterior commissure rectimarginate. Shell very thick in the posterior region; costate, but relatively smooth at the umbonal end. The costae appear also on the lateral and anterior areas of the inside of the valve, as is shown by the steinkern. The costae are low, and rounded in cross-section; the interspaces are about a quarter of the width of the costae. There are six costae per cm. at the anterior margin.

Septal plates diverge at first at the umbonal end, and then converge. They reach three-quarters of the way down the valve, and are thick and deep. The spaces between the septa and the lateral walls of the valve are filled with callists which are 4 mm. thick next the septa (their thickest part). The median septum has been overgrown near the umbo with secondary deposition, and there is a median ridge between the septa at their anterior end. Indistinct knobs or short ridges occur at the posterior ends of the septa, and these are regarded as branchial supports.

Comment. The genus *Notoconchidium* was established on fossils from the Heathcote District of Victoria (Gill, 1950*c*), where it is an index fossil of the Mt. Ida Beds (Lower Devonian), is limited to that formation, and occurs in a sandy facies. Likewise, *N. florencensis* is an index fossil of the Florence Quartzite, is limited to that formation, and occurs in a sandy facies. The new species is distinguished readily from the genotype by its more squat proportions and its coarser costation. After much search there has been located one of the type specimens of Etheridge's (1883) *Pentamerus tasmaniensis*, which is reg. no. B361 of the Tasmanian Museum and Art Gallery, Hobart, and it is probable that the other specimens will also be found. The specimen now figured (Pl. I, figs 10-11) is Etheridge's Plate II, fig. 1 (fig. 2 is on the other side of the same specimen), and I suggest this be accepted as the lectoholotype. Etheridge himself was apparently struck by the unusual features of this brachiopod as he comments (p. 159), 'The commonest, and at the same time the most interesting fossil met with in the specimens under description, is undoubtedly a Pentamerus, although at first sight its affinities were certainly obscure'. Etheridge seems to have been puzzled at the differences between the various dorsal valves as he refers to the original of fig. 1 as a 'modification' (p. 160). Fig. 1 represents an older valve with the internal structures considerably thickened. A series of growth stages of both valves of the genotype has been figured (Gill, 1950*c*). Etheridge's figs 3 and 4 are not of a ventral valve, as stated (p. 162), but of a dorsal valve. Figs 2, 10, and 16 are rhynchonellids.

Notoconchidium tasmaniensis has proportions similar to those of *N. florencensis*, but a finer costation comparable with that of the Victorian form, *N. thomasi*. One feature in *N. tasmaniensis* not seen in the other two species is the bifurcation of the costae. In B361 the anterior margin is not complete, but along the sides it is noted that about half the costae bifurcate, viz., those on the posterior end of the deflected border (Pl. I, fig. 10). Bifurcated costae have not been seen in either *N. thomasi* or *N. florencensis*. *N. tasmaniensis* was collected from pebbles in a Permian glacial conglomerate at Table Cape, near Wynyard, North Tasmania, and the material is thought to have come from an area to the S.S.W. (David, 1908). David described the matrix as 'an ochreous brown soft sandstone', a description which fits very well weathered Florence Quartzite.

In the Zeehan district *N. florencensis* is very abundant but a ventral valve is hardly ever seen. None good enough to figure was discovered. The absence of ventral valves is apparently due to the fact that during life the dorsal valve is considerably thickened and so strengthened over a considerable portion of its area, while in the ventral valve only a small area at the umbo is so fortified. All large shells in the Florence Quartzite have suffered severely from the action of currents, and it would appear that the ventral valves of *Notoconchidium* seldom escaped harm before being finally buried in the sediments. It has been noted that although *N. thomasi* is very common in the Mt. Ida Beds of Victoria, ventral valves are comparatively rare.

A series of specimens covering the various growth stages of *N. tasmaniensis* and *N. florencensis* are now needed for an adequate comparison of the species with the genotype. *N. florencensis* is common in the Florence Quartzite both throughout its stratigraphical thickness and its lateral extent. A detailed examination was made of the cutting at the Silver Bell railway station, which is in Florence Quartzite, and *Notoconchidium* was collected all along the 800 feet of exposed beds. It is not found in any of the other formations. By its ready identification, its abundance, its occurrence both vertically and horizontally in the formation, and its limitation to the formation, *N. florencensis* constitutes an ideal index fossil of that formation, and hence its name. Going north in the Tasman geosyncline one meets *N. florencensis*, then *N. tasmaniensis*, and finally *N. thomasi*, the central one (on present knowledge) appearing to be intermediate between the other two. *N. tasmaniensis* (under its original name of *Pentamerus*), is one of the most quoted fossils in the Tasmanian geological literature—e.g., Johnston, 1888 (who also figured it after Etheridge, 1883), Twelvetrees, 1908, David, 1908, Basedow, 1909, Twelvetrees and Ward, 1910, Nye and Lewis, 1928, Nye, Blake, and Scott, 1938, and Thomas, 1947 (where the species is wrongly attributed to Johnston).

Notoconchidium was collected in the Zeehan district from localities 9, 15, 23, 24, 25, 26, 27, 32, 35, 51, 52, 53, 60, 61.

Genus **Eatonia** Hall, 1857

Subgenus **Eatonia** McLearn, 1918

Eatonia (Eatonia) pleonecta, sp. nov.

Pl. I, figs 33-35

Type Material. 1. HOLOTYPE consisting of a steinkern (N.M.V. 14840) of both valves preserved in whitish sandstone (leached quartzite) from locality 23, Smelters' ridge, S.E. of Zeehan.

2. PARATYPE consisting of the steinkern (N.M.V. 14841) and external mould (N.M.V. 14842) of another ventral valve in the same matrix and from the same locality.

Formation. Florence Quartzite.

Description. 1. HOLOTYPE. Shell small, biconvex with dorsal valve the deeper, subcircular in outline, 1 cm. long and 1 cm. wide; two valves together 6 mm. thick. Ventral valve with median sinus, but not deep as in *Eatonia (Pareatonia) euplecta*, and dorsal valve with corresponding fold. Anterior commissure uniplicate. Valves costate, about 10 costae on each valve; there are two on the ventral sinus. Costae well developed anteriorly, but valves smooth on the umbo. Ventral muscle field deeply set, the posterior lateral areas being considerably thickened. The diductor scars are sub-parallel, but a little wider than in the paratype; long, extending 7 mm. from the umbo, i.e., more than half the length of the valve.

Dorsal valve with strong median septum, which extends more than half the length of the valve. The costae of the fold begin about half way down the valve, which is the anterior to the comparable point in *Eatonia (Pareatonia) euplecta*. Large erect cardinal process with myophore having two prongs, 1 mm. apart, which jut into the cavity of the ventral valve. These prongs are seen as holes in the steinkern.

2. PARATYPE ventral valve convex, subcircular in outline; 9 mm. long in plan down the midline to the centre of the sinus, which is about 1 mm. deep, giving an overall length of 1 cm. Following the profile of the midline, the length is 12·5 mm. The greatest width, which is about half way down the length of the valve, is 11 mm. In plan, the muscle field reaches a point 7 mm. from the umbo, i.e., more than half the length of the valve. The adductor scar is heart-shaped and 2 mm. long.

Comment. The subgenus *Eatonia* is characterised by a decline in the fold and sinus, radial striae superimposed on the costae, and an elongate ventral muscle field (McLearn, 1918, 1924). In *Eatonia (Eatonia) pleonecta* the fold and sinus is much shallower than in *Eatonia (Pareatonia) euplecta*, the radial striae can be seen in the external mould of the paratype, and the ventral muscle field is elongate, reaching well past half way down the length of the valve. In general proportions the new species simulates *E. (Pareatonia) euplecta* (Gill, 1948*a*), but is very readily distinguished by its more numerous costae, and so the trivial name is taken from the Greek word *pleonecteo* meaning 'to have more'.

The new species is also common at locality 23, which is at the base of the Florence Quartzite.

Genus **Leptocoelia** Hall, 1859

Leptocoelia polyspera, sp. nov.

Pl. I, figs 25-28, 38

Type Material. 1. HOLOTYPE consisting of the steinkern of a ventral valve (N.M.V. 14795) preserved in a light-grey indurated siltstone from locality 16.

2. PARATYPE consisting of the steinkern (N.M.V. 14796) and external mould (N.M.V. 14797) counterparts of a dorsal valve in the same matrix and from the same locality.

Formation. Bell Shale.

Description. 1. HOLOTYPE ventral valve longer than wide, and greatest width posterior to transverse midline. Convex, but not evenly so, the transverse midline profile being almost an obtuse angle, while the longitudinal midline profile is evenly curved, rising nearly 3 mm. above the plane uniting the anterior and posterior margins. Hingeline short and curved. Length of shell 9·5 mm. and greatest width 9 mm. Beak prominent, the shoulders on each side falling away evenly to constitute an angle of the order of 140°. Cardinal angles well rounded. Median sinus commences a little past half way to the anterior margin, i.e., at about the point where the muscle field ends. Commencing at the same place is a costa which occupies the middle of the sinus. Examination of a number of specimens shows that fifteen costae is usual, but the full number does not show on the steinkern. Costae rather rounded in cross-section, and wider than the interspaces. The ends of the costae are arched at the anterior margin so that the anterior commissure is wavy; it is also uniplicate by reason of the sinus. In the steinkern is a fine ridge near the anterior margin and almost parallel to it; this is not limited to the holotype but commonly seen in other steinkerns. It does not show on the external moulds and so is a ridge on the interior of the valve and not a crinkle in the shell itself.

Teeth large and without dental plates; the outline of each tooth base is the shape of an arrowhead with the tip pointing towards the umbo; the tooth prong is at the tip of the arrowhead. Interarea small, smooth. The muscle field is well defined, there being three areas of excavation, viz.:—

(*a*) Flabellate diductor field bounded by a fine ridge anteriorly and laterally; margin slightly scalloped. The carinae bounding the field turn inwards and posteriorly to the midline, coalescing with the linear but well-defined median septum. This point is 7·5 mm. from the tip of the beak.

(*b*) Heart-haped adductor field well-excavated, and more so posteriorly than anteriorly. Divided by the median septum. Scar 1·25 mm. long and 1 mm. wide; the posterior end is 3·5 mm from the tip of the beak.

(*c*) At the beak there is an excavated area reaching 2 mm. from the tip, and separated from the diductor field by a ridge which appears as a furrow in the steinkern. This field is bisected, like the others, by the median septum. It is interpreted as the place of attachment of the pedicle muscle.

2. PARATYPE dorsal valve 9 mm. long overall, and 7 mm. wide; slightly convex in that most of the valve is planate but the antero-lateral and lateral borders are deflected ventrally. The area corresponding to the ventral sinus is not deflected but continues on in the plane of the main part of the valve, and thus constitutes the homologue of the dorsal fold that in medially folded brachiopods usually corresponds to the ventral sinus. As the median costa characterizes the ventral sinus in this species, so two costae characterize the dorsal 'fold', one being on each side of the midline. On each side of this pair are six costae, making a total of fourteen. A little more than half-way down the valve is a concentric furrow which affects the interspaces only, i.e., it does not interrupt the costae. A comparable structure is seen in *L. flabellites* as figured by Cooper in Shimer and Shrock, 1944, Pl. 121, fig. 26. A parallel with the internal ridge of the ventral valve (situated almost on the anterior margin) is a short ridge on the interior of the dorsal valve which affects only the two costae on the 'fold'. Right at the margin, on the anterior side of the ridge, the two costae turn ventrally. They thus would occupy in the live animal the two spaces on each side of the ventral median costa, ensuring that no foreign body entered the mantle cavity. Interspaces wider than costae, contrasting thus with the ventral valve where the costae are wider. This likewise is a provision ensuring that the anterior margins of the two valves are wholly contiguous when the shell is closed.

The cardinalia are set on a thickening of the valve occupying the postero-central part, and projecting into the ventral valve. From this there extends anteriorly a fine median septum extending about half way to the anterior margin. On each side of the midline at the posterior end of the septum are excavations interpreted as muscle attachments. Immediately posterior to these are the nodose crural bases. The cardinalia constitute a solid component with large somewhat tear-shaped sockets on the outer sides for the accommodation of the large teeth of the ventral valve. Between these are two recesses separated by a fine median septum, and this central block stands out a little from the sockets at the sides, thus forming a kind of cardinal process which may be described as bilobed.

Comment. *Leptocoelia* often occurs in great numbers in the Bell Shale, and so is given the trivial name *polyspera* from the Greek word meaning 'spread far and wide' and so 'numerous'. Chapman (1920) referred to the closely related genus *Coelospira* a brachiopod from Gippsland, Victoria (*C. australis*). His specimens show no internal structures (thus making determination uncertain), but the external form is quite different from that of the species now described. *L. polyspera* differs from the genotype, *L. flabellites*, in its different outline, greater number of costae, and in the construction of the cardinalia, including the possession of a bilobed instead of a quadrilobate cardinal process. The excavation of the beak area of the interior of the ventral valve also seems to be a point of difference.

Genus **Eospirifer** Schuchert, 1913

Eospirifer parahentius, sp. nov.

Pl. I, figs 1-6

Type Material. 1. HOLOTYPE ventral valve steinkern, N.M.V. 14792 coated with yellowish brown iron oxide and preserved in a light grey siltstone from locality 16, on the right bank of the Little Henty River about a mile S.E. of Zeehan.

2. PARATYPE consisting of the steinkern (N.M.V. 14793) and external mould (N.M.V. 14826) of a dorsal valve similarly preserved and from the same locality.

3. HYPOTYPE ventral valve on same slab as the external mould of the paratype (N.M.V. 14826). It is the half exo-skeleton of a more developed animal.

Formation. Bell Shale.

Description. 1. HOLOTYPE ventral valve 2·4 cm. greatest width 2·0 cm. along the hingeline; length 2·4 cm. including the beak. The latter juts about 2 mm. beyond the hingeline, which is straight. Cardinal angles obtuse, and anterior margin rounded. Anterior commissure uniplicate; this plication forms an arc and is not subquadrate as in the genotype (St. Joseph, 1935). Valve convex, the midline profile rising about 4 mm. above the plane joining the anterior and posterior margins of the valve. Ventral muscle field strongly excavated, and reaching 13 mm. from the beak, i.e., about half way down the arched surface of the valve. The field is bounded on each side by strong dental plates 8 mm. long; these continue round the anterior end of the muscle field as very faint linear carinae. The palintrope is a strong incurved plate over 0·5 mm. thick near the umbo; interarea finely striated transversely. Well-defined median longitudinal sinus, 5 mm. wide in the middle of the valve and about 1·5 mm. deep; the transverse profile is curved. Fine costellae of the exterior surface show also on the steinkern; they number about 55 per cm. The delthyrium is about 5 mm. wide at the hingeline, i.e., one quarter of the length of the hingeline.

2. PARATYPE steinkern of dorsal valve is somewhat sheared but of similar size and proportions to the ventral valve, but not quite as convex. Four or five low plicae are present on each side of the median fold. The median longitudinal fold has a rounded cross-section like that of the sulcus in the ventral valve. The costellation is likewise similar. A low linear median septum extends for 1·5 cm. down the midline. The hinge plate is divided, each section being about 3 mm. wide and 0·5 mm thick; supported by slightly divergent lamellar crural bases.

3. HYPOTYPE ventral valve is more developed showing deeper excavation of the muscle field, and stronger dental plates. Mesially, immediately under the umbo, is a short ridge 3 mm. long; St. Joseph (1935, p. 321) refers to a similar structure in the genotype, commenting that 'the genus shows the weakest euseptoid development of any of the forms included in Frederic's group Elythenae' (1926).

Comment. Because of the shearing of the rocks containing these fossils, it is difficult to find a complete and undistorted specimen. The shells are thin and readily yield to the shearing pressures; the distortion makes many valves look more transverse than they really are, and develops puckers of varying dimensions. It is difficult to determine the precise degree of plication of the valves.

Two groups of *Eospirifer* have been noted in the Lower Devonian rocks of Tasmania, Victoria, and New Zealand, viz.:—

1. Those with a median fold having a squarish cross-section. To this belong the forms figured by Shirley (1938) from the Baton River Beds of New Zealand, and those figured by the writer from Victorian localities in the Lilydale District (1942) and in Gippsland (1949*c*).
2. Those with a median fold having a rounded cross-section. To this group belong *E. parahentius* and undescribed forms from Lilydale and Mooroolbark, Victoria.

The new species described above is very common at locality 16. It is so characteristic of this faunule beside the Little Henty River that it has been called *parahentius* (Greek *para* beside, and the name *Henty*).

Genus **Meristella** Hall, 1860

Meristella bellensis, sp. nov.

Pl. I, figs 14-18

Type Material. 1. HOLOTYPE consisting of the steinkern of a ventral valve (N.M.V. 14823) in fawnish grey indurated siltstone from locality 16, S.E. of Zeehan. Numerous other valves occur on the same slab, and one of these has been selected and figured as a HYPOTYPE. It is another ventral valve.

2. PARATYPE consisting of the steinkern of a dorsal valve from the same bed as that yielding the holotype.

Formation. Bell Shale, and hence the trivial name.

Description. 1. HOLOTYPE ventral valve 2·5 cm. long and 2·1 cm. wide in plan. The median longitudinal profile rises 0·5 cm. above the plane uniting the anterior and posterior margins. Oval in outline longitudinally. Very deeply impressed muscle area, this being a very mature specimen. Muscle field reaches 1·5 cm. down the midline from the tip of the beak, i.e., more than half way. Weak dental plates present in both holotype and hypotype, but the plates become somewhat overgrown with the internal thickening of the postero-lateral areas. Teeth strong. The counterpart of the holotype is not preserved, but other specimens prove the exterior to be smooth except for growth lines.

The HYPOTYPE illustrates a full-grown ventral valve, but not so thickened as the holotype, where the various structures are accentuated.

2. PARATYPE dorsal valve 2 cm. long and 1·5 cm. wide in plan. Muscle field deeply impressed, and is 1·4 cm. long with a width of 6 mm. Median septum comparatively wide on the floor of the shell and narrowing upwards; high anteriorly. The septum gradually recedes so that it is merged with the floor of the valve by the time the anterior margin of the muscle field is reached. Hinge-plate divided by median groove. Deep teeth sockets.

Comment. There are 16 individuals of this species crowded on the slab which preserves the holotype. The species seems thus to occur in profusion in certain horizons but is absent from others that do not seem to present a very different facies. This suggests that it was rather sensitive to environment. *Leptocoelia polyspera* and crinoid columnal 2 are also present on the same piece of rock. On the small piece with the paratype, there is another specimen of *Meristella*, a few *Beyrichia*, and numerous crinoid columnals including no. 2.

The new species has many points of resemblance with *Meristella nasuta* (Hall, 1867, Pl. 48), which is of Onandaga (Lower Devonian) age. There are many small differences, but the striking one is the difference in size and development of the ventral and dorsal muscle fields. *M. bellensis* is genetically related to McCoy's *Pentamerus australis* (1877) which is a *Meristella*. *M. bellensis*, or a closely related form, occurs in the Baton River Beds of New Zealand.

Genus **Plectodonta** Kozlowski, 1929

Plectodonta bipartita (Chapman)

Pl. I, figs 21-23

Chonetes bipartita Chapman, 1913, pp. 104-105, Pl. 10, figs 8-10.

Noting that this species was referred to the wrong genus, the writer (1945) referred it provisionally to *Stropheodonta*, and then later to *Plectodonta* (1948*b*, p. 13). Recently, Dr. Ida Brown (1949) has referred Mitchell's *Stropheodonta davidi* from New South Wales to *Plectodonta*, and redescribed it. The species is closely related to *P. bipartita*, but lacks the bipartition which is so characteristic of it. However, Dr. Brown's fig. 1*a* exhibits a tendency thereto. The Tasmanian specimens are strongly bipartite.

P. davidi is Upper Silurian and *P. biparita* Lower Devonian, and it is conceivable that the latter developed out of the former. The genus is known from the Silurian of North America, and the Silurian and Devonian of Europe (see Solle, 1938, Volk, 1939, Mailleux, 1941, for Devonian species).

The figured specimens are a steinkern of a ventral valve (N.M.V. 14804), the steinkern of a dorsal valve (N.M.V. 14807), and the external mould of another dorsal valve (N.M.V. 14810). All are from locality 1.

Genus **Chonetes** Fischer, 1837

Chonetes aff. **ruddockensis** Gill

Pl. I, fig. 36

In the Bell Shale at locality 1 occurs a *Chonetes* (N.M.V. 14804) which is comparable with the one named above from the Lower Devonian of the Lilydale District, Victoria. It has similar proportions and prosopon (for term see Gill, 1949*d*) but is more obese and a little larger than is usual for that species. However, it is not as large as *C. cresswelli* nor has it the median sinus of that species. The spines have yet to be seen on the Tasmanian form, and these will help to define its relationships.

Genus **Notanoplia** gen. nov.

Genotype **Notanoplia pherista**, gen. et sp. nov.

Diagnosis. Chonetoids without spines on the ventral margin; small. Planoconvex, or with the dorsal valve slightly concave. Surface of both valves smooth, except sometimes for faint incipient costellae or fine growth lines. Interior surface of valves smooth except for septa. Long median septum in both valves; rather squarish in cross-section and terminating bluntly. Variable number of accessory septa, but the number is stable for each species, and there is the same number in both ventral and dorsal valves. In the ventral valve are strong teeth, but no dental plates. In the dorsal valve are sockets to accommodate the ventral teeth, and with the sockets are socket ridges (or possibly combined socket ridges and crural bases).

Comment. This genus is established to accommodate a group of more than six species of chonetoid brachiopods found in the Lower Devonian rocks of Tasmania and Victoria. Two of these species have already been described as *Anoplia australis* and *Anoplia withersi* (Gill, 1942, 1945, 1950*b*), and in addition to these is the genotype which was previously referred to as *Anoplia* sp. (Gill, 1948*a*, p. 72). The new genus compares with *Anoplia* in its chonetoid outline, small size, smooth exterior surface, and presence of bluntly terminating median septum in both dorsal and ventral valves. On the other hand, it contrasts with *Anoplia* in that the median septa are long, and apparently associated with a long ventral muscle field and not a short one as in *Anoplia.* The median septa are accompanied by accessory septa, and this set-up of septa is one of the most characteristic features of the new genus. The interior of both valves of the genotype is 'strongly pustulose' whereas in *Notanoplia* the interior surfaces are smooth except for the septa. No 'tripartite median process' has been found on the exterior of the dorsal valve as in the genotype, nor any spines as in *A. helderbergiae.* Published figures show ridges in the ventral valve of the genotype that look like dental plates; there are no comparable plates in *Notanoplia.*

Because of its obvious affinities with *Anoplia*, the new genus is named *Notanoplia* (Greek *notos* = south, a reference to its description from Australia, and the generic name *Anoplia*). The two genera are probably isocronons. Stratigraphically the new genus is valuable as an index fossil because it occurs in both arenaceous and argillaceous facies. Also the numerous septa greatly strengthen the shell mechanically, and it is rare to find a broken one. Where currents have not been too strong, it is not uncommon to find both valves still attached to one another, which suggests that this brachiopod possessed strong hingeline ligaments. When *Notanoplia* occurs, it is usually present in large numbers. These last two characters it shares with *Plectodonta bipartita* (Chapman), with which it is frequently associated.

Notanoplia pherista, gen. et sp. nov.

Pl. I, figs 29-32

Type Material. 1. HOLOTYPE consisting of the steinkern of a ventral valve (N.M.V. 14827).

2. PARATYPE consisting of the steinkern (N.M.V. 14828) and external mould (N.M.V. 14827) of a dorsal valve.

Both specimens are preserved in a greyish white siltstone and the impressions of the shells are covered with a film of yellow iron oxide. The locality is no. 16, which is on the right bank of the Little Henty River about one mile S.E. of Zeehan.

Formation. Bell Shale.

Description. HOLOTYPE ventral valve subsemicircular, being 1 cm. wide and 7 mm. long. Hingeline straight, and a little shorter than the greatest width of the shell, making the cardinal angles a little obtuse. Palintrope narrow, but highest in centre and reducing in height towards cardinal extremities. Valve well inflated for this genus, which usually has a very thin body cavity; the median longitudinal profile rises quickly at the umbonal end to 2·5 mm. above the plane joining the valve margins, then descends slowly towards the anterior margin. Short blunt umbo.

Median septum whole length of valve; 0·5 mm. at widest; of somewhat squarish cross-section. It commences at the umbonal end as a fine line 0·5 mm. long, then expands into a flat platform 1·5 mm. long. Such structures are common in strophomenids, and are interpreted as muscle attachments. From this platform to the anterior margin the septum continues more or less even in size. The accessory septa are approximately one-third of the distance from the hingeline to the median septum. They reach the lateral margins of the valve, but the umbonal termini are not clearly defined. This appears to be characteristic of this species, and is no doubt due to secondary calcification; this sometimes causes the secondary septa to almost disappear. Muscle impressions are difficult to detect, but in the holotype there is a faint excavation of a central flabellate area which reaches most of the length of the valve, if not the entire length. It has been noted (Gill, 1950b) that in chonetids there is a close relationship between the length of the septum and the length of the muscle field. In *Anoplia helderbergiae* the median septum is short and the muscle field likewise short (Schuchert, Swartz, Maynard, and Rowe, 1913, p. 340).

Teeth blunt and short; 2·5 to 3 mm. apart. Associated with them are minute thickenings on the shell wall which might be regarded as either wide teeth bases or incipient dental plates. The external mould of the holotype is not preserved, but the steinkern suggests that the valve was smooth except for traces of radial costellae. Review of a large number of topotype specimens shows that the species was smooth-shelled except for such striae, and sometimes concentric growth lines.

2. PARATYPE dorsal external mould is on the same slab as the holotype, and shows that its surface was smooth except for some fine concentric growth lines. The position of the median septum can be seen, traced by a slight ridge; this is unusual and is due to crushing. However, it suggests that the shell was fairly thin.

The paratype steinkern of the dorsal valve presents a sub-quadrate valve 7 mm. long, and a little over 8 mm. wide, but it has been affected by the shearing the matrix has suffered. Hingeline straight and a little shorter than the greatest width of the valve, thus making the cardinal angles a little obtuse. Palintrope linear, and more or less the same width across the valve. Valve flat in the areas around the cardinal angles but slightly concave in the median area. Short, blunt cardinal process jutting a very short distance beyond the hingeline; there are two faint longitudinal furrows on the process, so that to this extent it may be described as tripartite. The median process is not fused with the process, but commences a little anterior to it. The septum extends the whole length of the shell, and although fairly consistent in strength it is a little higher in the middle; it is somewhat squarish in cross-section. Accessory septa are present, and like those in the ventral valve do not join the median septum or other structure, extend to the lateral margins, and tend to be obliterated by secondary calcification. Here again too they are nearer the hingeline than the median septum, and not as well developed as the median septum. Continuous with the cardinal process are socket ridges, or possibly combined socket ridges and crural bases. These ridges curve anteriorly from the process, then run along almost parallel to the hingeline and close to it. The ridges are fine structures, but begin comparatively thick and gradually thin out terminally.

Comment. Notanoplia pherista is the largest and best preserved of the species of this genus at present known, whether described or undescribed, and hence its trivial name (Greek *pheristos* = strongest and best). It is common in the beds from which it comes.

The new species has two accessory septa in each valve like *Notanoplia australis*, but all the septa reach the anterior margin, and there is a tendency for the accessory septa to be obliterated by secondary calcification. *Notanoplia australis* and *N. withersi* have a very thin body cavity, but the new species' inflated ventral valve with a subplanate dorsal valve provides a body cavity large for this genus. The cardinalia differ in detail from the other described species, and *N. pherista* is the only species in which concentric growth lines have been found.

Associated with the type specimens on the same pieces of rock are *Eospirifer*, *Maoristrophia*, *Trimerus*, and crinoid columnals.

Genus **Protoleptostrophia** Caster, 1939

Protoleptostrophia plateia Gill

Protoleptostrophia plateia Gill, 1948, pp. 64-65, Pl. VIII, figs 29, 45.

Impressions of shells belonging to this species are very common in the Florence Quartzite, including localities 15, 26, 32, 45, 46, 60, 61. (N.M.V. 14833-4). *P. plateia* is so characteristic of this formation that, like *Notoconchidium*, it may be regarded as one of its index fossils. A limitation on precise identification exists in the fact that the prosopon of neither the type specimens nor those from Zeehan can be distinguished satisfactorily because of the coarseness of the enclosing sediments.

The relationships of *P. plateia* to other protoleptostrophids has been discussed in a recent paper (Gill, 1949*c*, pp. 100-103). It seems to the writer also that the form from the Baton River Beds in New Zealand which Shirley (1938, p. 468, Pl. XLI, figs 7-9) named *Leptostrophia explanata*, and Allan (1942, p. 146) renamed *Rhytistrophia shirleyi*, belongs to this gens or group of species. Many wrinkles in specimens examined by the writer are due to crushing, but some weakly developed wrinkles do occur, however, as they do in *P. affinalata* (Gill, 1949*c*). Whether one places the New Zealand species in *Protoleptostrophia* or *Rhytistrophia* depends on how strictly one interprets Caster's (1939) definition of the latter genus as possessing 'strong concentric wrinkles as in *Leptaena*'. However, whichever is the correct generic position, there can be no doubt that the Australian protoleptostrophids are related to the form from the Baton River Beds.

Genus **Maoristrophia** Allan, 1947

Pl. I, fig. 39

Allan established this genus on brachiopods from the Reefton Beds in New Zealand (Allan, 1947). Since then two species have been described from locality 16 at Zeehan, viz., *M. careyi* and *M. banksi*, and another species from Lilydale, Victoria, viz., *M. keblei* (Gill, 1949*a*, 1950*a*). The last named species has now been recognized also in strata near the top of the Mt. Ida Beds in the Heathcote District of Victoria (Thomas, 1937) at locality 54, parish of Redcastle (*vide* maps published by the Mines Dept. of Victoria). The genus has also been noted in a collection in the National Museum, Melbourne, made by the author from the Baton River Beds in New Zealand, and as this is a new record it is figured herein (Pl. I, fig. 39). The specimen is determined as *Maoristrophia neozelanica* Allan, and is registered number 14786 in the National Museum palaeontological collection.

In recent revision of the age of the Reefton Beds, Allan (1947) concluded that they are middle Lower Devonian (Siegenian) in age. The Baton River Beds are generally regarded as being of the same age but a different facies. The beds at Lilydale from which *Maoristrophia* was obtained are believed to be Siegenian in age by the writer, and the overlying Cave Hill limestone to be Coblenzian. The presence of *Maoristrophia* at Zeehan, therefore, suggests that the beds there are likewise Siegenian in age.

Genus **Notoleptaena** Gill, 1950

Notoleptaena sp.

The genotype of *Notoleptaena* is *N. linguifera* from the Heathcote District of Victoria (Gill, 1950*c*), and a second species, *N. otophera*, was at the same time described from the Killara District of Victoria. The former species is a massive one from a sandy facies, and the latter a more finely built shell from an argillaceous facies. The Tasmanian specimen is comparable with neither of the above species, but it closely resembles an undescribed species from the Kinglake District of Victoria. This third species is more like *N. otophera* than *N. linguifera*, but lacks the alate cardinal angles which characterize it.

Notoleptaena has been collected from locality 1 at Zeehan (N.M.V. 14812).

Genus **Parmorthis** Schuchert and Cooper, 1931

Parmorthis aff. **allani** (Shirley)

Pl. I, fig. 24

Schizophoria allani Shirley, 1938, pp. 465-466, Pl. XLI, figs 1-3.

The figured specimen (N.M.V. 14836) is from the Bell Shale at locality 16 and closely resembles Shirley's species from the Baton River Beds in New Zealand (Shirley, 1938, Allan, 1945). The cardinalia, muscle arrangements, prosopon, and outline are all closely comparable. The same occurs in the Lilydale District of Victoria.

In the opinion of the writer, Shirley's species belongs to *Parmorthis* and not *Schizophoria*. The latter possesses generally a convexo-concave shell with resupinate lateral profile and a low dorsal fold; the diductor scars of the ventral valve tend to be divergent; the dorsal valve has large and not small cardinalia, the crural apparatus is widely divergent and not compact, and there are characteristic muscle marks and pallial trunks (Schuchert and Cooper, 1932, Cooper in Shimer and Shrock, 1944). In all these ways *Schizophoria* differs from *Parmorthis*.

Genus **Camarotoechia** Hall and Clarke, 1893

Camarotoechia synchoneua, sp. nov.

Pl. I, figs 12-13, 19-20

Type Material. 1. HOLOTYPE represented by the steinkern of a ventral valve preserved in whitish sandstone (leached quartzite) from Smelters' ridge, near Zeehan (loc. 17). N.M.V. 14844.

2. PARATYPE represented by the steinkern of a dorsal valve preserved in the same matrix and from the same locality as the holotype. N.M.V. 14845.

Formation. Crotty Quartzite.

Description. 1. HOLOTYPE ventral valve shallow, transversely ovoid in outline, being a full-grown shell. The younger shells are more rounded, and nearer the proportions of the paratype. Greatest width, which is about the transverse midline of the shell, 3 cm. Length in plan about 2 cm., but length down the midline from the tip of the beak to the centrepoint of the tongue is 2·7 cm. The main part of the valve is flattish, but the deep median sinus extends as a tongue about 8 mm. beyond the rest of the anterior margin. The sinus is 3·5 mm. deep at its deepest part, and 13 mm. wide. Valve strongly costate with about 19 costae, three of which are in the sinus. Anterior commissure strongly uniplicate. Beak well defined. Well developed dental plates continue forward round the sides of the muscle field as low ridges. The anterior margin of the field is faintly indicated by an incipient ridge. Muscle field spatulate, undivided. The lateral margins of the delthyrium define an angle of the order of 105°.

2. PARATYPE dorsal valve strongly convex, always much deeper than ventral valve. Width 21 mm. in plan, and length 17 mm. in plan, but 24 mm. following the midline profile. Anterior margin strongly uniplicate. Valve costate like the ventral valve; four costae on median fold which corresponds to the sinus of the opposing valve. Strong median septum extending about 1 cm. down the midline. Hingeplate divided, the sides extending anteriorly into crura which show as holes in the steinkern about 4 mm. apart.

Comment. The trivial name is from the Greek *synchoneuo* meaning *to smelt*, being a reminder that the species is described from, and is the dominant fossil in, the fossiliferous band on the crest of the ridge behind the Smelters' works, near Zeehan. Being the only adequately decipherable fossil found so far in the Crotty formation, this fossil is important from a stratigraphical point of view. The formation has been given many different ages in the past, but the presence of a large well-developed *Camarotoechia* means that the strata are either Upper Silurian or younger.

Lamellibranchiata

Genus **Cypricardinia** Hall, 1859

Cypricardinia sp. is present in the Bell Shale at locality 1 (N.M.V. 14802, 14805 counterparts). Chapman (1908) claimed to find *Cypricardinia contexta* (Barrande) in the Lower Devonian of the Lilydale District, Victoria, and Shirley (1938) has recorded the genus from the Lower Devonian of New Zealand.

Arthropoda

Genus **Proetus** Steiniger, 1831

Proetus euryceps (McCoy)

Forbesia euryceps McCoy, 1876, pp. 17-18, Pl. XXII, figs 10, 10*a*.

From grey siltstone at locality 1 in Zeehan have been collected pygidia which cannot be specifically differentiated from those of the above species (N.M.V. 14806, 14811 counterparts). A detailed study has not been made of this trilobite yet, but it is fairly common in the Lower Devonian siltstones of the Kinglake West District, Victoria.

Genus **Trimerus** Green, 1832

Trimerus zeehanensis Gill

Trimerus zeehanensis Gill, 1949*b*, pp. 70-72, Pl. IX, figs 1, 2, 4; text fig. 1D.

Collecting at locality 16 on the bank of the Little Henty River, S.E. of Zeehan, since the species was described, has yielded specimens showing that this trilobite grew larger than the type specimen. For example, a pygidium (N.M.V. 14787, 14788, counterparts) measures 4 cm. long, and a cephalon (N.M.V. 14789-14791, counterparts) measures 3·8 cm. long. Trilobites to which these sections of carapace belonged would be about six inches long.

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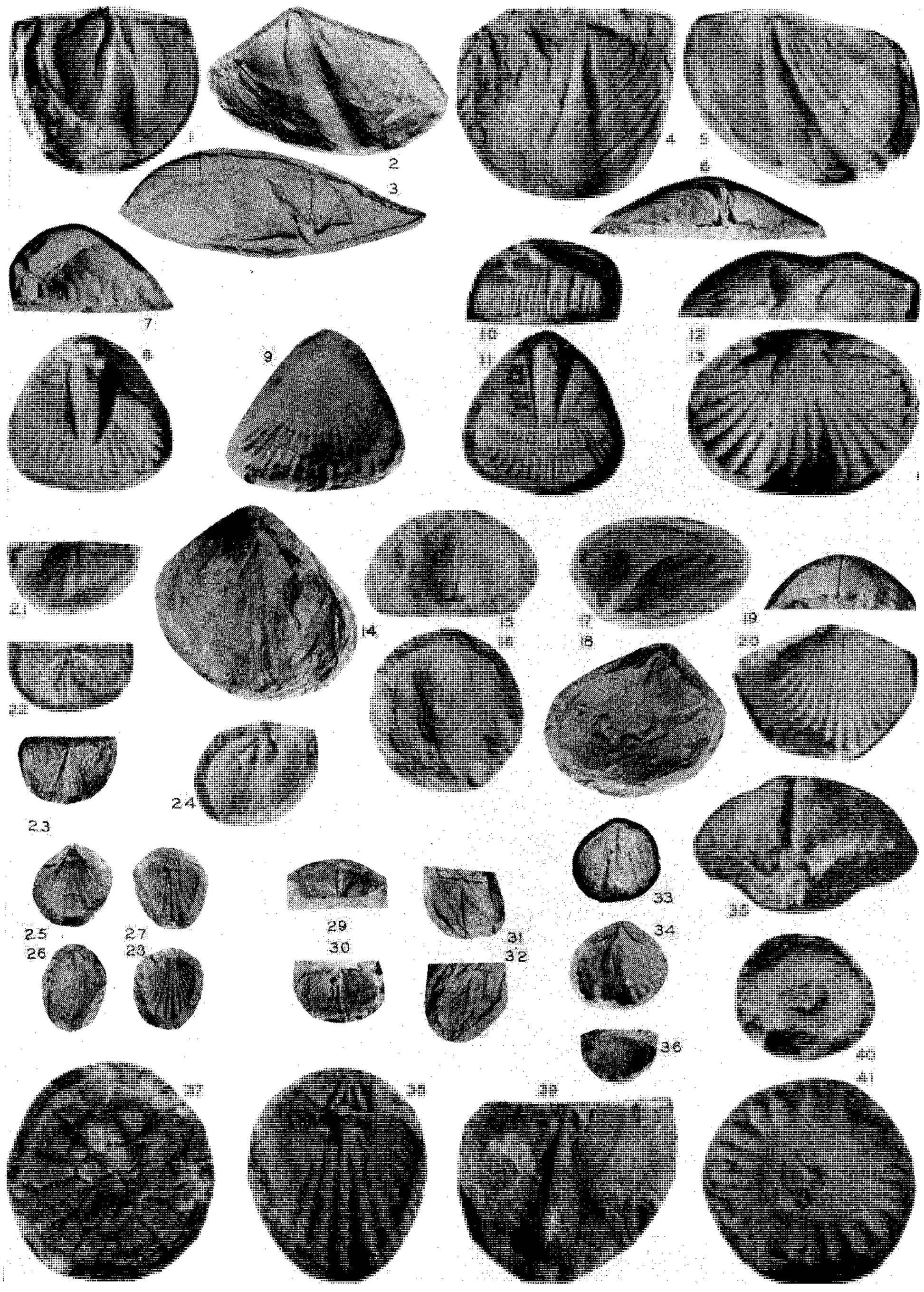
Explanation of Plate I

The photographs are from unretouched negatives, and are natural size unless otherwise indicated. The photography is by Mr. L. A. Baillôt of the Melbourne Technical College.

Fig. 1.—*Eospirifer parahentius*, sp. nov. Steinkern of ventral valve. Holotype.
Fig. 2.—Do. Steinkern of ventral valve. Hypotype.
Fig. 3.—Do. Umbonal view of specimen in fig. 2.
Fig. 4.—Do. External mould of dorsal valve. Paratype.
Fig. 5.—Do. Steinkern of dorsal valve. Paratype.
Fig. 6.—Do. Umbonal view of specimen in fig. 5.
Fig. 7.—*Notoconchidium florencensis*, sp. nov. Oblique view of steinkern of dorsal valve. Holotype.
Fig. 8.—Do. View from above of steinkern of dorsal valve. Holotype.
Fig. 9.—Do. External mould of dorsal valve. Holotype.
Fig. 10.—*Notoconchidium tasmaniensis* (Etheridge). Side view of steinkern of dorsal valve. Lectoholotype.
Fig. 11.—Do. View from above steinkern of dorsal valve. Lectoholotype.
Fig. 12.—*Camarotoechia synchoneua*, sp. nov. Steinkern of ventral valve, umbonal view. Holotype.
Fig. 13.—Do. View from above of steinkern of ventral valve. Holotype.
Fig. 14.—*Meristella bellensis*, sp. nov. Steinkern of ventral valve. Holotype.
Fig. 15.—Do. Steinkern of dorsal valve, umbonal view. Paratype.
Fig. 16.—Do. Steinkern of dorsal valve, view from above. Paratype.
Fig. 17.—Do. Steinkern of ventral valve, umbonal view. Hypotype.
Fig. 18.—Do. Steinkern of ventral valve, view from above. Hypotype.
Fig. 19.—*Camarotoechia synchoneua*, sp. nov. Steinkern of dorsal valve, umbonal view. Paratype.
Fig. 20.—Do. Steinkern of dorsal valve, view from above. Paratype.
Fig. 21.—*Plectodonta bipartita* (Chapman). Steinkern of ventral valve, x 3.
Fig. 22.—Do. Steinkern of dorsal valve, x 3.
Fig. 23.—Do. External mould of dorsal valve, x 3.
Fig. 24.—*Parmorthis* aff. *allani* (Shirley). Steinkern of dorsal valve.
Fig. 25.—*Leptocoelia polyspera* sp. nov. Steinkern of ventral valve. Holotype.
Fig. 26.—Do. Oblique view.
Fig. 27.—*Leptocoelia polyspera*, sp. nov. Steinkern of dorsal valve. Paratype. See also fig. 38.
Fig. 28.—Do. External mould of dorsal valve. Paratype.
Fig. 29.—*Notanoplia pherista*, gen. et sp. nov. Steinkern of ventral valve, umbonal view. Holotype.
Fig. 30.—Do. View from above. Holotype.
Fig. 31.—Do. Steinkern of dorsal valve. Paratype.
Fig. 32.—Do. External mould of dorsal valve.
Fig. 33.—*Eatonia (Eatonia) polynecta*, sp. nov. Dorsal view of steinkern of both valves. Holotype.
Fig. 34.—Do. Steinkern of another ventral valve. Paratype.
Fig. 35.—Do. Umbonal view of steinkern of both valves, x 3. Holotype.
Fig. 36.—*Chonetes* aff. *ruddockensis* Gill. Steinkern of ventral valve.
Fig. 37.—*Pleurodictyum megastomum* Dun.
Fig. 38.—*Leptocoelia polyspera*, sp. nov. Steinkern of paratype dorsal valve, x 3. to show cardinalia and prosopon.
Fig. 39.—*Maoristrophia neozelanica* Allan.
Fig. 40.—Crinoid columnal 1 from Crotty grit.
Fig. 41.—Crinoid columnal 2 from Bell Shale, x 3, to show structure.



Palaeontology of the Eldon Group Formations, Zeehan, Tasmania.