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FURTHER STUDIES IN CHONETIDAE (PALAEOZOIC BRACHIOPODA) FROM VICTORIA

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Summary

The *Chonetes robustus* gens is described and its evolution discussed. *Chonetes australis* McCoy is re-described with the help of some special preparations. New species are established, viz. *Chonetes micrus* and *Notanoplia loyolensis* from the Lower Devonian, and *Chonetes buchanensis* and *C. teicherti* from the Middle Devonian.

Introduction

Chonetidae occur only in Silurian and Devonian rocks in Victoria, as far as is known at present, but they exist in great numbers and variety, especially in the Devonian. The following is a list of described species, and there are still others waiting the collection of better material before description.

Upper Silurian	*Chonetes melbournensis* Chapman
Lower Devonian	*C. cresswelli* Chapman
	C. baragwanathi Gill
	C. bowieae Gill
	C. killarensis Gill
	C. micrus sp. nov.
	C. productoidus Gill
	C. psiloplius Gill
	C. robustus Chapman
	C. ruddockensis Gill
	C. taggertyensis Gill
	Notanoplia australis (Gill)
	N. loyolensis sp. nov.
	N. withersi (Gill)
Middle Devonian	*Chonetes australis* McCoy
	C. buchanensis sp. nov.
	C. gaskini Gill
	C. teicherti sp. nov.

The Victorian chonetids are comparable with those of Tasmania (Gill 1948, 1950a), New Zealand (Allan 1935, Shirley 1938, Gill 1950b), and Indochina (Mansuy 1916, 1919, 1921, Gill 1945).

Evolution

The Palaeozoic faunas of Victoria lived in geosynclinal seas, a tectonically mobile area where change was common and enormous thicknesses of sediments accumulated (Browne 1947). Even if the mutation rate were the same as elsewhere, the evolution rate was probably much higher by reason of the changing evironment.

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A well-adapted species shows little development in a constant evironment, whatever the mutation rate, but when the environment is fluid, new mutations are utilized, and so the rate of evolution goes up. The flux within the organism (genotypic change or mutation rate) is thus geared to the flux in the environment. It may be as well to state that by rate of evolution the writer means the speed of change in morphology.

Chonetes exhibits a monopodial type of evolution (cf. Small 1948).

Incidence of Species

In Silurian time, *Chonetes melbournensis* was prolific in this part of the Tasman geosyncline. This is the only species so far described from the Silurian rocks of Victoria, and there are traces of but few others. On the other hand, in Devonian time there was a comparatively sudden burst of evolution in Chonetids, yielding a whole galaxy of species. Fourteen species have been described, and there is material in hand proving the existence of others. In addition, three species of *Notanoplia* have been described.

Genetic Relationships

As the chonetid fauna is described, the genetic relationships of the species are becoming clearer. The chief hindrance is that many of the species are still inadequately known. The ventral valve only has been described in a number of cases, and the type of preservation often prevents the determination of small but important structures.

There is evidence to suggest that *C. taggertyensis* is related to the European *C. sarcinulatus,* and so it may be a migrant. On the other hand, there is a rich gens of apparently indigenous species related to *C. robustus,* and it is proposed that in future this group be known as the *C. robustus gens.* The term gens is employed in its original sense (Vaughan 1905) of 'the aggregate of all the species which possess, in common, a large number of essential properties, and are continuously related either in space or time' (cf. Fenton 1929, p. 502). Figure 1 indicates the

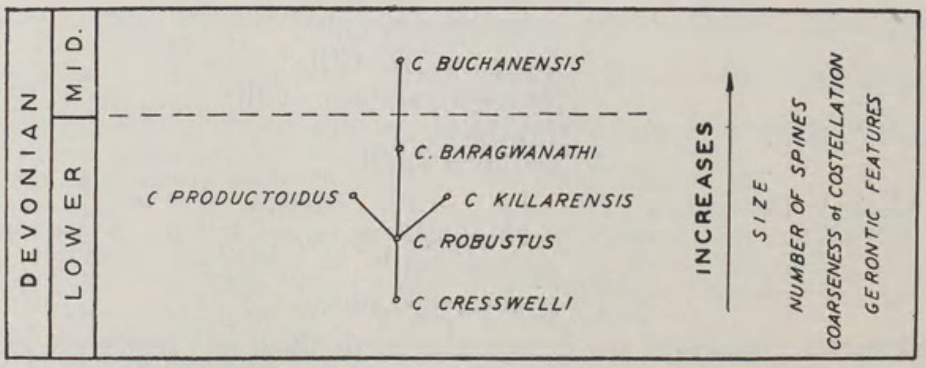

FIG. 1.—Age, composition and evolution of the *Chonetes robustus* gens.

probable relationships of the species in the *C. robustus* gens; the lines indicate relationships as now understood, and no significance is to be attached to the length of the lines. All the species occur in numbers except *C. killarensis* and *C. productoidus,* and it may be that these were offshoots from the main line of evolution that did not progress very well.

The gens of *C. robustus* comprises a group of larger, rather coarsely costellate species, with short ventral median septum, and spines set at right angles to the

hingeline. Where known, the dorsal valve has a comparatively long median septum and two accessory septa as described herein for *C. cresswelli* (Fig. 2). The body cavity is small, the shells being concavo-convex. Table 1 sets out some of the

TABLE I. *Table of features of species of the* Chonetes robustus *gens.*

SPECIES	Size in mm.	No. of spines	No. of costellae	No. of costellae per cm.	Median sinus	Gerontic features
C. buchanensis . .	25 x 20	?10	40	11	Absent	1, 2, 3
C. baragwanathi .	30 x 12	10	42	10	Present	1,2
C. killarensis . . .	20 x 17	10	37	16	Present	
C. productoidus . .	21 x 17	8	c.45	15	Absent	1
C. robustus . . .	19 x 12	8	c.40	15	Present	
C. cresswelli . . .	13 x 7·5	8	54	22	Present	

features of this group of species. 'Number of costellae' means how many occur along the anterior margin of the holotype ventral valve, and 'Costellae per cm.' means the number measured in a width of one centimetre across the middle of the holotype ventral valve of the species concerned. The gerontic features represented by numbers are—

1. Obesity.
2. Irregular growth lines (especially towards the anterior margin).
3. Irregularity of costellae (especially towards the anterior margin).

The development of gerontic features towards the anterior margin of the shell (i.e. the latest area of growth of the individual) while the younger parts of the shell have a more regular growth, appears to be a reflection of phylogeny in ontogeny. While one is aware of the well-based criticisms by de Beer and others of the classic Theory of Recapitulation, it appears to be true as Swinnerton says (1932, p. 333) that 'As applied to the individual character, the palaeontological evidence in support of this doctrine is overwhelming. . . The fundamental phenomenon is . . . parallelism (i.e. in ontogeny and phylogeny), for evolution is not an abstraction; it is a process which proceeds through the medium of developing individuals.'

In Table 1 the species are listed according to age, in that *C. buchanensis* is Middle Devonian, *C. baragwanathi* is late Lower Devonian (Gill 1949), and the other species earlier in the Lower Devonian. The table shows that there is an overall increase in size of shell, in the number of spines, in the number of costellae per centimetre of valve surface, and in the appearance of gerontic features. The outline of the shells, the presence or absence of a median sinus, and the shape of the spines appear to be merely specific characters, and not constant through the gens in any way. The median sinus disappears in the tumid members of the gens. It may be noted that the median sinus evolved independently a number of times in the Chonetidae.

Migration

Before being named as new species, the brachiopods described in this paper were compared with those described in literature. Many superficial comparisons were noted, but no intimate relationships. However, scientific comparison is difficult in many cases owing to limited knowledge of the species concerned.

It has been suggested that *a priori* we can assume that forms of marine life found in Australia, for instance, will be different from those found in Europe and North America, because of the great distances involved. However, taking the geological column as a whole, we cannot as a rule correlate fossil faunas which are less than a million years apart in age. If a form migrated 10,000 miles in 1,000,000 years, this would be an average of only 17·6 yards (about 15 metres) per year.

Distance therefore is not the barrier so much as the concomitants of distance—differences in temperature, depth, nature of sea-floor (where bottom-living forms are concerned), salinity, turbidity, and so on. It is not a matter of time and space so much as a problem of opportunity.

Thus the facies of a form probably has more to do with whether it may be expected to be widely dispersed or not, than any other factor. If an animal is pelagic, then it is much more likely to be widely distributed. If it has a limited habitat, e.g. a brachiopod limited to a muddy sea-floor of moderate depth, these very limitations will make it less likely to achieve distant migration.

Moreover, migration over long distances inevitably involves areas with a different range of ecological factors, and these will cause selection which tends to differentiate the animal from the parent stock. It would appear also that the same or similar mutations occur in different places, and so homoeomorphy is rife. General similarity of form thus does not necessarily mean genetic relationship.

One pictures the 'Victorian' chonetids making their way about the Tasman geosynclinal seas and perhaps into neighbouring waters, but whether they effected any more distant migrations has yet to be proved.

Systematic Descriptions

A. Lower Devonian Species.

Genus **Chonetes** Fischer de Waldheim 1837

Chonetes cresswelli Chapman

(Pl. III, fig. 5; Text fig. 2)

C. cresswelli Chapman, 1903, pp. 77-78, Pl. XII, fig. 7.
C. cresswelli Gill, 1945, pp. 134-135, Pl. VIII, fig. 5.

Type material. Holotype: A photograph of this specimen has not been published before, and so one is reproduced as Plate III, fig. 5. New is a Hypotype consisting of a dorsal valve preserved as a steinkern and external mould (N.M.V.* 14712, the counterparts being set in one block of plaster) in fawn micaceous siltstone from Lilydale (no doubt loc. 2), Victoria. Collected by Rev. A. W. Cresswell, after whom the species was originally named.

Description of Hypotype. Valve semicircular, being 1·4 mm. wide and 8 mm. long. Mildly concave. Cardinal angles approximately right angles. Hingeline straight, and palintrope linear. About 55 radial costellae. The area between the accessory septa on the interior of the valve is nearly smooth, and the costellae show through on the rest. Cardinal process small, divided by a median longitudinal groove. Continuous with it on each side is a plate (probably a crural base) about 1·75 mm. long and making an angle of about 25° with the hingeline. A median septum is present, scarcely traceable at the umbonal end but higher and rather plate-like further anteriorly; it then gradually fades out into the floor of the valve. The septum is fine and reaches at least 4 mm. from the hingeline, i.e. at least half the length of the valve. On each side of the median septum is an accessory septum about 2 mm. long which makes an angle of about 15° with it. These septa merge into the crural bases, and are aligned with the sides of the cardinal process (see Fig. 2).

Comment. A dorsal valve of this species has not been previously described. Its general plan is very similar to that of *Chonetes baragwanathi,* and provides further evidence of the compactness of the *C. robustus* gens.

* References in this paper to registered numbers in public fossil collections are given thus: N.M.V. = National Museum of Victoria; M.D.V. = Mines Department of Victoria (Geological Survey of earlier records); M.U.G.D. = Department of Geology, University of Melbourne.

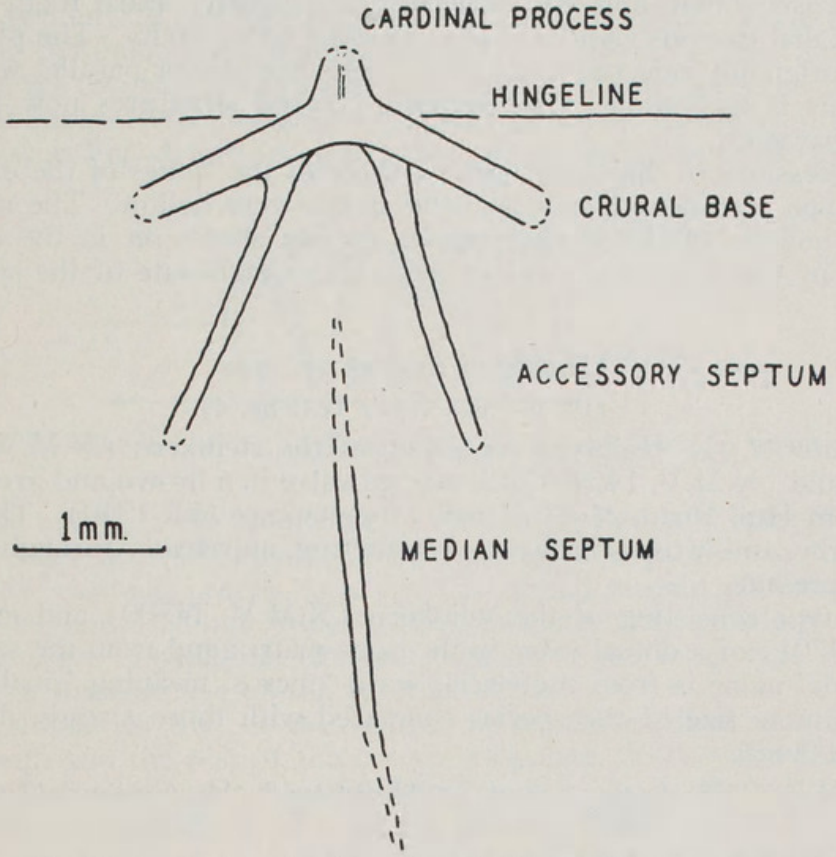

FIG. 2.—Camera lucida drawing of cardinalia of *Chonetes cresswelli*.

Chonetes is generally described as having a quadrilobate cardinal process 'divided by a narrow median and two broader lateral grooves' (Schuchert 1913, p. 389). One groove, which is probably the median one, shows plainly as a narrow ridge in the skeinkern, and there is but indecisive evidence of further subdivision.

A dorsal valve of *C. cresswelli* has also been found in the reddish siltstone from Hull Road, Lilydale (loc. 1). It shows the arrangement of septa described above, but the cardinal process is poorly preserved (N.M.V. 14714, 14715 counterparts).

CHONETES CRESSWELLI *with annular spine*

In 1945 the writer described *C. gaskini* as having an annular spine. A specimen of *C. cresswelli* (N.M.V. 15133) has now been discovered with a similar structure. It was collected from 'Lilydale' (no doubt loc. 2) by Rev. A. W. Cresswell. More than a dozen rings can be seen on the mould of the spine.

Chonetes bowieae Gill

(Pl. III, fig. 16)

Chonetes bowieae Gill, 1945, p. 136, Pl. VIII, figs. 1-2.

Generally the palintrope in *Chonetes* approximates the thickness of the valve wall so that it extends very little into the valve cavity. In *C. bowieae,* however, the palintrope is comparatively high and thick, extending into the body cavity of the ventral valve, as is shown by the plate-like recesses in steinkerns (Pl. III, fig. 16). The median septum continues right to the posterior margin of the valve, and has a slightly widened and flattened area between the teeth. The teeth have a triangular

outline in cross-section, and are directed apart slightly. Each tooth is continuous with a plate that extends about 1·5 mm. into the valve cavity. The plate-like structures were originally referred to as 'dental lamellae almost parallel with the hingeline,' but this is misleading. The better preserved structures now figured reveal their true character.

The impressions of the outer ends of three of the spines of the external mould of the holotype provide evidence that the spines were hollow. The material which infilled the hollows of the spines remains as fine shafts set in the centres of the cavities left by the dissolving away of the calcium carbonate of the spines.

Chonetes micrus sp. nov.

(Pl. III, figs. 6-11; Text fig. 4)

Type material. 1. Holotype consisting of the steinkern (N.M.V. 14698) and external mould (N.M.V. 14699) of a ventral valve in a brown and grey fine-grained siltstone from Hull Road, Mooroolbark (for map see Gill 1940). The matrix was originally grey, and it turns brown on weathering, apparently through the oxidation of the iron present.

2. Paratype consisting of the steinkern (N.M.V. 14700) and external mould (N.M.V. 14701) of a dorsal valve in the same matrix and from the same locality.

The trivial name is from the Greek word 'micros' meaning 'small', a reference to the diminutive size of the species compared with those already described from the Lilydale fauna.

Occurrence. The species occurs at Hull Road, Mooroolbark (types), and at Lilydale (e.g. N.M.V. 14702, collected by Rev. A. W. Cresswell from the 'Lilydale mudstone,' which is very probably loc. 2).

Description of Holotype. Ventral valve convex, sub-semicircular in outline, 5 mm. wide and 3·5 mm. long when measured in plan, and 4·5 mm. long when measured along the midline profile. Valve tumid, the midline profile rising about 1·5 mm. above the line joining the umbo and the midpoint of the anterior margin. The highest point of the profile is about a third of the way from the umbo to the anterior margin. There is a tendency for the valve to flatten on the cardinal extremities. Hingeline straight and less than that of the greatest width of the valve, the cardinal angles being obtuse.

Median septum 1·25 mm. long, thin. The steinkern is broken away a little at the umbo, revealing that the septum is high at the umbonal end, but half way along its length is reduced to a linear ridge. The umbo is insignificant and does not extend beyond the hingeline; palintrope linear. In the interior of the valve, on the cardinal extremities and on the lateral borders, are comparatively large papillae set in the intercostellar spaces of the steinkern. There are about twenty on each side of the valve along with some smaller ones.

The external mould shows that there is a slight depression down the midline of the valve, i.e. an incipient sinus. Prosopon costellate, but the cardinal extremities are almost smooth. Costellae number about 34 on the margin, and 22 half way down the valve; the primary costellae gradually widen from the umbo and then bifurcate when about half the length of the valve, but those nearest the cardinal extremities are not bifurcated. The costellae are rounded in cross-section although their crests are somewhat flattened by the time they attain their full width. The furrow occupying the midline of the valve between the two central costellae is a little more pronounced in the posterior half of the valve than are the others.

Description of Paratype. Greatest width 6·5 mm. and length 4·5 mm. (or 5 mm. following the profile). The valve is concave, its midline rising about 1 mm. above the line joining the umbo and the midpoint of the anterior margin. Thus the body cavity between the two valves must have been small. Palintrope linear, and approximately at right angles to the posterior border of the valve. Cardinal process quadrilobate as shown in Fig. 3, and set in the plane of the palintrope; the lobes jut pos-

FIG. 3.—Diagram of the cardinal process of *Chonetes micrus* sp. nov.

teriorly at right angles to the palintrope. Crural bases fine, and splayed apart at an angle of the order of 130°; distally they tend to turn parallel to the hingeline. Merged into the cardinal process is a low flat-topped median platform or septum about 1 mm. long and 0·25 mm. wide; it terminates abruptly anteriorly. The whole interior of the valve is papillose, elongate papillae of the ramp type (Gill 1950c) being aligned to the costellae of the external surface.

Prosopon similar to that of the ventral valve, the cardinal extremities being relatively smooth and the rest of the surface costellate, 36 costellae being counted. Increase by bifurcation, but one intercalation noted. As in the ventral valve the midline furrow is a little more pronounced than the others.

Comment. Special midline structures are not unusual in chonetids (e.g. *Chonetes melbournensis* has a more prominent central stria in the ventral valve, while *C. cresswelli* and related forms have a median ventral sinus) and to this class belongs the slightly accentuated median intercostellar furrow of this species.

Spines do not appear on the type specimens but are to be seen on specimens 14705-14706, which show two long thin spines on one side of the umbo so placed as to suggest that this was the full number for each side, i.e. a total of four. The spines are thus of similar number and type to those found on *Chonetes ruddockensis* and *C. teicherti*. From both these species, however, *C. micrus* is readily distinguished by its strongly papillose interior and the nature of the prosopon as well as other details.

Genus **Notanoplia** Gill 1950

Notanoplia loyolensis sp. nov.

(Pl. III, figs. 1-4)

Leptaena rhomboidalis Chapman, 1913, pp. 103-104, Pl. 10, figs. 6-7.

Type material. Holotype consisting of the steinkern of a ventral valve in fawn siltstone from 'Loyola, near Mansfield,' Victoria (N.M.V. 12403).

Description. Ventral valve mildly convex, subquadrate in outline, 6·5 mm. wide and 6 mm. long. Beak prominent for genus. Strong teeth situated at inner ends of teeth bases. There are seven septa on the interior of the valve, as follows:

1. Median septum, which begins on the umbo and extends for a little more than two-thirds of the length of the valve, ending abruptly. There is a row of pits along the top of the septum, which appear as a row of papillae in the steinkern.

2. Two main accessory septa, which are roughly half way between the median septum and the hingeline, but actually nearer the latter. They begin anteriorly to the umbo, not connecting with the median septum, and end a short distance from the margin of the valve; both terminations are abrupt. These septa also have a row of pits along the top.

3. Two short septa, of similar character, between the last-described septa and the hingeline.

4. Two septa, or rather callus mounds (because of their indefinite shape), without pits, between the median septum and the main accessory septa.

Comment. The holotype was described and figured by Chapman (as shown in the synonymy) as a brachial valve of *Leptaena rhomboidalis*, the various septa being interpreted as 'brachial impressions.' Species of *Notanoplia* with three septa (*N. australis* and *N. pherista*), and with five septa (*N. withersi*) have been described, and the new species is readily recognized by its possession of seven septa. The presence of pits along the ridge edges of the septa is also a feature not described before. Specimens of *Notanoplia* with seven septa and associated pits have been noted in a piece of sandstone or grit from '12 chains S.W. of low saddle at head of right branch of Cable's Creek,' which is a tributary on the west side of the Big River in the Enoch's Point District. This bed is near the base of the Yeringian strata of that area (Harris and Thomas 1942, map and section).

Notanoplia australis (Gill)

Anoplia australis Gill, 1942, pp. 38-39, Pl. IV, fig. 8.
A. australis Gill, 1945, p. 144.

A new record of occurrence is reported through the help of Messrs. J. Talent and J. Neal, who presented to the National Museum a specimen showing both valves opened out flat but still joined together (N.M.V. 15135 and 15136 counterparts) from 'Flowerfield Quarry, near Coldstream.'

It has been noted that there is a smaller variety of this species present at Ruddock's Quarry and many other Lower Yeringian localities, while in the Upper Yeringian the species is represented by a larger variety. There are also other small differences in structure. The new record is of the larger type, being 8 mm. wide and 7 mm. long. The holotype is of the larger kind, measuring 6 mm. wide, while the smaller kind is typically 3·5 mm. to 4 mm. wide.

B. Middle Devonian Species.

Genus **Chonetes** Fischer de Waldheim 1837

Chonetes australis McCoy

(Pl. III, figs. 18, 19, 21; Text figs. 4-7)

Chonetes australis McCoy, 1876, pp. 17-18, Pl. XXV, figs. 3-5.

In 1876 McCoy described *Chonetes australis* and figured two specimens occurring on one piece of rock. He did not indicate where these type specimens came from, merely stating that the species is 'Very abundant in the Middle Devonian limestone of Lucknow, E. of Mitchell River; also of Buchan.' McCoy's figured specimens consist of a large and a small ventral valve. The interior of the ventral valve has not been previously described, nor the nature of the dorsal valve. With the help of material from the Mines Department of Victoria, the University of Melbourne Department of Geology, and the National Museum, this species has now been studied. As the types have not yet been located, the species is illustrated by various hypotypes.

Description of Ventral Valve. The specimen chosen for figuring (Pl. III, fig. 19) and description is a ventral valve (M.D.V. 47639), collected by Dr. C. Teichert from a little below the top of the Cave Limestone, Slocombe's Creek, half a mile north of East Buchan Road. The matrix is a bluish-grey dense crystalline limestone. The measurements of the valve are:

Greatest width	15 mm.
Width along hingeline	13 mm.
Greatest length	10 mm.

These measurements are in one plane and not following the profile of the shell. The midline profile rises about 2·5 mm. above a line joining the centres of the anterior and posterior margins; the highest part of the profile is in the middle of the valve. Outline semi-circular, the cardinal angles being slightly obtuse, and the greatest width of the valve about one third of the way along its length. The hingeline is straight, and the umbo inconspicuous. The valve is evenly tumid except for a flattening on the cardinal extremities and a tendency to develop a median longitudinal sinus. Bases of spines along the ventral margin, and a part of one, show that these were set at a slightly oblique angle to the hingeline, as figured by McCoy. Surface of valve multicostellate. The costellae are rounded in cross-section, and are about the same width as the interspaces. Increase is both by bifurcation and intercalation. There are about 45 costellae when numbered half way down the length of the valve and about 60 when counted along the anterior margin. The costellae radiate from the umbo where they are very fine; a young shell thus appears to have a finer costellation. Under the microscope exceedingly fine concentric growth lines can be seen. The three costellae occupying the incipient sinus down the middle of the valve are slightly finer than those on each side of them.

Description of Dorsal Valve. (Plate III, figs. 18, 21). The specimen is in greyish limestone from just above the *Spirifer Limestone,* immediately north of the north end of Moon Road, Buchan; collected by Dr. C. Teichert (M.U.G.D. 1984). Valve concave; the outline and costellation are comparable with those of the ventral valve. Measurements:

Greatest width	11 mm.
Length (incomplete)	5·5 mm.

There is a short median septum, about one millimetre long. Traces of accessory septa are present (Pl. III, fig. 21). On each side of the median septum at the posterior end, and almost in continuity with it, there is a short ridge about half the length of the septum, and forming an angle of about 45° with it. The septum and ridges constitute in form a minute arrowhead. The ridges may be interpreted as crural bases.

The arrangement of the cardinalia is very similar to that occurring in *C. teicherti.*

Special Preparations

In order to elucidate structures in *C. australis* not appearing in field specimens, special preparations were made by grinding, etching, and calcining. These are now described with a few notes on technique. Line drawings were made with the help of a camera lucida. It was found that if a flat view of the specimen being drawn were required, then the use of paper of the same colour as the fossil was helpful. More often, however, a view of the specimen providing contrast was required, and in this case it was found that a contrasting shade of paper was helpful. Red brought out the relief in fawn-coloured fossils like the specimen of *C. cresswelli,* and yellow did the same for the bluish limestone containing *C. australis.*

1. *Specimen M.D.V. 47556.* The Geology Department of the University of Melbourne has designed a much improved type of fossil serial section grinder, a description of which is to appear elsewhere. It provides a thorough control of the direction of section, and a precision device lowers the fossil on to the grinding plate by movements measurable to 0·01 mm. There is thus no difficulty in cutting series of sections 0·1 mm. apart. This machine was employed for the ground sections made during the present investigation. The fossil selected was a ventral valve of *C. australis* with spines from 35 feet below the top of the Cave Limestone, south of Fairy Cave. The specimen was ground until one of the spines was clearly sectioned transversely. All except the ground surface was covered with collodion, and then the specimen was etched with concentrated hydrochloric acid, the collodion protecting the shell from attack by the acid. The result is given in Fig. 4, which shows clearly that the spines in *C. australis* were hollow.

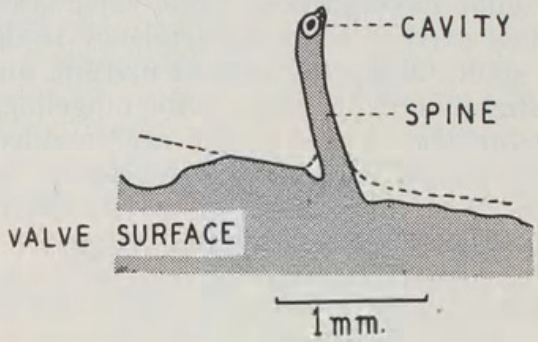

FIG. 4.—Camera lucida drawing of a specimen of *Chonetes australis* showing a spine sectioned by grinding and then etched with acid to demonstrate the cavity or lumen. The stippled area is that part of the fossil not obscured by matrix.

2. *Specimen M.D.V. 47557.* Another specimen of *C. australis* from the same locality as M.D.V. 47556 was then ground at right angles to the direction of the previous section in such a way as to provide a longitudinal section of a spine. Owing to the curve of the spine, the section is slightly oblique. The ground surface was then etched, and Fig. 5 is a camera lucida drawing of the result. When examined

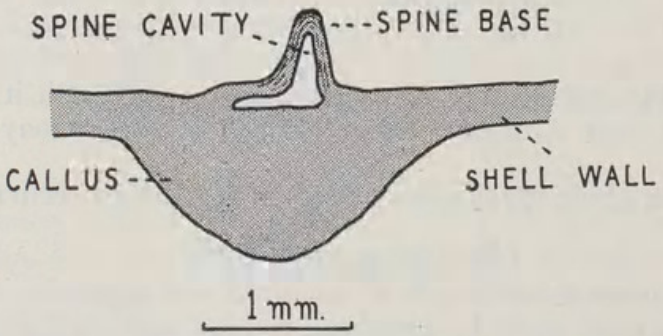

FIG. 5.—Camera lucida drawing of a section cut obliquely through a spine of *C. australis*. The section was ground and then etched with acid.

under a stereoscopic microscope, the growth lines of the spine as brought out by etching can be distinctly seen, indicating a lamellar structure. The cavity or lumen of the spine extends laterally towards the cardinal angle, and is reminiscent of subsurface extensions of spine cavities in productids figured by Dunbar and Condra

(1932, fig. 11). The spine cavity in the specimen studied does not connect with the body cavity, although it must have done so originally for the spine to be grown. Once the spine is grown, the orifice leading to the spine cavity apparently tends to become blocked by secondary calcareous deposition. This is not just the overall thickening of the valve by the addition of new lamellae on the interior, because it is so thick and localized. It rather falls within the category of a callus. No growth lines indicating lamellar structure could be made out in this part of the section in spite of acid etching.

3. *Specimen N.M.V. 15134.* This was collected by Mr. F. S. Colliver from Buchan, Victoria, and kindly presented to the National Museum. It is a mature ventral valve of *C. australis,* being a little larger than most. The whole specimen was immersed in dilute hydrochloric acid and left until a general reduction of the valve had taken place, then stood with the beak in the acid so as to bring out the interior umbonal structures. Some difficulty is usually experienced in controlling this part of the process, as it is all too easy to lose desired parts of the specimen. This has been overcome by a technique of differential etching. It was found that a tube of 1·5 mm. diameter (inside measurement) tapered at one end in the shape of an eye-dropper to 0·75 mm. diameter works well. This was dipped in a watch-glass of 12N HCl, which was drawn into the tube by capillary attraction, but on touching the fossil the acid ran out again due to surface tension effects. The tube (3 inches is a convenient length—7.5 cm.) was kept touching the fossil until the required amount of acid had run out, and by lifting it the acid ceased running from the tube. This differential etching was carried out under a low-power set-up of a wide-field binocular microscope. The method described gives safe and easy control of a dangerous reagent, and permits a controlled etching of the finest structures.

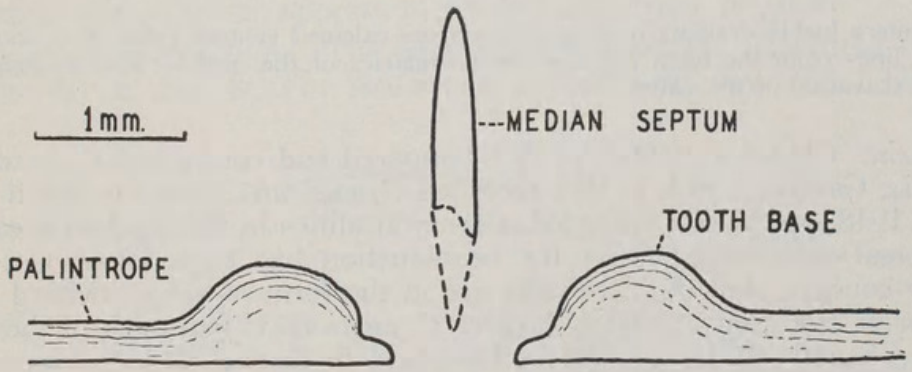

FIG. 6.—Structures on the interior of the ventral valve of *C. australis* as obtained by acid etching. Camera lucida drawing.

Figure 6 shows the interior umbonal structures of *C. australis* as obtained by etching only. The palintrope is shown to be continuous with the teeth bases (cf. Fig. 8), and the lines brought out by etching indicate the manner of growth of these structures. Between the teeth is the delthyrium. The median septum is seen to be broadest in the middle at this line of section. The muscle areas in *C. australis* are not usually defined, but in this old valve the area can be made out as a slightly excavated zone of sub-circular outline. The greatest length is approximately 7 mm. and the width 8 mm.

4. *Specimen N.M.V. 1222.* The method of calcining was employed on another specimen of *C. australis* from Buchan in order to elucidate the relationship of the

median septum to the other umbonal interior structures. After the valve had been calcined in the oxidizing flame of a Bunsen burner, the shell material was chipped and scraped away, leaving structures as shown in Fig. 7. This preparation shows that the septum, teeth and palintrope meet and fuse in the middle of the posterior margin. The T-shape of palintrope and septum, strutted together by the over-spanning shell-wall, constitutes a mechanically sound structure in which to set the articulating teeth. The teeth are placed in the strongest place, viz. the junction of the septum, palintrope, and shell wall (*vide* Gill 1950c).

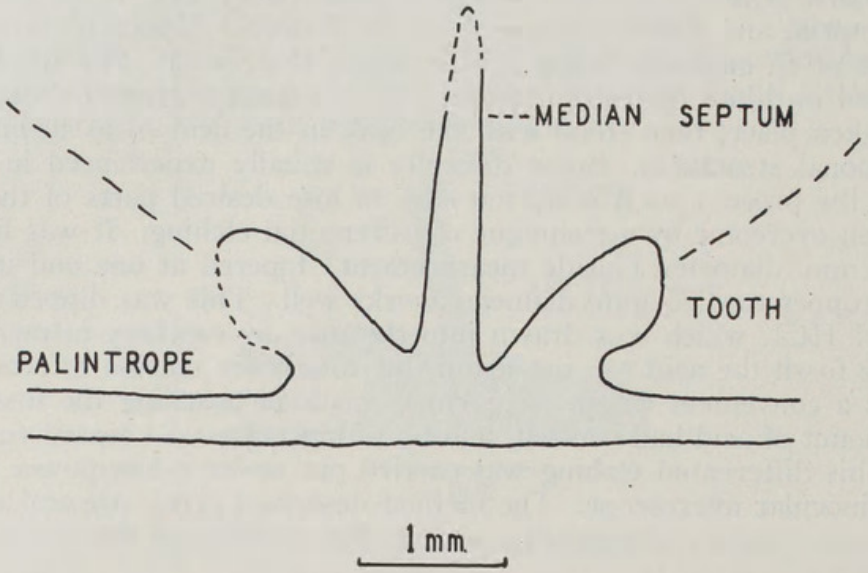

FIG. 7.—Camera lucida drawing of preparation from calcined ventral valve of *C. australis*. The broken lines from the teeth indicate the boundaries of the muscle field as suggested by a slight excavation of the valve.

Comment. Chapman (1903, p. 77) compared and contrasted *C. cresswelli* and *C. australis*, Gaskin (1943, p. 91) recorded *C. australis* from the Bindi area, and Teichert (1948, pp. 61-62) recorded it from localities in the Buchan area.

No dorsal valve satisfactory for reproduction has been found yet, but it is apparently concave, and the cardinalia are in the form of an arrowhead like those of *C. teicherti*, but proportionately larger. *C. australis* is like most of the Victorian Devonian *Chonetes* in its general outlines and in having a short ventral median septum. It differs by its possession of spines set obliquely to the hingeline, and in the character of its cardinalia. McCoy compared *C. australis* with *C. sarcinulatus*, but now that the interior structures are known, it is clear that there is really very little comparison.

Chonetes buchanensis sp. nov.

(Pl. III, figs. 17, 20; Text fig. 8)

Type material. 1. Holotype consisting of a ventral valve preserved in bluish-grey crystalline limestone (M.D.V. 48690) from big eastward bend in the Gelantipy Road, half a mile south of Murrindal State School. Collected by Dr. C. Teichert.

2. Paratype consisting of a calcined ventral valve (M.D.V. 48824). Same locality.

3. Hypotype consisting of a ventral valve broken in such a way as to reveal the umbonal structures. The specimen is M.D.V. 48825B, occurs in a bluish-grey

crystalline limestone, and comes from the ridge east of Rocky Camp, 215 feet above the top of the Cave Limestone.

Description of Holotype. Ventral valve sub-semicircular, with straight hinge-line and well rounded anterior margin. Measured in one plane, the width is approximately 22 mm. (the cardinal angles are incomplete), and the length 18 mm. Following the midline profile, the length is 28 mm. The valve is obese, the midline profile rising about 9 mm. above the plane uniting the anterior and posterior borders. The profile is steeper at the posterior end than at the anterior end, the highest point being about one third of the length of the valve from the umbo. The tumidity is much reduced about the cardinal angles. There is no longitudinal median sinus as in *Chonetes robustus*. Prosopon (for term see Gill 1950d) consists of low rounded costellae, which increase by bifurcation and intercalation. Costellae and interspaces of about equal width. Costellae number about 34 in the middle of the valve, and about 40 on the anterior margin. These numbers are minima as the cardinal angles are incomplete. The costellae tend to be irregular or sinuous, especially towards the anterior margin. Growth lines are present and these become more pronounced and wavy towards the anterior margin. The stumps of two or three spines can be recognized. In a couple of places on the valve, decortication has revealed the pseudo-punctate character of the subsurface layer of the shell wall.

Description of Paratype. Ventral valve 25 mm. wide and 20 mm. long measured in one plane. Length following profile 30 mm. Profile as holotype and rising about 9 mm. above the plane uniting the posterior and anterior margins. Costellae number about 36 in the middle of the valve, and about 42 on the anterior margin. The uneven nature of the costellae, the wavy growth lines, and the pseudo-punctation show well on the calcined specimen. Palintrope about 0·75 mm. wide. Teeth small. Fine median septum which appears to reach 6 mm. from the umbo.

Description of Hypotype. The umbonal structures are illustrated by a camera lucida drawing in Fig. 8. The structures are comparatively large. The teeth are

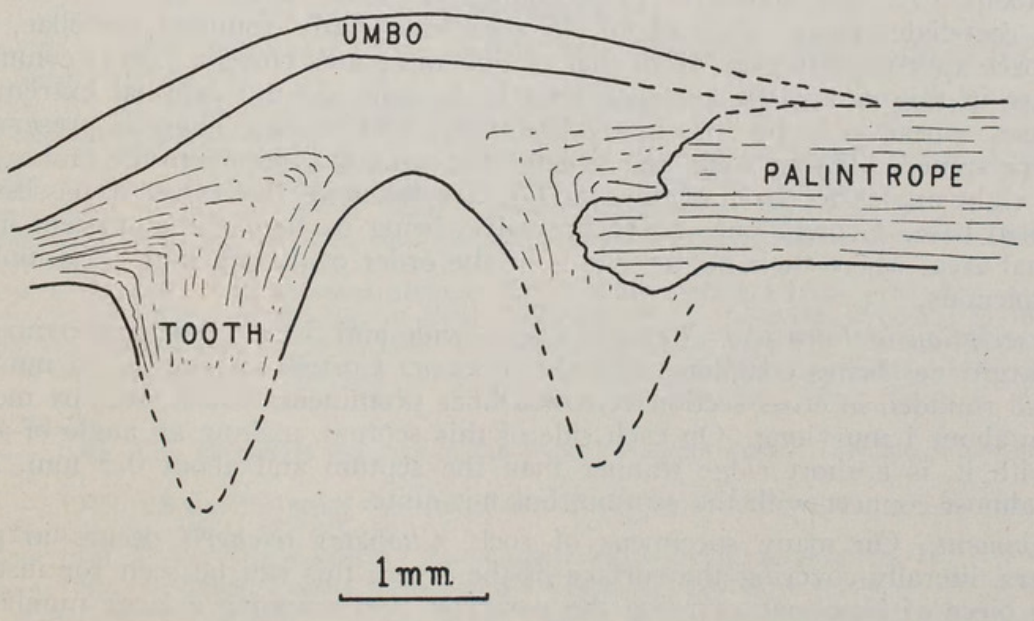

FIG. 8.—Camera lucida drawing of umbonal structures of the ventral valve of *Chonetes buchanensis* sp. nov. Broken lines indicate areas covered with matrix.

shown by the growth lines to grow outwards and downwards. The palintrope shows as a separate plate with a different direction of growth; it is of a slightly different colour in this specimen from the rest of the shell. Some of the etched specimens of *Chonetes australis* also show that the palintrope is probably a separate plate.

Comment. Chonetes buchanensis, which derives its name from the district of its origin, is clearly a member of the *Chonetes robustus* gens. From this species it differs in size, and in the absence of the median sinus. The irregular costellae and wavy growth lines are also a difference, and these features suggest group gerontism. *C. buchanensis* is probably nearest *C. baragwanathi* (Gill 1949), which is likewise of large size and possesses growth lines, but has a median sinus and is of different proportions. The costellae are sharp in *Chonetes baragwanathi* but rounded in *C. buchanensis.* Although these two species are fairly closely related, the latter possesses more marked gerontic features than the former, and this suggests that it is younger stratigraphically.

Chonetes teicherti sp. nov.

(Pl. III, figs. 12-15)

Type material. 1. Holotype consisting of a ventral valve preserved as counterparts of a ventral valve (M.U.G.D. 1979-1980) preserved in dark bluish-grey crystalline limestone from just above the Cave Limestone north of the north end of Moon Road, Buchan. Collected by Dr. C. Teichert, after whom I have the pleasure of naming the species.

2. Paratype consisting of the interior of a dorsal valve preserved in dark bluish-grey silty limestone from McLarty's Gully, Buchan District (M.U.G.D. 1982-1983 counterparts).

Description of Holotype. Valve small, sub-quadrate in outline and mildly convex. Width 5·5 mm. and length 3·75 mm., but the actual anterior margin is missing; full length probably 4·25 mm. Median longitudinal profile has its highest point about one third of its length from the midpoint of the posterior margin; the profile rises about 0·75 mm. above the plane joining the anterior and posterior margins. Valve costellate, there being about 45 somewhat flatly rounded costellae, each interspace approximating in width that of the contiguous costella. As is commonly the case in this genus, the costellae tend to be finer on the cardinal extremities. Increases appear to be by both intercalation and bifurcation. There is preserved a long fine spine, 1·75 mm. long, and situated the same distance from the umbo. It is set at right angles to the hingeline, and where it enters the valve, it possesses a thickened base. Growth lines cover the valve, being particularly prominent in the umbonal area, where their occurrence is of the order of 12 per mm. The umbo is inconspicuous.

Description of Paratype. Valve 4·5 mm. wide and 3 mm. long approximately, the margin not being complete; slightly concave. Costellae about 40 in number; low and rounded in cross-section. Growth lines prominent. Short, stumpy median septum about 1 mm. long. On each side of this septum, making an angle of about 45° with it, is a short ridge thinner than the septum and about 0·5 mm. long. They almost connect with the septum, but not quite.

Comment. On many specimens of rock, *Chonetes teicherti* occurs in great numbers, literally covering the surface of the layer; this can be seen for instance on the piece of limestone carrying the paratype. On scanning a large number of specimens, it is seen that the ventral valve commonly has a stronger central costella and the dorsal valve sometimes has a corresponding linear depression down the

midline. The ventral valve may also have the posterior part of its muscle field excavated, showing as two nodes in the steinkern. It is also clear that the species possesses two spines on each side of the umbo; a number can be seen on the specimens referred to, and they are always of the long, fine type. The commonest width for the species is 4 mm. to 4·5 mm., and the largest specimen observed was 6 mm. wide.

The new species is readily recognized by its small size, the prominent and regular growth lines (they are not wavy and aberrant as in gerontic forms), the nature of the spines, and the structures of the dorsal valve. With most species of *Chonetes* there is difficulty in obtaining dorsal valves as they are apparently weaker in construction than the ventral valves and break up more readily. When concave the dorsal valve is held within the shielding ventral valve, and when planate is like a lid to the ventral valve, in both cases being considerably protected by the other valve; it therefore did not need to be as strong as the ventral valve. However, in *C. teicherti* dorsal valves occur more frequently than is the general rule, and from this it is inferred that the dorsal valve was nearer the ventral one in strength.

Chonetes teicherti and *C. australis* occur together on the same slabs, and the difference in size is the first thing that claims attention. The new species has also been found at Slocombe's Creek, half a mile north of the East Buchan Road, near the top of the Cave Limestone (M.D.V. 47606). The species is thus characteristic of both the top of the Cave Limestone and of the overlying formation.

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Description of Plate III

Fig. 1.—*Notanoplia loyolensis* sp. nov. HOLOTYPE. N.M.V. 12403 X4.
Fig. 2.—*N. loyolensis* sp. nov. HOLOTYPE, natural size.
Fig. 3.—*N. loyolensis* sp. nov. HOLOTYPE. Umbonal view to show teeth (represented by holes in steinkern). X4.
Fig. 4.—*N. loyolensis* sp. nov. HOLOTYPE. Umbonal view, natural size.
Fig. 5.—*Chonetes cresswelli* Chapman. HOLOTYPE. N.M.V. 652, natural size.
Fig. 6.—*Chonetes micrus* sp. nov. HOLOTYPE external mould of ventral valve. N.M.V. 14699 X4.
Fig. 7.—*C. micrus* sp. nov. HOLOTYPE steinkern of ventral valve. N.M.V. 14698 X4.
Fig. 8.—*C. micrus* sp. nov. HOLOTYPE steinkern, natural size.
Fig. 9.—*C. micrus* sp. nov. PARATYPE steinkern of dorsal valve. N.M.V. 14700 X4.
Fig. 10.—*C. micrus* sp. nov. PARATYPE steinkern, natural size.
Fig. 11.—*C. micrus* sp. nov. PARATYPE external mould of dorsal valve. N.M.V. 14701 X4.
Fig. 12.—*Chonetes teicherti* sp. nov. HOLOTYPE ventral valve. M.U.G.D. 1979 X4.
Fig. 13.—*C. teicherti* sp. nov. HOLOTYPE ventral valve, natural size.
Fig. 14.—*C. teicherti* sp. nov. PARATYPE dorsal valve (incomplete). M.U.G.D. X4.
Fig. 15.—*C. teicherti* sp. nov. PARATYPE dorsal valve, natural size.
Fig. 16.—*C. bowieae* Gill. Umbonal view of a steinkern. X4.
Fig. 17.—*Chonetes buchanensis* sp. nov. HOLOTYPE ventral valve. M.D.V. 48690, natural size.
Fig. 18.—*Chonetes australis* McCoy. HYPOTYPE dorsal valve. M.U.G.D., natural size.
Fig. 19.—*C. australis* McCoy. HYPOTYPE ventral valve. M.D.V. 47639, natural size.
Fig. 20.—*C. buchanensis* sp. nov. PARATYPE ventral valve. M.D.V. 48824. Part of middle anterior of valve to show irregular costellae and growth lines. X6.
Fig. 21.—*C. australis* McCoy. HYPOTYPE dorsal valve. X4.