ORDOVICIAN NAUTILOIDS OF TASMANIA.

by

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Except as stated herein this thesis contains

no material which has been accepted for the

award of any other degree or diploma in any

university, and, to the best of my knowledge

and belief, this thesis contains no copy or

paraphrase of material previously published

or written by another person, except when

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Bryan Stait

BRYAN   STAIT.

ABSTRACT

Of the 57 species of nautiloids known in Tasmania 26 are newly described and there are 17 new genera and one new family.

The nautiloids in the Ordovician of Tasmania are divided into six biostratigraphic assemblages. The *Piloceras-Manchuroceras* assemblage is Late Canadian in age and occurs at Adamsfield in the Florentine Valley. It is composed of *Pycnoceras adamsense* n.sp., *Manchuroceras excavatum*, *M. steanei*, *Suecoceras robustum*, *Piloceras tasmaniense*, *Metamanchuroceras wadeae* n.gen.,n.sp.,and *Allocotoceras insigne*. The Whiterock *Wutinoceras-Adamsoceras* assemblage occurs in northern and western Tasmania and the Florentine Valley. It contains *Wutinoceras paucicubiculatum*, *W. multicubiculatum*, *Adamsoceras johnstoni*, *Karmbergoceras duosiphonatum* n.gen.,n.sp., and Endoceratidae n.gen.,n.sp. The *Discoceras-Gorbyoceras* assemblage is widespread in strata of Chazy to Blackriver age in Tasmania. It contains *Mysterioceras australe*, *Gorbyoceras settlementense* n.sp., *Fitzgeraldoceras juneese* n.gen.,n.sp., *Standardoceras burretti* n.gen.,n.sp.,*Orthoceras* sp., *Discoceras idaense*, *Beloitoceras* sp., *Centrocyrtocerina frizonense* n.gen.,n.sp., *Armenoceras corbetti* n.sp., *Ormocerina asymmetrica* n.gen.,n.sp., *Paramadiganella banksi* n.gen.,n.sp., *Florentinoceras calveri* n.gen.,n.sp., *Anmoceras lauriei* n.gen.,n.sp., *Octoceras uniquum* n.gen.,n.sp., *Felixoceras curtainense* n.gen.,n.sp., and *Probotryceras westfieldense* n.gen.,n.sp.. The *Tasmanoceras-Hecatoceras-Gouldoceras* assemblage is the most widespread, occurring throughout Tasmania in the Early Trenton. It contains *Anaspyroceras? anzaas*, *Discoceras reidi* n.sp., *Beloitoceras kirtoni*, *Miamoceras bubsense* n.sp., *Zeehanoceras teicherti* n.gen.,n.sp., *Tasmanoceras zeehanense*, *T. pagei* n.sp., *Hecatoceras longinquum*, *Gouldoceras synchonena*, *G. obliquum*, *G. benjaminense* n.sp.. The *Gordonoceras* assemblage is of uncertain age, probably Eden, and occurs in the Florentine Valley and the Gordon River. It contains only one species *Gordonoceras bondi*. The *Westfieldoceras* assemblage is Maysville in age and is only found in the Florentine Valley. It contains *Westfieldoceras taylori* n.gen.,n.sp., *Tigeroceras florentinense* n.gen.,n.sp., *Armenoceras?* sp., and Gouldoceratidae, n.gen.,n.sp.. *Stromatoceras eximium*, *Ephippiorthoceras decorum*,

Sinoceras? sp., *Beloitoceras? molense* n.sp., and *Centrocyrtocerina sharplesi* n.gen.,n.sp., cannot be assigned to an assemblage. The number of endemic genera in the Ordovician of Tasmania increases from a relatively low number in the Late-Early Ordovician to a very high number in the Middle and Late Ordovician.

An origin for the Discosorida in the Ellesmeroceratida is suggested by the simple two-layered connecting rings present in the Gouldoceratidae (n.fam., Discosorida). The Gouldoceratidae evolved from the Central Australian genus *Madiganella* along two different trends. The first trend is towards more orthochoanitic septal necks and a relative increase in the size of the siphuncle. The second trend is towards more cyrtochoanitic septal necks and for a change in the slope of the siphuncular segments. *Armenoceras corbetti* has dorso-ventrally differentiated adnation similar to the Wutinoceratidae and supports an origin in that family for the Armenoceratidae. *Centrocyrtocerina* is a gyroconic cyrtocerinid which evolved from the Late Canadian *Eothinoceras* through *Tangshanoceras*. *Karmbergoceras* is an unusual member of the Endoceratidae as it has two endosiphotubes adorally forming a divided endosiphocone, the phylogenetic affinities of this genus are unclear.

The shell structure is preserved in some specimens of nautiloids from Tasmania. They show that fossil nautiloids had a three-layered shell similar to that in *Nautilus* except that the oldest specimens known have only two-layers, suggesting that primitively nautiloids had only two layers and that the third (inner) layer evolved later.

ACKNOWLEDGEMENTS

LIST OF CONTENTS

*   *   *   *   *   *   *

LIST   OF   FIGURES

*   *   *   *   *   *   *

LIST   OF   PLATES

CHAPTER 1.

INTRODUCTION

Ordovician Sequence:-   The Junee Group ranges in age from the
Late Cambrian to the Early Silurian, and can be sub-divided into a
lower clastic sequence, the Denison Sub-Group, and an upper mainly
carbonate sequence, the Gordon Sub-Group (Corbett and Banks, 1974).

The Denison Sub-Group is a sequence of clastic sediments which
is widely distributed throughout Western Tasmania. Although it is
richly fossiliferous in many areas only external impressions and
badly crushed specimens of nautiloids have been found.

The Gordon Sub-Group has a similar distribution to the Denison
Sub-Group and ranges in age from Arenig to Llandovery. It reaches
a maximum thickness of 2100 metres in the Florentine Valley. In
Corbett and Banks (1974) the Gordon Limestone Sub-Group was defined
as "that sequence of marine limestone with lesser siltstone and
sandstone lying comformably between the Florentine Valley Formation
below and the Westfields Beds above". Corbett and Banks (1975)
redefined the Sub-Group to include the Westfield Beds and renamed
it the Gordon Sub-Group. This sub-group contains the majority of
the nautiloids known in Tasmania, and all the Ordovician nautiloids
described in this study have been collected from it. Figure (1.1)
is a general summary of the Lower Palaeozoic geology of Tasmania.
Other general accounts of the Lower Palaeozoic geology of Tasmania
can be found in Banks (1957, 1962) and Banks and Burrett (1980).

Choice of localities:-   Banks and Burrett (1980) based much
of their work on the Ordovician faunas and stratigraphy on the

Fig. (1.1)

ROCK DISTRIBUTION MAP OF TASMANIA

BASED ON 1:250,000 GEOLOGICAL MAP SHEETS - DEPARTMENT OF MINES
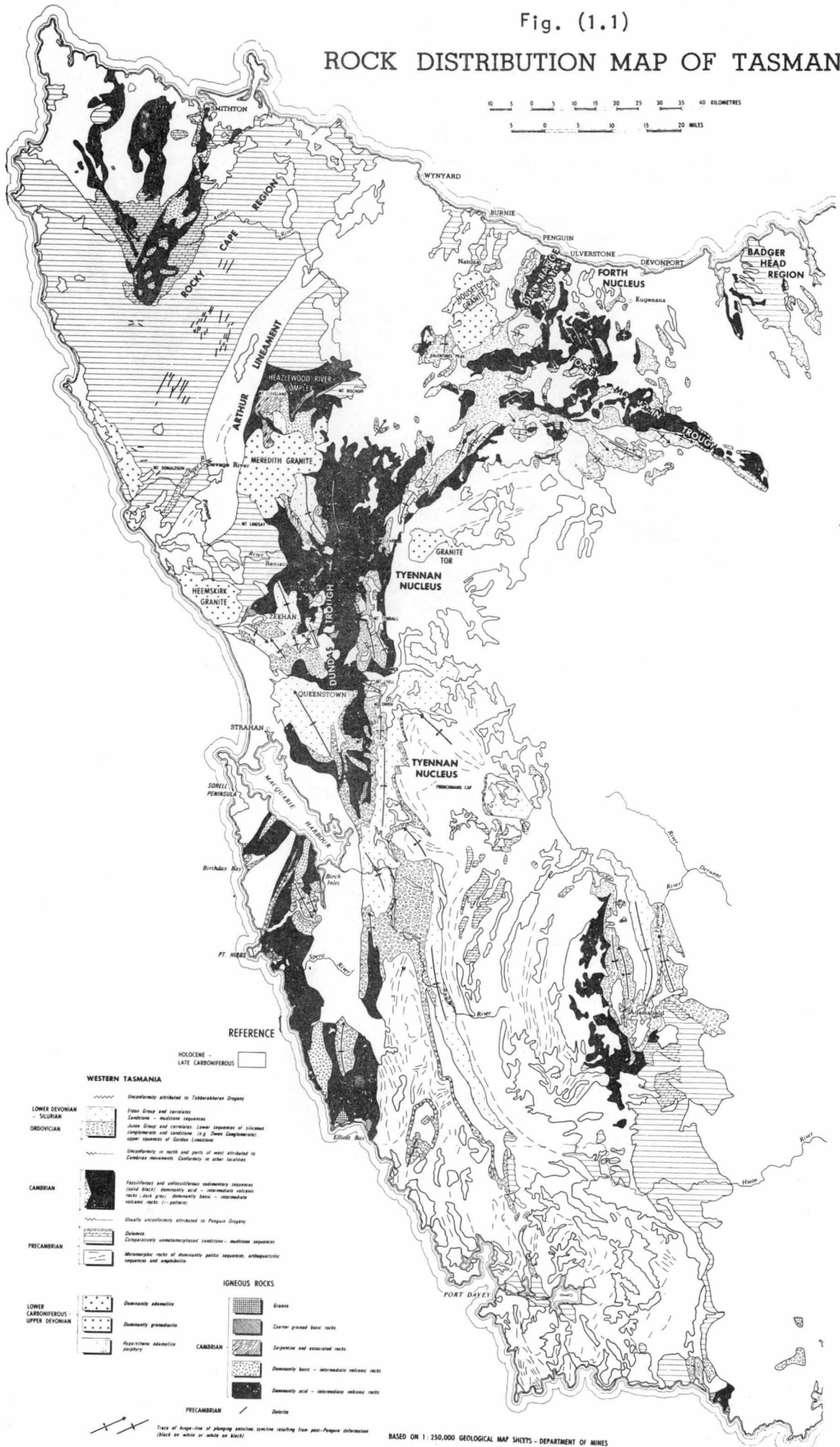
sections at Mole Creek in northern Tasmania. This area was chosen as a comparative area for the Florentine Valley sequence due to its structural simplicity, reasonable completeness, lack of thick vegetation and location in the north of Tasmania. In the present study the Florentine Valley has been chosen as the major area of study. During the 1960's and especially the 1970's, logging in the Florentine Valley has uncovered large areas of excellent outcrop of Gordon Sub-Group rocks. These sections have been studied in some detail from a sedimentological and stratigraphic viewpoint since this time by Corbett (1963), Corbett and Banks (1974), Weldon (1974), Whyte (1974), Calver (1977) and Page (1978). The combination of detailed stratigraphic information and excellent outcrop has made the Florentine Valley ideal for detailed collection of sections for taxonomic and biostratigraphic purposes. The entire Ordovician System is represented in a small area in the Florentine Valley, which is structurally simple and contains excellent outcrops (80%-90%). The problem of rapid growth of the vegetation was a major disadvantage of the Florentine Valley but this has now been circumvented by Australian Newsprint Mills agreeing to stop regrowth on the vital sections. The Mole Creek sections have been sampled to allow detailed comparison with the Florentine Valley sequence. Collections were also made from other areas of Ordovician limestone where possible to give as complete an areal cover as possible of the Ordovician in Tasmania. All sections were collected in collaboration with John Laurie who has described the brachiopods from the sequences. This was done to allow the biostratigraphy obtained to be of maximum use. Ordovician Gordon Sub-Group localities that were sampled are shown in Fig. (1.2).

Aims:- The major aims of this study were to collect nautiloids

Fig. (1.2) Distribution of the Gordon Sub-group in Tasmania (modified from Burrett, 1978).

Key to localities:

Florentine Valley	1
Bubs Hill	2
Eugenana	3
Flowery Gully	12
Gordon River	4
Gunns Plains	13
Hardwood River	5
Ida Bay	6
Mole Creek	7
Picton River	15
Precipitous Bluff	14
Queenstown	8
Railton	9
Surprise Bay	10
Wilson River	16
Zeehan	11
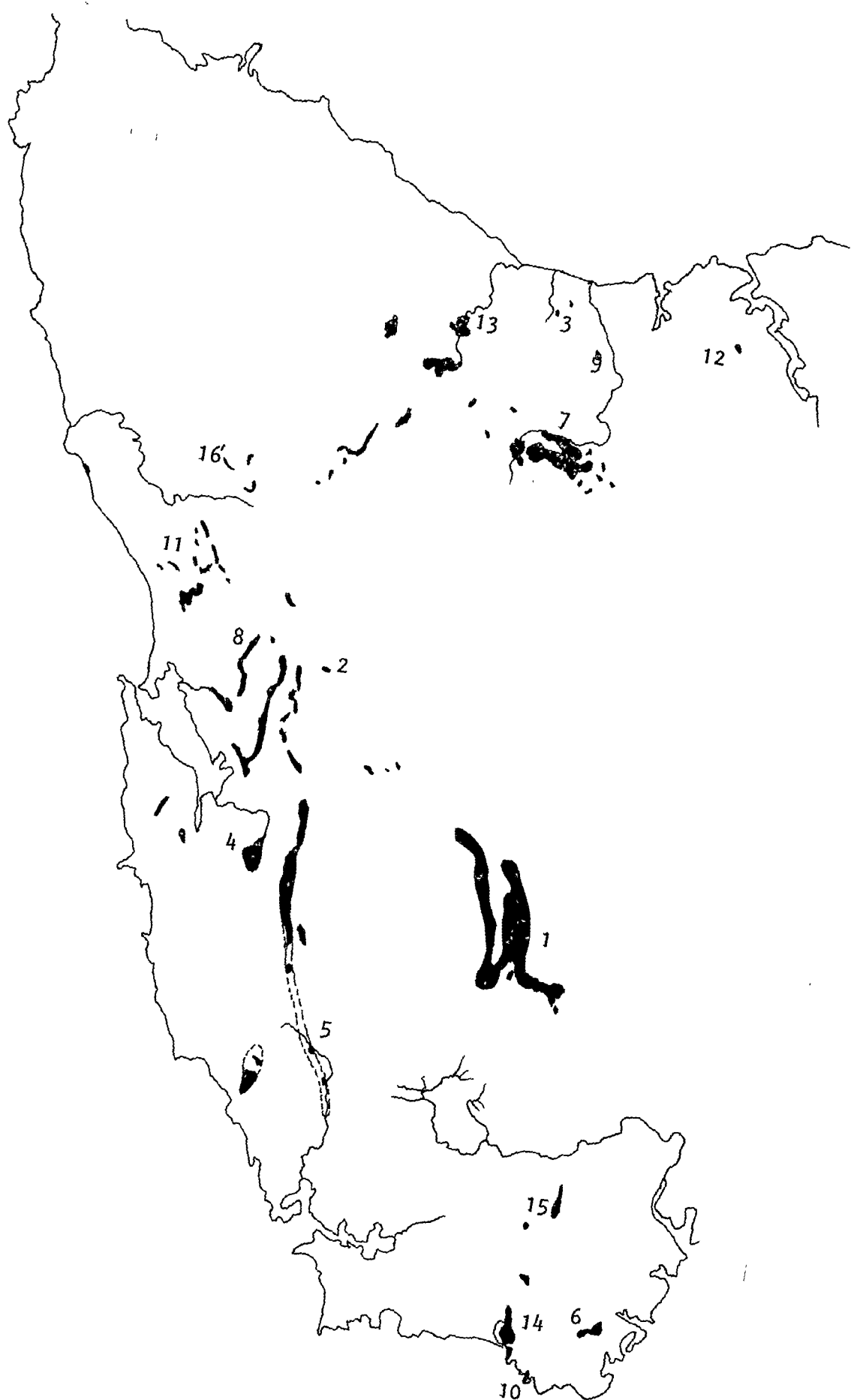
from well-studied stratigraphic sequences, allowing the biostratigraphy of the cephalopods to be determined. Previously and newly collected material was then described and the taxonomic assignment of the nautiloids determined. This combination of detailed taxonomy and known stratigraphic position allows the phylogeny of the Tasmanian Ordovician nautiloids to be determined.

CHAPTER 2.

LITHOSTRATIGRAPHY

INTRODUCTION

The following discussion is a summary of the Ordovician litho-
stratigraphy of Tasmania.   It is based on published and unpublished
work done in the last twenty years plus the examination of the
sections by the author during the collection of the nautiloid faunas.

In this study the Junee Group will not be used, but instead the
rocks will be assigned to either the Denison Sub-Group or the Gordon
Sub-Group. Fig. (2.1) is a summary of the Junee Group stratigraphy.

DENISON SUB-GROUP

The Denison Sub-Group was established for the Late Cambrian
to Middle Ordovician clastic sequences in the Denison Range. No
nautiloids collected from this sub-group were identifiable. Details
of the lithostratigraphy and biostratigraphy of the Denison Sub-
Group can be found in Banks (1962), Corbett (1975), Corbett and
Banks (1974, 1975), Laurie (1980), Banks and Burrett (1980) and
Stait and Laurie (1980).

GORDON SUB-GROUP

This is the upper carbonate dominated sub-group of the Junee
Group. All the nautiloids described in this study have been collected
from the Gordon Sub-Group. The detailed lithostratigraphy in the
following sections are based on a redefinition of the formations of
Corbett and Banks (1974).

This redefinition has been made possible following a large

GORDON		WESTFIELD	BEDS	
		BENJAMIN LIMESTONE	UPPER LIMESTONE MEMBER	
			LORDS SILTSTONE MEMBER	
			LOWER LIMESTONE MEMBER	
SUB-GROUP		CASHIONS CREEK LIMESTONE		
		KARMBERG LIMESTONE	WHERRETTS CHERT MEMBER	

DENISON	SQUIRREL CREEK FORMATION	UPPER SANDSTONE MB.	FLORENTINE VALLEY FORMATION	MT. FIELD SILTSTONE MB.
		SILTSTONE-LIMESTONE MB.		PONTOON HILL SILTSTONE MB.
		LOWER SANDSTONE MB.		CHURCHILL SANDSTONE MB.
SUB-GROUP	REEDS CONGLOMERATE		TIM SHEA SANDSTONE	
	GREAT DOME SANDSTONE			
	SINGING CREEK FORMATION			

Fig (2.1) Summary of the Gordon Sub-Group and Denison Sub-Group stratigraphy in Tasmania (modified from Stait and Laurie 1980)

amount of recent work on the Gordon Sub-Group by a number of different workers (largely unpublished). These studies have been verified and supplemented by the author and John Laurie, while the faunas were being collected from the sections. The studies on which the reassessments are based will be acknowledged in the appropriate section of the following text.

FLORENTINE VALLEY:-   The Florentine Valley, locality 1 on Fig. (1.2), contains the most complete, structurally simple and accessible sections of the Gordon Sub-Group in Tasmania, Fig. (2.2). As a result of forestry operations by Australian Newsprint Mills the area is clear of the normally dense forest and criss-crossed by roads. Vegetation on these sections grows again in a short time (10-15 years) and so sections are of a transient nature. As regrowth is now being stopped on the major sections formal definition of the formations and members of the Gordon Sub-Group can be undertaken with the knowledge that future studies will be possible.

The Gordon Sub-Group consists of the Karmberg Limestone at the base conformably overlain by the Cashion Creek Limestone which is conformably overlain by the Benjamin Limestone, and the upper most lithostratigraphic unit is the Westfield Beds. The Benjamin Limestone consists of three members, at the base is the Lower Limestone Member, which is overlain by the Lord's Siltstone Member, which in turn is overlain by the Upper Limestone Member.

The lithostratigraphy was first established by Corbett and Banks (1974), but no type sections (or tops or bases) of the formations were defined, although a map showing the distribution of the formation was included. It is now considered possible to define the formations formally, so in the following discussions the type area

FIGURE (2.2)   Florentine Valley locality map.

Key to localities:

Karmberg Limestone
             A - Nine Road
             B - Sunshine Road
             C - Manning Road

Cashions Creek Limestone
             D - Lawrence Ck Road
             E - Sunshine Road
             F - Felix Curtain Road
             G - Settlement Road
             H - Frizons Road
             N - 8 Road West

Lower Limestone Member
             I - Westfield
             J - Settlement Road
             K - Eleven Road

Upper Limestone Member
             L - Westfield
             M - Settlement Road Section.

Key to inserts:
   Insert 1:- Manning-Frizons Road , Fig. (3.4)
   Insert 2:- Westfield Section , Fig. (3.6)
   Insert 3:- Eleven Road , Fig. (3.8)
   Insert 4:- Settlement Road Section , Fig. (3.10)
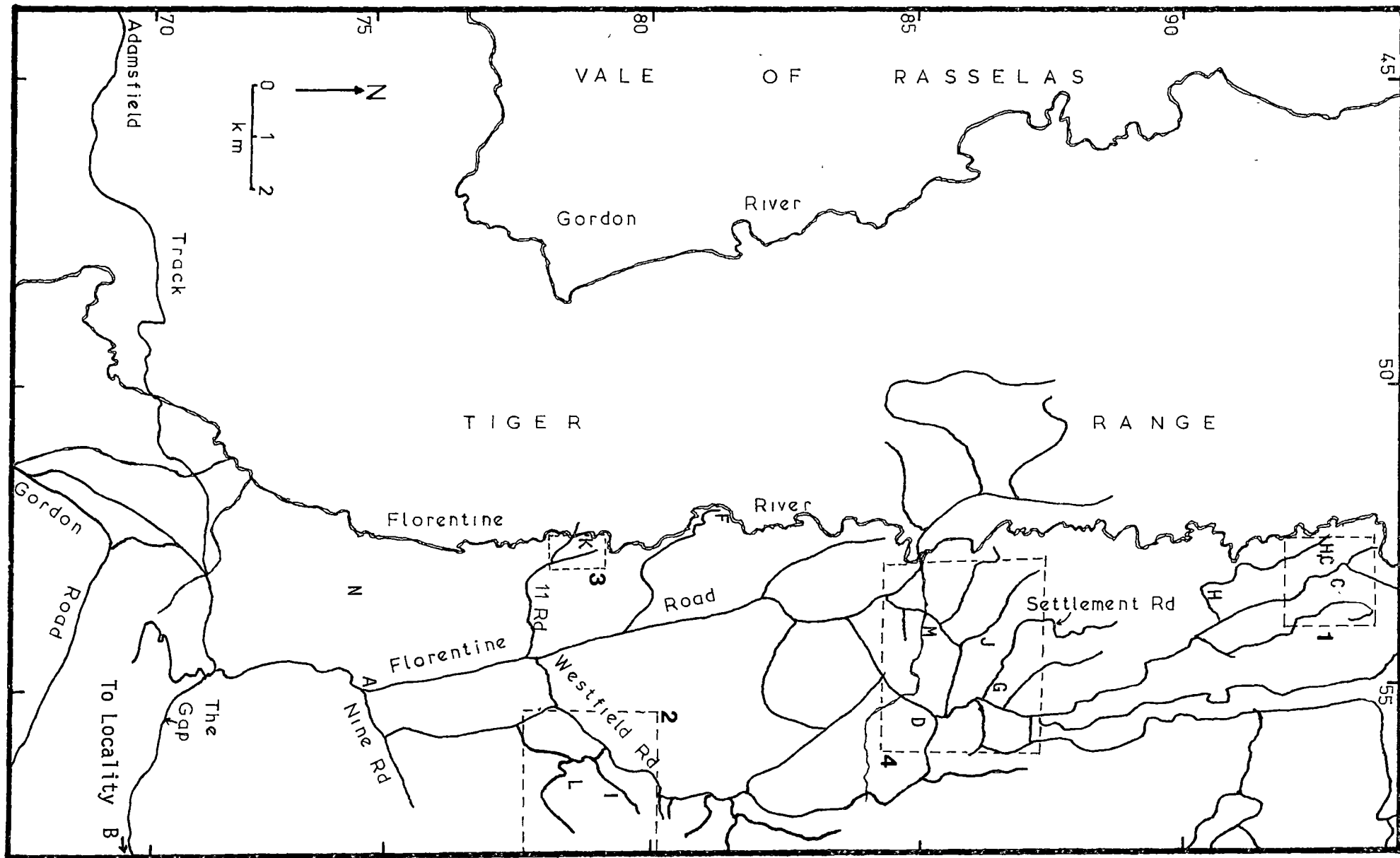
of each formation will be described and the base and top will be
defined.

Karmberg Limestone:- Corbett and Banks (1974) defined the Karmberg
Limestone as "that formation of impure limestone and chert-rich
limestone lying between the Florentine Valley Formation below and the
Cashions Creek Limestone above".   No type section was designated
and no boundaries were defined although they were shown on a map.
Recent work by the author (in conjunction with John Laurie and Clive
Burrett) has shown that a good section of Karmberg Limestone, with
both a base and a top present, exists along Sunshine Road, Fig. (3.1).
There are no other complete sections of Karmberg Limestone known;
the other major sections are at the Gap, the Florentine Road-Nine
Road junction, locality A on Fig. (2.2) and the hills on either side
of the Florentine Road near Manning Road, locality C on Fig. (2.2).

The type section of the Karmberg Limestone is herein defined
as occurring along Sunshine Road, with the base defined as occurring
above the Florentine Valley Formation at the first appearance of
lenses of limestone (State grid ref. 643689).   The base is transi-
tional., The top of the Karmberg Limestone is defined as the first
appearance of abundant oncolites (greater than 50%) on the Sunshine
Road (State grid ref. 645694).   The Karmberg Limestone is 320
metres thick.   Fig. (3.3) is a section through the Karmberg Lime-
stone at Sunshine Road.   The top of the Florentine Valley Formation
was defined by Stait and Laurie (1980) at the Gap, but is not taken
as the base of the Karmberg Limestone as the outcrop of that forma-
tion is poor.   The lithology of the upper Florentine Valley Forma-
tion and lower Karmberg Limestone both at the Gap, Fig (2.2-A),
and at Sunshine Road, Fig (2.2-E), are very similar.   The Karmberg

Limestone consists predominantly of impure limestone, but there is a part of the formation which has a very high chert content. Corbett and Banks (1974) separated this chert rich part from the rest of the Karmberg Limestone as the Wherretts Chert Member. They defined the Wherretts Chert Member as "that unit of dark grey limestone containing up to 50% chert". The Wherretts Chert Member is herein defined as the limestone with a large number of chert nodules occurring along the Sunshine Road in the middle to upper part of the Karmberg Limestone. The base of the Wherretts Chert member occurs at 220 metres above the base of the formation, the member is approximately 40 metres thick. The greatest thickness of the Wherretts Chert Member, 180 metres, occurs on the slopes of Wherretts Lookout, but the lack of other outcrop of the Karmberg Limestone and extremely difficult access makes this section less useful as a type section.

The Karmberg Limestone is a distinctive lithofacies consisting of a thickly-bedded sequence of nodular limestone as well as the chert-rich, dark micrite of the Wherretts Chert Member. The nodular limestone has silty, dolomitic and bituminous partings which anastomose to form a "rod-like" structure.

Manning Road:- The Karmberg Limestone on the hills either side of the Florentine Road just south of its intersection with Manning Road is approximately 70 metres thick. The base is unknown with an unconformable contact with the overlying Late Palaeozoic Parmeener Super-Group at the top of the hill to the south-east of the Florentine Road. The top of the Karmberg Limestone is a contact with the Cashions Creek Limestone at the top of the hill to the south-west of the Florentine Road, locality C on Fig (2.2), which is transitional over approximately 15 metres with the oncolite-rich beds gradually

increasing in number when compared to the nodular limestone typical of the Karmberg Limestone. There is no chert known in this section.

Cashions Creek Limestone:-   The Cashions Creek Limestone was defined by Corbett and Banks (1974) as "that formation of thick-bedded dolomitic limestone containing abundant *Girvanella* colonies which form a prominent strike ridge in many areas ...". They did not define a top or base or a type section. A near complete section of the Cashions Creek Limestone exists at Felix Curtain Road, where it is 100 metres thick, with both a top and base present. The Cashions Creek Limestone is only 30 metres thick at Sunshine Road. A recently uncovered section between Settlement Road and Frizons Road may with future detailed examination prove to be the most complete section known. So until this section has been measured a type section for the Cashions Creek Limestone is not defined.

Lawrence Creek Road:-   Corbett and Banks (1974) stated that the Cashions Creek Limestone outcropped best "where Cashions Creek is crossed by an easterly branch from Lawrence Creek Road". They estimated the thickness as 150 metres. They did not define a top or a bottom to the section in this area. Regrowth in the area has made recollection of this section impossible. The location is D in Fig. (2.2).

Felix Curtain Road:-   The Cashions Creek Limestone at Felix Curtain Road is 100 metres thick. Both the top and the base are present, but very little of the Karmberg Limestone or Lower Limestone Member outcrop in this area. The lithologies are typical of the Cashions Creek Limestone with oncolite-rich micrite predominating. The Felix Curtain section is locality F on Fig. (2.2).

Settlement Road:-   The Cashions Creek Limestone at Settlement
Road is 180 metres thick. The underlying Karmberg Limestone is not
exposed at Settlement Road. Above the Cashions Creek Limestone is
extremely good outcrop of nearly the entire Benjamin Limestone. The
top of the Cashions Creek Limestone is at State grid. ref. sheet
8112 568863. The Limestone is oncolitic micrite with some beds
rich in dolomite. The Settlement Road section is locality G on
Fig. (2.2).

Frizons Road:-   The Cashions Creek Limestone at Frizons Road
is 200 metres thick. Both the base and top of the Cashions Creek
Limestone are exposed in the same section and the outcrop is near
100%. This section also has the advantage of being very close to
the Settlement Road section where a nearly complete sequence of the
Benjamin Limestone exists. This section was only very recently
(1980) cleared by forestry operations, and as yet has not been
studied in detail. It has been uncovered too late to be included
in this thesis, but future examination will almost certainly prove
it to be the best section of the Cashions Creek Limestone in the
Florentine Valley. Frizons Road is locality H on Fig. (2.2).

Sunshine Road:-   The Cashions Creek Limestone at Sunshine Road is
only 30 metres thick. The limestone is the typical oncolitic lime-
stone with some dolomite present. The stratigraphic sequence is
shown in Fig (3.5) and the locality is E on Fig. (2.2). The base
of the Cashions Creek Limestone is transitional with the underlying
Karmberg Limestone and is overlain by the Lower Limestone Member
of the Benjamin Limestone.

Benjamin Limestone:- Corbett and Banks (1974) defined the Benjamin
Limestone as "That formation of limestone and minor siltstone lying

between the Cashions Creek Limestone below and the siltstone and sandstones of the Westfield Beds above". The Benjamin Limestone is approximately 1200 metres thick. The Benjamin Limestone is made up of three members, these are at the base the Lower Limestone Member, which is overlain by the Lord's Siltstone Member, which is overlain by the Upper Limestone Member. The Benjamin Limestone is the major formation in the Gordon Sub-Group. The only complete section of the Benjamin Limestone known is at Westfield. This section is now difficult to study due to the regrowth in the area.

Lower Limestone Member:- Corbett and Banks (1974) did not define the Lower Limestone Member or name a type section. They only made general comments about the localities and lithology of the member. Recent work by Clive Calver(1979-80), in conjunction with the author and John Laurie, has shown that there is a very good section of the Lower Limestone Member at Settlement Road. The only other complete section of the Lower Limestone Member known in the Florentine Valley is at Westfield; this was studied by Weldon (1974) and Calver (1977). Other sections of the Lower Limestone Member are at Eleven Road (K on Fig. (2.2)) and the Junee Quarry Road, Fig.(3.1) .

The type section of the Lower Limestone Member is herein defined as occurring to the north of Settlement Road to the south of Sixteen Road, Fig (3.10). The base is defined as occurring above the Cashions Creek Limestone at the first appearance of calcisiltite and the last appearance of a dominant oncolitic micrite (State grid ref. 586863). The boundary at the base is transitional. The top of the Lower Limestone Member is defined as the first appearance of the buff-coloured siltstone of the Lord's Siltstone Member (State grid ref. 559861). The boundary is conformable and well defined.

The Lower Limestone Member is 610 metres thick. The dominant

lithologies in the Lower Limestone Member are algal-laminated micrite

birds eye micrite, and horizontally-burrowed micrite. The strati-

graphic sequence through the Lower Limestone Member is shown in

Fig.(3.11). The Settlement Road section occurs at J on Fig. (2.2),

the section collected is B-B^1, C-C^1 and D-D^1, and E-E^1 on Fig.

(3.10).

Westfield:- The Westfield section was first examined in detail

by Weldon (1974) and contains a sequence from the upper Cashions

Creek Limestone to the top of the Westfield Beds. Regrowth since

the initial study has reduced the usefulness of this section. Calver

(1977) examined the Lower Limestone Member at Westfield in detail.

The Lower Limestone Member at Westfield is 450 metres thick, it over-

lies the oncolitic limestone of the Cashions Creek Limestone and is

overlain by a 15 metre thick siltstone band which is correlated

with the Lord's Siltstone. The author follows Page (1978) in plac-

ing the top of the Lower Limestone Member at Westfield at the thick

siltstone band 65 metres above the point taken by Calver (1977) as

the top. The dominant lithologies in the Lower Limestone Member

at Westfield are in the lower 100 metres, thick-bedded dolomitic

micrite, while in the upper part burrowed micrite, algal-laminated

micrite and dolomitic micrite predominate. The Westfield section

is locality I on Fig. (2.2.). The stratigraphic section through

the Westfield section is given in Fig. (3.7), while the plan of the

Lower Limestone Member outcrops is given in Fig. (3.6).

Eleven Road:- The Lower Limestone Member at Eleven Road (locality

K, Fig. (2.2)) was examined by Calver (1977) and is 480 metres thick.

The Lower Limestone Member (Fig. (3.8)) is underlain by the

Cashions Creek Limestone, but a siltstone band, equivalent to the Lord's Siltstone, has not been found. The lithologies at Eleven Road indicate a larger amount of intertidal sediments than is typical in the other sections in the Valley, the dominant lithofacies are intrasparite, burrowed micrite (mainly horizontally-burrowed), and algal-laminated micrites.

Lord's Siltstone:- The Lord's Siltstone was defined by Corbett and Banks (1974) as "that unit of buff coloured micaceous and fine sandstone, about 15 m (50 feet) thick, exposed on the main Florentine Road 200 m east of the Florentine River bridge". As this locality is only one kilometre from the new type section of the Benjamin Limestone at Sixteen Road area and is traceable between the two localities the Lord's Siltstone is not redefined. The base of the Lord's Siltstone therefore occurs at State grid ref. 555835. The Lord's Siltstone horizon is the only major clastic horizon known in the Benjamin Limestone and therefore makes a useful marker horizon within the bounds of the Florentine Valley, to separate the Lower Limestone Member from the Upper Limestone Member.

Upper Limestone Member:- The Upper Limestone Member was defined by Corbett and Banks (1974) as the upper part of the Benjamin Limestone conformably underlain by the Lord's Siltstone Member and overlain by the Westfield Beds. Corbett and Banks (1974) designated no type section. Weldon (1974) described a section through the Upper Limestone Member at Westfield (L on Fig. (2.2)). This section has the advantage that both the top and base of the member are present, but the disadvantage that regrowth has greatly reduced the outcrop. The other important section of the Upper Limestone Member is at Settlement-Sixteen Road; this was studied by Page (1978).

At Sixteen-Settlement Road there is a good outcrop and the base is well preserved, but the top does not outcrop. Therefore, as no good section of the Upper Limestone Member is known the member will not be redefined in this study, but will be left for a future study when a new area may be cleared by forestry operations.

Westfield:- The Westfield section was first examined by Weldon (1974); he discussed the general petrographic characteristics and depositional environment, but not the detailed stratigraphy. Calver (1977) remeasured the Upper Limestone Member and briefly described the sequence. Page (1978) examined the Westfield section in detail with particular emphasis on the lithostratigraphy and palaeoecology and measured the section which is 740 metres thick. The Upper Limestone Member at Westfield is dominantly silty, impure micrite, horizontally-burrowed micrite, massive unfossiliferous micrite, fossiliferous micrite, and coral and stromatoporoid-rich calcarenite. The upper part of the Upper Limestone Member is very rich in coral and stromatoporoid fragments. Fig. (3.12) is a simplified stratigraphic section through the Upper Limestone Member at Westfield, based on Page (1978). The locality is I on Fig. (2.2).

Settlement-Sixteen Road:- Page (1978) studied the Upper Limestone Member at Settlement-Sixteen Road, J on Fig. (2.2), where it is 480 metres thick. The top of the member is not preserved in this section, though it was probably of similar thickness to the Westfield section, Fig. (3.13). At Settlement-Sixteen Road the Upper Limestone Member conformably overlies the Lord's Siltstone Member and there is very good outcrop (approximately 70-80%). The lithofacies are similar to the Westfield section with silty, impure micrite being dominant, with horizontally-burrowed micrite, massive unfossiliferous

micrite and fossiliferous micrite being the other common lithofacies.

Westfield Beds:- The Westfield Beds are the uppermost unit of the Gordon Sub-Group. Corbett and Banks (1974) defined the Westfield Beds as "that unit of buff-coloured siltstone and fine sandstone, with some coarse sandstone ...". Baillie (1979) considered that the Westfield Beds correlated with part of his Arndell Sandstone, which outcrops on the Tiger Range. The Westfield Beds are at least 150 metres thick.

BUBS HILL:- The Gordon Sub-Group at Bubs Hill, locality 2 on Fig. (2.2) is represented by 350 metres of dark grey micrite, commonly with patches of dolomite and becoming more silty towards the top of the sequence. Reid (1964) mapped the Princess River area and he measured a section, and collected the fauna, through the limestone at Bubs Hill, Fig (3.14). Reid (1964) described the sequence as follows: "... consists of a succession of medium to dark grey hard limestones of variable composition, and minor intercalations of calcareous siltstone, lime sandstones and dolomites". The section contains a number of fossiliferous horizons and those containing nautiloids are shown in Fig. (3.14).

GORDON RIVER-OLGA RIVER AREA:- The Gordon Sub-Group in the Gordon River-Olga River area, locality 4 in Fig. (1.2), was studied by Collins (1975). The sequence is approximately 1500 metres thick. The dominant lithologies are silty, impure micrite and calcarenite. The position within the sequence from which the specimens described in Teichert and Glenister (1953) were collected is not known.

HARDWOOD RIVER:- The Gordon Sub-Group at the Hardwood River, locality 5 in Fig. (1.2), has not been examined in detail. The

inaccessibility of this area is such that resampling of the sequence would be extremely difficult. The sequence has Denison Sub-Group clastics below and there may be a chert-rich horizon on the lower part of the limestones of the Gordon Sub-Group in the Hardwood River region.

IDA BAY:- At Ida Bay (Lune River) area in south-eastern Tasmania, locality 6 on Fig. (1.2), are 350 metres of limestone of the Gordon Sub-Group. The area was first examined in detail by Twelvetrees (1915) and more recently by Everard (1957), Forsyth and Green (1976), and Sharples (1979). The stratigraphic section, Fig. (3.15), and details of the lithofacies used in this study is taken from Sharples (1979). The Ida Bay limestones are exposed in a number of quarries, the lowest part of the section in a cave. There is very good exposure in the quarries and cave, but quite large gaps between. The dominant lithologies and palaeoenvironments at Ida Bay are a supratidal-upper intertidal birdseye micrite, a subtidal burrowed micrite, an intertidal burrowed intrapelsparite, and an intertidal micrite and biomicrite containing a high percentage of dolomite.

MOLE CREEK:- The carbonate portion of the Gordon Sub-Group at Mole Creek, locality 7 on Fig. (1.2), is represented by the Chudleigh Limestone. The Chudleigh Limestone is 1300 metres thick and overlies the Moina Sandstone and is overlain by the uppermost clastics of the Gordon Sub-Group. The area was examined by Drs. Banks and Burrett, with seven members being established within the Chudleigh Limestone by Burrett (1978). The lowermost member is the Standard Hill Member which is 145 metres thick and is oncolitic limestone with minor calcarenite beds. The Standard Hill Member is overlain by the Ugbrook Nodular Member which is 120 metres thick and consists

of nodular limestone and minor micrites. The next member is the
Sassafras Creek Member which is 135 metres thick and consists of
micrites and dolomitic micrites with some nodular micrite. This is
overlain by the Dog's Head Member which is 450 metres thick and con-
sists of micrites and dolomicrites; chert is common in the lower third
of the member. Above the Dog's Head Member is the Mole Creek Member
which is 75 metres thick and consists of a reddish siltstone, black
shales, micrites and calcarenite. Next is the Overflow Creek Member
which is 240 metres thick and consists of dolomicrites and dolosilt-
ites. The uppermost member is the Den Coralline Member which is
45 metres thick and consists of Coralline calcirudite and micrites.
The Den Coralline Member is overlain by buff-coloured siltstones of
the uppermost Gordon Sub-Group.

The best exposure of the Chudleigh Limestone is to the west of
Mole Creek, Fig. (3.17). Burrett (1978) measured two sections through
the sequence, these are shown on Fig. (3.18). Seymour (1975) des-
cribed the geology south of Standard Hill. No sections there were
sampled in the present study, but the lithostratigraphy is similar
to that described by Burrett (1978). Kenna (1978) described the
Den Coralline Member in more detail.

QUEENSTOWN:- Due to structural complication the detailed Ordovician
stratigraphy in the Queenstown area, locality 8 in Fig. (1.2), has
not been determined. The section shown in Fig(3.20) is through the
Smelter's Quarry and up to a calcareous siltstone to the north of
the Quarry. In the Smelter's Quarry the limestone is steeply dipping
(nearly vertical), highly-cleaved limestone. The limestone in the
Quarry sequence contains no facing evidence, so the section shown in
Fig(3.20) may be inverted.

RAILTON:- The Gordon Sub-Group at Railton, locality 9 in Fig. (1.2), consists of at least 800 metres of limestone. The top is unknown, but at the base, the clastics of the Denison Sub-Group are overlain by a nodular limestone at Blenkhorn's Quarry. At the top of the "Blenkhorn's Quarry Limestone" are 11 metres of siltstone and above this,in the Goliath cement quarries,is a dark-grey massive limestone.

SURPRISE BAY:- The Gordon Sub-Group at Surprise Bay, locality 10 on Fig. (1.2), is a monotonous sequence of interbedded thin dark grey limestones and siltstones or calcareous siltstones, which is 325 metres thick. In the lower half of the sequence lenses of light grey calcarenite are common. In the upper 100 metres the sequence contains less siltstone and there is at least one thin (70mm) iron and phosphate-rich horizon . A stratigraphic section through the Surprise Bay sequence is given in Fig. (3.21).

ZEEHAN:- The Gordon Sub-Group in the Zeehan district, locality 11 on Fig. (1.2), varies in thickness, with Pitt (1962) estimating a thickness of 500 metres near the Zeehan township, while Gill and Banks (1950) estimated a thickness of 650 metres at Grieves Siding. Pitt (1962) measured a section through the Gordon Sub-Group near the Zeehan township at Smelter's Quarries, Fig (3.23). The limestone at Zeehan is dominantly a dark grey impure limestone with dolomite common in some areas. Due to the acidic weathering in the area much of the limestone has been reduced to a decalcified residual clay known as pug.

SUMMARY

The dominantly clastic Denison Sub-Group and the dominantly carbonate Gordon Sub-Group together constitute the Junee Group. As the only identifiable nautiloids are found in the Gordon Sub-Group its lithostratigraphy has been discussed in detail. The wide areal cover of the Gordon Sub-Group in the western half of Tasmania has necessitated the establishment of a number of formation names. These names and the correlations (mainly biostratigraphic) between them are given in fig. (2.3).

The Gordon Sub-Group sequence in the Florentine Valley is the most complete and important. Four formations have been defined, the Karmberg Limestone, the Cashions Creek Limestone, the Benjamin Limestone and the Arndell Sandstone (= Westfield Beds). The Benjamin Limestone is composed of the Lower Limestone Member, the Lords' Siltstone Member and the Upper Limestone Member.

The other major sequence of the Gordon Sub-Group is the Chudleigh Limestone at Mole Creek in Northern Tasmania. The Chudleigh Limestone is composed of the Standard Hill Member, the Ugbrook Nodular Member, the Sassafras Creek Member, the Dogs Head Member, the Mole Creek Member, the Overflow Creek Member and, uppermost, the Den Coralline Member.

Many other areas, such as Ida Bay, Zeehan, Queenstown, Precipitous Bluff, Surprise Bay, and Bubs Hill, have thick sequences of carbonates belonging to the Gordon Sub-Group.

Fig. (2.3)   A correlation chart of the Ordovician
        lithostratigraphy in Tasmania.

            Florentine Valley; locality 1 on Fig. (1.2)
            Mole Creek; locality 7 on Fig. (1.2)
            Ida Bay; locality 6 on Fig. (1.2)
            Queenstown; locality 8 on Fig. (1.2)
            Zeehan; locality 11 on Fig. (1.2)
            Bubs Hill; locality 2 on Fig. (1.2)
            Railton; locality 9 on Fig. (1.2)
            Surprise Bay; locality 10 on Fig. (1.2)

FLORENTINE VALLEY	MOLE CREEK	IDA BAY	QUEENSTOWN	ZEEHAN	BUBS HILL	RAILTON	SURPRISE BAY
Westfield Beds	Siltstone				Crotty Quartzite		
Upper Lst Mb.	Chudleigh Lst. (upper part)	Ida Bay Lst.		Smelters Quarry Lst.	Bubs Hill Lst.		Limestone
Lords Siltstone	siltstone		Smelters Quarry Lst.				
Lower Lst Mb	Chudleigh Lst. (lower part)	Limestone		Limestone		Lst at Goliath	
Cashions Ck Lst						Blenkhorns Quarry	
Karmberg Lst.	Moina Sandstone	Denison Sub-group					
Florentine Valley Fm.	Roland Conglomerate						
Tim Shea S.S.	Cambrian						

CHAPTER 3.

BIOSTRATIGRAPHY

INTRODUCTION

The Ordovician of Tasmania had not been studied from a bio-stratigraphic point of view until recently, with the bulk of the palaeontological work being done without detailed stratigraphic control. Etheridge (1883) described Ordovician fossils from Tasmania, since then there has been a small number of studies on Tasmanian faunas; for a summary of these works see Banks and Burrett (1980).

The oldest Ordovician fauna is a Mesial Tremadoc (Early Canadian) fauna from the Florentine Valley Formation in the Florentine Valley, while the Westfield Beds at the Westfield Quarry in the Florentine Valley are earliest Silurian.

In recent years studies which integrate the palaeontology with detailed collecting in stratigraphically controlled sequences have been published (Corbett and Banks, 1974; Banks and Burrett, 1980; Stait and Laurie, 1980; Laurie, 1980; and Burrett, Laurie and Stait, 1981), but the bulk is as yet unpublished (Stait, 1976; Calver, 1977; Page, 1978; Burrett, 1978; Kenna, 1978; Sharples, 1979 and Laurie, 1982). Of these studies the two most important biostrati-graphically are Burrett (1978) on the conodonts and Laurie (1982) on the brachiopods. These two studies have allowed a detailed bio-stratigraphic framework to be established for the Ordovician of Tasmania and have made intercontinental and detailed internal cor-relations throughout Tasmania possible. The nautiloids are not as useful for intercontinental correlation as the conodonts nor are they abundant enough to compete with the brachiopods for internal

correlations. However they do allow a check to be made on both the internal and external correlations and in some cases (e.g., Ida Bay) they are the major macrofossil correlation at present (as brachiopods are very rare at Ida Bay).

The major stratigraphic section under study will be the Forentine Valley sequence. The other areas of Tasmania from which nautiloids have been collected will be correlated back to the Florentine Valley sequence. The correlations with the sequences outside the Florentine Valley will be made on the best information available, not necessarily the nautiloids. The international correlations will also largely be based on the conodonts with the nautiloids being used to verify the correlations obtained, or, as in the case of China, the nautiloids may be the major group used to correlate.

The conodont biostratigraphy established by Sweet, Ethington and Barnes (1971) was updated and related to the North American stages by Sweet and Bergström (1976) and therefore this paper is the one used throughout this thesis.

DENISON SUB-GROUP

No identifiable nautiloids have been found in the Denison Sub-Group. The only formation in the Denison Sub-Group which has been subdivided biostratigraphically is the Florentine Valley Formation. The Florentine Valley Formation has been divided into assemblages OT1-OT7. For details of the composition and position of these assemblages see Stait and Laurie (1980)(included in appendix 4). Banks and Burrett (1980) included the Denison Sub-Group assemblages in their Ordovician biostratigraphy.

GORDON Sub-GROUP

Corbett and Banks (1974) briefly described the faunas which occurred in the type sections of the Gordon Sub-Group, but this was only a preliminary biostratigraphy. Recently Banks and Burrett (1980) have combined all the palaeontological work up to 1979 to give a

preliminary biostratigraphy. In this paper they established thirteen faunal assemblages in the Gordon Sub-Group throughout Tasmania. These assemblages were based on total faunal information available at the time of publication. The assemblages were labelled OT8-OT20.

These faunal assemblages can now be supplemented by a biostratigraphic zonation based only on brachiopod genera (Laurie, 1982). This zonation can be correlated at the species level from the type Florentine Valley sequences to the northern part of Tasmania, thus enabling precise correlations to be made. There are 17 brachiopod biozones in the Ordovician of Tasmania, their composition and range is given in figure (3.24).

The nautiloids are not very useful for correlation within Tasmania, largely because of their comparative rarity.

FLORENTINE VALLEY:- The Florentine Valley sequences are the most complete sections of Ordovician rocks known in Tasmania. They were chosen as the sequences to be studied in most detail. The other areas collected in this study will be compared to the Florentine Valley sections. Correlations within the Florentine Valley, based on nautiloids, is very difficult. Nautiloids tend to be rare and it is uncommon to find one species in more than one section. The major horizon that can be used for correlation is the *Tasmanoceras-Hecatoceras-Gouldoceras* assemblage; of this assemblage *Tasmanoceras* and *Hecatoceras* are wide spread in the Florentine Valley. Each section of each Ordovician formation was collected in as much detail and over as wide an area as possible, fig. (2.2.). The Lower Limestone Member of the Benjamin Limestone contains the most diverse nautiloid fauna, with very few species known in other formations (or parts of

formations).

John Laurie collected the brachiopods from the same sections and has been able to establish a detailed biostratigraphic zonation of the Ordovician in the Florentine Valley, fig.(3.24). Conodonts have also been collected from the Florentine Valley sections (Burrett, 1978) and are of use in determining the age relations and in correlation.

Banks and Burrett (1980) established a preliminary biostrati-graphy of the Ordovician, based on a State-wide appraisal, but most of the OT assemblages can be recognized in the Florentine Valley.

Karmberg Limestone:- Other than the diverse endoceroid fauna at the base of this formation nautiloids are uncommon. Teichert (1947) and Teichert and Glenister (1953) described an endoceroid fauna from the basal Karmberg Limestone at Adamsfield, fig. (2.2), the species described were *Manchuroceras excavatum*, *M. steanei*, *Suecoceras robustum*, *Piloceras tasmaniense*, *Allocotoceras insigne*, *Endoceras* sp., and *Utoceras*(?). In the present study *Metamanchuroceras wadeae Pycnoceras adamense* have also been described from the same horizon. *Piloceras* cf. *tasmaniense* also occurs in the basal Karmberg Limestone at the Gap (A on fig. (2.2)), but no other nautiloids have been collect-ed from this locality. A diverse conodont fauna from the basal Karmberg Limestone at the Gap correlates with the zone of *Prioniodus evae* (Upper Canadian)(Burrett and Stait, in prep.). *Karmbergoceras duosiphonatum* occurs in the Sunshine Road section (B on fig. (2.2)), fig. (3.1), 290 metres above the base, fig. (3.3.). This is probably Whiterock in age, based on conodont and brachiopod evidence. *Wutinoceras* cf. *paucicubiculatum* has been collected from two localities in the Florentine Valley; both specimens occur in the Wherrett's
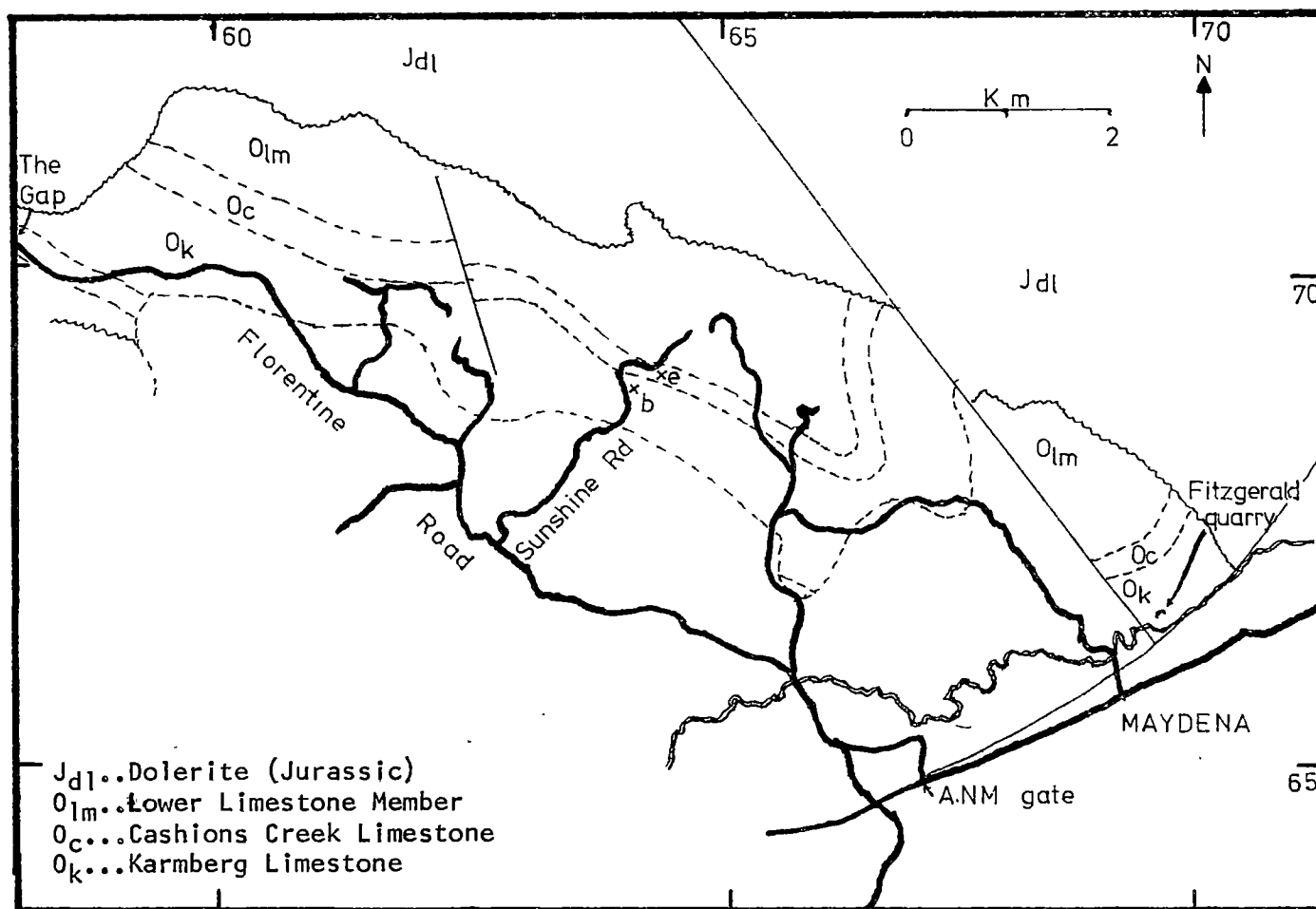
Fig. (3.1) Geology and locality map of the Gap to Maydena (modified from Whyte 1974).
b Localities at which collections were made

J_{dl}..Dolerite (Jurassic)
O_{lm}..Lower Limestone Member
O_c...Cashions Creek Limestone
O_k...Karmberg Limestone

Fig. (3.2) Key to symbols used on the stratigraphic sections.

MICRITE

DOLOMITIC MICRITE

BURROWED MICRITE

SPARITE

MICRITE with CHERT (nodules & patches)

NODULAR MICRITE

ONCOLITIC MICRITE

SILTSTONE

LORDS SILTSTONE & correlates in the Florentine Valley.

QUARTZITE

SUNSHINE ROAD

Karmbergoceras duosiphonatum •

Mysterioceras australe? •

Orthoceras sp. •

metres 20 0
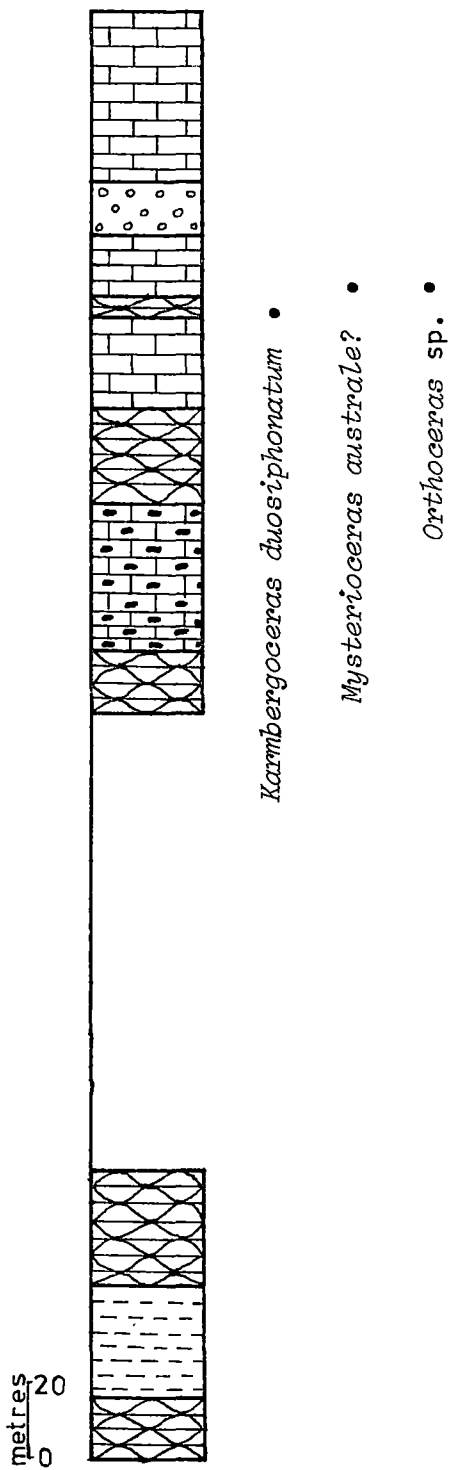
Fig. (3.3) Stratigraphic section through the Karmberg Limestone and Cashions Creek Limestone at Sunshine Road. (Key to symbols Fig.(3.2)).

Chert Member of the Karmberg Limestone. *Wutinoceras paucicubiculatum* occurs in the Limestone of Whiterock age at Blenkhorn's Quarry, Railton. An endoceroid which occurs at the top of the Karmberg Limestone, fig. (3.5), at Manning Road (C on fig. (2.2)), in the Florentine Valley is very similar to one found with *Wutinoceras* at Blenkhorn's Quarry. *Mysterioceras australe* (?) occurs in the Karmberg Limestone and lower Cashions Creek Limestone in the Settlement Road area of the Florentine Valley. Ida Bay is the type locality of *Mysterioceras australe* where it occurs in Entrance Cave along with *Discoceras idaense*. *Discoceras idaense* occurs above all known specimens of *Mysterioceras australe* (?) in the Florentine Valley. *Fitzgeraldoceras juneense* occurs in the Karmberg Limestone of the Fitzgerald Quarry near Maydena, fig (3.1). The exact position within the Karmberg Limestone of this horizon is as yet unresolved.

The Karmberg Limestone contains the nautiloid assemblages 1, 2 and the lower part of 3. There are 3 brachiopod biozones in the Karmberg Limestone of the Florentine Valley, these biozones also are found in the uppermost Denison Sub-Group rocks of northern Tasmania.

Cashions Creek Limestone: Nautiloids are rare in the Cashions Creek Limestone, with small faunas having been collected from 8 Road West, Felix Curtain Road, Frizons Road, and Settlement Road (N, F, H, and G respectively on fig. 2.2.). Eight species are known from the Cashions Creek Limestone, they are *Armenoceras corbetti*, *Octoceras uniquum*, *Felixoceras curtainense*, *Gorbyoceras settlementense*, *Centrocyrtocerina frizonense*, michelinoceroid A, michelinceroid B and endoceroid A. The majority of the species are only found in one section and are therefore of no use in correlation. At Settlement Road *Gorbyoceras settlementense* ranges from the upper Cashions Creek Limestone through the

Fig. (3.4) Locality map of the Manning Road-Frizons Road area.
— Locality of sections measured
A Localities from which collections were made

Centrocyrtocerina frizonense •

Endoceratidae n.gen.,n.sp. •
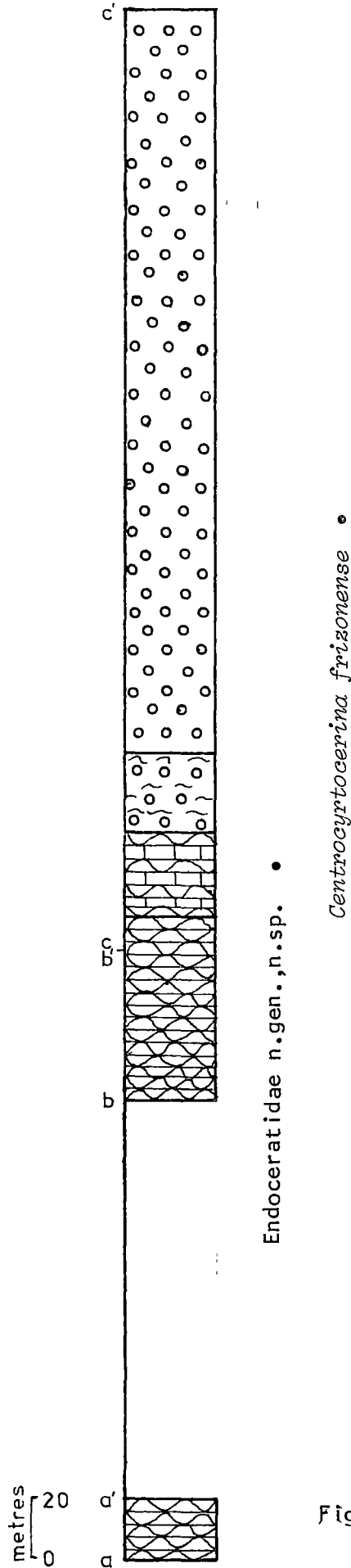
Fig.(3.5) Stratigraphic section through the Karmberg and Cashions Creek Limestones at Manning Road-Frizons Road area. (Key to symbols Fig.(3.2)).

lower half of the Lower Limestone Member, so is of little use for precise correlation although it is widespread in Tasmania. At Frizons Road, figs. (3.4, 3.5), *Centrocyrtocerina frizonense* is found in the lower half of the Cashions Creek Limestone. This species is not found elsewhere, but *Centrocyrtocerina sharplesi* occurs in what are probably much younger rocks at Ida Bay. The other localities, which contain only endemic species are 8 Road West which contains *Armenoceras corbetti, Octoceras uniquum,* and michelinoceroid A, and Felix Curtain Road which contains *Felixoceras curtainense.* Laurie (1982) has recognized one brachiopod biozone which spans the Cashions Creek Limestone, and also the upper part of the Karmberg Limestone at Sunshine Road. Teichert and Glenister (1953) described *Orthonybyoceras tasmaniense* from Junee Caves; this is in Cashions Creek Limestone equivalents, but the species is too poorly known to be of any biostratigraphic significance.

Lower Limestone Member:- The most diverse nautiloid faunas found in Tasmania occur in the Lower Limestone Member of the Benjamin Limestone in the Florentine Valley. The majority of the fossiliferous horizons in the Lower Limestone Member contain silicified fossils which makes locating and collecting of nautiloids much easier. The three main sections of the Lower Limestone Member that were collected were Westfield (I on fig. (2.2)), Eleven Road (K on fig. (2.2)), and Settlement Road (J on fig. (2.2)). The Westfield section contains the following nautiloids: *Probotryceras westfieldense,Florentineoceras calveri, Hecatoceras longinquum,Tasmanoceras zeehanense, Discoceras idaense,* and *Gorbyoceras settlementense,*(figs. 3.6 and 3.7). The Eleven Road section contains *Beloitoceras* sp., *Tasmanoceras zeehanense* and *Hecatoceras longinquum,*(figs. 3.8 and 3.9). The most important and complete section of the Lower Limestone Member is the Settlement Road section, the

Fig. (3.6)   A detailed locality and outcrop map of

the Westfield section in the Florentine Valley

(insert 2 on Fig. (2.2)), (modified from Calver,

1977)

——— Locality of the measured section.

α Localities from which collections were made.

metres

0   500

N

Westfield Road

UPPER LIMESTONE MB

UPPER LIMESTONE

LOWER LIMESTONE MB.

LOWER LIMESTONE

LORDS SILTSTONE

WESTFIELD QUARRY
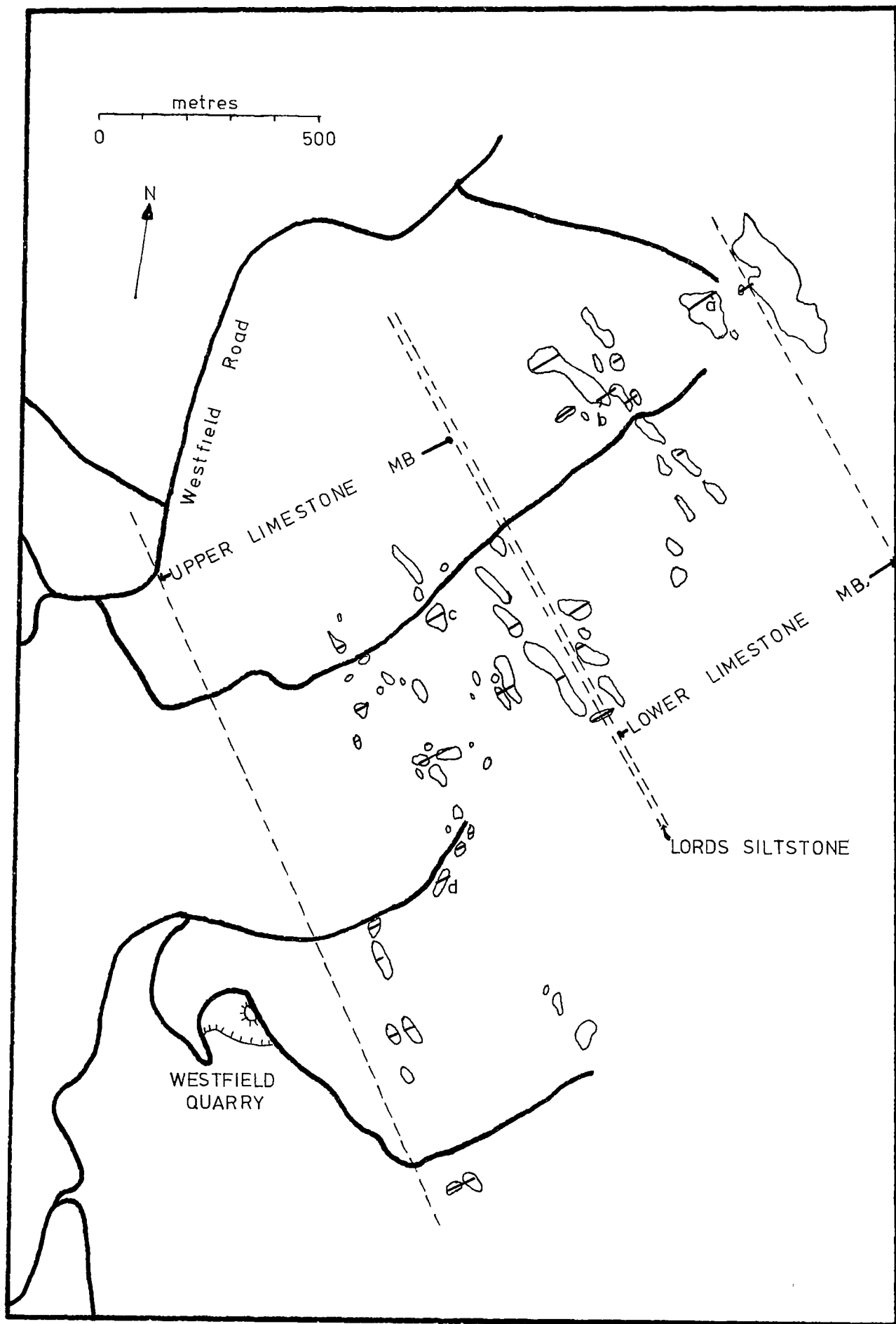
WESTFIELD   SECTION

Fig.(3.7) Stratigraphic section of the Lower
Limestone Member at Westfield (Key to symbols
Fig.(3.2)] (modified from Calver 1977)
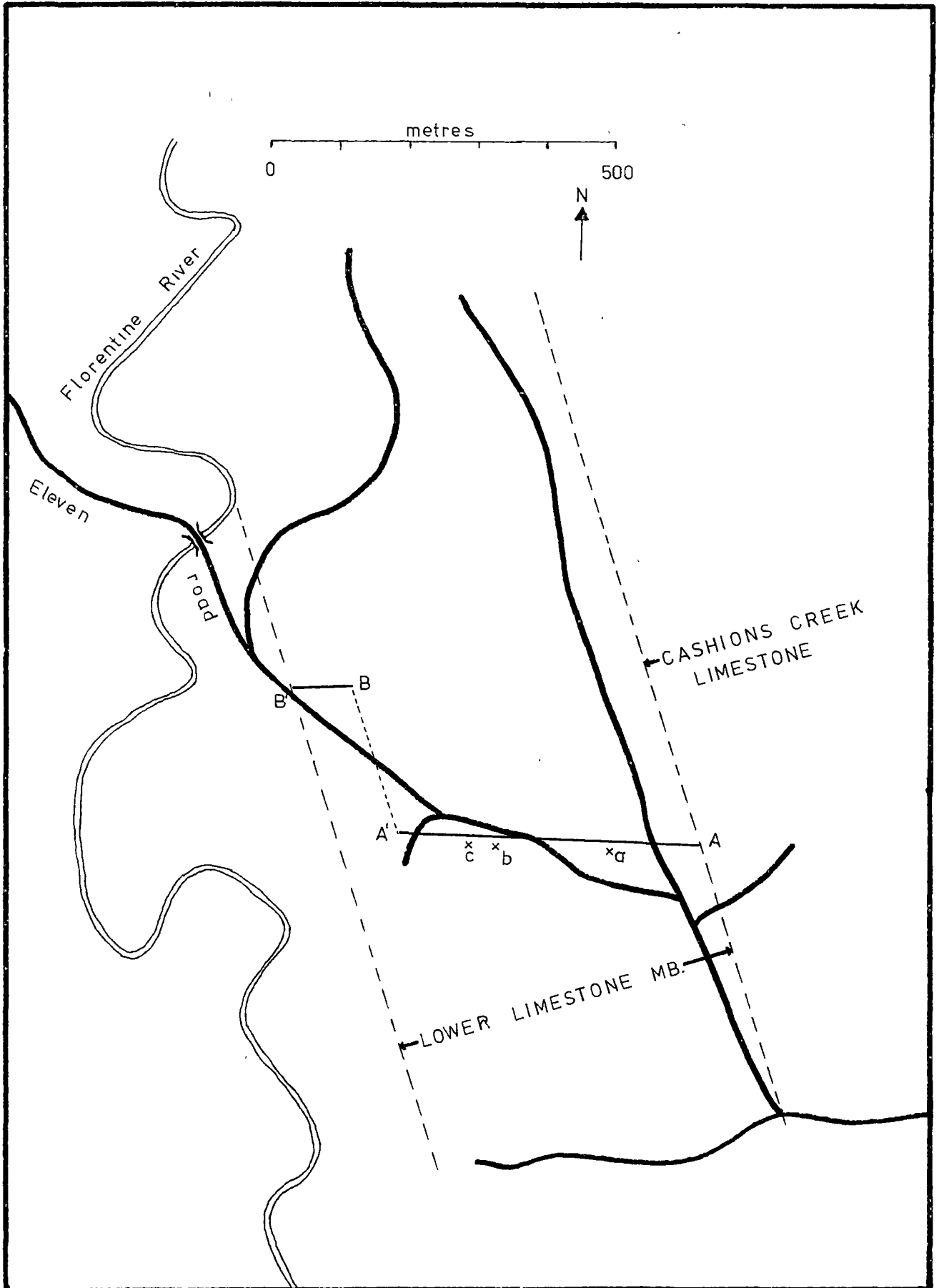
Fig.(3.8) Locality map of the Eleven Road section (modified from Calver 1977) — Locality of measured sections
a Localities from which collections were made

ELEVEN ROAD

• *Tasmanoceras zeehanense*

• *Hecatoceras longinquum*

• *Beloitoceras* sp.

55 metre gap

metres 20 0

Fig. (3.9) Stratigraphic section of the Lower Limestone
Member at Eleven Road (Key to Symbols Fig.(3.2))
(modified from Calver 1977)

fauna present contains *Ormocerina asymmetrica, Hecatoceras longinquum, Gouldoceras benjaminense, Paramadiganella banksi, Armoceras lauriei, Tasmanoceras zeehanense, T.* cf. *pagei, T. pagei, Gorbyoceras settlement-ense, Mysterioceras australe*(?)*, Discoceras idaense,* and endoceroid gen. et sp. indet, figs. (3.10 and 3.11).

The Lower Limestone Member contains two nautiloid assemblages the lower is the *Gorbyoceras-Discoceras* assemblage, the higher is the *Tasmanoceras-Hecatoceras-Gouldoceras* assemblage. The *Tasmanoceras-Hecatoceras-Gouldoceras* assemblage is widespread in the Florentine Valley occurring between 320-450 metres above the base of the Lower Limestone Member in the sections studied,(figs. 3.7, 3.9 and 3.11). *Paramadiganella, Ormocerina* and *Armoceras* occur at 68-140 metres above the base of the Lower Limestone Member at Settlement Road, this corresponds to a gap in the Westfield section, where these genera do not occur. Correlations with sections in many areas outside of the Florentine Valley are possible. These correlations will be discussed in detail in the appropriate section of the following text. The most precise correlations are with Ida Bay and Zeehan,where there are species in common with the Florentine Valley.

Tasmanoceras zeehanense and *Gouldoceras* are found at Smelter's Quarry, Zeehan,and they also occur at 320-370 and 450 metres respectively above the base of the Lower Limestone Member at the Settlement Road section. *Hecatoceras longinquum* occurs in the Mystery Creek Quarry at Ida Bay and also at 380 metres above the base of the Lower Limestone Member at Settlement Road, fig. (3.16). *Beloitoceras* sp. occurs near the base of the Lower Limestone Member at Eleven Road. The other species of this genus occur in the Den Member at Mole Creek and the Smelter's Quarries at both Queenstown and Zeehan, but on other evidence the sections at Mole Creek,
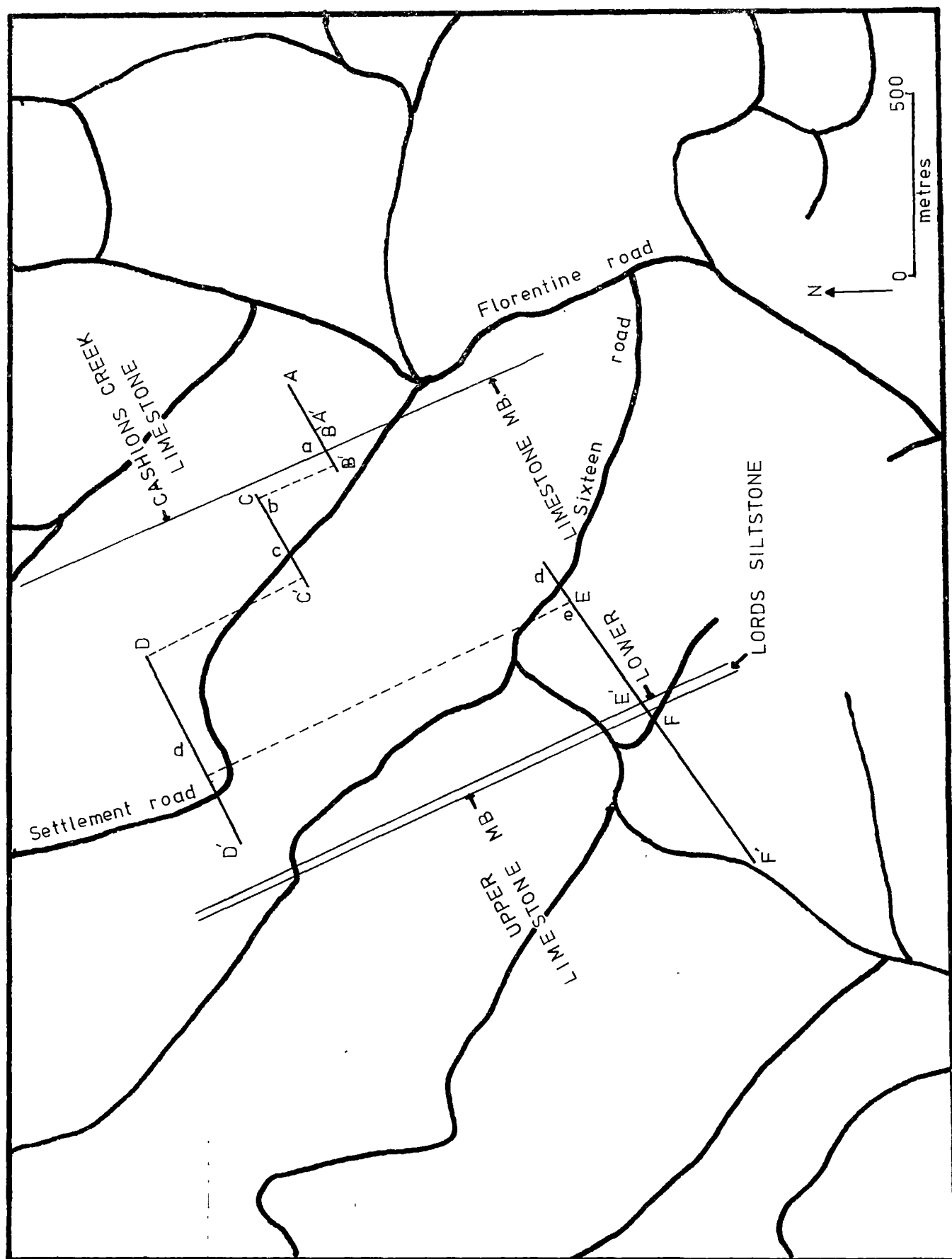
Fig.(3.10) Locality map of the Settlement Road section.
——— Locality of the measured section
a Localities from which collections were made
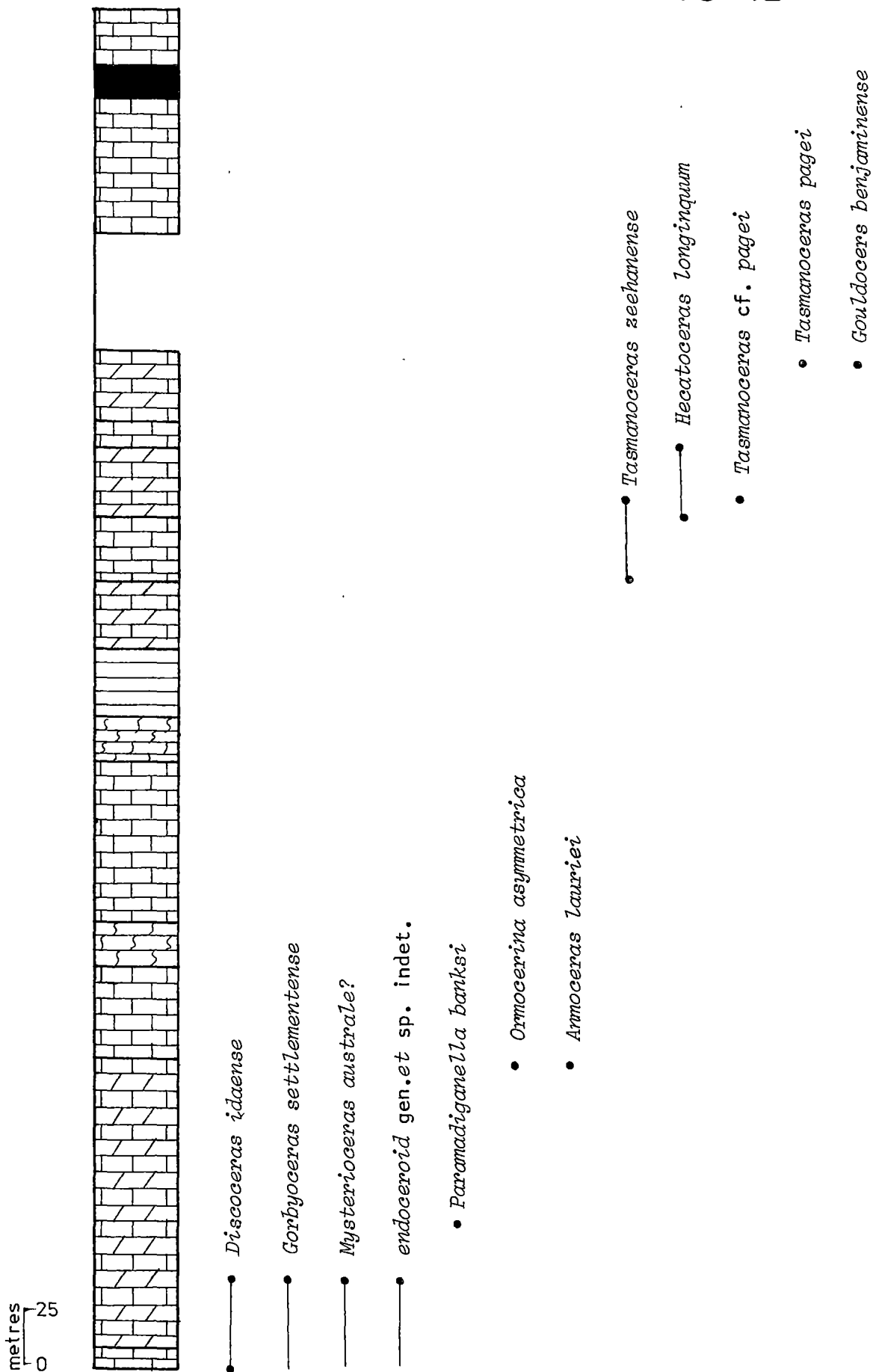
Fig.(3.11) stratigraphic section of the Lower Limestone
Member at Settlement Road. (Key to symbols Fig.(3.2))
(drawn from data supplied by   C.Calver)

Queenstown and Zeehan are all much younger. One third of the genera
which occur in the Lower Limestone Member of the Florentine Valley
have not been found in other areas.

The Lower Limestone Member contains 3 brachiopod biozones, Laurie
(1982) fig. (3.24). These brachiopod zones give the most reliable
correlations between sections both within the Florentine Valley and
with other areas in Tasmania .

Upper Limestone Member:-   Nautiloids are very rare in the Upper Lime-
stone Member of the Benjamin Limestone. A possible explanation for
the small number of nautiloids found is that there is very little sili-
fication in the Upper Limestone Member, compared to the Lower Limestone
Member, and this means that the nautiloids do not weather out so are
very difficult to see when collecting, unless they are unusually
abundant. Of the two main sections in the Florentine Valley the
Westfield section contains two horizons with identifiable nautiloids
figs. (3.6 and 3.12), while the Settlement Road section, figs. (3.10
and 3.13), also contains two horizons, but no identifiable nautiloids
have been found. In the upper part of the Upper Limestone Member on
the Adamsfield Track where it crosses the Tiger Range is a horizon
which contains two species of nautiloids, *Tigeroceras florentinense*
and *Armenoceras*(?) sp.

The lowermost horizon containing nautiloids at Westfield is
195 metres above the base and contains *Gordonoceras bondi*, while
Westfieldoceras taylori and Gouldoceratidae n.gen. n.sp. occur at
550 metres above the base, fig. (3.12).

BUBS HILL:-   Two species of nautiloids are known from Bubs Hill,
fig. (1.2), they are *Discoceras reidi* and *Miamoceras bubsense*. These

metres
40
0

Gordonoceras bondi
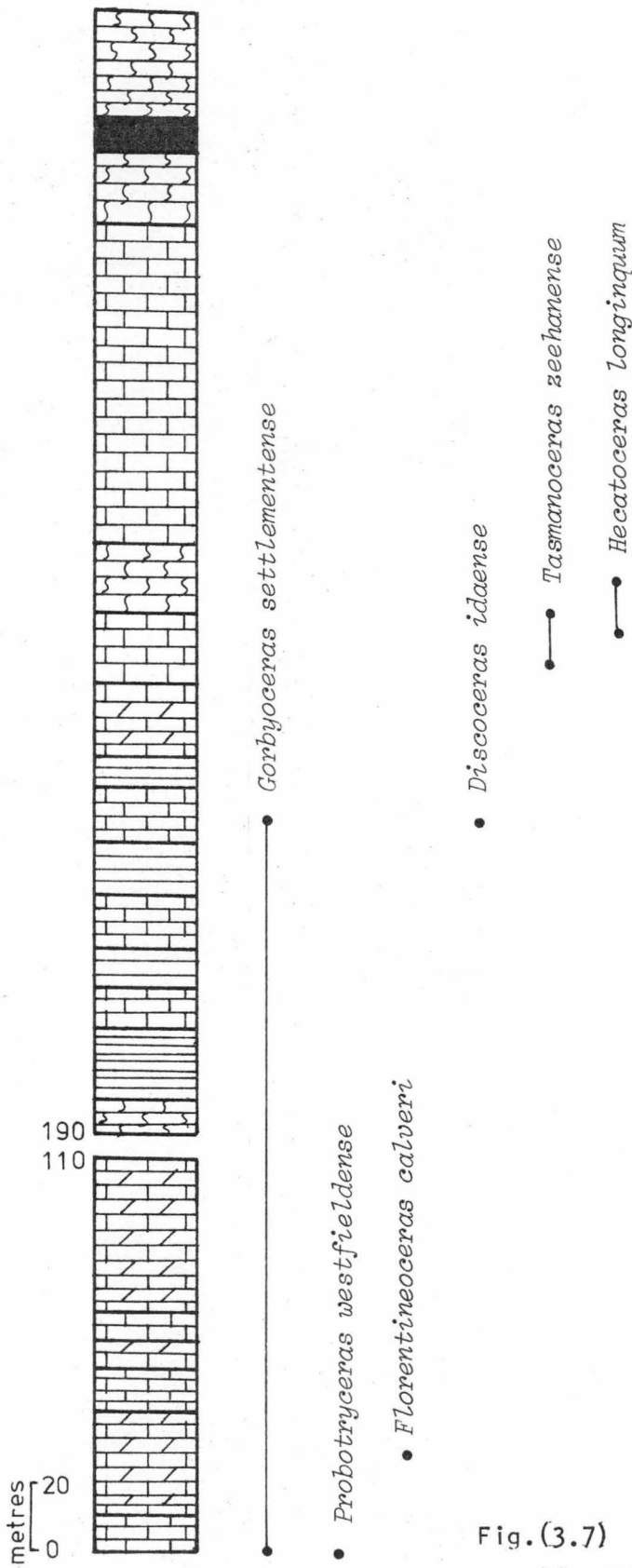
Westfieldoceras taylori

Gouldoceratidae gen. *et* sp. nov.
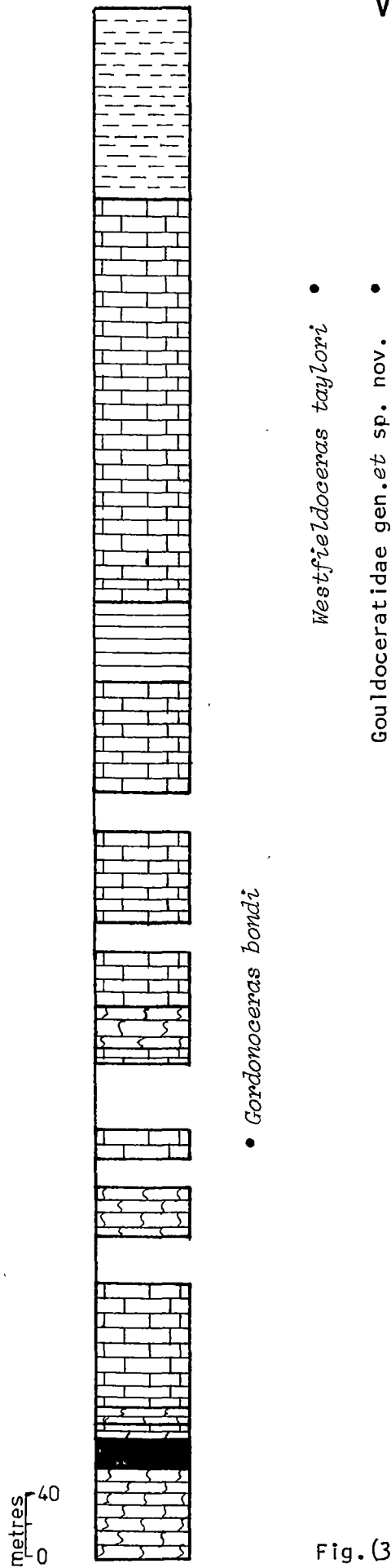
Fig. (3.12) Stratigraphic section of the Upper Limestone Member at Westfield (Key to symbols Fig. (3.2)) (modified from Page 1978)

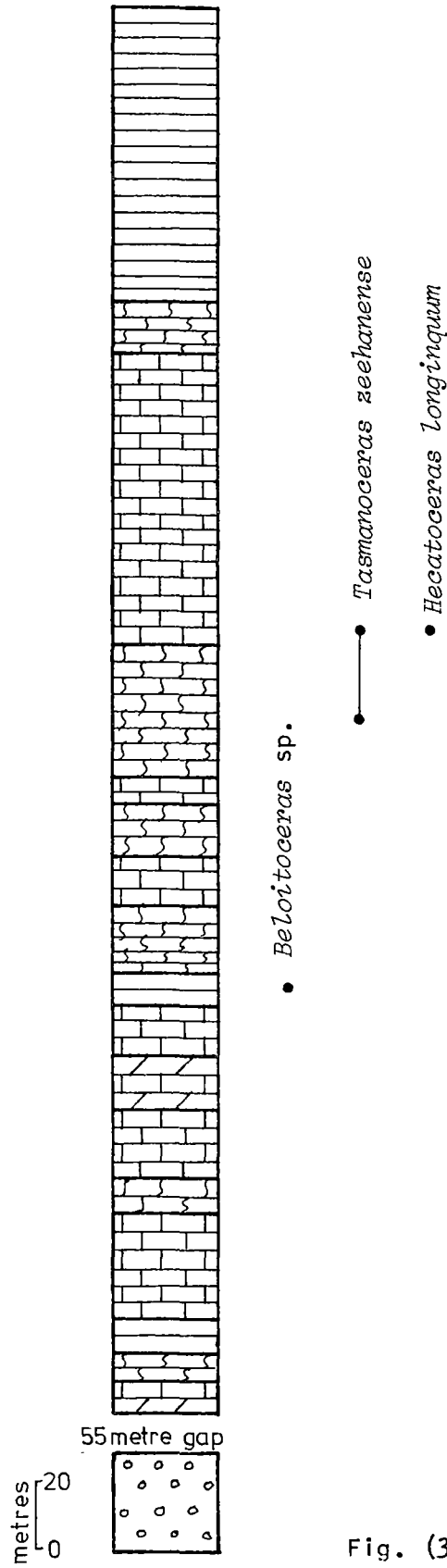# SETTLEMENT ROAD

Fig.(3.13) Stratigraphic section of the Upper
Limestone Member at Settlement Road (Key to
symbols Fig.(3.2)) (modified from Page 1978)

two species occur in the same horizon, fig. (3.14). *Discoceras reidi* also occurs in the stratigraphically higher of the two Smelter's Quarries at Zeehan, but the age of this horizon is unclear. *Discoceras* also occurs in the lower half of the Lower Limestone Member of the Benjamin Limestone in the Florentine Valley, but it is a different species.

EUGENANA:- Nautiloids are uncommon in this section, but in the onco-litic limestone of the Eugenana Quarries *Gorbyoceras settlementense*(?) has been found. Similar species occur in the Dog's Head Member at Mole Creek and also in the upper Cashions Creek Limestone to middle Lower Limestone Member in the Florentine Valley. The age indicated is Late Chazy to Blackriver. No conodonts or brachiopods have been collected from this locality, however the presence of *Maclurites* and certain species of stromatoporoids suggest a Chazy age.

GORDON RIVER:- No new nautiloid specimens have been collected from the Gordon River, fig. (1.2). Teichert and Glenister (1953) described *Gordonoceras bondi, Stromatoceras eximium, Ephippiorthoceras decorum, Tasmanoceras zeehanense, Anaspyroceras* sp. and *Gasconsoceras insperatum* from the Gordon River. On the presence of *Gasconsoceras* they suggest a middle Silurian age for this fauna. *Gasconsoceras insperatum* is now thought to be a gastropod. The exact location from which the specimens were collected is unknown. The only species which have been found outside of the Gordon River are *Tasmanoceras zeehanense* and *Gordonoceras bondi*. *Gordonoceras bondi* occurs in the middle of the Upper Limestone Member of the Benjamin Limestone in the Florentine Valley. *Tasmanoceras zeehanense* occurs at Smelter's Quarry, Zeehan, and the middle of the Lower Limestone Member in the Florentine Valley.

HARDWOOD RIVER:- The only nautiloid which has been collected from

BUBS HILL

Discoceras reidi •

Miamoceras bubsense •

Gorbyoceras settlementense? •

20

0

F — F
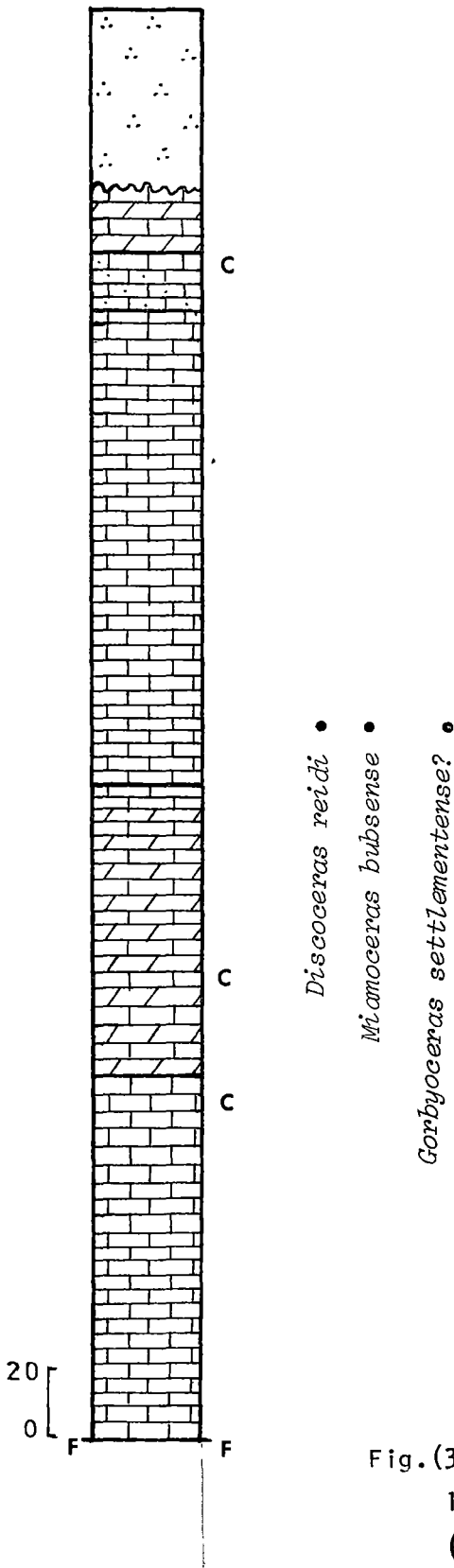
Fig.(3.14) Stratigraphic section through the Ordovician
limestone at Bubs Hill (Key to symbols Fig.(3.2)).
(modified from Reid 1964)

the Hardwood River is one specimen of *Wutinocerac*, closely related to *W. multicubiculatum*, fig. (1.2). *W. multicubiculatum* was first described from Blenkhorn's Quarry at Railton in rocks of Whiterock age. *W. cf. multicubiculatum* has also been found in the Wherrett's Chert Member in the Florentine Valley. As all the specimens of *Wutinoceras* known in Tasmania are Whiterock in age, the Hardwood River locality is probably also Whiterock in age. No other fossils have been identified from Hardwood River to verify this age or correlation.

IDA BAY:- Five nautiloid species have been collected from the Ida Bay section. These are *Hecatoceras longinquum*, *Discoceras idaense*, *Mysterioceras australe*, *Gorbyoceras settlementense* ? and *Centrocyrtocerina sharplesi*. The range of these species at Ida Bay is given in fig. (3.15). *Hecatoceras longinquum* and *Mysterioceras australe* were first described from Ida Bay by Teichert and Glenister (1952, 1953), who also described *Trocholitoceras idaense*, now *Discoceras*, from the Mystery Creek Cave.

A comparison of the biostratigraphic sequence at Ida Bay with that at the Settlement Road area of the Florentine Valley is given in fig. (3.16). *Hecatoceras longinquum* and *Discoceras idaense* both occur in the Florentine Valley and at Ida Bay and probably provide the most reliable correlation between the two areas. All of the remaining genera occurring at Ida Bay are also found in the Florentine Valley, but the sequence is not the same. The range of *Mysterioceras* in the two areas overlap. *Gorbyoceras settlementense* occurs below *Hecatoceras longinquum* in the Florentine Valley , with a closely related species at Ida Bay both below and above *Hecatoceras longinquum* . The largest disparity is in the occurrence of *Centrocyrtocerina sharplesi* and *C. friznense*, with *C. frizonense* occurring in the Chazy Cashions Creek Limestone at
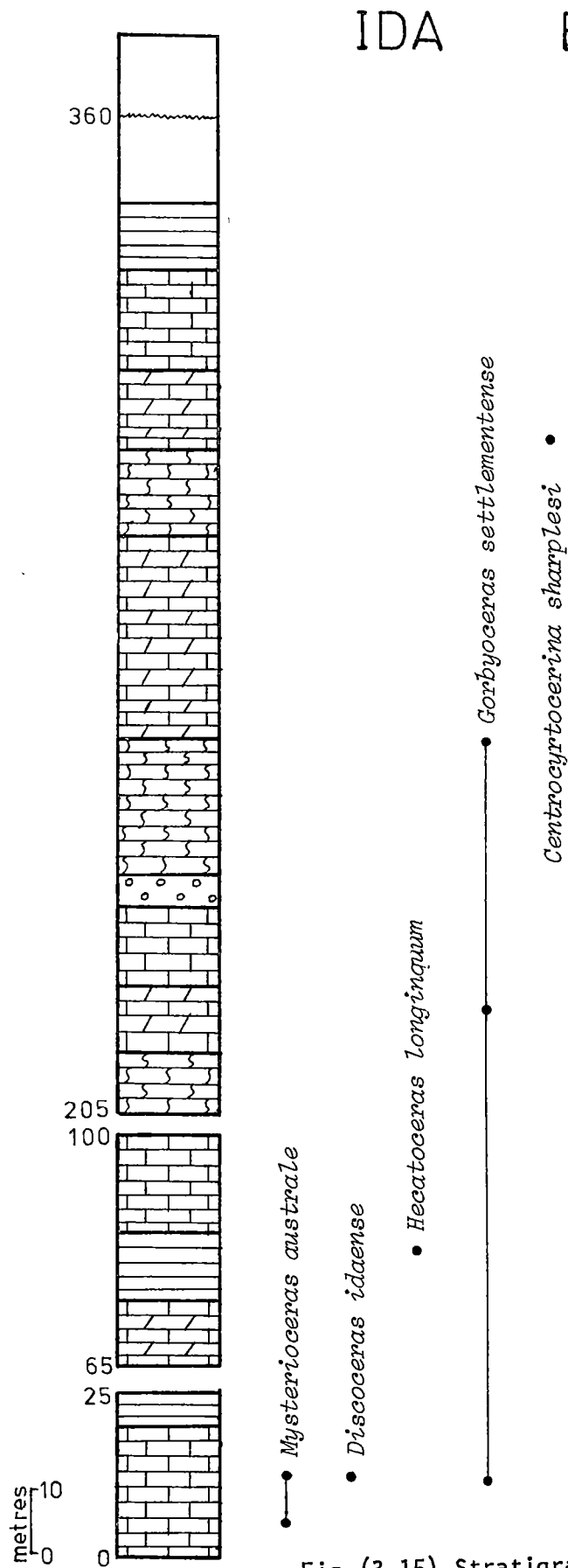
IDA   BAY

Fig.(3.15) Stratigraphic section through the
Ordovician limestone at Ida Bay (Key to symbols
Fig.(3.2)) (modified from Sharples 1979)

Fig. (3.16)   Comparison of the ranges of the nautilod

genera and species between Ida Bay and a composite

Florentine Valley section. The correlation lines

between Ida Bay and the Florentine Valley are based

on conodonts.

A includes *Panderodus* n.sp. and *Belodina alabamensis*.

B includes *Plectodina aculeata, Belodina compressa,*

Pandeodus gracilis and *Phragmodus undatus*.

Centrocyrtocerina sharplesi   °

    Gorbyoceras settlementense   •————○————————•

      Hecatoceras longinquum   •

        Mysterioceras australe   •

          Discoceras idaense   •

```
┌─────────────────────────────────────┐
│   IDA    BAY      LIMESTONE          │
└─────────────────────────────────────┘
              /                │
             /                 │
            /                  │
           B                   A
          /                    │
         /                     │
        /                   metres
       /                  50 ┌──────┐ 0
┌──────┬─┬──────────────────────────┬────────┐
│UPPER │ │ LOWER   LIMESTONE  MEMBER │        │
│LST MB│ │                          │        │
└──────┴─┴──────────────────────────┴────────┘
```
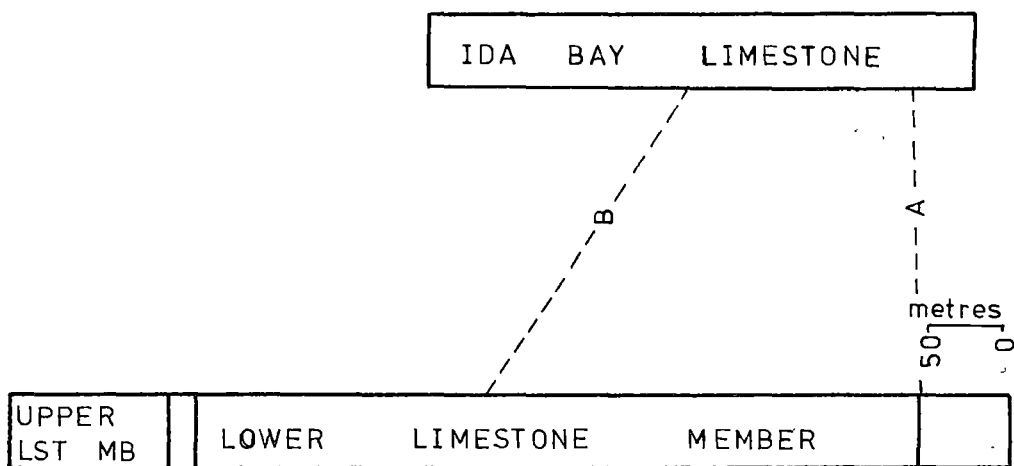
      Mysterioceras cf. *australe*   •————————————

        Centrocyrtocerina frizonense   •

     Discoceras idaense   ○————————•

   Gorbyoceras settlementense   •————————•

Hecatoceras longinquum   ○———•

Frizons Road in the Florentine Valley while *C. sharplesi* occurs above *Hecatoceras longinquum* at Ida Bay and is probably Trenton in age. The Ida Bay area is structurally complicated,(Sharples 1979), but it is unlikely that the horizon containing *C. sharplesi* could be as old as Chazy.

Conodonts have been collected from the limestones at Ida Bay. Burrett (1978) described this fauna, with two horizons being of most significance. The first of these is from the lowermost horizon in Entrance Cave which contains *Panderodus* sp. nov. and *Belodina alabamensis,* these indicate a Chazy age and correlate with the fauna from Cashions Creek Limestone in the Florentine Valley. *Plectodina aculeata, Belodina compressa, Panderodus gracilis,* and *Phragmodus undatus* were collected from the base of the road to the Newlands Quarry. These correlate with the fauna from the upper part of the Lower Limestone Member in the Florentine Valley.

Brachiopods have been collected from two horizons, one on the road up to Newlands Quarry, the other in the Quarry. In the lower horizon, on the road, is an orthid which correlates with one from the middle of the Lower Limestone Member in the Florentine Valley. The upper horizon, in the Quarry, contains a strophomenid that correlates with the upper Lower Limestone Member just below the Lord's Siltstone Member in the Florentine Valley.

The biostratigraphic correlation between Ida Bay and the Florentine Valley indicates that the faunas known at Ida Bay correlate with those found in the Cashions Creek Limestone to the upper part of the Lower Limestone Member in the Florentine Valley. This would indicate an age range for the Ida Bay sequence of Chazy to Late Trenton.

MOLE CREEK:- There are three horizons which contain identifiable
nautiloids at Mole Creek, figs. (1.2, 3.17). The nautiloid species
known are *Standardoceras burretti, Tasmanoceras* cf. *zeehanense,
Discoceras* sp., *Beloitoceras*(?)*molense,* and *Gorbyoceras settlementense*(?),
fig. (3.18). None of the species found at Mole Creek have been found in
the Florentine Valley, but the bulk of the genera are in common, with
Standardoceras the only genus endemic to Mole Creek. In the Florentine
Valley *Discoceras, Tasmanoceras* and *Gorbyoceras* all occur in the upper
Cashions Creek Limestone up to the middle of the Lower Limestone Member
at Settlement Road, fig. (3.19). *Standardoceras burretti* is the oldest
nautiloid from Mole Creek, it occurs in the lower part of the Standard
Hill Member at Standard Hill. The next nautiloid fauna is in the
lower part of the Dog's Head Member at the Western section (Burrett,
1978), this contains *Discoceras* sp. and *Gorbyoceras settlementense*(?).
Beloitoceras(?) *molense* occurs in the Den Member in the western
section. *Tasmanoceras* cf. *zeehanense* occurs near Mayberry, southwest
of Mole Creek, but the exact correlation with the Chudleigh Limestone
at Mole Creek is unclear. The most probable correlation for *T.* cf.
zeehanense is with the Sassafras Creek Member or the Dog's Head Member.

Laurie (1982) collected the brachiopods from the Mole Creek
section and is able to correlate at the species level to the Florentine
Valley; the correlations obtained are summarized in fig. (3.19).

Burrett (1978) studied the conodonts from the Mole Creek
sections. The correlations based on conodonts from Mole Creek to
the Florentine Valley are summarized in fig. (3.19). The Mole Creek
section was one of the major sequences used by Banks and Burrett
(1980) in establishing a preliminary biostratigraphy of the Ordovician
of Tasmania.

Od.:.Den Member
Oo..Overflow Creek Member
Om..Mole Creek Member
Odh.Dog's Head Member
Osa.Sassafras Creek Member
Ou..Ugbrook Member
Os..Standard Hill Member

N

0   2
K m,

Mersey   River

Od

Oo

Standard   Hill

A'

B

B'

t

Odh

Osa
Ou
Os

Om

MOLE
CREEK

A

r

u
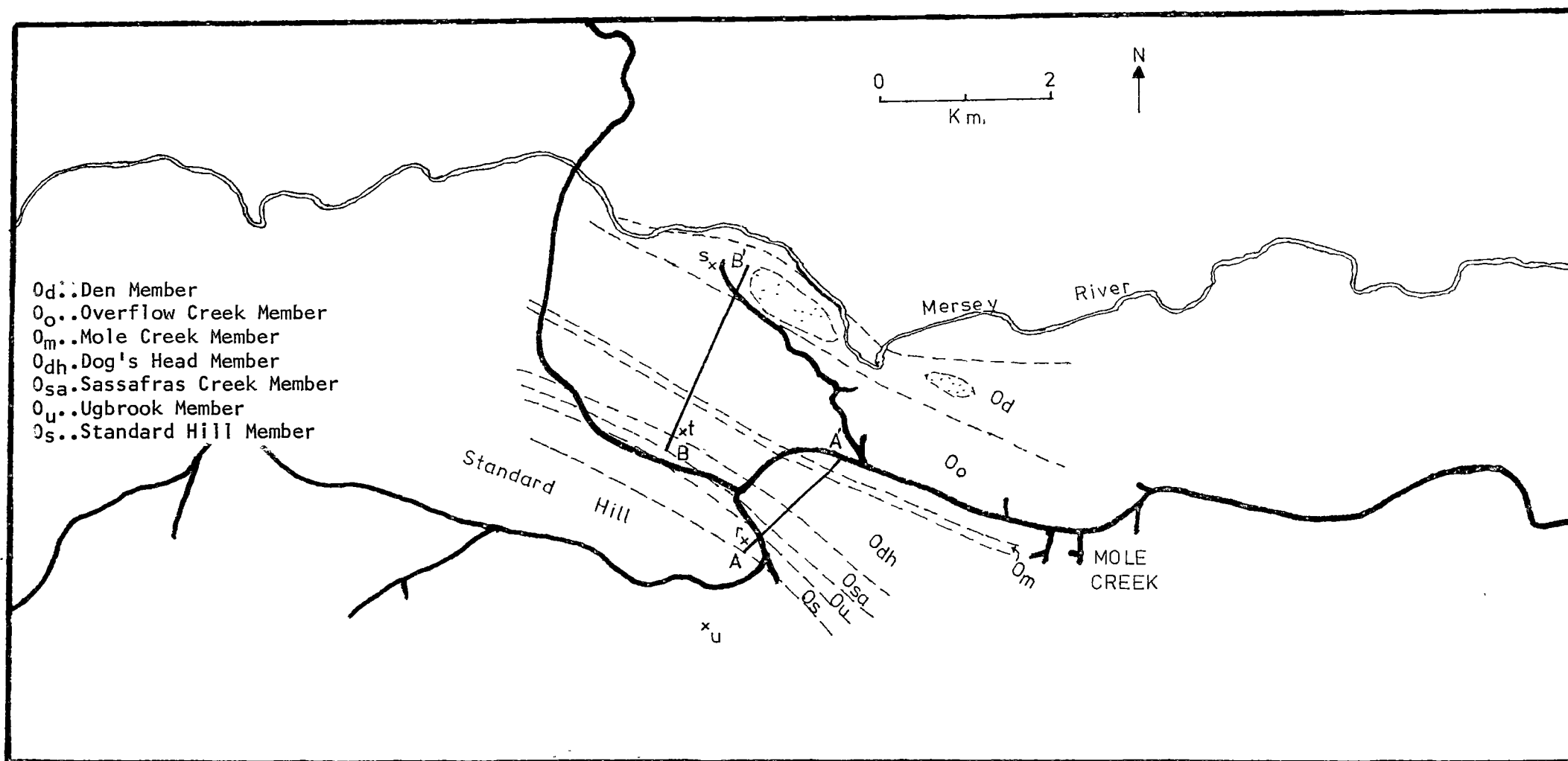
Fig. (3.17)   Geology and locality map of the Mole Creek area.

—— Locality of the measured sections   (modified from Burrett 1978)
s Localities where collections were made

52

Fig. (3.18)   Stratigraphic sections through the

Chudleigh Limestone at Mole Creek. The nautiloid

species collected are plotted against the stratigraphic

columns taken from Burrett (1978). The correlations

between the sections are also those of Burrett.

EASTERN SECTION   WESTERN SECTION
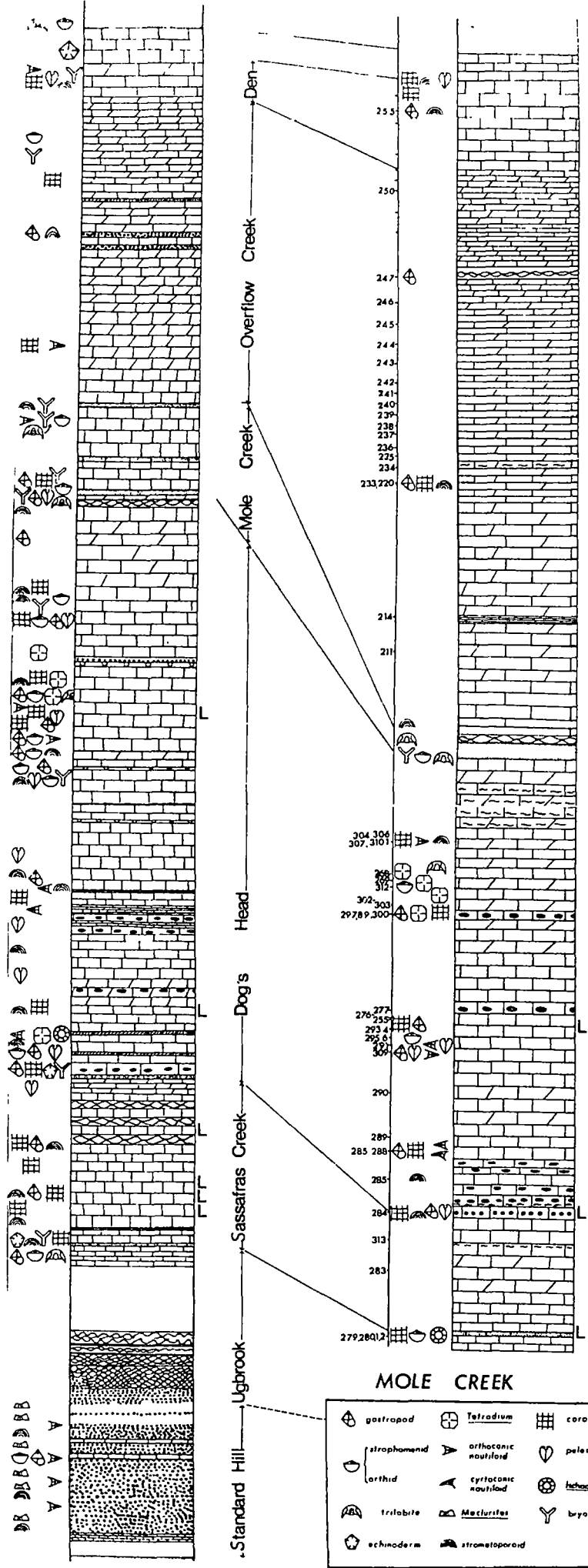
Beloitoceras ? molense ●

255
250
247
246
245
244
243
242
241
240
239
238
237
236
275
234
233,220

214
211

304,306
307,3101
308
312
302—303
297,89,300

276—277
255
293,44
292,6
301

290

289
285,288
285
284
313
283

279,2801,2

Den
Overflow Creek
Mole Creek
Head
Dog's
Sassafras Creek
Ugbrook
Standard Hill

Standardoceras burretti ●—●

Discoceras sp. ●

Gorbyoceras settlementense? : ●

MOLE CREEK

⬦ gastropod	⊞ Tetradium	⌗ coral
⌂ strophomenid	▷ orthoconic nautiloid	♡ pelecypod
⌂ orthid	◀ cyrtoconic nautiloid	⊗ Ischadites
trilobite	Maclurites	Y bryozoan
⬠ echinoderm	stromatoporoid	

Fig. (3.19)   Comparison of the ranges of the nautiloid
genera and species at Mole Creek and those in a
composite Florentine Valley section. The two columns
are at the same scale. The correlation lines between
Mole Creek and the Florentine Valley are based on
conodonts.

A includes *Belodina copenhagenensis*, *B. compressa*
and *Plectodina aculeata*.

B includes *Phragmodus undatus*, *Belodina abrupta*
and *B. compressa*

metres

0 ⊢ 50

	LOWER LIMESTONE MEMBER		UPPER LIMESTONE MEMBER

●————————● *Discoceras idaense*

●————————● *Gorbyoceras settlementense*

● *Beloitoceras* sp.

A

B

STANDARD HILL MB	UGBROOK MB	SASSAFRAS CREEK MB	DOG'S HEAD MB	MOLE CREEK MB	OVERFLOW CREEK MB	DEN MB

●————● *Standardoceras burretti*

● *Discoceras* sp.

● *Gorbyoceras settlementense?*

Beloitoceras? molense ●

QUEENSTOWN:- The section through Smelter's Quarry at Queenstown contains very few nautiloids, fig. (1.2). The species known are *Beloitoceras kirtoni, Gorbyoceras* sp. and *Gouldoceras synchonena,* fig. (3.20). Both *Beloitoceras kirtoni* and *Gouldoceras synchonena* occur at Smelter's Quarry, Zeehan. The Smelter's Quarry at Zeehan is probably Trenton in age (Hill, 1955). *Gouldoceras* occurs in the upper part of the Lower Limestone Member of the Benjamin Limestone in the · Florentine Valley, but it is a different species from that at Queenstown No brachiopods or conodonts have been found at Smelter's Quarry, Queenstown.

RAILTON:- Only one locality contains nautiloids in the Railton area, and that is Blenkhorn's Quarry, fig. (1.2). The fauna at Blenkhorn's Quarry contains both actinocerids and endocerids. The actinocerid fauna described by Teichert and Glenister (1953) contained *Wutinoceras multicubiculatum,* and *W. paucicubiculatum.* Teichert and Glenister (1953) also described *Adamsoceras johnstoni* from Zeehan, but recent work (see page 89) has shown that *A. johnstoni* was probably collected from Blenkhorn's Quarry. Both *Wutinoceras* and *Adamoceras* are typical of the Whiterock of North America (Flower, 1968a,1976).

The endocerid fauna contains a new genus, which has a siphonal blade pattern similar to *Meniscoceras,* but has holochoanitic septal necks. The other endocerid present cannot be assigned to a genus or species. The new genus of endocerid also occurs near the top of the Karmberg Limestone at Manning Road in the Florentine Valley, although it may not be the same species.

SURPRISE BAY :- Nautiloids have been collected from one horizon at Surprise Bay, fig. (3.21). The specimens are generally poorly preserved,
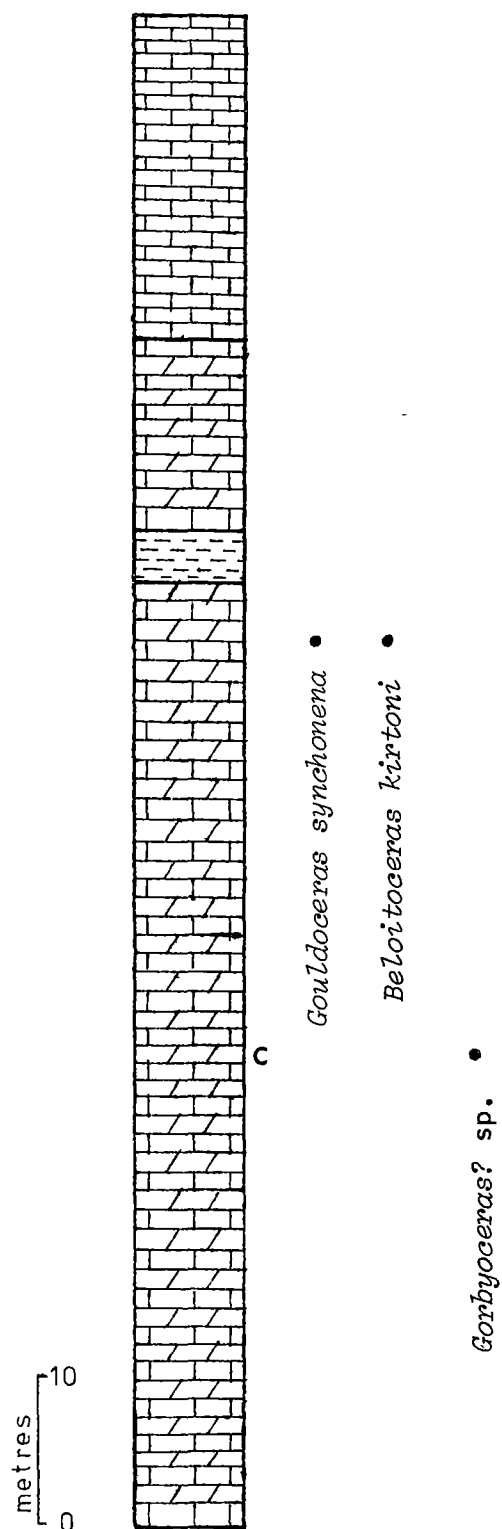
QUEENSTOWN

Fig. (3.20) Stratigraphic section through the Ordovician limestone at Queenstown. (Key to symbols Fig.(3.2)) (modified from Burrett 1978)

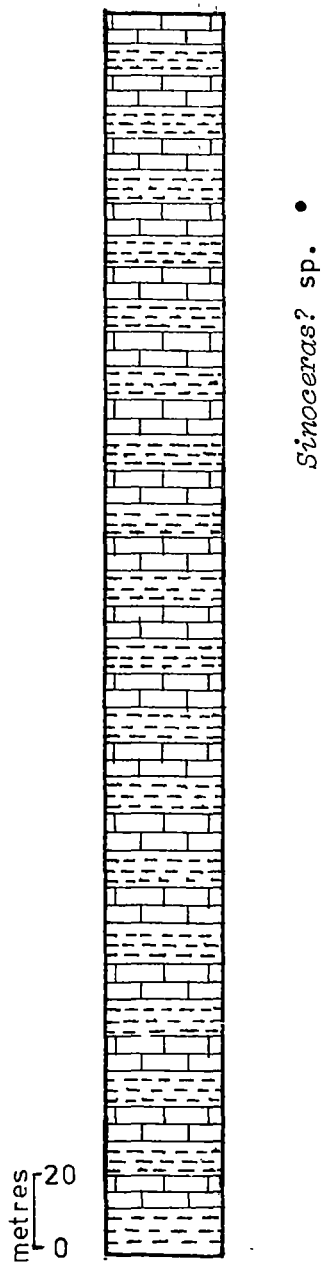# SURPRISE   BAY

Sinoceras? sp. ●

metres ⌐20
⌐ 0

Fig.(3.21) Stratigraphic section through the Ordovician
limestone at Surprise Bay. (Key to symbols Fig.(3.2)

but they are most probably assignable to *Sinoceras*. This genus does not occur elsewhere in Tasmania.

ZEEHAN:- Identifiable nautiloids have been collected from two horizons at Zeehan, fig. (1.2). Both the localities unfortunately have been named Smelter's Quarry, so to save confusion they will be called the larger Smelter's Quarry (A on fig. (3.22)), State Grid. ref. 625582, and the small Smelter's Quarry (B on fig. (3.22)), State Grid. ref. 627582.

The larger Smelter's Quarry contains a diverse fauna, including *Gouldoceras synchonena*, *G. obliquum*, *Zeehanoceras teicherti*, *Beloitoceras kirtoni*, *Anaspyroceras*(?) *anzaas* and *Tasmanoceras zeehanense*,(fig. 3.23). The smaller Smelter's Quarry contains *Beloitoceras kirtoni* and *Discoceras reidi*, fig. (3.23).

Gouldoceras synchonena and *Beloitoceras kirtoni* are also found in the Smelter's Quarry, Queenstown, suggesting a strong correlation between the two horizons. *Discoceras reidi* is found at Bubs Hill with a genus closely related to *Beloitoceras*.

Tasmanoceras zeehanense occurs in the middle of the Lower Limestone Member in the Florentine Valley (300-380 metres above the base) in association with *Hecatoceras longinquum*.

Tasmanoceras occurs in association with *Gouldoceras* at 450 metres above the base of the Lower Limestone Member of the Benjamin Limestone at Settlement Road section in the Florentine Valley. The *Gouldoceras* species is different, but closest to *G. obliquum*. These correlations would suggest a Trenton age for Smelter's Quarry at Zeehan. Hill (1955) described a coral fauna from the Oceana Mine, thought to be slightly older than the larger Smelter's Quarry, and suggested a Trenton
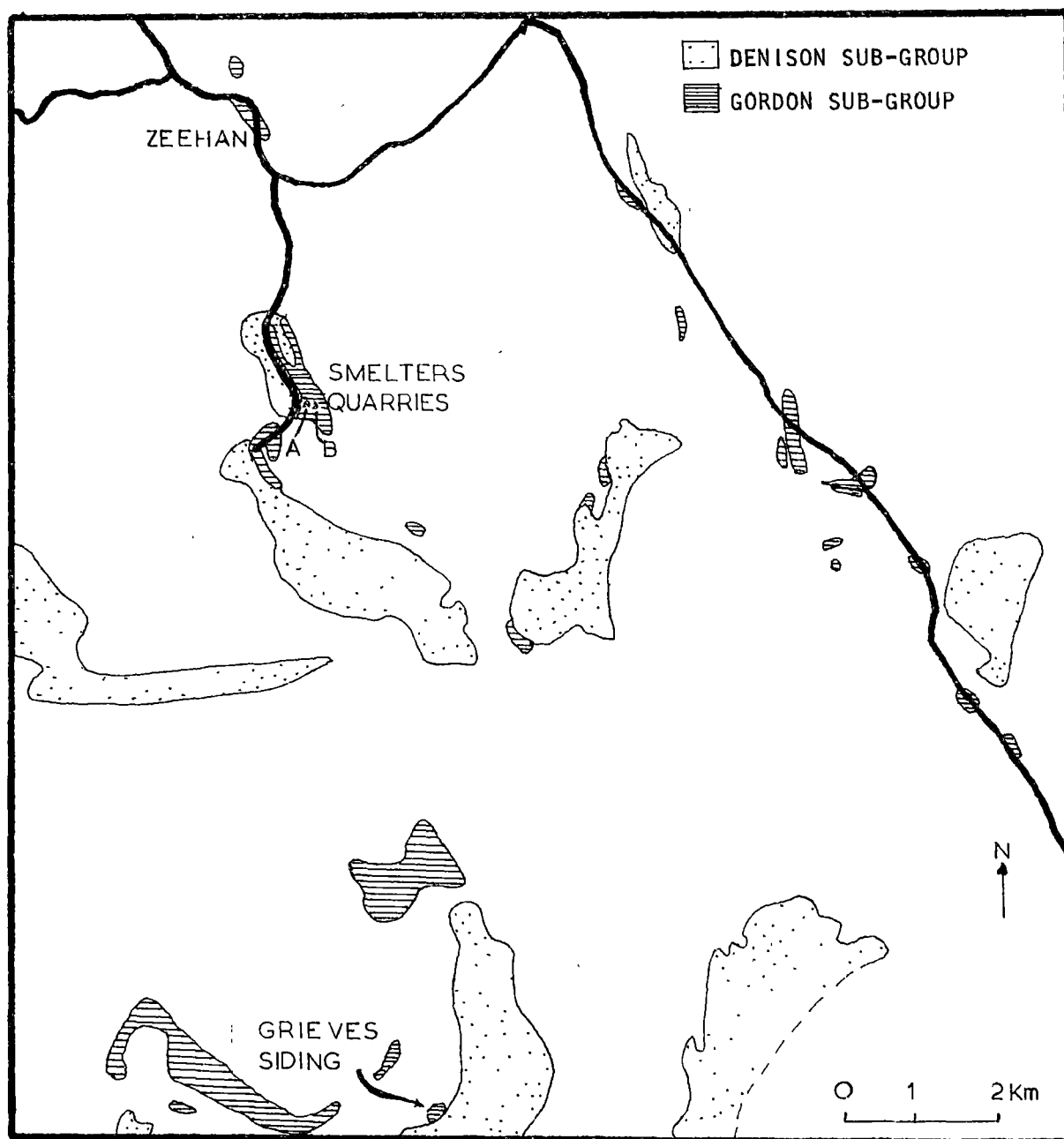
Fig.(3.22) Geology and locality map of the Zeehan area

(modified from Burrett 1978)

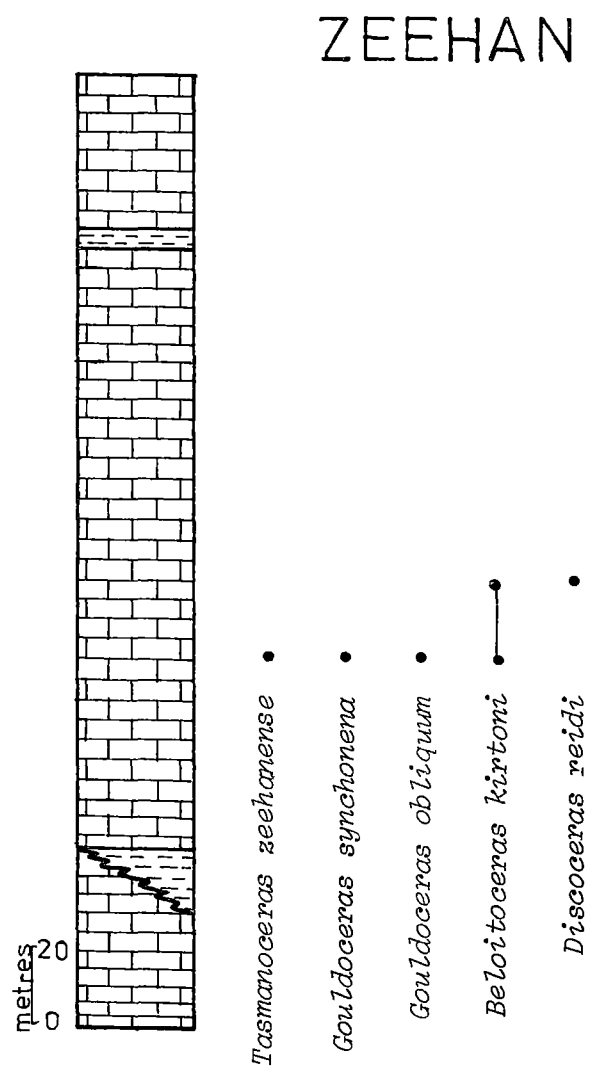A - Larger Smelter's Quarry

B - Smaller Smelter's Quarry

ZEEHAN

Fig.(3.23) Stratigraphic section through the
Ordovician limestone at Zeehan (Key to symbols
Fig.(3.2)). (modified from Pitt 1961)

age for this locality. The conodonts from the larger Smelter's Quarry suggest a Late Trenton to Early Cincinnatian age (Burrett, 1978).

WILSON RIVER:- One isolated siphuncle has been collected from the Gordon Sub-Group at Wilson River (16 on fig. (1.2)). The stratigraphy of the limestones in this area is only poorly known, with the base probably faulted. The isolated siphuncle is of *Hecatoceras longinquum* which occurs at 350-380 metres above the base of the Lower Limestone Member of the Benjamin Limestone in the Florentine Valley in association with *Tasmanoceras zeehanense*. This is approximately 100 metres below the horizon containing *Tasmanoceras* and *Gouldoceras* in the Florentine Valley, these genera also occur at Smelter's Quarry, Zeehan, which is only 30 kilometres south of the Wilson River locality. The age of the limestone from which the siphuncle was collected is probably Blackriver to Early Trenton.

ORDOVICIAN NAUTILOID ASSEMBLAGES

Although the nautiloids are of only slight use for correlation a number of general assemblages can be found in the Ordovician of Tasmania. There are 6 nautiloid assemblages, these are:

1. *Piloceras-Manchuroceras* assemblage at the base of the Karmberg Limestone at Adamsfield.

2. *Wutinoceras-Adamsoceras* assemblage at Blenkhorn's Quarry, Railton.

3. *Discoceras-Gorbyoceras* assemblage of the upper Cashions Creek Limestone-lower Lower Limestone Member at Settlement Road.

4. *Tasmanoceras-Hecatoceras-Gouldoceras* assemblage of the middle Lower Limestone Member at Settlement Road.

5. *Gordonoceras* assemblage of the middle Upper Limestone Member at Westfield.

6. *Westfieldoceras* assemblage from the upper part of the Upper
   Limestone Member at the Westfield section.

These assemblages in most cases contain a number of species and
may be correlated at both the generic and species level throughout
Tasmania. The composition and distribution of the six assemblages are
as follows:

1. *Piloceras-Manchuroceras* assemblage which contains at Adamsfield,
   Metamanchuroceras wadeae, *Manchuroceras excavatum*, *M. steanei*,
   Suecoceras(?) *robustum*, *Piloceras tasmaniense*, *Pycnoceras*
   adamense and *Allocotoceras insigne*. This assemblage is common
   only at Adamsfield, *Piloceras* cf. *tasmaniense* from the basal
   Karmberg Limestone at the Gap, is the sole occurrence outside
   the Adamsfield area.

2. *Wutinoceras-Adamsoceras* assemblage which contains at Blenkhorn's
   Quarry, *Wutinoceras multicubiculatum*, *W. paucicubiculatum*,
   Adamsoceras johnstoni and endocerid n.gen. et n.sp. A. Of this
   assemblage only *Wutinoceras* occurs outside of the Railton area;
   Wutinoceras cf. *multicubiculatum* occurs in the Wherrett's Chert
   Member in the Florentine Valley and also in a chert within lime-
   stone at the Hardwood River in south western Tasmania.

3. *Discoceras-Gorbyoceras* assemblage contains at Settlement Road,
   Discoceras idaense, *Gorbyoceras settlementense*, *Mysterioceras*
   australe(?), *Paramadiganella banksi*, *Ormocerina asymmetrica*
   and *Armoceras lauriei*. At Ida Bay *Discoceras idaense*, and
   Mysterioceras australe occur together in Entrance Cave, but
   Gorbyoceras ranges higher in the sequence. The preservation is such
   that the *Gorbyoceras* may be a different species from that found in
   the Florentine Valley. At Mole Creek *Gorbyoceras* and *Discoceras*
   occur in the lower Dog's Head Member, but they are different

species to those found in the Florentine Valley. *Gorbyoceras* occurs at the Eugenana Quarries, but preservation is poor.

4. *Tasmanoceras-Hecatoceras-Gouldoceras* assemblage contains at Settlement Road, *Tasmanoceras zeehanense, T.* cf. *pagei, T. pagei, Hecatoceras longinquum,* and *Gouldoceras benjaminense. Tasmanoceras zeehanense* and species of *Gouldoceras* occur together in the Smelter's Quarry at Zeehan. *Gouldoceras synchonena* occurs in the Smelter's Quarry at Queenstown. *Tasmanoceras* cf. *zeehanense* is found to the south-west of Mole Creek at Mayberry, but none of the other members of this assemblage are known in the Mole Creek area. *Hecatoceras longinquum* occurs at Blaney's Quarry at Ida Bay and also at the Wilson River, but neither *Tasmanoceras* or *Gouldoceras* are known from this locality. This assemblage is the most useful for correlation within the Florentine Valley, occurring in all sections of the Lower Limestone Member at between 300&450 metres above the base.

5. *Gordonoceras* assemblage at Westfield contains only *Gordonoceras bondi,* but it is abundant at this locality. Teichert and Glenister (1952) described this species from an unknown locality in the Gordon River.

6. *Westfieldoceras* assemblage contains in the Westfield section, *Westfieldoceras taylori,* and Gouldoceratidae n.gen. et n.sp. This assemblage is known only in the Westfield section in the Florentine Valley.

These nautiloid assemblages are most significant as supportive evidence for the correlations based on the brachiopods and conodonts. A summary of the biostratigraphic information available for the Ordovician of Tasmania is given in fig.(3.24).

Fig. (3.24) Correlation chart of the biostratigraphic
schemes proposed for the Ordovician of Tasmania.

Conodont fauna from Burrett (1978)

OT. assemblages from Banks and Burrett (1980)

Brachiopod biozones from Laurie (1982).

KEY TO BRACHIOPOD BIOZONES

17..........*Isorthis (Ovalella)* n.sp.

16..........*Dinorthis* n.sp. 2

15..........*?Plectorthis* n.sp.

14..........*Dinorthis* n.sp. 1

13..........n.gen. aff. *Plectorthis* n.sp. 2

12..........n.gen. aff. *Plectorthis* n.sp. 1

11..........*Lepidomena* n.sp. 2

10..........*Lepidomena* n.sp. 1

9..........*Aporthophyla* n.sp.

8..........n.gen., n.sp.

7..........*Hesperonomiella* n.sp.

6..........n.gen. aff. *Taffia* n.sp.

5..........*?Tritoechia careyi*

4..........*Tritoechia florentinensis*

3..........*Tritoechia lewisi*

2..........*Nanorthis carinata*

1..........*Apheoorthis humboldtensis*

Note : Brachiopod biozones 7 & 8 are not found
in the Florentine Valley

	TASMANIAN BRACHIOPOD ZONES	CEPHALOPOD ASSEM.	OT ASSEM.	CONODONT FAUNAS
WESTFIELD BEDS	17			
	////////			
UPPER LST. MB.	16	*Westfieldoceras* Ass.	OT19	
	////////		OT18	F
	15	*Gordonoceras* Ass.	OT17	
	////////		OT16	E
			OT15	
LOWER LST. MB.	14	*Tasmanoceras-Hecatoceras-Gouldoceras* Ass.		D
		Gorbyoceras-Discoceras Ass.	OT14	C
	13		OT13	
	12		OT12	B
CASHIONS CREEK LST.	11		OT11	A
	10		OT10	
KARMBERG	9	*Wutinoceras-Adamsoceras* Ass.		
	///// 8		OT9	
LST.	///// 7			
	6	*Piloceras-Manchuroceras* Ass.	OT8	
FLOR.	5		OT7	
	4		OT6	
VALLEY	3		OT5	
	2		OT4	
FM.	1		OT3 OT2	
	////////		OT1	

CORRELATIONS WITHIN AUSTRALIA

The Ordovician nautiloid faunas of Australia, outside of Tasmania, are extremely poorly known, with the only major faunal study being on the lower Ordovician of Western Australia. The only studies outside of Tasmania including illustrations and descriptions of the faunas are Teichert (1939), Thomas and Teichert (1947), Teichert and Glenister (1952, 54), Glenister (1952), Hill, Playford and Woods (1969) and Wade (1977a, 77b).

There are no species in common between Tasmania and the rest of Australia, and of the faunas that have been described in detail there is only one genus in common. A number of the genera that occur in Tasmania have been reported in unillustrated lists from elsewhere, for example, *Armenoceras* sp. Wade (1977a) and *Gorbyoceras* sp. Percival (1976). Teichert and Glenister (1954, p. 23) in comparing the Emanuel Formation and the Tasmanian nautiloid faunas stated "It is peculiar that the two faunas have nothing in common". This statement is still largely true. The only genus in common between Tasmania and the rest of Australia is *Pycnoceras*, which occurs at the base of the Karmberg Limestone at Adamsfield and in the Emanuel Formation in the Canning Basin, Western Australia (Teichert and Glenister, 1954). The age of both localities (on conodont and other evidence) is Late Canadian. Dr. M. Wade has kindly allowed me to examine her unpublished material from the Toko Range, Western Queensland, and there are no genera in common between that fauna and Tasmania. The fact that there are nautiloid faunas known of similar age from Western Australia, Central Australia, Western Queensland and Tasmania (albeit in some cases poorly known), all containing endoceroids and other nautiloids, but with only one genus in common between two of the localities is

Fig.(3.25) Correlation chart of nautiloids from Tasmania
with those of the rest of Australia.

Correlations with Queensland, Central Australia and
Western Australia based on those in Webby *et al.*
(1981).   Those from N.S.W. from Glenister (1952)
and Percival (1976). Victoria from Thomas and
Teichert (1947).

U.S. SERIES	TASMANIA	QUEENSLAND	CENTRAL AUST.	WESTERN AUST.	N. S. W.	VICTORIA
MAYSVILLE						
	Westfieldoceras Ass.					
EDEN						
	Gordonoceras Ass.					
TRENTON	*Tasmanoceras-Hecatoceras-Gouldoceras* Ass.				*Bactoceras Gorbyoceras*	
BLACKRIVER	*Gorbyoceras-Discoceras*					
CHAZY	Ass.					
WHITEROCK	*Wutinoceras-Adamsoceras* Ass.			Gap Creek Fm.		
CANADIAN	*Manchuroceras-Piloceras* Ass.	Nora Fm. / Coolabah Fm.	Horn Valley Fm.	Emanuel Fm.		*Discoceras?* sp.

extremely puzzling.

The description of the non-nautiloid part of the Ordovician faunas in Australia is now reaching the stage where an Australia wide biostratigraphy can be established with some reliability. This has recently been attempted (Webby *et al.*, 1981) and the results have incorporated all the available faunal and stratigraphic information from Australia. The correlations in fig.(3.25) are largely based on this study.

INTERNATIONAL CORRELATIONS

International correlations based on the Ordovician nautiloids of Tasmania are broadly rather than closely controlled as all the species and many of the genera are endemic. A correlation is obtained based on the conodonts and then the nautiloid faunas are compared with this correlation. The conodont correlations are taken from Burrett (1978) and are largely based on the 'mid-continent' North American conodont faunas of Sweet and Bergstrôm (1976). These conodont correlations have been supplemented by data from other fossil groups, mainly brachiopods. The conodonts of China are poorly known, therefore the nautiloids are used to make correlations with China.

For convenience of organization the discussions on international correlations will be based on the six nautiloid assemblages.

Piloceras-Manchuroceras assemblage:- The *Piloceras-Manchuroceras* assemblage is the oldest known in Tasmania. The majority of its components were described by Teichert (1947). A diverse conodont fauna from the base of the Karmberg Limestone at the Gap includes *Prioniodus intermedius* and *Juanagnathus variabilis*, indicating a correlation

with the late Canadian *Prioniodus evae* Zone. The trilobites, brachio-
pods and graptolites suggest an identical correlation which is dis-
cussed in detail in Banks and Burrett (1980) and Stait and Laurie (1980).
The conodont fauna will be described in Burrett and Stait (in prep.).
The cephalopods at Adamsfield correlate with the fauna at The Gap.
Flower(1976a,p527) stated that "Cephalopod faunas of this interval (Middle-
Late Canadian] are dominated by two new, rapidly expanding orders,
the Endoceratida and Tarphyceratida". This is certainly true of
Tasmanian where the fauna is composed only of those two orders. In the
late Canadian of the United States of America *Piloceras* is extremely
common and is a major component of the fauna. *Pycnoceras* is also common
in the Late Canadian of the U.S.A. The presence of *Manchuroceras* in
the Tasmanian fauna indicates a link with China and South-east Asia
where it is a dominant component in the Wolugian (Late Canadian,
Ningkuoian and Chongyian, Sheng (1980)). Kobayashi (1977, p.19) stated
that "the *Manchuroceras* province on the Western Pacific side was con-
nected with the Piloceratidae province at Tasmania". Flower (1976a,
p.528) also commented on this merging of the endoceroid faunas. The
newly recorded presence of *Pycnoceras* and the description of *Manchuroceras*
from U.S.A.,(Hooks and Flower ,1977),has strengthened the North American
affinities of the Tasmanian fauna, but it still has much in common with
the Asian faunas. This merging of the two faunas in Tasmania make it
a useful test of the Late Canadian to Wolungian correlation often made.

Wutinoceras-Adamsoceras assemblage:- The *Wutinoceras-Adamsoceras*
assemblage is found in both northern and southern Tasmania. In southern
Tasmania the Karmberg Limestone contains the conodont *Histiodella sinuosa,*
indicating a correlation with fauna 3 and basal fauna 4 of Sweet and
Bergström (1976). These faunas are correlated with the Late Whiterock
stage. The Whiterock age is supported by the occurrence of the

brachiopods, *Hesperonomiella* spp. and *Aporthophyla* n.sp. from a similar level in northern Tasmania (Laurie, 1982). *Wutinoceras* is widespread in both North America and China and may represent a breakdown of the Late Canadian provincalism in the nautiloids. In Utah, *Wutinoceras* occurs in zone N and in Newfoundland it occurs in the lower part of the Table Head Limestone. Flower (1976b) suggested a Whiterock age for both these localities. Flower (1976b) reported that *Wutinoceras* was widespread in the Wuting Limestone and its correlates in China. The Chinese occurrences of *Wutinoceras* are probably in correlates of the Whiterock of North America (Chen 1976). As *Adamsoceras* occurs in the same strata as *Wutinoceras* in North America and China, its presence reinforces the Whiterock correlation for Tasmania. In summary, Flower (1976a, p8) stated that "..actinoceroids from Tasmania which seem, from their evident reticular canals, to be Wutinoceratidae and to indicate Whiterock equivalents in that region also".

Discoceras-Gorbyoceras assemblage:- As this is a long-ranging assemblage, spanning the Cashions Creek Limestone and the lower half of the Lower Limestone Member in the Florentine Valley, it will be discussed in two sections. The first section will be the strata assignable to the Chazy, while the second will be those of the Blackriver. Above and below the Cashions Creek Limestone and within the Standard Hill Member, Burrett (1978) found the conodonts *Phragmodus flexuosus*, *Belodina alabamensis* and *Panderodus* n.sp. which indicate a correlation with faunas 5 and 6 of Sweet and Bergstrôm (1976). The lower part of the Lower Limestone Member and the Ugbrook Nodular Member, the Sassafras Creek Member and the Dogs Head Member, contain the conodonts *Phragmodus* n.sp., *Tasmanognathus careyi* and *Chirognathus monodactylus*. The correlation with the Blackriver is difficult as the first two conodont species are endemic, but the strata are underlain by strata

containing Chazy conodonts and overlain by strata containing Early-Trenton conodonts supporting a Blackriver age. Moreover, although *C. monodactylus* may be facies controlled it is characteristic of Blackriver strata (Sweet and Bergstrøm, 1976).

The bulk of the cephalopods in this assemblage belong to an endemic family, the Gouldoceratidae. *Armenoceras*, found in the Cashions Creek Limestone, ranges from the Chazy to the Late Silurian, so the Tasmanian species is early for that genus. *Armenoceras corbetti* is morphologically unusual for *Armenoceras* and a correlation based on the generic assignment may be misleading. In the upper Cashions Creek and the lower Lower Limestone Member are found *Discoceras*, *Gorbyoceras* and *Beloitoceras*, all long ranging and widespread genera. The Tasmanian occurrences are early for, but within the range of, these genera. The *Discoceras* species in Tasmania are most like *D. depressum* from the Oslo-Asker district in Norway, which is considered by Sweet (1958) to be Middle Ordovician (Llandeilo, Chazy-Blackriver, fig (3.26)). This assemblage also contains *Mysterioceras* which has been reported from both the U.S.S.R. and China, but as discussed elsewhere (page 174) both assignments must be questioned. Thus *Mysterioceras* is endemic for the purposes of these correlations.

Tasmanoceras-Hecatoceras-Gouldoceras assemblage:- This assemblage is the most widespread and useful within Tasmania, but as it is composed predominantly of endemic genera it is of little significance for international correlations. The conodonts from this assemblage are *Phragmodus undatus*, *Bryantodina abrupta*, *Plectodina* cf. *furcata* and *Plectodina aculeata* indicating a correlation with faunas 8 and 9 of Sweet and Bergstrøm (1976). The age of this assemblage is Early Trenton. Brachiopods, including *Protozyga* n.sp. and *Holtedahlina* n.sp., support

this correlation (Laurie, 1982).

This assemblage contains *Tasmanoceras, Hecatoceras* and *Gouldoceras* which have not as yet been found beyond Tasmania. The other genera are all long-ranging and widespread. *Beloitoceras* is extremely common in the Late Ordovician of North America. It also occurs in China, Europe and U.S.S.R. The Tasmanian occurrence of *Beloitoceras* is early but within its known range. *Miamoceras* is known from strata of similar age in North America and in the Late Ordovician of Kazakhstan (Barskov, 1972). *Anaspyroceras* also occurs in this assemblage, but problems with its assignment make it of little use in correlation.

Gordonoceras assemblage:- There is only one endemic nautiliod, *Gordonoceras bondi,* in the *Gordonoceras* assemblage. The non-nautiloid components of the fauna are of low diversity and of only slight use in correlation. The conodonts in this assemblage are *Drepanoistodus suberectus,Bryantodina abrupta, Plectodina aculeata* and *Belodina compressa,* none of these conodonts are restricted to any one fauna of Sweet and Bergströn (1976). As this assemblage is above the *Tasman-oceras-Hecatoceras-Gouldoceras* assemblage and below the *Westfieldoceras* assemblage in the Westfield section it probably belongs to fauna 10. Therefore the correlation with the North American stages would be Late Trenton to Early Eden.

Westfieldoceras assemblage:- This assemblage contains a more diverse, but still endemic, fauna. It is not known outside of the Florentine Valley although *Beloitoceras? molense* occurs in correlates at Mole Creek. The conodonts present are *Oulodus robustus, O.* cf. *oregonia, Plectodina* cf. *furcata, Phragmodus undatus* and *Staufferella falcata.* These would indicate a correlation with fauna 11 of Sweet and Bergströn (1976), which lies in the Late Eden-Maysville stages in North America.

A combination of the corals *Calapoecia anticostiensis, Falsicatenipora chillagoensis,* species of *Palaeofavosites, Foerstephyllum, Catenipora* and *Propora* are consistent with a Late Ordovician age. The presence of *Coccoseris astomata* indicates a correlation with the Late Edenian of the Second Value formation of the Montoya (K. Kenna, pers.comm.). Brachiopods are not common in this assemblage, but above this assemblage in the Westfield Beds elements of the *Hirnartia* fauna have been found (Laurie, 1982),with *Glyptograptus persculptus* (Baillie, Banks and Rickards, 1978) and suggests an Early Silurian age for the upper half of the Westfield Beds.

FIGURE (3.26): Correlation chart between Tasmania
and the standard stages of Australia, U.S.A., Britain
and China.

Australia, British and U.S.A. correlations were obtained
from Webby *et al.* (1981). Chinese correlations were
obtained from Sheng (1980).

Key to abbreviations used on chart:

Dat - Datsonian,   Ya. - Yapeenian,

Wa. - Warendian,   Da. - Darriwilian,

La. - Lancefieldian,   Gi. - Gisbornian,

Be. - Bendigonian,   Ea. - Eastonian,

Ch. - Chewtonian,   Bo. - Bolindian.

Ca. - Castlemanian,

Florentine Valley	Tasmanian Cephalopod Asseblages	Australia	U S. A	Britian	China
Westfield					
Beds		Bo	Richmond	Ashgill	Wufengian
___?___			Maysville		
Upper	Ass. 6		Eden	Caradoc	Linsiangian
Limestone Member	Ass. 5	Ea.	Trenton		Pagodaian
Lower Limestone Mb	Ass. 4		Blackriver	Llandeilo	Huloian
Cashions Creek lst.	Ass 3	Gi.	Chazy		
Karmberg		Da.	Whiterock	Llanvirn	Niushangian
Limestone	Ass 2	Ya.		Arenig	Chongyian
	Ass 1	Ca			
Florentine		Ch.	Canadian		Ningkuoian
		Be			
Valley		Wa / La			
Formation		Dat		Tremadoc	Xinchangian
___?___					

SUMMARY

The Ordovician nautiloids of Tasmania are found in the Gordon Sub-Group, and range in age from Late Canadian to Late Ordovician. There are 38 genera known of which 22 are endemic. All the species from Tasmania are endemic. The nautiloid fauna can be divided into six biostratigraphic assemblages.

1. *Piloceras-Manchuroceras* assemblage:- This assemblage is only known from the Florentine Valley and Adamsfield. It contains *Pycnoceras adamense, Manchuroceras excavatum, M. steanei, Suecoceras robustum, Piloceras tasmaniense, Metamanchuroceras wadeae,* and *Allocotoceras insigne.* The major correlations are with the Late Canadian of North America and the Wolungian of China.

2. *Wutinoceras-Adamsoceras* assemblage:- This assemblage is widespread in Tasmania, occurring at Railton, the Florentine Valley and the Hardwood River. It contains *Wutinoceras paucicubiculatum, W. multicubiculatum, Adamsoceras johnstoni,* and endoceroid n.gen., n.sp. The assemblage correlates with the Whiterock of North America and the Wuting Limestone of China.

3. *Discoceras-Gorbyoceras* assemblage:- This is the longest ranging assemblage, ranging through the Cashions Creek Limestone and half way up the Lower Limestone Member. It is also found at Mole Creek in the Dog's Head Member and at Ida Bay. It contains *Mysterioceras australe, Gorbyoceras settlementense, Fitzgeraldoceras juneense, Standardoceras burretti, Orthoceras* sp., *Discoceras idaense, Beloitoceras* sp., *Centrocyrtocerina frizonense, Armenoceras corbetti, Ormocerina asymmetrica, Paramadiganella banksi, Anmoceras lauriei, Florentinoceras*

calveri, Ocl002eras uniquum, Felixoceras curtainense, Probotryceras westfieldense. The assemblage correlates with the Chazy and Blackriver of North America.

4. *Tasmanoceras-Hecatoceras-Gouldoceras* assemblage:- This is the most widespread assemblage occurring in the Florentine Valley, Zeehan, Mayberry, Bubs Hill, Ida Bay, and Queenstown. It contains *Anaspyroceras? anaas, Discoceras reidi, Beloitoceras kirtoni, Miamoceras bubsense, Zeehanoceras teicherti, Tasmanoceras pagei, T. zeehanense, Hecatoceras longinquum, Gouldoceras synchonena, G. obliquum,* and *G. benjaminense.* The assemblage correlates with the Early Trenton of North America.

5. *Gordonoceras* assemblage:- This assemblage is only known from the Westfield section in the Florentine Valley and contains only one species, *Gordonoceras bondi.* The age of the assemblage is probably Late Trenton to Early Eden.

6. *Westfieldoceras* assemblage:- This is the uppermost assemblage in the Ordovician of Tasmania. It only occurs in the Florentine Valley, although rocks of similar age contain nautiloids at Mole Creek. It contains *Westfieldoceras taylori, Tigeroceras florentinense, Armenoceras?* sp. and Gouldoceratidae n.gen., n.sp. The age of the assemblage is Late Eden to Maysville.

CHAPTER 4.

TAXONOMY OF TASMANIAN NAUTILOIDS

GENERAL COMMENTS

The Ordovician of Tasmania contains 49 species of nautiloids, which are assigned to 38 genera, 18 families and seven orders. Of these species 26 are new. There are 17 new genera and one new family.

Teichert (1947) and Teichert and Glenister (1952, 1953) described the Tasmanian Ordovician nautiloid faunas. In the following section all the species described in these studies are reassessed in light of the taxonomic advances of the last 30 years.

The terminology used in the descriptions in this study is largely based on that in Flower (1964b) and to a lesser extent that of Teichert (1964a) and Aronoff (1979).

The techniques used in preparation and photography of the specimens are discussed in Appendix 3.

The status of the higher taxonomic categories in the nautiloids is a point of debate. Flower and Kummel (1950) established the Class Nautiloidea and all the major divisions of the nautiloids were treated as orders. Teichert and Moore (1964) considered that there were three sub-classes : the Nautiloidea, Actinoceratidea and the Endoceratidea, which were, in turn, divided into orders. In this they followed Ruzhentsev (1962) who had a similar division but designated his sub-classes super-orders. Flower (1976a) reaffirmed his view that the Actinoceratida and Endoceratida were not distinctive morphologically from the remainder of the Nautiloidea. However, Chen *et al.* (1979a, b)

described nautiloids from the Late Cambrian of China that may indicate that the Nautiloidea (through the Ellesmeroceratida), Actinoceratidea and Endoceratidea had separate origins in the Plectronoceratida. Chen *et al.* (1979a,b) considered that the three part division used in Teichert and Moore (1964) was correct. In the present study the original groupings of Flower and Kummel (1950) supported by Flower (1976a) are used. This was done, as,until the Chinese material is fully assessed, its axact relevance to the origins and higher taxonomy of the nautiloids cannot be determined.

Wherever possible in the following descriptions the dimensions of the conch are expressed using the Siphonal Formula of Flower (1968a, p.6).

$$A \:/\: B \:/\: C \::\: D \:/\: E \:/\: F; \quad G$$

where

A is the distance from the venter to the septal foramen;

B is the height across the septal foramen;

C is the distance from the foramen to the dorsum;

D is the distance from the venter to the expanded part
   of the segment;

E is the distance across the expanded part of the segment;

F is the distance from the expanded part of the segment to
   the dorsum;

G is the length of the siphuncular segment.

All photographs in the following text are   , unless otherwise stated, oriented venter down.

Throughout the thesis the type-species of a genus has been labelled as the genotype, this was done to conform with the practice of the main worker on nautiloids (Dr. R.H. Flower) while admitting this is not in line with recommendation 67A of the International Code of the Zoological Nomenclature.

The phylogenetic reconstructions and conclusions in this thesis are the best approximation possible on the available information and as such it is recognized that for most of the conclusions to be verified large collections of each member will have to be made. The rarity of the nautiloids makes these collections impossible so the picture presented is meant only as a framework gleaned from the available information.

SYSTEMATIC   PALAEONTOLOGY

Order   ACTINOCERATIDA

Family ARMENOCERATIDAE   Troedsson, 1926

Genus   ARMENOCERAS   Foerste, 1924a

Armenoceras corbetti   n.sp.

Plate 1   fig.1-7   ; Fig. 4.1(2)

The one specimen of this species is a straight orthocone, the
adoral end of which has been slightly damaged. As the specimen was
ground down from a naturally weathered surface, it may be a slightly
oblique section. The specimen is 125mm long and contains 21 camerae.
The siphuncle is large and was probably approximately half the diameter
of the conch.   The siphuncle is highly expanded, the length of
four segments being equal to the height. The septa, where preserved,
are only gently curved. Apically the siphuncle is 4mm from the
preserved shell wall, adorally it is 7mm. Apically the height of the
expanded part of the siphuncular segments is 18mm, at the foramen
9mm, and the length is 5mm, the corresponding adoral measurements
are 20mm, 10mm, and 5mm.   The connecting rings are adnate to the
septa, with the length of adnation of the apical part of the connect-
ing ring 3.0mm, and the adoral part of the ring is 4.0mm on the
venter, the corresponding measurements on the dorsum are 4.0 mm and
3.0mm.

The septal necks are short and recumbent, with the brim adnate to
the septa. Apically on the venter the necks are 0.3mm, the brims
0.8mm, while on the dorsum the necks are 0.3mm, brims 0.8mm. The
corresponding measurements adorally are 0.4mm, 1.2mm, 0.4mm, and 1.5mm.

The annulosiphonate deposits are well developed and equally
distributed apically and adorally of the septal foramen. The central

canal is large, with a height of from $^1/2$ to a $^1/3$ of the siphuncular diameter. The radial canals are simple, thin and horizontal. The perispatium is well developed, with the radial canals reaching it at the most expanded part of the segment. The connecting rings are thin. The cameral deposits are well developed, with both hyposeptal and episeptal deposits present, of which the latter are more strongly developed.

Location and Material:- One partially preserved phragmocone; Holotype UTGD81156. The specimen was collected at 16 Road in the Florentine Valley from the Cashions Creek Limestone. The age is Chazy.

Remarks:- It is extremely difficult to compare *Armenoceras corbetti* with the majority of the species of *Armenoceras* as they are either unsectioned or lateral sections. This means that *Armenoceras corbetti* could be a synonym of a pre-existing species, but without sagittal sections of these species comparison with them is not possible. *Armenoceras corbetti* is unusual in that the area of adnation on the dorsal side of the siphuncle is like that of the Wutinoceratidae. The combination of the septal differentiation between the dorsum and venter, and the simple horizontal canals may indicate that *A. corbetti* is a new genus, as the type species of *Armenoceras* does not show these features. A new genus has not been established as the majority of the species of *Armenoceras* are not known from sagittal sections and until this is done a revision of the genus cannot be undertaken. *A. corbetti* is left assigned to *Armenoceras* until such a revision is undertaken.

The two species of *Armenoceras* which are most closely related to *Armenoceras corbetti* in shape and size of the siphuncle are *A. vesperale* Flower (1957) and *A. richardsoni* (Stokes), but neither of these species

have the wutinocerid-type adnation of the connecting rings and the horizontal radial canals.

<div align="center">

Armenoceras(?) sp.

Plate 1   fig. 8-11 .

</div>

The only specimen is a straight, longiconic orthocone, 42mm long which contains 11 camerae. It is a partially-preserved phragmocone in which only the venter and the dorsal septal foramen are present. The siphuncle is expanded with the segments sloping adorally from the venter to the dorsum relative to the siphuncular axis.

The siphuncle apically is 6.4(+)mm high at the most expanded part, 3(+)mm at the foramen and 3mm in length; adorally the corresponding measurements are 8(+)mm, 3.5mm and 3mm. On the venter,the adoral and apical connecting rings are adnate to the septa. Adorally the length of adnation is 3mm, while apically it is 1mm.

The septal necks are short and recumbent and on the venter are 0.4mm long. The brims are adnate to the septa and 0.5mm in length. The annulosiphonate deposits are formed equally adorally and apically of the foramen. The central canal is narrow, while the radial canals are thin and horizontal. The connecting rings are 0.1mm thick. There are no cameral deposits present.

Material and Location:- One partially preserved phragmocone, UTGD22089. The specimen was collected from the Upper Benjamin Limestone, on the Adamsfield Track, as it crosses the Tiger Range. The age is probably Maysville.

Remarks:- The specimen is an actinoceroid which has expanded segments, recumbent septal necks, brims which are adnate to the septa, connecting

rings which are both apically and adorally adnate to the septa and a simple horizontal canal system. This would indicate an assignment to *Armenoceras*. The slope of the siphuncular segments forward on the venter is not typical of *Armenoceras*. The preservation of the specimen does not allow assignment to a species or to a genus with certainty.

Family   WUTINOCERATIDAE   Shimuzu and Obata, 1936

Genus   WUTINOCERAS   Shimuzu and Obata, 1936

The classification of the Tasmanian species of *Wutinoceras* has been a problem, as the taxonomic validity of *Wutinoceras* has been in dispute. Shimuzu and Obata (1935) established *Wutinoceras*. In 1936 they distinguished it from *Nybyoceras* using three characters which were based on a misconception of the type species of *Nybyoceras*. Flower (1957) emended the definition so as to establish valid distinctions between *Wutinoceras* and *Nybyoceras*; the appropriateness of these distinctions has been in dispute (for details of the arguments see Teichert and Glenister (1953), Teichert (1964b) and Flower (1957, 1968a, 1976b). Aronoff (1979) agreed with Flower that *Wutinoceras* is a valid genus, and emended the scope of the Wutinoceratidae to include *Nybyoceras* and *Orthonybyoceras* (as emended by Aronoff). Flower (1957) considered the reticulate canal system as the diagnostic feature of *Wutinoceras*, while Aronoff (1979) placed more weight on the thick connecting rings. The combination of these features certainly are enough to separate *Wutinoceras* from *Nybyoceras*.

As *W. paucicubiculatum* (Teichert and Glenister) has a reticulate canal system, although less complex than in *W. multicubiculatum* (Teichert and Glenister), and thick connecting rings, I cannot agree with Aronoff's (1979) assignment to *Orthonybyoceras*. An explanation

for the less complex reticulate canal system in *W. paucicubiculatum* may be the destruction of the finer canals by the recrystallization that has occurred. Aronoff (1979) also used the relative size of the siphuncle to the phragmocone, but this criterion cannot be used in the Tasmanian material as the ventral phragmocone wall in *W. paucicubiculatum* and both the ventral and dorsal walls of *W. multicubiculatum* have been destroyed in all available sagitally sectioned specimens.

The thickness of the connecting rings is a subjective criterion as the measured thickness will vary with the size of the specimen; in this study if the connecting ring is the same thickness, or greater than, the septa it is considered as thick. Aronoff (1979) considered that *Orthonybyoceras* had connecting rings less than 0.2mm in thickness, but *W. multicubiculatum* which Aronoff considered to be an "undoubted *Wutinoceras*" has connecting rings only 0.15mm thick. As *W. paucicubiculatum* has connecting rings of a similar thickness to *W. multicubiculatum*, and is similar in the other features mentioned above, it is considered cogeneric with *W. multicubiculatum*.

Wutinoceras multicubiculatum (Teichert and Glenister, 1953)

Plate 2   fig. 1 - 6 .

The holotype is an incomplete phragmocone which is subcircular, orthoconic and 162mm long containing 29 siphuncular segments. Both the ventral and dorsal shell walls have been destroyed. The cross section was probably slightly depressed. The conch was probably slowly expanding as the siphuncle expands adorally. The siphuncle

is sub-ventral   moderately large, and approximately half the diameter
of the preserved portion of the conch. The siphuncular segments are
highly expanded, with the length of two segments being equal to the
height. The septa are evenly curved with the centre of curvature
at the centre of the conch. The siphuncular segments become more
expanded during ontogeny.

Apically the siphuncle is 9mm at its maximum height, 3mm at the
foramen, and 6mm in length. Adorally the corresponding measurements
are 11mm, 5mm and 6mm. The septal necks are recurved and most common-
ly free, although in some, especially on the dorsum, the tip of the
brim is adnate to the septa. Apically the septal necks are 0.7mm long,
the brims are 0.8mm long on the venter, and on the dorsum the necks
are 0.4mm, the brims 0.8mm. The corresponding measurements adorally
are 0.7mm, 0.8mm, 0.5mm and 0.8mm. On the dorsum the adoral part
of the connecting ring is adnate to the septa for 1.0mm apically,
and 1.8mm adorally. The apical part of the connecting ring is adnate
to the septa for 0.5mm apically and 0.8mm adorally. On the venter
the apical part of the connecting ring is adnate to the septa for
2.5+mm apically and 2.7+mm adorally.

The annulosiphonate deposits are well developed throughout
the length of the specimen. The canal system is reticulate. The
central canal is wide, approximately one third of the diameter of the
siphuncle. The radial canals are thin. The perispatium is very
well developed, with perispatial deposits present near the foramen in
most segments.

The connecting rings are 0.1mm in thickness. The cameral
deposits are developed dorsally with the episeptal and hyposeptal

deposits developing at the same time and extent. They both increase equally in the more apical camerae.

Material and Location:- Two partially preserved phragmocones, both stored at the Queen Victoria Museum, holotype O.S.:37:15, paratype O.S.:37:9. The specimens were collected from Blenkhorn's Quarry at Railton. The age is Whiterock.

Remarks:- The above description has been included as new information has been obtained from the thin sections made for this study. For details of the generic assignment see page 81 .

Wutinoceras cf. *multicubiculatum* (Teichert and Glenister, 1953)

Plate 2 fig. 7 - 9 .

The specimen is a straight phragmocone 35mm long. The height at the apical end is slightly more than 32mm (the ventral phragmocone wall is not preserved), the adoral height 38mm. The septa are gently and evenly curved, the point of maximum depth being 5mm to the dorsal side of the siphuncle. The siphuncle is subventral and is highly expanded between the septal foramen. The camerae are 4.8mm long. The specimen has been dorso-ventrally sectioned. The siphonal formula is 8/6/25:1/14/21; 5.8, this is taken at the dorsal end of the specimen as this is the only end with the ventral phragmocone wall intact. The septal necks are very short (0.2mm), the brims of moderate length (1mm). The apical part of the connecting ring is adnate to the septa for 3.0mm ventrally and dorsally the adoral part of the connecting ring is adnate to the septa for 2.2mm.

The cameral deposits have been largely recrystallized, but it would appear that there are both episeptal and hyposeptal deposits developed. The siphuncular canal is central with an average height of 1.8mm. The radial canal system has been largely destroyed by the recrystallization, but would appear to be reticulate. The connecting rings are 0.1mm thick.

Material and Location:- One partial phragmocone UTGD59373. Base of the Gordon Sub-Group, south of View Hill, west side of Hardward River Valley (locality 5 on fig. 1.2).

Remarks:- Due to the complete silicification of this specimen some of the morphological detail has been lost. The siphuncle is slightly smaller than is typical of *W. multicubiculatum* and the septal brim would appear to be adnate to the septa on the ventral side of the phragmocone in *W. cf. multicubiculatum* rather than free as is typical of *W. multicubiculatum*. Due to the poor preservation of the specimen a new species is not established.

Wutinoceras paucicubiculatum (Teichert and Glenister, 1953)

Plate 3   fig. 1 - 9 ; Fig. 4.1(3).

The holotype is an incomplete phragmocone which is subcircular orthoconic, 232mm long and containing 49 siphuncular segments in which the ventral wall is not preserved. The cross section is slightly depressed, with the venter probably being slightly flattened. The conch is slowly expanding. The siphuncle is sub-ventral, moderately large, approximately one quarter the diameter of the conch. The

siphuncular segments are highly expanded, the length of two segments is equal to the height.   The septa are evenly curved, the centre of the curvature is central.   The siphuncular segments become more expanded during ontogeny.

The siphonal formula is apically 8/4/21.5:5/9/19, 4.5, adorally it is 11/6.5/40:7/14/36; 6.   The septal necks are recurved and most commonly free, although in some the tip of the brim is adnate to the septa.   Apically the septal necks are 0.5mm long, the brims 0.6mm long on the venter;   on the dorsum the necks are 0.4mm while the brims 0.9mm.   Adorally the septal necks are 1mm long, the brims 1mm long on the venter, and on the dorsum the necks are 0.4mm long, the brims are 1.5mm.   On the dorsum the adoral part of the connecting ring is adnate to the septa for 0.4mm apically and 1.5mm adorally, the apical part of the connecting ring is adnate to the septa for 0.5mm apically and 1.6mm adorally.   On the venter the apical part of the connecting ring is adnate to the septa for 3.0mm apically and 4.0mm adorally. The annulosiphonate deposits are well developed throughout the length of the specimen.   The canal system is reticulate, with a simple pattern of branching.   The central canal is wide, approximately one-third the diameter of the siphuncle, the radial canals are an average of 0.2mm in diameter.   The perispatium is very well developed, with perispatial deposits present near the foramen in most segments.   The connecting rings are 0.1mm in thickness.   The cameral deposits are irregular in development and develop equally on both the venter and the dorsum. They are irregular and it is possible that they may be inorganic in origin.

Material and Location:- 3 partially preserved phragmocones. All specimens held at Queen Victoria Museum, holotype O.S.:37:10, paratype O.S.:37:11, topotype, 1957:38:130. All specimens collected from the basal Gordon Sub-Group, Blenkhorn's Quarry, Railton, Tasmania. The age is Whiterock.

Remarks:- The above description has been included as new information has been obtained from the thin sections made for this study. For details of the generic assignment see page 81 .

Wutinoceras cf. *paucicubiculatum*

Plate 4   fig. 7 - 8 .

The specimen is poorly preserved and has been completely recrystal-lized. It is an othoconic longicone 60mm long containing 14 camerae. The specimen has been weathered down to the siphuncle and probably represents a lateral section. The conch is slowly expanded from 47mm to 52mm. The silicification has allowed the remnants of the reticulate canal pattern to be seen, thus suggesting an assignment to *Wutinoceras*. The less complex canal pattern and the size of the siphuncle relative to the conch, would indicate it is similar to *W. paucicubiculatum*, but the preservation does not allow the assignment to be verified.

Material and Location:- One partially preserved phragmocone UTGD94297. Collected from the Wherretts Chert Member on the Gordon Road. The age is Whiterock.

Genus   ADAMOCERAS   Flower, 1957

Adamsoceras johnstoni   (Teichert and Glenister, 1953)

Plate 4   fig. 1 - 6 .

The holotype is an incomplete, probably orthoconic phragmocone, 106mm long containing 14 siphuncular segments. The shell wall of the specimen has been completely destroyed and it cannot be determined if the section is sagittal, but the difference in the form of the septa on each side of the siphuncle would imply that the section is close to sagittal.

The siphuncle is probably on the ventral side of the centre. The height of each siphuncular segment is approximately equivalent to the length. The septa are evenly curved with the centre of curvature being slightly to the dorsal side of the siphuncle.

Apically the siphuncle is 11mm at its maximum height, 4.7mm at the foramen, and 8mm in length. Adorally the corresponding measurements are 11mm, 4.6mm and 8mm.

The septal necks are cyrtochoanitic and free. Apically the septal necks are 0.9mm long, while the brims are 1mm long on the venter, while on the dorsum the necks are 0.9mm, the brims 0.9mm. The corresponding measurements adorally are 1.2mm, 1.4mm, 1.2mm and 1.0mm. On the dorsum the connecting rings are not adnate to the septa. On the venter the apical part of the connecting ring is adnate to the septa for 2.4mm.

Annulosiphonate deposits are well developed throughout the length of the specimen. The canal system is reticulate. The central canal is wide, approximately one fifth the diameter of the siphuncle. The radial canals are narrow, and the perispatium is well developed, with perispatial deposits present near the foramen in most segments.

The connecting rings are 0.1mm thick.

The cameral deposits are developed both dorsally and ventrally, with both the episeptal and hyposeptal deposits forming at the same time and to the same extent.

Material and Location:- 1 partially preserved phragmocone. Holotype O.S.:37:12. Specimen registered at the Queen Victoria Museum as being collected from King Extended Hill, Zeehan. The mode of preservation, the identical bedding-cleavage relationship, and the lack of limestone of the lithology containing A. *johnstoni* in the Zeehan area leads the author to conclude that the specimen of A. *johnstoni* was collected from Blenkhorn's Quarry, Basal Gordon Sub-Group. The age is Whiterock.

Remarks:- For comparisons of *Adamsoceras johnstoni* with other genera and species see Teichert and Glenister (1953). Flower (1957) established *Adamsoceras* for the ormoceroids with a reticulate canal system and indicated that he considered that *Ormoceras johnstoni* belonged to *Adamsoceras*. As discussed elsewhere (page 81) the reticulate canal system is considered a valid generic character, so the assignment of *O. johnstoni* to *Adamsoceras* is supported.

Family   UNCERTAIN

Genus   ORMOCERINA   n.gen.

Genotype:- *Ormocerina asymmetrica*   n.sp.

The phragmocone is an orthoconic, longicone, slowly expanding and subcircular in cross-section. The siphuncle is midway between the centre and the venter and one quarter the diameter of the phragmocone. The siphuncular segments are expanded, and the connecting rings are not adnate to the septa. The septal necks are cyrtochoanitic, with the necks and brims of similar length. Siphuncular deposits are well-developed.

The annulosiphonate deposits are very extensively developed ventrally around the septal foramen, but do not occur on the dorsum. The ventral radial canals are simple and straight, and the ventral perispatium is well developed. On the dorsum the perispatial deposits are developed on the siphonal surface of the connecting ring. The siphonal canal is dorsally situated. The connecting rings are of moderate thickness and unstructured. Cameral deposits are present in both the ventral and dorsal camerae.

Remarks:- *Ormocerina* is similar to the Actinoceratidae as it has cameral deposits, expanded siphuncular segments which are higher than long and simple radial canals. Its small size is more typical of the Ormoceratidae but the shape of the siphuncular segments and the size of the siphuncle relative to the phragmocone are not typical of that family.

The asymmetric siphuncular deposits constitute the major generic characteristic of *Ormocerina*. As it occurs in more than one specimen it is not just pathalogical. There is no other actinocerid genus which has annulosiphonate deposits on the venter and only perispatial deposits on the dorsal side of the siphuncle. The size of the specimen and the simple radial canal system is reminiscent of *Ormoceras*, but the shape of the siphuncular segments and the size of the siphuncle relative to the phragmocone is not typical of *Ormoceras*.

Ormocerina asymmetrica   n.sp.

Plate 5   fig.1 - 9 ; Fig. 4.1(1).

The phragmocone is an orthoconic, longicone, sub-circular in cross-section. The siphuncle is midway between the centre and the venter and one quarter of the diameter of the phragmocone. There are 18

siphuncular segments in a length of 34mm. The phragmocone expands slowly. The siphuncular segments are strongly expanded with the point of maximum expansion at the centre of the segment. The septa are gently curved, with the point of maximum depth at the siphuncle.

The siphonal formula at the most apical segment is 1.5/1.1/3.6: 1.1/1.9/3.2; 1.6, while adorally it is 1.7/2.1/6.2:1.0/3.6/5.5; 2.0.

The connecting rings are not adnate to the septa.

The septal necks are cyrtochoanitic. Apically the septal neck is 0.1mm long and the brim is 0.1mm long on the venter and on the dorsum, the necks are 0.1mm long and the brims are 0.1mm long, the corresponding measurements adorally are 0.25mm, 0.2mm, 0.3mm, and 0.2mm.

Well developed annulosiphonate deposits occur in the siphuncle. The siphuncular canal is dorsal, large and includes the dorsal peri-spatium. There has been a layer of organic origin, deposited on the dorsal connecting ring. The ventral annuli are well developed and there is a straight, simple radial canal to a restricted ventral perispatium. The annulosiphonate deposits surround the septal foramen and have distinct lamellae which are symmetrical about the septal foramen. The ventral annuli fill three quarters of the height of the septal foramen.

The connecting rings are moderately thick (0.05mm) and unstructured.

The cameral deposits are well developed in the ventral camerae with both episeptal and hyposeptal deposits formed and nearly filling the camerae. Dorsally they are not as well developed with only a thin lining on the septa.

Material and Location:- Two incomplete phragmocones, the holotype

UTGD121127, and paratype UTGD121128. The specimens were collected from 140 metres above the base of the Lower Limestone Member of the Benjamin Limestone at the Settlement Road Section in the Florentine Valley (locality C of fig. 3.10). The age is Blackriver.

Remarks:- See remarks under genus.

Fig. (4.1) :

1. *Ormocerina asymmetrica* n.gen,n.sp. : A is a
   longitudinal section of the adoral end of the
   holotype showing the asymmetry of the siphonal
   deposits; apex left, venter down, X10. B is a
   cross-section showing the position and relative
   size of the siphuncle, venter below.

2. *Armenoceras corbetti* n.sp. : A is a longitudinal
   section of the adoral end of the holotype showing
   the wide siphonal canal and the horizontal radial
   canals; apex right, venter below, X1. B. is a
   schematic cross-section showing the probable
   position and relative size of the siphuncle,
   venter below.

3. *Wutinoceras paucicubiculatum* : A is a longitudinal
   section of the holotype showing the siphonal
   canal and the radial canal system; apex right,
   venter below, X0.5.B. is a schematic cross-
   section showing the probable position and relative
   size of the siphuncle, venter below.
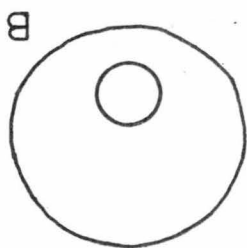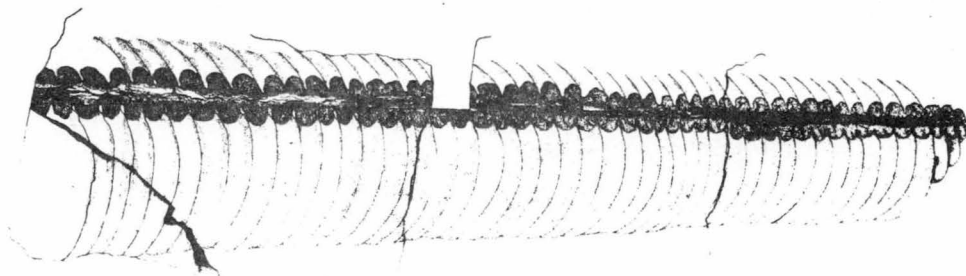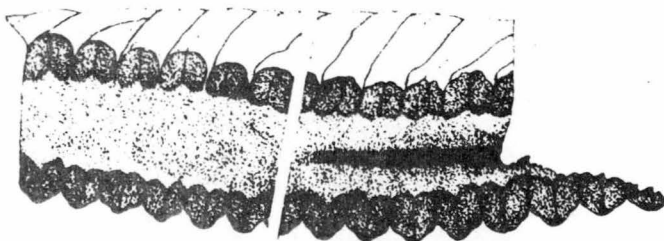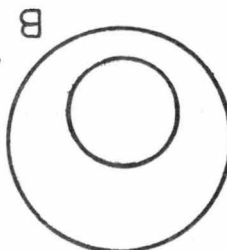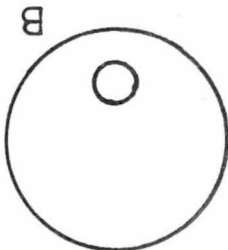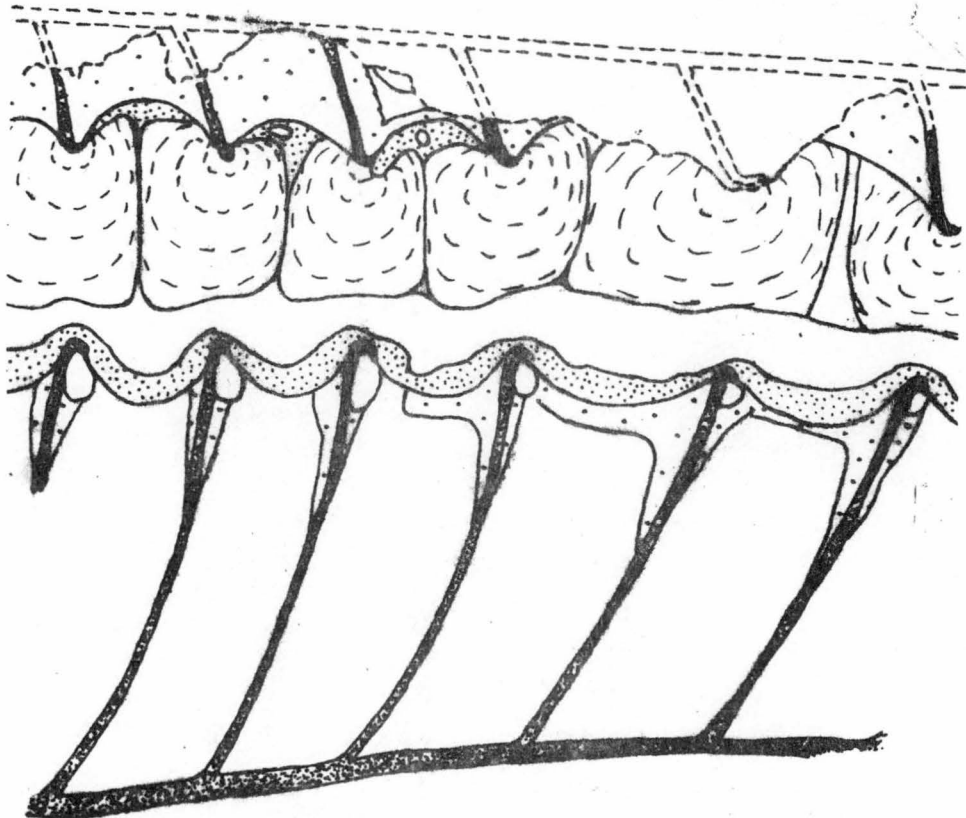
PLATE 1.

Armenoceras corbetti; Armenoceras? sp.

Figs. 1-7: *Armenoceras corbetti* n.sp., UTGD 81156;

1. A sagittal section of the holotype showing the siphuncle and ventral side, apex right, X1.

2. A close up of the dorsal side of the siphuncle, X4.

3. A close up of the dorsal septal necks showing the area of adnation between the connecting rings and septum, X10.

4. A close up of the ventral septal neck, X10.

5. A close up of the ventral side of the siphuncle and the ventral camerae, X4.

6. A transverse section of the holotype showing the relative size of the siphuncle to the phragmocone at the point of maximum expansion of the siphuncle, looking adorally, X1.

7. A transverse cut at septal foramen, looking apically, X1.

Figs. 8-11:   *Armenoceras?* sp., UTGD 22089;

8. A sagittal section of the whole specimen, apex right, X1.

9. A close up of the ventral wall of the siphuncle and the ventral camerae, X5.

10. An enlargement of the septal neck and area of adnation on the dorsal side of the specimen, X10.

11. A close up of the ventral side of the siphuncle showing the septal necks and the radial canal, X7.

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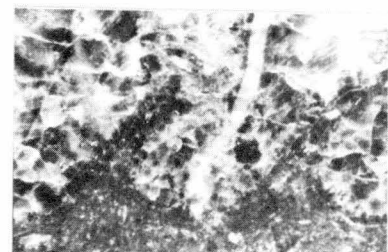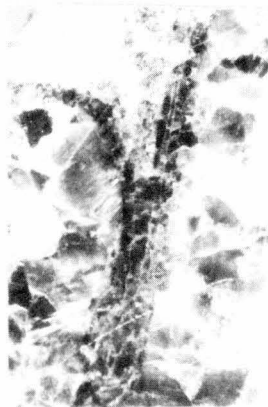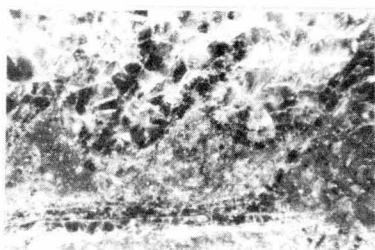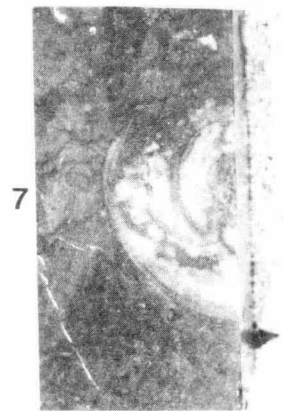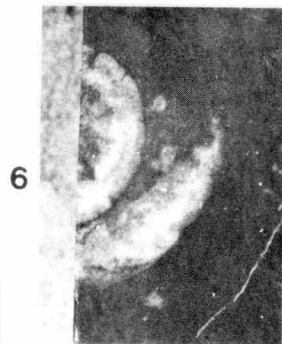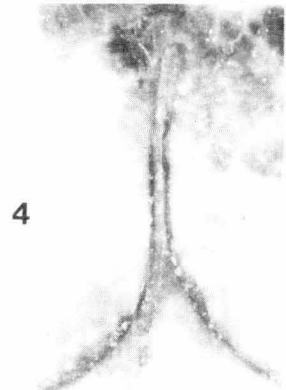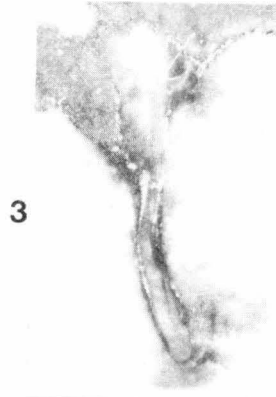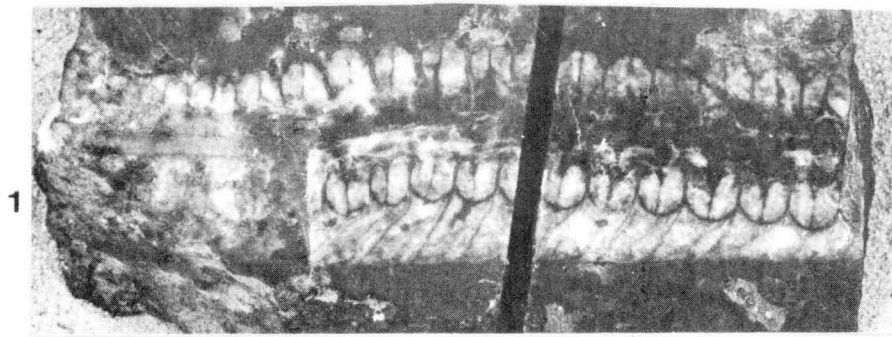
PLATE 2.

Wutinoceras multicubiculatum; W. cf. *multicubiculatum.*

Figs. 1-6:   *Wutinoceras multicubiculatum,*   Queen Victoria
              Museum (Q.V.M.) O.S. 37:13;

1.   A sagittal section of the holotype showing the siphuncle
     and central and radial canals, apex right, X0.8.

2.   The off-centre cut showing the reticulate radial canal
     system, apex left, X0.8.

3.   A lateral section of the Paratype, Q.V.M. O.S. 37:9·2,
     apex left, X1.

4.   A thin section of the ventral wall of the siphuncle
     in Q.V.M. O.S. 037:9, showing the connecting ring and
     central and radial canals, X3.

5.   A close up of the septal neck in 4, X15.

6.   A close up of the siphuncle in Q.V.M. O.S. 37:9·2,
     X2.5.

Figs. 7-9:   *Wutinoceras* cf. *multicubiculatum,*
              UTGD 59373;

7.   A sagittal section showing the siphuncle and the central
     and radial canals, apex left, X1.

8.   A close up of the dorsal septal neck, X7.

9.   A close up of the ventral septal necks, X8.
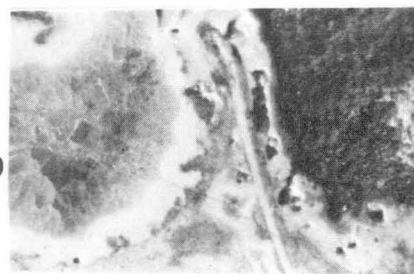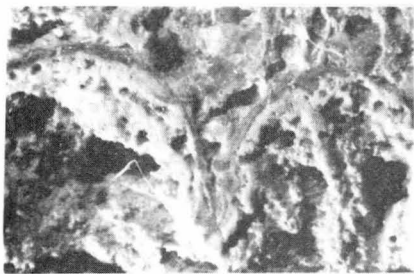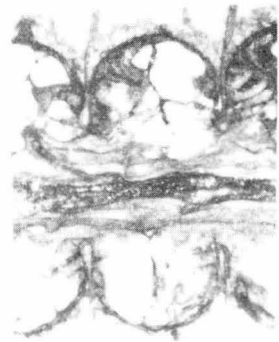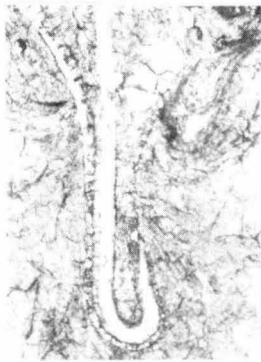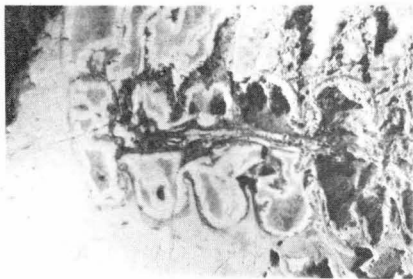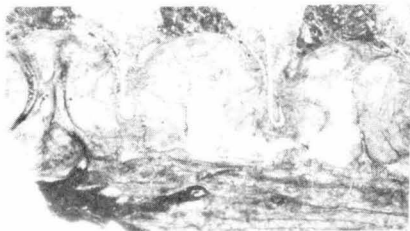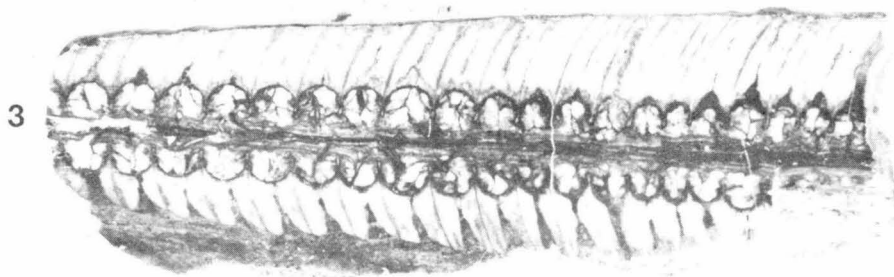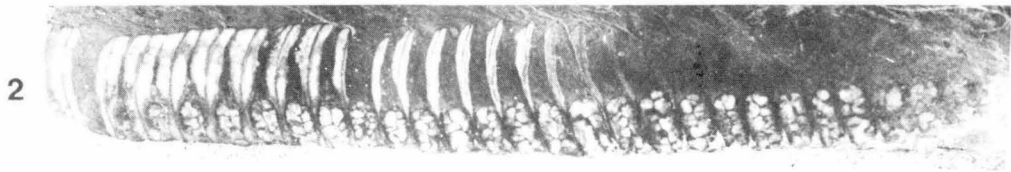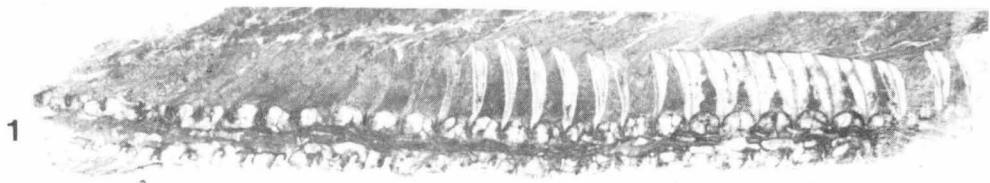
PLATE 3.
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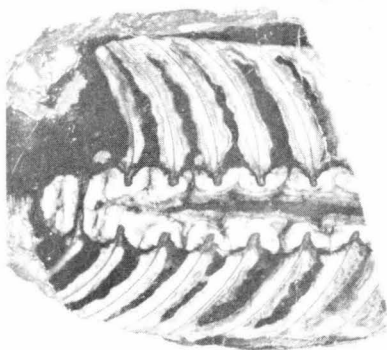
Wutinoceras paucicubiculatum

Figs. 1-9: *Wutinoceras paucicubiculatum*.
Q.V.M. O.S. 37:10;

1. A sagittal section of the holotype showing the siphuncle and the central and radial canals, apex left, X0.5.

2. An off-centre section of the holotype showing the radial canals, apex right, X1.

3. A lateral section of Q.V.M.1957:38:130, apex right, X1.

4. A transverse cross section of 3 showing the size and position of the siphuncle.

5. A lateral section of the hypotype Q.V.M. O.S. 37:11, apex left, X0.8.

6. A close up of the siphuncle of the holotype showing the radial and central canals, X2.5.

7. A close up of the siphuncle of the off-centre cut of the holotype, X2.5.

8. A close up of the dorsal septal neck Q.V.M. 1957; 38:130,X8.

9. A close up of the ventral septal neck, X9.

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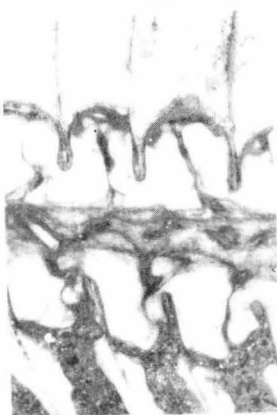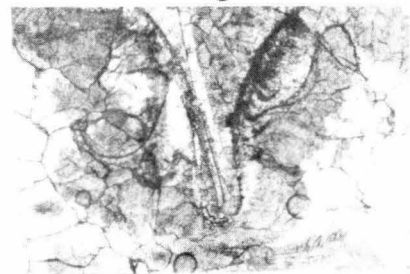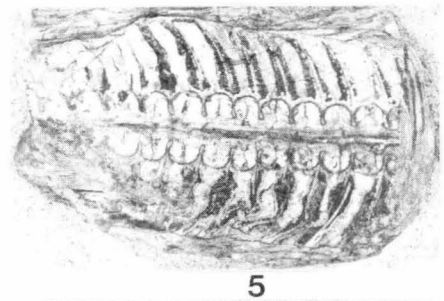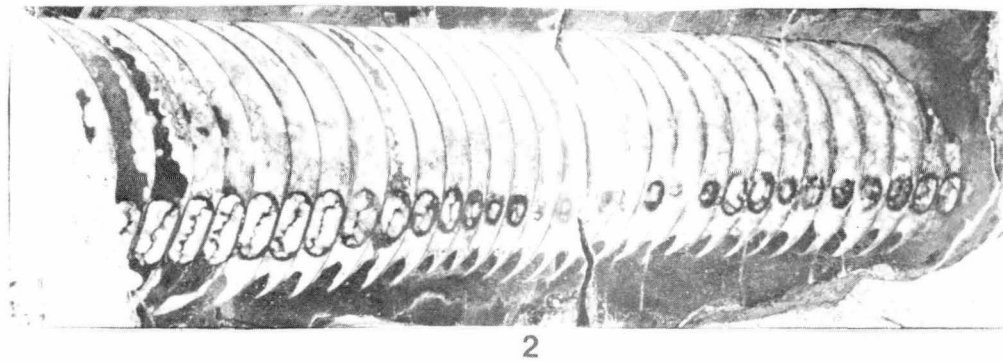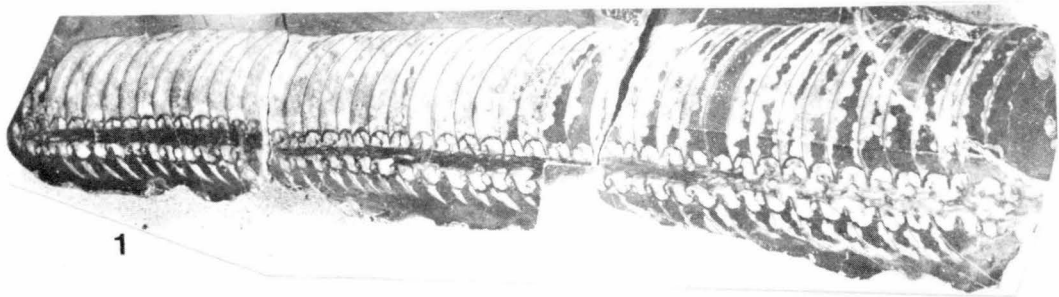
PLATE 4.

Adamsoceras johnstoni; Wutinoceras cf.
paucicubiculatum.

Figs. 1-6: *Adamsoceras johnstoni,* Q.V.M. O.S. 37:12;

1. A sagittal section of the holotype, apex left, X1.2.

2. An off-centre section of the holotype, apex right,
    X1.

3. A close up of the siphuncle in 1, showing the
    central and radial canals, X3.

4. A close up of the off-centre section, X3.

5. The dorsal septal neck showing the area of adnation,
    X7.

6. The ventral septal neck, X7.

Figs. 7-8: *Wutinoceras* cf. *paucicubiculatum*
        UTGD 94297;

7. A lateral section of the specimen showing the size
    and position of the siphuncle, apex left, X1.

8. A close up of the siphuncle showing the radial
    canals, X7.

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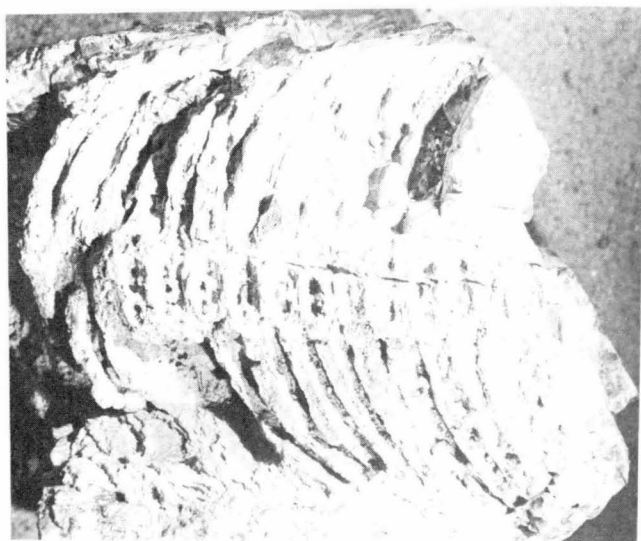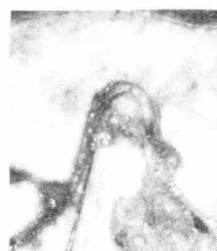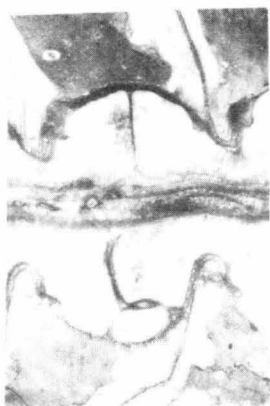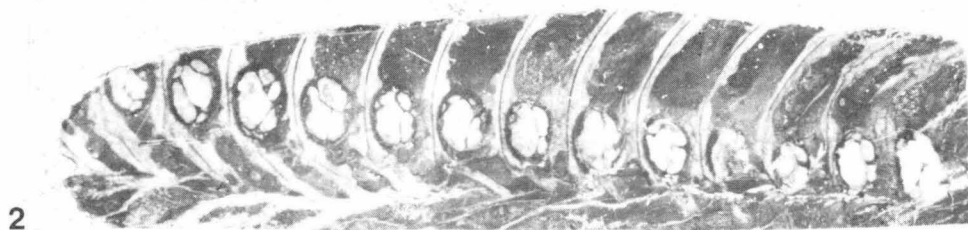
PLATE 5.

Ormocerina asymmetrica n.gen., n.sp.

Figs. 1-5, 8-9:   *Ormocerina asymmetrica*
                    holotype UTGD 121127;

1.   A sagittal section of the holotype, apex left, X4.

2.   A thin section showing the siphuncle and the
      camerae, X5.

3.   A close up of the siphuncle showing the asymmetric
      siphonal deposits, X11.

4.   A close up of the dorsal side of the siphuncle
      showing the perispatial deposits in the segment,
      X20.

5.   A close up of the ventral side of the siphuncle
      showing the septal neck, the siphonal deposits and
      the radial canals, X20.

6.   A thin section of an off-centre cut at the apical
      end showing the absence of siphonal deposits on
      the dorsum, X10.

7.   An off-centre cut at the adoral end showing the
      distribution of the siphonal deposits, X8.

Figs. 6-7:   *Ormocerina asymmetrica* paratype,
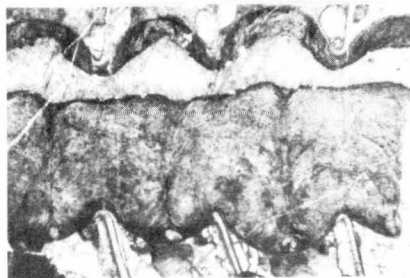   UTGD 121128;

8.   A naturally weathered sagittal section, apex right,
      X1.

9.   A close up of the siphuncle showing the lack of
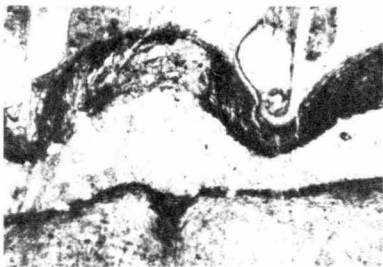   siphonal deposits on the dorsum, X3.
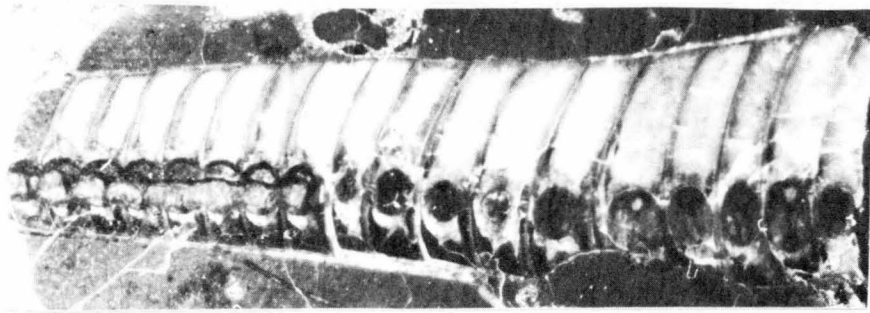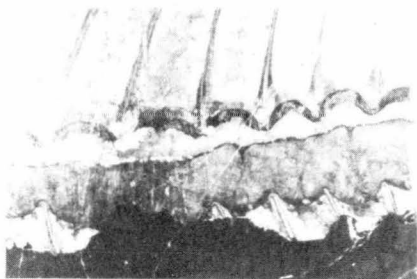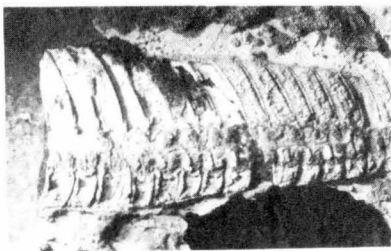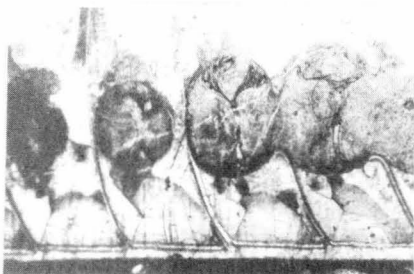
Order   DISCOSORIDA

Family   GOULDOCERATIDAE   n. fam.

This family is herein proposed for straight to slightly cyrto-conic, exogastric shells with a circular to slightly depressed cross-section. The siphuncle is large-from $1/5$ to $1/2$ the diameter of the phragmocone. The siphuncle is ventral to sub-ventral in position. The septal necks range from orthochoanitic to cyrtochoanitic. The siphuncular deposits are composed of thin endocones which leave a central canal and in some cases "radial canals". The connecting rings are thick and composed of two layers.

Remarks: The most remarkable feature of this family is that they are typical discosorids except for the connecting rings which are composed of two layers and do not show the complex differentiation typical of the discosorids.

The two layered connecting rings are similar to those of the ellesmerocerids, which may suggest that the Gouldoceratidae are a relict group of the ancestral discosorids, and that they developed from the ellesmerocerids(for possible phylogenies see Chapter 5). There are eight genera in the Gouldoceratidae, namely *Gouldoceras, Florentineoceras, Westfieldoceras, Anmoceras, Tigeroceras, Paramadiganella, Tasmanoceras* and Gouldoceratidae n.gen., n.sp.. *Madiganella,* described by Teichert and Glenister (1952) from central Australia, may also be a member of this family, but until it is better known this cannot be confirmed. Prior to the current study only *Tasmanoceras* was known. Its order and family assignment had proved a problem with Teichert and Glenister (1952), p. 739) assigning it to the Endoceratidae of the Endoceratida, while Flower (1968c, p.83) placed it

in the Donacoceratinae of the Narthecoceratidae which he transferred to the Michelinoceratida. With the description of the new material from Tasmania it is now clear that *Tasmanoceras* is a discosorid.

Genus   GOULDOCERAS   Stait, 1980

Genotype:- *Gouldoceras synchonena*,   Stait, 1980.

Derivation of name:-   In honour of Charles Gould, well-known early explorer and geologist in Tasmania.

Only phragmocones are known; they are slender exogastric cyrtocones, compressed in section. The siphuncle is large and subventral. The siphuncular segments are highly inflated, with a long area of adnation dorsally with the adoral side of the septa. The siphonal deposits consist of a thick lining which forms a central canal and "radial canals". The septal necks are gently curved, with the brims and necks being of similar length. There is a mid-ventral groove on the expanded part of the siphuncle. Connecting rings are thick and composed of two layers.

Remarks:-   The combination of the thick siphuncular deposits, "radial canals" and the large subventral siphuncle with a central segmental groove distinguish this genus from any other described genus. Flower (1976a, p.549) stated that "the position of both these genera" (one of which is *Hecatoceras* with a segmental groove, i.e. *Gouldoceras*) "as members of the Discosorida now seems dubious". Flower considered that this genus may be assignable to the Oncoceratida. Examination of the siphuncular structures make this unlikely as there is a continuous siphuncular lining which almost fills the siphuncle, leaving only a central canal and "radial canals" unknown in the Oncoceratida.

Teichert and Glenister (1953) compared the hypotype (No. 1999) of *Hecatoceras longinquum* (now *Gouldoceras synchonena*) with *Endodiscosorus* (*Endostokesoceras*) *eifliensis* (now *Alpenoceras eifliensis*) illustrated by Schindewolf (1944) and noted a strong similarity. Examination of Schindewolf's illustration indicates that the siphuncular structures are similar to *Gouldoceras* in the presence of a siphuncular lining; there is also a "radial canal" system present. The "radial canals" appear to be formed in another type of deposit and not by the extreme development of the lining as in *Gouldoceras*.

The thick two layered connecting rings and endocones in the siphuncle indicate that this genus is assignable to the Gouldoceratidae. The "radial canals" formed in this genus are unusual for this family, but not unique.

Gouldoceras synchonena   Stait, 1980.

Plate 6   figs. 1 - 7 ; Fig. 4.2(2,9).

Hecatoceras longinquum, Teichert and Glenister, 1953, p. 43, Plate 6, Fig. 11, Text-fig. 3B.

The conch is a gently expanding exogastric, compressed cyrtocone, with the dorsum more strongly rounded than the venter. The siphuncle is large and subventral, consisting of 15 segments which together are 33m long; the apical conch height is 11mm, while adorally it is 14mm (at the 12th segment). The most apical segment is 1mm long and expands in height from 1mm to 2.5mm; the corresponding adoral measurements are 2mm in length and expanding from 2mm to 5mm. The septal necks are cyrtochoanitic, with the septal necks and brims being of similar length, each being 0.5mm long. The area of adnation is greater on the dorsal

side (1.0mm) than the venter (0.4mm). The connecting rings are thick and composed of two layers, a thick lighter layer on the cameral surface and a thin dark layer on the siphonal surface, and highly expanded. The siphuncular deposits are a continuous lining over the connecting rings and septal necks. A central canal with "radial canals" is present, the "radial canals" do not penetrate the siphuncular lining. The segmental furrow described by Teichert and Glenister (1953, Plate 6, fig. 11) cannot be seen on the holotype, but is visible on isolated siphuncles. The segmental furrow would appear to be an indentation in the connecting ring on the central side of the siphuncle. It also appears to develop to a greater extent in the mature animal, with all juvenile segments seen only having it poorly developed.

Location and Material:- Holotype UTGD55553, phragmocone, Smelter's Quarry, Queenstown, Hypotypes UTGD81791 a, b, c, d; isolated siphuncles, Smelter's Quarry, Zeehan.

Derivation of Name:- from the Greek *synchoneio* meaning to smelt.

Remarks:- See remarks under genus.

Gouldoceras obliquum (Teichert and Glenister, 1953)

Hecatoceras obliquum, Teichert and Glenister, 1953, p. 46, Plate 6, figs. 5-10, Text-fig. 3A.

Remarks:- *Hecatoceras obliquum*, Teichert and Glenister (1953), is also only represented by isolated siphuncles. Drawings of the siphuncular structures in Teichert and Glenister (1953, Text-fig. 3A) show similar structures to those present in *Gouldoceras synchonena*. In the present study no new information has been obtained on this species, so the descriptions and illustrations of Teichert and Glenister

(1953) are not revised.

Gouldoceras benjaminense   n.sp.

Plate 7   fig. 1 - 10.

The phragmocone is unknown. The siphuncle is slightly curved
the curvature is probably exogastric. There are ten siphuncular
segments in a length of 25mm. The siphuncular segments are highly
expanded. The segments slope apically from the venter to the dorsum
at an angle of 70° to the axis of the siphuncle.

Apically the siphuncle is 1.0mm high at the septal foramen,
3.7mm high at the point of maximum expansion and 2.3mm long, while
adorally the corresponding measurements are 1.5mm, 3.8mm. and 2.3mm.

On the dorsal side of the siphuncle the apical part of the
connecting ring is adnate to the adoral surface of the septum for a
distance of 0.8mm, while ventrally it is adnate for 1.2mm.

The septal necks are cyrtochoanitic. Adorally the septal necks
are 0.4mm long, while the brims are 0.4mm long on the venter, and
the necks are 0.5mm long, and the brims are 0.4mm long on the dorsum,
while apically the corresponding measurements are 0.3mm, 0.5mm, 0.4mm,
and 0.4mm.

The siphuncular deposits are a continuous lining over the connect-
ing rings and septal necks. The continuous lining is formed by thin
"endocones" which closely parallel the shape of the siphuncle and
fill the siphuncle except for a central canal and "radial canals".
There are two short "radial canals" in the dorsal part of each of
siphuncular segment, but only one on the venter. The "radial canals"
do not penetrate the siphuncular deposits. The deposits also have a

fine radial structure perpendicular to the connecting rings. The central canal is crossed by lobate structures which are interpreted as diaphragms.

The connecting rings are thick and structured. The connecting ring is two-layered with a thin dark layer on the siphonal surface and a thick lighter layer on the cameral surface.

Material and Location:- There are three isolated siphuncles known, holotype UTGD121129, paratypes UTGD121130, and UTGD121131   The specimens were collected from 450 metres above the base of the Lower Limestone Member of the Bejamin Limestone at the Settlement Road Section in the Florentine Valley. The age is late Blackriver-early Trenton.

Remarks:- *Gouldoceras benjaminense* differs from *Goulderoceras synchonena* in having a higher slope from the venter to the dorsum, diaphragms that cross the central canal and in having two "radial canals" in each segment on the dorsal side of the siphuncle. In the slope of the siphuncular segments *G. benjaminense* is similar to *G. obliquum*, but differs from that species in having two "radial canals" on the dorsal side of the siphuncle and in the development of diaphragms across the central canal.

<div align="center">Genus   ANMOCERAS   n. gen.</div>

Genotype:- *Anmoceras lauriei*, n.gen., n.sp.

Derivation of Name:- After Australian Newsprint Mills Ltd. (A.N.M.), without whose permission the sections in the Florentine Valley could not have been examined.

The phragmocone is a straight, subcircular longicone. The

siphuncle is evenly and moderately expanded. The siphuncular deposits consist of thin, continuous endocones which are symmetrical dorso-ventrally. The septal necks are orthochoanitic and short. The connecting rings are thick and are formed from two layers with a short area of adnation to the septa. There are no cameral deposits.

Remarks:- This genus is assignable to the Gouldoceratidae as it has thick, layered connecting rings and thin, well-developed endocones. It differs from any of the other members of this family in having longer less-expanded siphuncular segments and orthochoanitic septal necks.

Plate 8 fig. 9, 10 shows a specimen collected from the same bed as *Anmoceras lauriei*. It may be a more advanced ontogenetic stage of *Anmoceras*. The only important difference between this specimen and *Anmoceras* is the morphology of the septal necks, which exhibit three bends. The transition from the simple orthochoanitic septal necks of *Anmoceras* to those of the specimen being discussed would only require minor changes in morphology. Although the shape of the septal necks in the other members of the Gouldoceratidae do not vary during ontogeny other structures often undergo dramatic morphological change. An example of such change is the dramatic ontogenetic variation in the morphology of the siphuncle of *Paramadiganella*. Considering the possible ontogenetic variability and the lack of more complete material the specimen is tentatively assigned to *Anmoceras lauriei*. The size of the specimen, near twice that of any definite *Anmoceras* specimen, also supports this interpretation.

Anmoceras lauriei   n.sp.
Plate 8   fig. 1 - 10 ; Fig. 4.2(5).

The species is only known from the phragmocone which is an

orthoconic longicone. It is subcircular in cross-section, with the venter slightly flattened. The holotype consists of 16 segments in a distance of 40mm. The phragmocone is probably slowly expanding. The siphuncle is one-third of the diameter of the phragmocone, with the expanded part of the segment in contact with the ventral phragmocone wall for a short distance. The siphuncular segments are moderately and evenly expanded and slope adapically from the venter to the dorsum at 80°. The septa are gently curved, with the point of maximum depth at the siphuncle. The connecting rings are adnate to both the apical and adoral side of the septa for a short distance, 0.1mm.

The siphonal formula is 1.6/3.1/-:1.1/4.2/-, 2.3 adorally, while at the most apical segment it is 1.3/2.6/-:0.9/3.6/-, 1.9.

The septal necks are orthochoanitic and moderately long. The septal necks adorally on the dorsum are 0.6mm long, while on the venter they are 0.4mm long; the corresponding apical measurements are 0.4mm, and 0.2mm.

The siphuncle contains extensive and well-developed deposits which have been largely recrystallized in the known specimens. Enough of the deposits are preserved to indicate that they were finely laminated continuous cones which converge apically at a low angle. The surface of these cones is wavy, mimicking the shape of the siphuncle segments. A central canal was probably present although only the adoral portion is now preserved. The deposits extend adorally for the same distance on both the venter and dorsum.

The connecting rings are thick and layered. There are two distinct layers: 1. is a thin black layer on the siphonal surface and 2. a thick lighter layer on the cameral surface. A light band is sometimes preserved at the apical end of the connecting ring between

the main light layer and the dark layer on the siphonal surface.
This light band lenses out adorally along the connecting ring and
is not known to reach the next septal foramen.

There are no cameral deposits.

Material and Location:-   Six partially complete phragmocones;
Holotype UTGD121132, Paratypes UTGD121133, 121134 , 121135 ,
and 121136 .   The specimens were collected from the Lower Limestone
Member of the Benjamin Limestone at 140 metres stratigraphically
above the base at the Settlement Road section in the Florentine
Valley. The age is Blackriver.

Remarks:-   See generic remarks.

Genus   FLORENTINEOCERAS   n.gen.

Genotype:- *Florentineoceras calveri*, n.gen., n.sp.

Derivation of Name:-   The type species was found in the Florentine
Valley.

The phragmocone is a straight, subcircular longicone, with the
venter slightly flattened. The siphuncle is close to the venter,
but not in contact.   The siphuncular segments are evenly and moder-
ately expanded. The siphuncular deposits consist of thin, continuous
endocones which are symmetrical dorso-ventrally and form a central
canal which is crossed by bracket diaphragms. The septal necks are
cyrtochoanitic with the necks and brims equal in length. The connect-
ing rings are thick. There is a short area of adnation of the apical
portion of the connecting ring with the adoral side of the septum
on both the venter and dorsum. There are no cameral deposits.

Remarks:-   This genus is represented by only one sagittally sectioned

phragmocone. The expanded siphuncle, thin continuous endocones, and the thick two-layered connecting rings present in this genus are typical of the Gouldoceratidae. The small size of the siphuncle relative to the phragmocone, the bracket diaphragms and the relatively short siphuncular segments together distinguish this genus from any of the other members of the Gouldoceratidae.

Florentineoceras calveri n.sp.

Plate 9   fig.1 - 5 ; Fig. 4.2(4).

This species is only known from one incomplete phragmocone. The phragmocone is a longiconic orthocone, subcircular, with the venter slightly flattened. The holotype consists of 14 siphuncular segments in a distance of 39mm. The phragmocone is probably slowly expanding. The siphuncle is one-fifth of the diameter of the phragmo-cone. The siphuncular segments are moderately and evenly expanded. The septa are gently curved with the point of maximum depth at the siphuncle. The apical portion of the connecting ring is adnate to the adoral face of the septum for a short distance, 0.3mm on the venter and 0.4mm on the dorsum.

The siphonal formula is 2.3/5.6/19:1.8/6.7/18.4, 2.5 adorally, while apically it is 2.1/5.3/17.8:1.8/6.4/17, 2.5.

Recrystallization has made the septal necks difficult to recog-nise, but they are short and cyrtochoanitic, with the necks and brims similar in length. The necks are only preserved adorally where the necks are 0.3mm long and the brim 0.1mm long on the venter and the necks 0.2mm long and the brim 0.1mm long on the dorsum.

The siphuncle contains well-developed and extensive deposits.

The deposits consist of finely-laminated endocones composed of a light brown material with each of these layers separated by a very thin dark layer. The light layers are highly variable in thickness both from one layer to the next and also within each layer. The layers are wavy and mimic the outline of the siphuncular segments. There is also a radial structure which is perpendicular to the connecting rings and in transverse section radial from the siphuncular canal.

The siphuncular canal is slightly to the dorsal side of centre and contains bracket diaphragms spaced at regular(approximately 5 mm) intervals along it . The endocones extend slightly further forward on the venter than the dorsum.

The connecting rings are thick and appear to have a thin dark layer on the siphonal surface and a thick lighter layer on the cameral surface, although as only an opaque section is available detailed study of the connecting ring is difficult.

There are no cameral deposits.

Material and Location:- One partially preserved phragmocone, Holotype UTGD121137 . The specimen was collected from the lower Limestone member of the Benjamin Limestone at the Westfield section in the Florentine Valley. The age is Chazy-Lower Blackriver.

Derivation of Name:- After Mr. C. Calver who collected the specimen.

Remarks:- See generic remarks.

Genus PARAMADIGANELLA n.gen.

Genotype:- *Paramadiganella banksi* n.gen., n.sp.

The phragmocone is a sub-circular, orthoconic, longicone, with the venter slightly flattened. The siphuncle is small, variable in position but always between the centre and venter and never in contact

with the ventral wall. The siphuncular segments are highly expanded,
with the adapical segments less expanded and the adoral segments more
expanded. In the apical portion of the phragmocone the segments slope
adorally from the venter to the dorsum, while adorally the segments
are perpendicular to the siphuncular axis. The septal necks and brims
are short and cyrtochoanitic. There are two different types of
siphuncular deposit present. In the apical asymmetric segments there
are parietal deposits which grow apically to form "endocones". In
the adoral symmetrical segments there are no deposits, but a free
siphuncular tube is preserved. The connecting rings are thick and
consist of two layers, a thin dark layer on the siphonal surface and
a thick lighter layer on the cameral surface. The connecting rings
are not adnate to the septa. There are both hyposeptal and episeptal
deposits present in the camerae, but they are only poorly developed.
The conch wall is composed of three layers.

Remarks:- *Paramadiganella* is unusual in that the siphuncle changes
position within the phragmocone, and after this change both the external
form and nature of the internal deposits are dramatically altered. The
presence of the thick, two layered connecting rings and the "endocone"-
like deposits indicate that *Paramadiganella* is a typical member of the
Gouldoceratidae, but the change in position of the siphuncle and the
presence of cameral deposits are unknown in any other members of this
family. Although they are much smaller the adoral segments of *Paramadi-
ganella* are very similar to those of *Madiganella* in the shape of the
siphuncle and the presence of a free siphuncular tube, but the genera
differ in the size and position of the siphuncle and in the curvature
of the septa. The apical portion of *Madiganella* is poorly known and it
is not possible to be certain that the change in siphuncular shape and
position does not occur. In fact a poorly preserved fragment
on loan from Dr. K. Campbell of A.N.U. suggests that the change does occur.

Paramadiganella banksi n.sp.

Plate 10 fig. 1 - 9 ; Fig. 4.2(1,8).

, The phragmocone is a subcircular, orthoconic, longicone, with the venter slightly flattened. The phragmocone is slowly expanding, subtending an angle of 7° at the apex. The siphuncle is one-tenth of the diameter of the phragmocone. The position of the siphuncle relative to the phragmocone changes in this species. The siphuncle is always approximately mid-way between the centre and the venter, but during ontogeny the siphuncle moves closer to the venter during a short interval of growth (over a distance of about five camerae). In the holotype there are 35 siphuncular segments in a distance of 32mm. All siphuncular segments are expanded, but prior to the onto-genetic shift towards the venter the segments are less expanded than after it. Prior to the ventral shift of the siphuncle the segments slope adorally from the venter to the dorsum, but after the change the segments are perpendicular to the siphuncular axis. The septa are only slightly curved, with the point of maximum depth at the siphuncle.

The siphonal formula is 2.7/0.7/7.1:2.2/1.6/6.7; 0.8 adorally, while apically it is 2.5/0.5/4.6:2.3/1.0/4.3; 0.9.

The connecting rings are not adnate to the septa.

The septal necks and brims are short and cyrtochoanitic. The septal necks are not clearly preserved in the asymmetric portion of the phragmocone, but they also appear to be small and cyrtochoanitic. Adorally on both the venter and the dorsum the septal necks are 0.2mm long while the brims are 0.1mm long.

The siphonal deposits are of two different types. In the apical asymmetric segments the deposits are parietal, formed in the septal

foramen then grown apically along the connecting ring and over the deposit in the next segment to form "endocones". The fine structure of the "endocones" is not preserved in any of the specimens found. In the adoral symmetrical segments there are no deposits, but there is a free central tube which is nearly half the diameter of the siphuncle. The "endocones" fill the siphuncle leaving a central tube, but whether or not the free tube extends into the tube formed by the endocones cannot be determined due to the poor preservation of the critical specimen.

The connecting rings are thick and layered. There is a thick light layer on the cameral surface and a thin dark layer on the siphonal surface. The connecting rings have been largely recrystallized but this is no indication that the rings are complexly structured.

Cameral deposits are present but have been largely recrystallized. Both hyposeptal and episeptal deposits are formed at the same time and develop at about the same rate. The deposits are formed to a similar extent ventrally and dorsally. The cameral deposits are rarely present and appear to form only in the camerae which have the symmetrical siphuncular segments. This distribution may indicate that they form late in the ontogeny, after the connecting rings of the asymmetric segments have been sealed by the siphuncular deposits.

The conch wall structures are preserved in this species and it consists of three layers - firstly the inner layer which is formed by the mural part of the septum (0.05mm thick), secondly a thick (0.2mm) central lighter layer which appears to be structureless, and finally a thin (0.05mm) darker layer on the outer surface.

Material and Location:- Nine partially preserved phragmocones. The Holotype is UTGD121138,paratypes UTGD81151,121139, 121140, 121141

121142, 121143, 121144, 121145, and 121146.

The specimens were collected from 68 metres above the base of the Lower Limestone Member of the Benjamin Limestone at the Settlement Road section in the Florentine Valley. The probable age is Blackriver.

Derivation of Name:-   In honour of Dr. M.R. Banks' contribution to Tasmanian palaeontology.

Remarks:-   See generic remarks.

Genus   TASMANOCERAS   Teichert and Glenister 1952

Genotype:- *Tasmanoceras zeehanense*, Teichert and Glenister, 1952.
Description   (emend Stait from Teichert and Glenister, 1952).

Small discosorids with slowly expanding straight or weakly curved siphuncles. The siphuncle is half the diameter of the phragmocone. The siphuncular segments are slightly expanded between the septa, sloping at a moderately high angle, to the axis of the siphuncle, apically from the venter to the dorsum. The septal necks are slightly recurved cyrtochoanitic to hemichoanitic. The siphuncular deposits are finely laminated endocones which develop leaving only a siphuncular tube which varies in position from the centre to the dorsal side of the siphuncle. The central tube may or may not be crossed by diaphragms. The connecting rings are thick and two-layered with a thin dark layer on the siphonal surface and a thick lighter layer on the cameral surface. No cameral deposits are known.

Remarks:- Teichert and Glenister (1952) established *Tasmanoceras* on two isolated siphuncles from Smelter's Quarry, Zeehan. Teichert and Glenister (1953) described another siphuncle of the type species from the Gordon River. They assigned *Tasmanoceras* to the endocerids due

mainly to the presence of endocones. Flower (1968c, p.83) noted the similarity between *Tasmanoceras* and *Donacoceras* and suggested that *Tasmanoceras* was a member of the Nanthecoceratidae, which he included in the Michelinoceratida. In the present study a great deal more material has been collected of this genus and it can now be seen that the similarities between *Tasmanoceras* and *Donacocerás* are only homeomorphic. *Tasmanoceras* has thick connecting rings, with cyrto-choanitic to hemichoanitic septal necks and it has the fine laminated endocones typical of the Gouldoceratidae. *Tasmanoceras* differs from *Florentineoceras* in having a siphuncle greater in diameter relative to that of the phragmocone, a siphuncle in contact with the ventral wall, and in having less recurved septal necks. *Tasmanoceras* differs from *Anmoceras* in having much shorter and more highly expanded segments and much longer and more recurved septal necks.

Tasmanoceras zeehanense   Teichert and Glenister, 1952.

Plate 11   fig.1 - 8 ; Fig. 4.2(6).

The phragomocone is straight, and the cross-section is subcircular, with the venter slightly flattened. The phragmocone is slowly expanding. In the holotype there are 15 siphuncular segments in a distance of 28mm. The siphuncle is approximately half the diameter of the phragmocone. The siphuncle is in contact with the ventral wall, although the variability of the siphuncle means that in some segments they are not quite in contact with the wall (Plate 11, fig.4). The siphuncle is composed of short expanded segments. The septa are gently curved, with the point of maximum depth at the siphuncle.

The siphonal formula of UTGD121147   is -/6.4/-:-/7.0/-; 1.8 apically, while at the adoral end of the specimen it is

-/6.7/-:-/7.5/-; 1.6.

The apical part of the connecting ring is adnate to the adoral surface of the septa for a short distance on both the ventral and dorsal sides of the siphuncle.

The septal necks are orthochoanitic and are on average 0.4mm long. The length of the septal necks are variable both in an individual specimen and between different specimens. There is a continuum of lengths and this cannot be used as a species characteristic.

The siphonal deposits consist of thin endocones which slope adorally at a low angle to the siphuncular axis. The endocones are wavy mimicking the outline of the siphuncular segments. The endocones are asymmetric and are more strongly developed on the ventral side of the siphuncle. The position of the siphonal canal is variable from almost central to very close to the dorsal wall of the siphuncle.

The connecting rings are thick and composed of two layers. There is a thick, light layer on the cameral surface and a thinner dark layer on the siphonal surface.

There are no cameral deposits.

Material and Location:- 8 isolated siphuncles and one incomplete phragmocone. The specimens are UTGD121147,121148 ,121149 ,121150 , 121151 ,121152 ,121153 ,121154, and121155 . The specimens have been collected from the Lower Limestone Member of the Benjamin Limestone in the Florentine Valley. They occur between 320&370 metres above the base of the Lower Limestone Member at the Westfield,Settlement Road and Eleven Road sections, localitiesb,d,c on figs. 3.6, 3.10 and 3.8 respectively.

Remarks:- This description of specimens from the Florentine Valley

belonging to the type species have been included as they show features not visible on either the holotype or paratype material. These descriptions are a supplement to the holotype description of Teichert and Glenister (1952).

Tasmanoceras cf. *zeehanense*

Plate 9   fig. 8 - 10 .

The specimens are only isolated siphuncles. There are 21 siphuncular segments in a length of 46mm. The siphuncular segments are expanded and slope apically from the venter to the dorsum at 80°. The siphuncular segments are 2.5mm long, 6.3mm high at the septal foramen and 7.0mm at the expanded part of the segment.

The septa are poorly preserved but it would appear that the apical part of the connecting ring is adnate to the adoral surface of the septum ventrally. The dorsal wall of the siphuncle is not visible. The septal necks are orthochoanitic and are 0.4mm long.

The siphuncular deposits are thin endocones and slope adorally at a low angle to the siphuncular axis. The endocones are asymmetric being strongly concentrated on the venter. The siphuncular canal is mid-way between the centre and the dorsal wall of the siphuncle.

The connecting rings are thick and contain two layers, a thick lighter layer on the cameral surface and a thinner dark layer on the siphonal surface.

Material and Location:-   Two isolated siphuncles, UTGD56471a, 56471b. The specimens were collected from just south of a quarry at State Grid. ref. Sheet 8114, 454980, at Mayberry near Mole Creek.

Remarks:- These specimens differ from *Tasmanoceras zeehanense* in having siphuncular segments which are slightly longer than is typical. The preservation is such that very few diagnostic features can be seen so a new species is not established.

Tasmanoceras pagei n.sp.

Plate 6   fig. 8 - 12 .

There is only a siphuncle and the ventral wall of the phragmocone preserved. There are 24 siphuncular segments in a distance of 28mm. The siphuncle is close to the venter (the section is not quite sagittal and the siphuncle may be in contact with the ventral wall of the phragmocone). The siphuncular segments are expanded and slope apically from the venter to the dorsum at 70° to the axis of the siphuncle.

The siphonal formula is 1.0/4.7/-:0.7/6.5/-; 1.2 apically, while at the adoral end of the specimen it is 1.0/4.6/-:0.8/6.5/0; 1.0.

The connecting rings are not adnate to the septum dorsally, but ventrally the apical part of the connecting ring is adnate to the adoral surface of the septum for a short distance.

The septal necks are orthochoanitic and are 0.4mm in length.

The siphuncular deposits are composed of thin endocones, which slope adorally at a low angle to the siphuncular axis. The endocones are strongly asymmetric and are predominantly developed on the venter. The endocones project much further forward on the venter than the dorsum. The siphuncular canal is near the dorsal wall of the siphuncle.

The connecting rings are thick and composed of two layers. There is a thick, light layer on the cameral surface and a thinner dark layer on the siphonal surface.

Material and Location:- One siphuncle and ventral wall of the phragomcone is preserved, UTGD121156. The specimen occurs 450 metres above the base of the Lower Limestone Member in the Settlement Road section in the Florentine Valley, locality e on fig. 3.10. The age is Trenton.

Derivation of Name:- For Mr. M.G. Page who did the detailed work on the stratigraphy and palaeoecology of the Benjamin Limestone in the Florentine Valley.

Remarks:- The major difference between *Tasmanoceras zeehanense* and *T. pagei* is the ratio between the length and the height of the siphuncular segments. *T. pagei* has much shorter segments relative to its height than does *T. zeehanense*. The only other consistent difference is that the curvature between the septal necks and the rest of the septa is almost a right angle in *T. pagei*, but in *T. zeehanense* it is gently curved and the septal necks are generally longer.

Tasmanoceras cf.*pagei*

Plate 9   fig. 6 - 7 .

UTGD121157 has been tentatively compared to *T. pagei* because of the very short siphuncular segments relative to its width. The specimen occurs stratigraphically below the holotype of *T. pagei* and in association with *T. zeehanense*, it is not assigned to a species as the specimen is poorly preserved.

Genus   TIGEROCERAS   n.gen.

Genotype:- *Tigeroceras florentinense*, n.gen., n.sp.

Derivation of Name:- The specimen was collected on the Tiger Range in the Florentine Valley.

The siphuncle is rounded and at the point of maximum expansion it is in contact with the phragmocone's ventral wall. The siphuncular

segments are highly expanded and are three times as high as they are
long. The siphuncular deposits consist of parietal deposits which
grow apically from the septal foramen to form "endocones". The
siphuncular deposits are more strongly developed on the venter.
Recrystallization of the deposits means that the fine detail of their
structure cannot be determined. Ventrally the septal necks are short
and recurved, the septal brims are also short and recumbent to the
septum. Dorsally the septal necks are short and there are no brims.
The connecting rings are thick and layered, with a thin dark layer on
the siphonal surface and a thick lighter layer on the cameral surface.
The connecting rings are adnate to the septa, the apical part of the
ring is adnate to the adoral portion of the septum for some distance
both ventrally and dorsally, while on the dorsum the adoral part of
the connecting ring is adnate to the apical part of the septum for
a short distance. There are two parallel conchal furrows on the phrag-
mocone. The shell structure consists of an inner thick, dark layer
which is composed of many finer parallel (lighter and darker) layers,
and of a thin lighter layer on the outer surface.

Remarks:- The presence of thick, two-layered connecting rings and
the "endocone"-like siphonal deposits indicate that *Tigeroceras* is
assignable to the Gouldoceratidae. It is most like *Westfieldoceras*
in the size of the siphuncle, but differs in that the siphuncle is in
contact with the ventral wall and the septal necks and brims are short
and not as recumbent. *Tigeroceras* is similar to the mature ontogenetic
stage of *Anmoceras* in the type and form of the septal necks and brims,
but differs from it in the shape and size of the siphuncle and also
Anmoceras probably has a relatively larger siphuncle.

Tigeroceras florentinense n.sp.

Plate 12 fig.10 - 13 .

The dorsal wall and camerae have been destroyed in the only specimen available. Based on the part of the phragmocone preserved it is probably an orthoconic, longicone, with a rounded cross-section. The siphuncle is probably relatively small, one-fifth or less of the diameter. The siphuncle is preserved only in the anterior part of the phragmocone and this contains five segments in 18mm. The siphuncle is highly expanded, with the dorsal segments nearly symmetrical along their length, the ventral segments expanding more rapidly in the adoral portion of the segment.

The siphonal formula is 2.4/6.3/-:1.2/10/0; 3.3. Ventrally the apical part of the connecting ring is adnate to the adoral surface of the septum for a distance of 2.7mm; the adoral portion of the ring is not adnate. Dorsally the apical part of the connecting ring is adnate to the adoral surface of the septum for 1.8mm, while the adoral part of the connecting ring is adnate to the apical surface of the septum for 0.6mm.

The septal necks and brims are both short with the brims on the venter recumbent to the septum, and on the dorsum very short and free. Ventrally the septal necks are 0.3mm long, and the brims are 0.2mm long, while dorsally the corresponding measurements are 0.6mm and 0.2mm.

Recrystallization in the only specimen has observed the details of the siphonal structures. The deposits are of the parietal type which form in the septal foramen and grow apically through many segments to form "endocones". The deposits are more extensively developed on the venter, with the siphuncular canal on the dorsal side of centre.

The connecting rings are thick and layered, with a thin dark layer on the siphonal surface and a thick lighter layer on the cameral surface. The connecting rings are 0.3mm thick.

There are no cameral deposits.

The structure of the ventral wall of the phragmocone is preserved in this specimen. The shell wall is 1.2mm thick. The shell consists of two major divisions, firstly the inner thick (1.1mm) layer which is composed of many (12+) finer, alternating lighter and darker layers of variable thickness, and secondly an outer thin (0.1mm) lighter layer. The outer layer is composed of many fine fibres which are perpendicular to the layering in the inner layer.

Material and Location:- One partially preserved phragmocone, Holotype UTGD22042. The specimen was collected from near the top of the Upper Limestone Member of the Benjamin Limestone, just below the track to Gordon Bend at the south end of the Tiger Range, State Grid. ref. Wedge 8112; 499702, in the Florentine Valley.

Derivation of Name:- The specimen was collected from the Florentine Valley.

Remarks:- See generic remarks.

Genus   WESTFIELDOCERAS   n.gen.

Genotype:- *Westfieldoceras taylori* n.gen., n.sp.

Derivation of Name:- The specimens were collected from the Westfield section in the Florentine Valley.

The phragmocone is a subcircular, orthoconic longicone, with the venter slightly flattened. The siphuncle is close to the venter but not in contact. The siphuncular segments are highly expanded. The siphuncular deposits consist of parietal deposits which first

form in the septal foramen and then develop apically along the connecting ring until they meet the adjacent deposit, forming a continuous lining. The septal necks are long and recurved, the brims are also long and recumbent to the septal neck. The connecting rings are thick and layered with a thin dark band on the siphonal surface and a thick lighter band on the cameral surface. The connecting rings are strongly adnate to the septa, with the adoral part of the ring adnate for a short distance to the apical face of the septum, while the apical portion of the connecting ring is adnate for some distance to the adoral face of the septum. There are no cameral deposits.

Remarks:- *Westfieldoceras* is unusual in that the morphology is reminiscent of two different orders. The septal necks and brims are very similar to those of *Lamboceras* and in general morphology it is assignable to the Armenoceratidae of the Actinoceratida. A detailed examination of the connecting rings and siphuncular deposits show that *Westfieldoceras* is a discosorid assignable to the Gouldoceratidae and not an actinocerid. The most closely related genus is *Tigeroceras* but it differs from *Westfieldoceras* in having its septal necks not recurved; the siphuncle is in contact with the venter and the septal brims are short and free.

<div align="center">

Westfieldoceras taylori   n. sp.

Plate 12   fig.1 - 9 ; Fig. 4.2(3).

</div>

The phragmocone is a subcircular, orthoconic, longicone, with the venter slightly flattened. The phragmocone is probably slowly expanding. The holotype consists of 28 segments in a length of 90mm. The siphuncle is one-quarter of the height of the phragmocone. The siphuncular segments are expanded, and the middle of the segment is the point of maximum expansion. The siphuncle is between the centre

and the venter, but is not in contact with the ventral wall. The septa are gently curved, with the point of maximum depth at the centre of the phragmocone.

The siphonal formula is 2(+)/6/19(+):1(+)/11/17(+), 4 adorally, while apically it is 3.5(+)/5/29(+):1(+)/10.5/26(+), 4.

The connecting ring is strongly adnate to the septa on the venter, and less strongly adnate to the septa on the dorsum. On the venter the apical portion of the connecting ring is adnate to the adoral side of the septum for a distance of 1.3mm, while the adoral portion of the connecting ring is adnate to the apical side of the septum for 2.0mm. On the dorsum the corresponding measurements are 0.9mm, and 1.0mm.

The septal necks are long and recurved, the septal brims are also long and are recumbent on the septal necks. Both the necks and brims have been recrystallized in the holotype and the paratype, UTGD121158 has only the venter preserved. The length of the necks and brims are variable from one segment to another, as is the degree of recurving. Ventrally the neck is 1.1mm long, and the brim is 0.8mm long, while on the dorsum the neck is 1.5mm and the brim is 1.2mm.

The siphonal deposits are extensively developed in the apical portion of the specimens. The deposits consist of parietal deposits which form in the septal foramen and then grow apically along the connecting ring. The deposits are thickest in the middle of the segment and thinner at the septal foramen. The deposits have a thinly laminated structure parallel to the siphonal surface of the deposits. The deposits grow until they meet the adoral end of the next most apical deposit and this then forms a continuous lining. The apical segments are not known, so there is no indication of whether or not the deposits grow

over one another to form endocones, but as this happens in all the other members of the Gouldoceratidae it is also probably true for *Westfieldoceras*.

The connecting rings are thick and consist of two layers. The two layers are: a thin dark band on the siphonal surface and a thick lighter band on the cameral surface. On the paratype, UTGD the lighter band appears to be made up of two layers, a darker inner band and a lighter band on the cameral surface, these two bands are of approximately equal thickness.

There are no cameral deposits.

Material and Location:- Three phragmocones, holotype UTGD95793, Paratype UTGD121158, and UTGD121159. The specimens were collected from the Upper Limestone Member of the Benjamin Limestone, at the West-field section in the Florentine Valley (locality d on fig. 3.6). The age is Eden.

Derivation of Name:- After Mr. M. Taylor who collected the first specimens.

Remarks:- See generic remarks.

GOULDOCERATIDAE   n.gen., n.sp.

Plate 7   fig. 11 - 13 .

This species is only represented by isolated siphuncles. The siphuncle is in contact with the ventral wall. There are 8 segments in a length of 30mm. The siphuncular segments are highly expanded. The siphuncular segments slope slightly adorally from the venter to the dorsum.

The siphonal formula at the fourth segment is 2/4/2(+):0/9/(+): 3.

The connecting rings are adnate to the septa both dorsally and ventrally. Ventrally the adoral part of the connecting ring is adnate to the apical surface of the septa for a distance of 2.0mm, while the apical part of the connecting ring is adnate to the adoral surface of the septa for a distance of 1.0mm. Dorsally the corresponding measurements are 1.0mm and 1.0mm.

The septa necks and brims are short and cyrtochoanitic, the brims are recumbent on the septa. The necks and brims are of similar length both dorsally and ventrally, 0.1mm long.

The siphuncular deposits have been completely recrystallized, one specimen shows structures - they may be remnants of a central canal and "radial-canals".

The connecting rings are thick; they also have been largely recrystallized but there is an indication of a thin dark layer on the siphonal surface and a thick lighter layer on the cameral surface (Plate 7 fig.12).

Material and Location:- Two isolated siphuncles, UTGD121160,and 95796. The specimens were collected from the upper part of the Upper Limestone Member of the Benjamin Limestone at the Westfield section in the Florentine Valley (locality d on fig. 3.6). The probable age is Eden.

Remarks:- The preservation of these specimens makes assignment difficult. The presence of a thick two-layer connecting ring suggests they belong in the Gouldoceratidae. The central and "radial" canals are not unlike those in *Armenoceras*(?) sp., but they also occur in *Gouldoceras* itself. The morphology and probable position of the siphuncle is different from that in *Armenoceras* ? sp..The siphuncles described are unlike those of any of the other members of the

Gouldoceratidae; it is most closely related to *Tigeroceras* but the septal necks and the shape of the siphuncular segments are different from those in *Tigeroceras*.

Family   Unknown

Genus   HECATOCERAS   Teichert and Glenister, 1952.

Plate 13   fig. 1 - 12 ; Fig. 4.2(7).

Genotype:- *Hecatoceras longinquum*, Teichert and Glenister (1952).

Description:- (emend from Teichert and Glenister, 1952).

Conch is an exogastric, depressed, moderately expanding, almost straight cyrtocone. The living chamber and aperture are unknown. The siphuncle is composed of expanded segments, with the connecting rings in broad contact with the ventral wall of the phragmocone. The siphuncle is half the diamater of the conch. The siphuncular segments slope apically from the concave towards the convex side of the siphuncle. The septal necks are short and strongly recurved with the brims being slightly longer than the necks. The connecting rings are thick and complex. The area of adnation of the septa with the adoral connecting ring is longer on the dorsum. There are three types of deposit in the siphuncle: 1. a continuous laminated layer, lining the connecting rings and septal necks, thinnest at the septal necks, 2. endocones which leave a central siphonal canal, 3. massive deposits between the endocones and the siphuncular lining. The camerae contain a cresent-shaped deposit (in cross section), against the dorsal wall of the phragmocone, which increases apically to nearly fill the camerae.

Remarks:- New material from the Florentine Valley and Ida Bay, allows a reassessment of the generic concept of *Hecatoceras*. *Hecatoceras* was based on *Hecatoceras longinquum*, the only specimen of which consists

of a series of sixteen siphuncular segments of a moderately well pre-
served siphuncle which was apparently sectioned not quite in the
sagittal plane. The new material is conspecific with the holotype and
shows that *Hecatoceras* is exogastric rather than endogastric, and that
the expanded part of the siphuncle is in contact with the ventral wall
of the phragmocone. The siphuncular deposit which lies between the true
endocones and the continuous lining may possibly be inorganic, but the
author considers it to be an early stage in the deposition of the endo-
cones. In this stage thick deposits are laid down in the cavities
left in the expanded part of the siphuncle with only thin deposits in
the septal foramen. Once the cavities were filled the endocones were
deposited. Another unusual feature is the dorsal wedge in the camerae
(Plate 13, fig. 9) which is consistent from one camera to another and
occurs in different orientations in two specimens in the one piece of
rock, although consistent with respect to the siphuncle. These relation-
ships would appear to rule out a geopetal origin.

Hecatoceras was accepted as a discosorid by Flower and Teichert
(1957, p. 39, 95) but its reported endogastric curvature was a problem
in determining its position within the Discosorida. The endocones
reported in *Hecatoceras* by Teichert and Glenister (1952) suggested a
relationship with advanced *Faberoceras*, but no endogastric forms were
known with endocones or lining prior to *Alpenoceras* from the Devonian.
The Blackriver age of *Hecatoceras* puts it early in discosorid evolution
and the presence of the thick structured connecting rings posed problems
not resolvable on available information.

Flower (1976a, p. 549) doubted the discosorid affinities of
Hecatoceras saying "A somewhat perplexing development is that of
Hecatoceras in Tasmania, an endogastric form known only from isolated

siphuncles apparently with a lining of endocones like those of *Faber-oceras* and the Lowoceratidae and Discosoridae. Siphuncles show a mid ventral groove, and similar grooves are known in an undescribed genus from the Platteville of the Mississippi Valley. The position of both of these genera as members of the Discosorida now seems dubious."
The present study has shown that *Hecatoceras* is exogastric, thus reducing the problems of placing it in the Discosorida. The study has also shown that all the specimens with the ventral segmental groove are not *Hecatoceras* but are members of a new genus *Gouldoceras*. The distinct "radial canals", the continuous siphuncular lining, the position and size of the siphuncle, and the gently recurved septal necks distinguish *Gouldoceras* from *Hecatoceras*.

The new material requires the recognition of two genera, *Hecatoceras* and *Gouldoceras* and of three species. The only material previously described which belongs to *Hecatoceras longinquum* is the holotype from Ida Bay, while all the siphuncles described as hypotypes of *H. longin-quum* in Teichert and Glenister (1953) are now included in *Gouldoceras synchonena*. The other species of *Hecatoceras, H. obliquum* Teichert and Glenister (1953) must also be transferred to *Gouldoceras* because of the similar siphuncular lining and morphology of the septal necks.

Hecatoceras longiquum   Teichert and Glenister, 1952.

UTGD95132 (Plate 13, figs. 2 , 4   ) is an incomplete phragmocone; and is an exogastric, slowly expanding, depressing cyrtocone. The siphuncle is ventral, approximately half the diameter of the phragmocone. The venter of the phragmocone is less strongly rounded than the dorsum. The siphuncular segments are highly expanded and slope apically from the venter to the dorsum, at a high angle to the siphuncular axis.

UTGD95131 (Plate 13, fig. 5-7). The specimen is an incomplete phragmo-cone, which is exogastric and cyrtoconic. The siphuncle is in contact with the ventral phragmocone wall. The siphuncle consists of 21 segments in 43mm (of which the adoral 15 are shown in Plate 13, fig. 5). The most apical segment has a length of 1.5mm, a height of 1.0mm at the septal foramen and 1.9mm at the expanded part of the segment. The corresponding measurements on the adoral-most segments are 2.8mm, 2.7mm and 5.1mm respectively. The septal necks are cyrtochoanitic, with the necks being short (0.1mm) and recumbent while the brims are longer (0.2mm). Two siphuncular deposits are present, a continuous lining over the connecting rings and septal necks, with an inner layer of endocones leaving a central canal. The massive deposits between these two are only visible on the thin section (Plate 13, fig.8). The connecting rings are thick.

Remarks:- Descriptions of two hypotype specimens of *Hecatoceras longinquum* have been included as they show features which are not visible on the holotype. These descriptions are short and are a supplement to the holotype description.

Fig. (4.2) :

1. *Paramadiganella banksi* n.gen.,n.sp. : a cross-section showing the position and relative size of the siphuncle, venter below.

2. *Gouldoceras synchonena* : a cross-section showing the position and relative size of the siphuncle, venter below.

3. *Westfieldoceras taylori* n.gen.,n.sp. : a cross-section showing the position and relative size of the siphuncle, venter below.

4. *Florentinoceras calveri* n.gen.,n.sp. : a cross-section showing the position and relative size of the siphuncle, venter below.

5. *Anmoceras lauriei* n.gen.,n.sp. : a cross-section showing the position and relative size of the siphuncle, venter down.

6. *Tasmanoceras zeehanense* : a cross-section showing the position and relative size of the siphuncle.

7. *Hecatoceras longinquum* : a cross-section showing the position and relative size of the siphuncle.

8. *Paramadiganella banksi* n.gen.,n.sp. : a, is a cross-longitudinal section of the apical end before the ontogenetic change in position of the siphuncle; apex left, venter below, X10. b, is the same specimen after the change in position: apex right, X10.

9. *Gouldoceras synchonena* n.gen.,n.sp. : a longitudinal section of the holotype showing the structures of the siphuncle; apex left, venter below, X 1.7.

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8b

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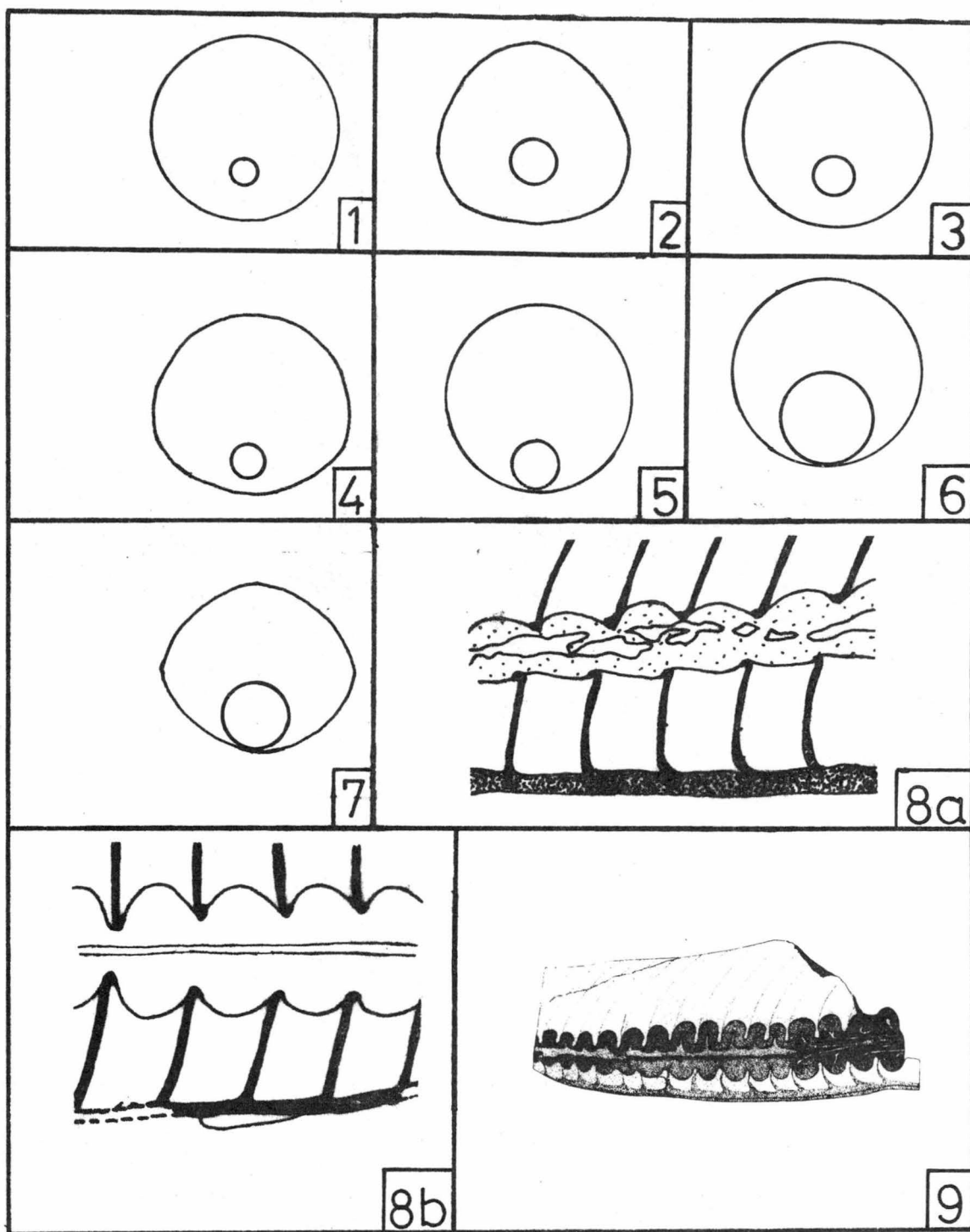
PLATE 6.

Gouldoceras synchonena; Tasmanoceras pagei n.sp.

Figs. 1-7: *Gouldoceras synchonena,*
holotype UTGD 55553, hypotypes 81791a, 81791b.

1. A sagittal section of the holotype, apex left, X2.2.

2. An enlargement of the siphuncle of the holotype,
    apex left, X10.

3. The external view of the holotype, apex right, X2.2

4. A thin section of the wall of the siphuncle in
    hypotype UTGD 81791a showing the siphonal deposits,
    X7.

5. A ventral view of an isolated siphuncle, hypotype
    UTGD 81791b, X10.

6. A transverse section of the holotype showing the
    shape of the phragmocone, X2.5.

7. A transverse view of the isolated siphuncle in 5,
    X10.

Figs. 8-21: *Tasmanoceras pagei* n.sp., UTGD 121156;

8. A thin section of a sagittal cut of the holotype,
    apex left, X2.

9. A close up of the connecting ring on the dorsal side
    of the holotype, X24.

10. The dorsal side of the siphuncle showing the septal
     necks and expansion of the siphuncle, X6.

11. A close up of the ventral wall of the siphuncle
     and the ventral camerae, X5.

12. A sagittal section of the holotype showing the
     endosiphocone and endosiphotubes, X1.

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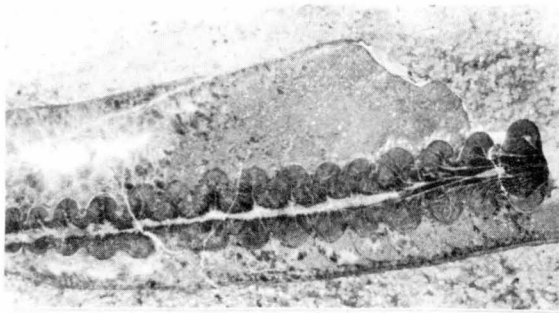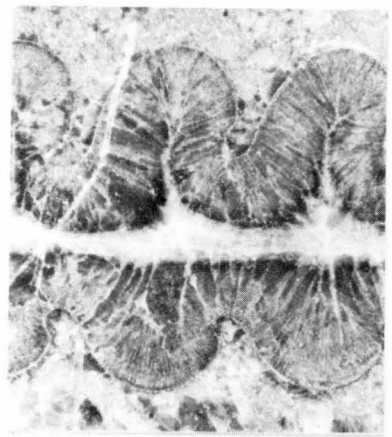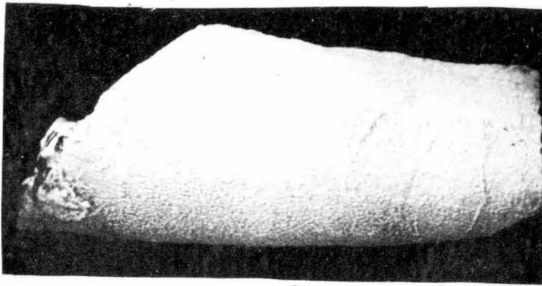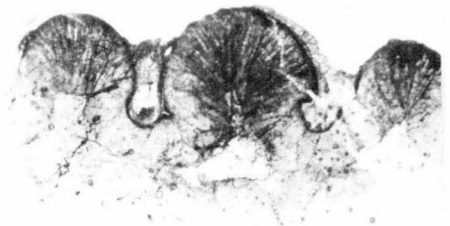
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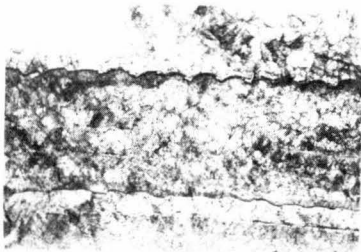
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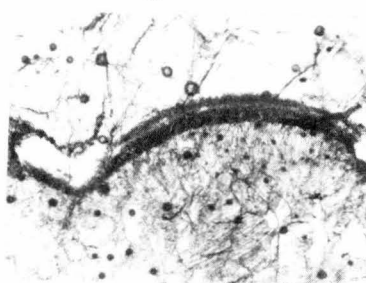
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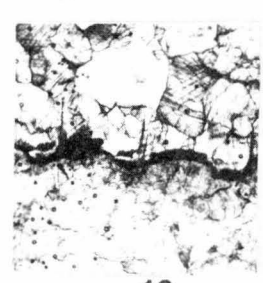
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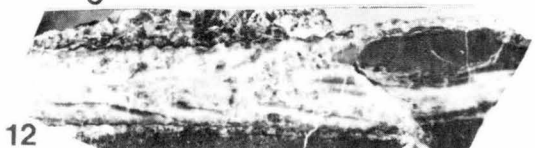
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PLATE 7.

Gouldoceras benjaminense n.sp.; Gouldoceratidae n.gen.,
n.sp.

Figs. 1-10:   *Gouldoceras benjaminense* n.sp.,
holotype UTGD 121129, paratypes
UTGD 121130, 121131;

1.   A sagittal section of the holotype apex right, X4.

2.   A close up of the siphuncle at the adoral end of the
holotype showing the siphonal deposits, X8.

3.   A close up of the siphuncle at the apical end of the
holotype, X4.

.4.   A close up of the "diaphragms" across the central
canal, X24.

5.   An enlargement of the central canal, X24.

6.   A close up of the dorsal side of the siphuncle
showing the "radial-canals" and the siphonal
deposits, X20.

7.   A close up of the ventral side of the siphuncle
showing the siphonal deposits and the thick
connecting ring, X20.

8.   A section of the paratype UTGD 121130, showing the
"diaphragms", apex left, X7.

9.   A close up of "radial canal" in the siphuncular segment,
X15.

10.   A close up of the "diaphragm", X15.

Figs. 11-13:   Gouldoceratidae n.gen., n.sp.
UTGD 95796, 121159;

11.   A close up of the dorsal wall of the siphuncle of
UTGD 95796, X7.

12.   A close up of the ventral wall of the siphuncle
of UTGD 95796, X7.

13.   A sagittal section of the siphuncle, X1.
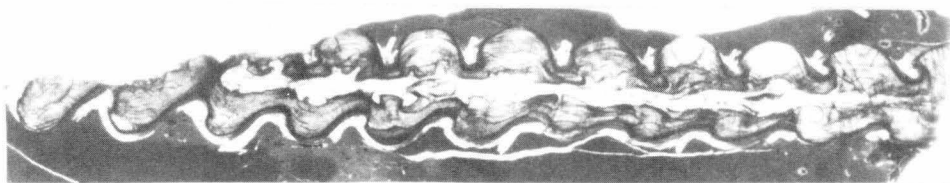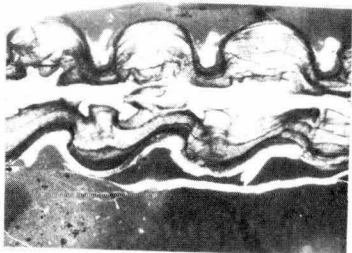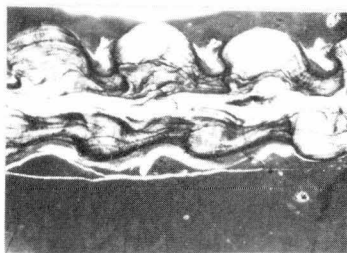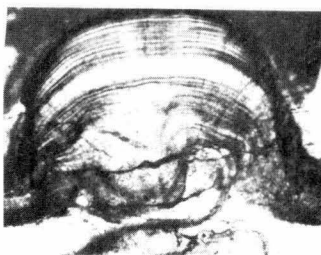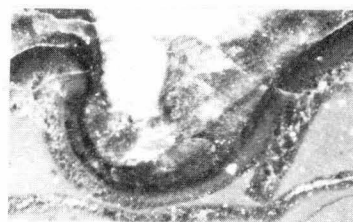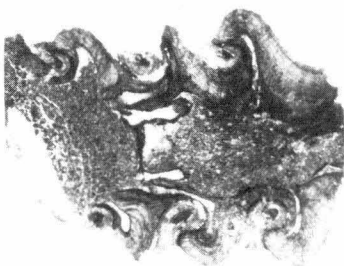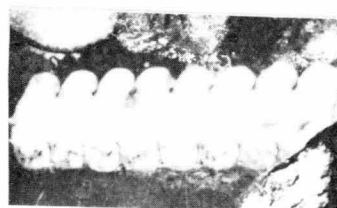
PLATE 8.

Anmoceras lauriei n.gen.,n.sp.

Figs. 1-10:   *Anmoceras lauriei* n.gen., n.sp., holotype
              UTGD 121132, paratype 121133, 121134;

1.   A thin section of the holotype showing the position
     of the siphuncle and the siphonal deposits, apex
     right, X2.

2.   The dorsal wall of the siphuncle showing the
     connecting rings, X10.

3.   The ventral wall of the siphuncle, X15.

4.   The septal neck on the dorsum, note the fine structure
     in the unrecrystallized part of the siphonal deposits,
     X25.

5.   The ventral septal neck, X25.

6.   A sagittal section of the paratype UTGD 121133,
     apex right, X1.

7.   A close up of the ventral wall of 6, note that
     connecting ring is in contact with the phragmocone
     wall, X8.

8.   The dorsal wall of the siphuncle in 6, X8.

9.   A thin section of the paratype UTGD 121134. This
     is probably the more mature stage, apex left, X1.5.

10. The ventral phragmocone wall in 9 showing the unusual
     shape of the septal necks and the thick connecting
   ring which is not in contact with the phragmocone
     wall, X5.

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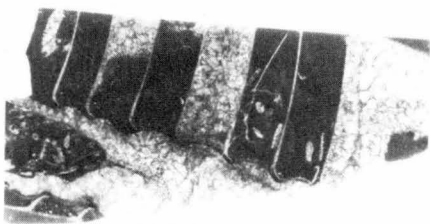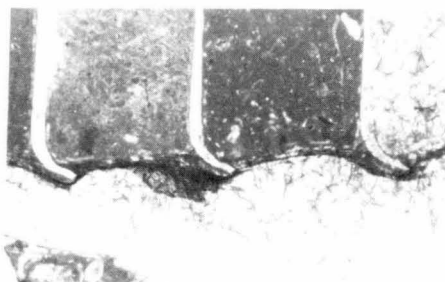
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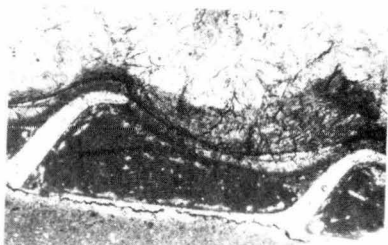
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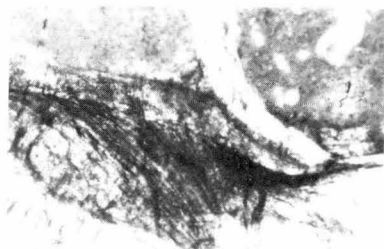
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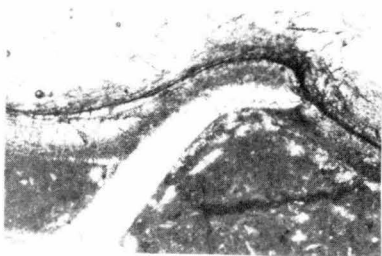
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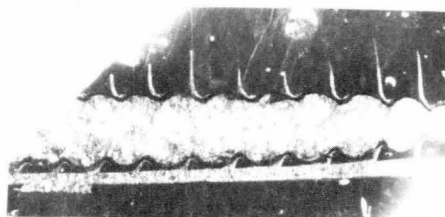
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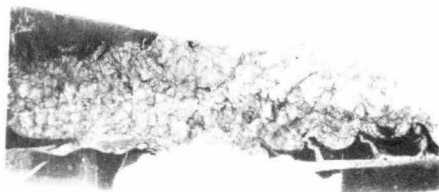
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PLATE 9.

Florentinoceras calveri n.gen., n.sp.;

Tasmanoceras cf. *Zeehanense;* *T.* cf. *pagei*

Figs.1-5: *Florentinoceras calveri* n.gen., n.sp.,
holotype UTGD 121137;

1. A sagittal section of the holotype, apex right, X0.75.

2. An enlargement of the siphuncle, showing the
siphonal deposits, central canal and diaphragms, X4.

3. The transverse section of the siphuncle showing the
radial fibrous structure in the siphonal deposits,
X5.

4. A close up of the ventral wall of the siphuncle,
X10.

5. A close up of the dorsal wall of the siphuncle, X10.

Figs. 6-7: *Tasmanoceras* cf. *pagei,* UTGD 121157;

6. An opaque section of an isolated siphuncle, apex
left, X4.

7. A close up of the ventral wall of the siphuncle
showing the septal necks and the connecting ring,
X20.

Figs. 8-10: *Tasmanoceras* cf. *Zeehanense,* UTGD 56471;

8. An opaque section of the siphuncle, note the dorsal
position of the siphonal canal, apex left, X25.

9. A thin section of an isolated siphuncle, only the
ventral wall of the siphuncle is preserved, apex
left, X6.

10. A close up of the ventral wall of the siphuncle
in 9, X25.

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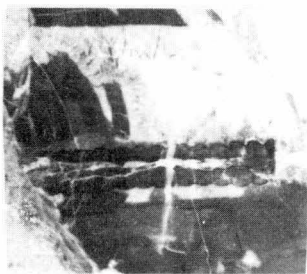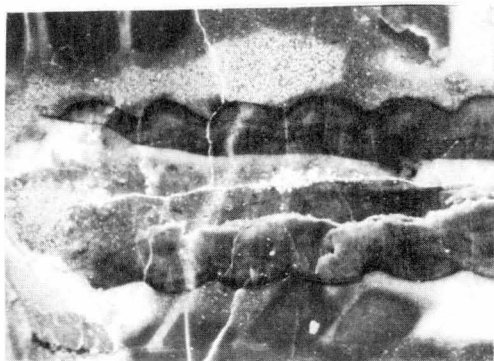
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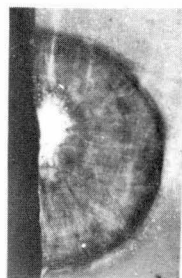
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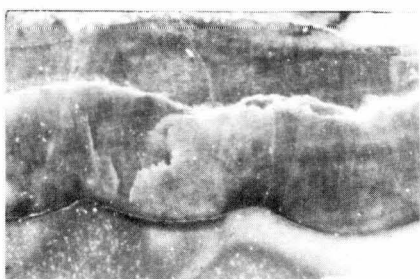
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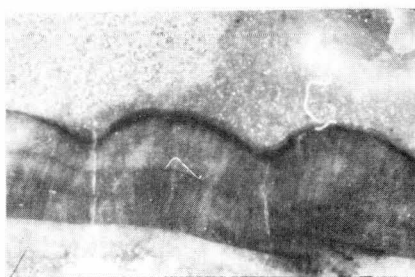
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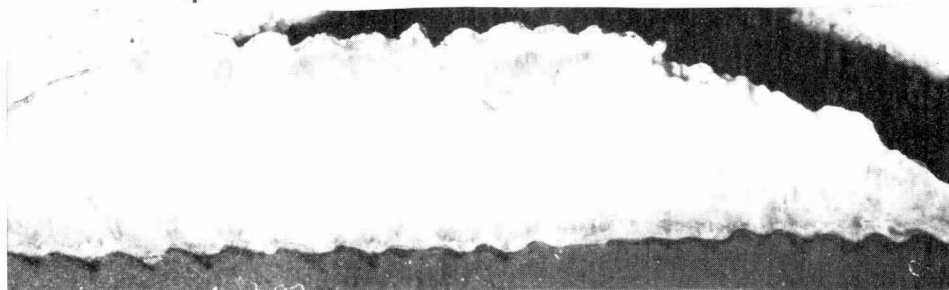
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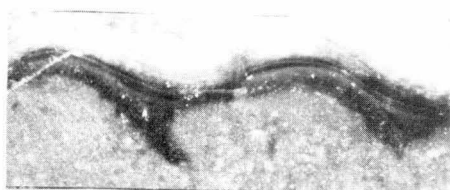
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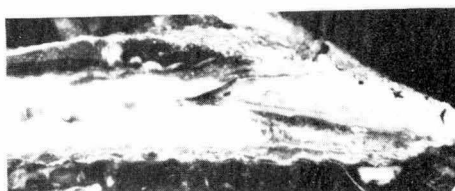
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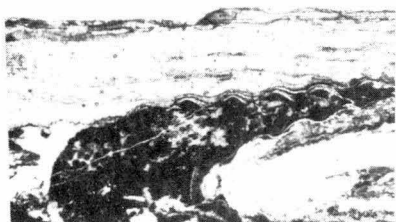
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PLATE 10.

Paramadiganella banksi n.gen., n.sp.

Figs. 1-9:   *Paramadiganella banksi* n.gen., n.sp.,
             holotype UTGD 121138, paratype UTGD 121139,
             121140, 81151;

1.   A sagittal section of the holotype, note the change
     in position of the siphuncle, apex right, X4.

2.   A thin section of the paratype UTGD 121139, after
   the ontogenetic change in position of the
     siphuncle, X10.

3.   A close up of the siphuncle of the holotype before
     the ontogenetic change, "endocones" are developed
     in the siphuncle, X14.

4.   A close up of the dorsal wall of the siphuncle in
     2, X20.

5.   A close up of the ventral septal neck in 2, X30.

6.   A close up of the dorsal septal neck in 2, X30.

7.   A lateral section of the paratype UTGD 81151,
     showing the free siphonal canal in the siphuncle,
     apex right, X3.

8.   A thin section of the paratype UTGD 121140,
     showing the thick connecting rings, X20.

9.   A thin section of the paratype UTGD 121140,
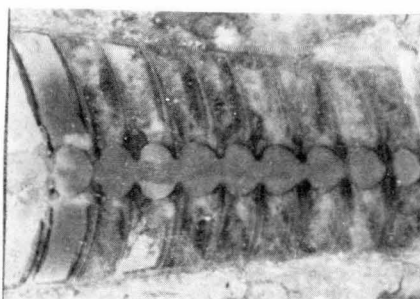   showing the siphuncle before the ontogenetic
   change in position, X20.
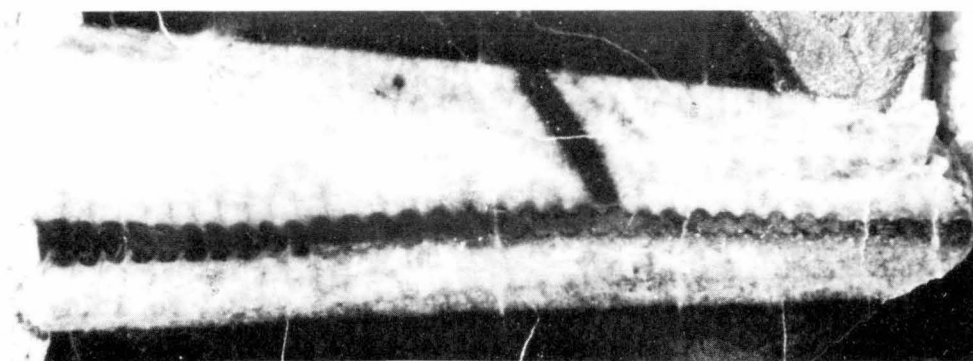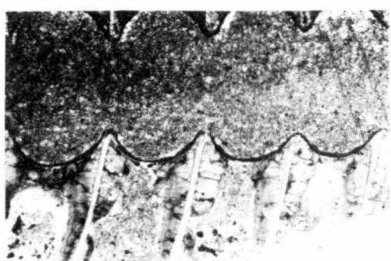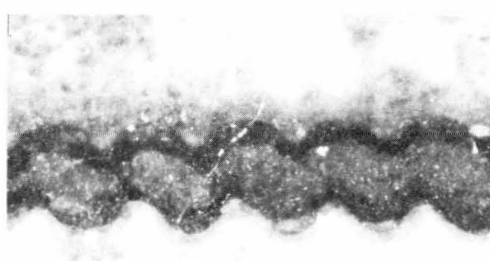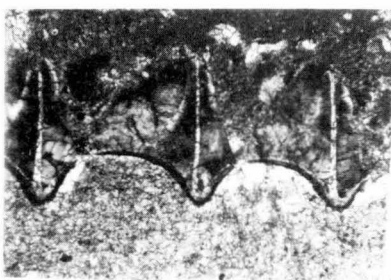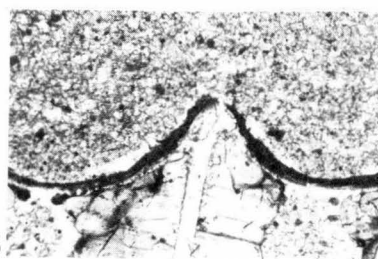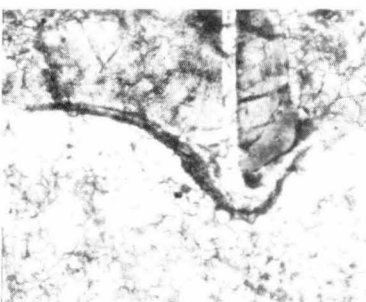
PLATE 11.

Tasmanoceras zeehanense

Figs. 1-8 *Tasmanoceras zeehanense;*

1. An opaque section of a siphuncle UTGD 121147, and part of the camerae showing the siphonal deposits, apex left, X3.

2. A close up of the dorsal wall of the siphuncle and the septal necks, X15.

3. A close up of the ventral wall of the siphuncle in UTGD 121153, X20.

4. A close up of the ventral wall of the siphuncle in UTGD 121150, showing the septal necks and connecting rings, X30.

5. A sagittal section of UTGD 121149, showing the "endocones" note the dorsal position of the siphonal canal, apex right, X2.

6. An isolated siphuncle UTGD 121148, which has diaphragms across the siphonal canal, apex right, X3.

7. A view down the siphocone of a silicified siphuncle UTGD 121152, note the flattened ventral wall, X5.

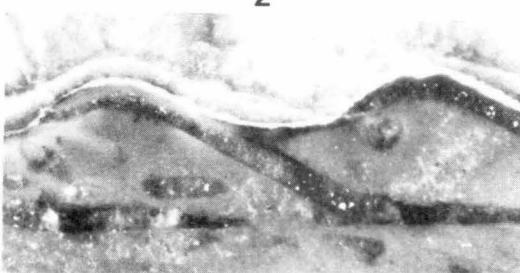8. A silicified isolated siphuncle showing the septal ridges, apex right, X3.
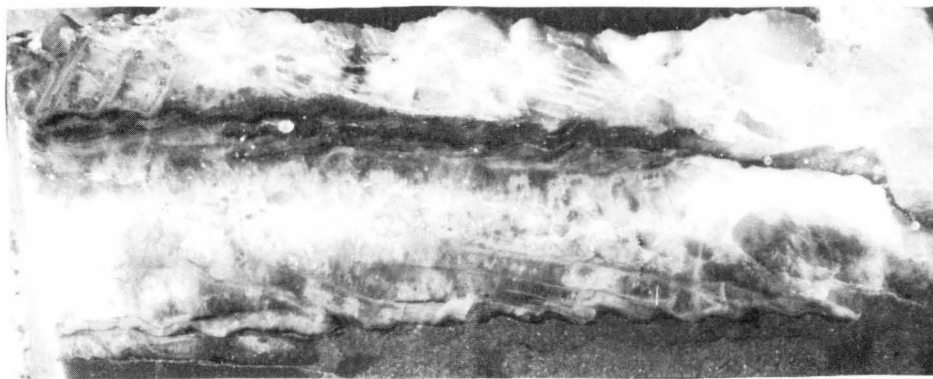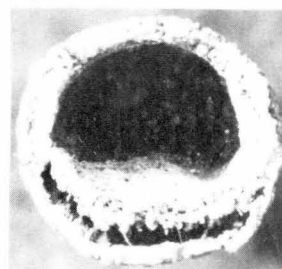
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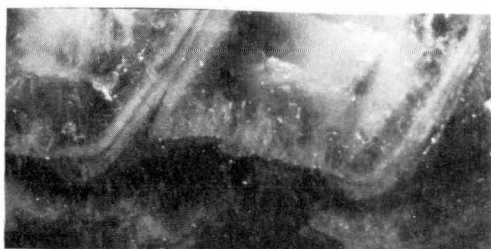
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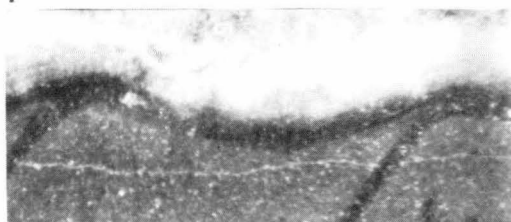
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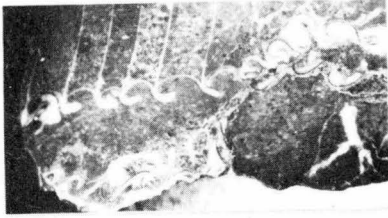PLATE 12.

Westfieldoceras taylori n.gen., n.sp.;
Tigeroceras florentinense n.gen., n.sp.

Figs. 1-9: *Westfieldoceras taylori* n.gen., n.sp.,
holotype UTGD 95793, paratypes UTGD 121158,
121159;

1. A sagittal section of the holotype, apex right, X1.

2. A close up of the dorsal segment of the holotype,
note the thick connecting ring, X9.

3. A thin section of the holotype showing the dorsal
side of the siphuncle, X8.

4. An opaque section of the paratype UTGD 121158, X10.

5. A sagittal section of 4 showing the ventral camerae,
apex right, X1.

6. A thin section of 4 showing the septal necks and
siphonal deposits, X10.

7. More adoral ventral segment, X10.

8. A sagittal section of the paratype UTGD 121159,
apex left, X2.

9. A close up of the ventral wall of 8, X10.

Figs. 10-13: *Tigeroceras florentinense* n.gen., n.sp.
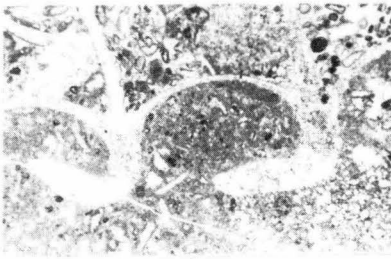holotype UTGD 22042;

10. A sagittal section of the holotype, apex left, X3.

11. A close up of the ventral wall of the phragmocone
and siphuncle, X8.

12. A close up of the dorsal wall of the siphuncle, X8.

13. An external mould of the phragmocone wall showing
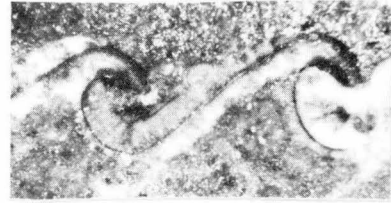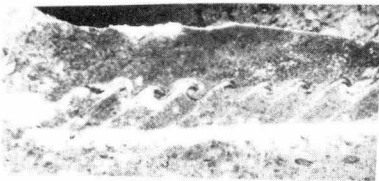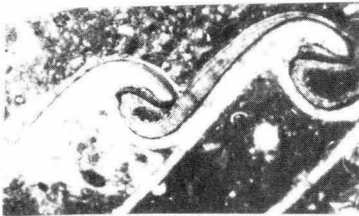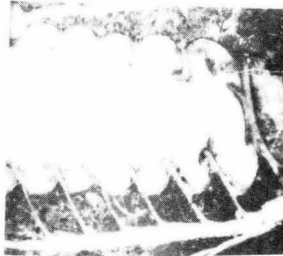the two conchical furrows, X1.

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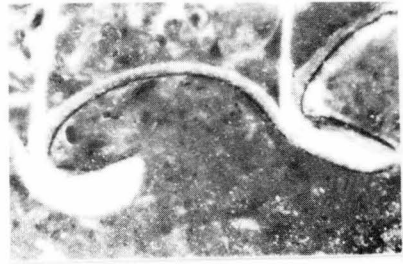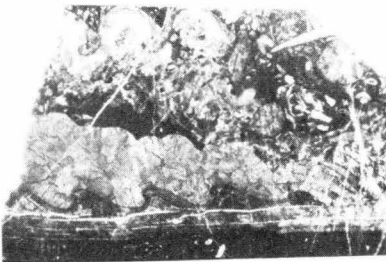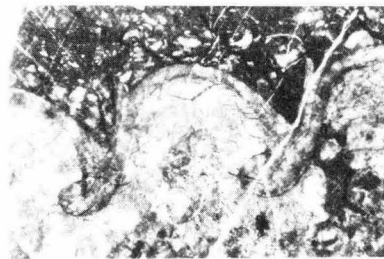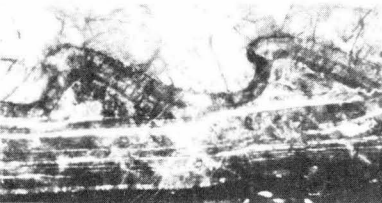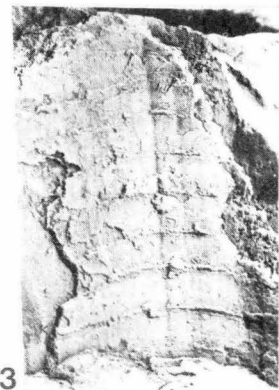
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PLATE 13.

Hecatoceras longinquum

Figs. 1-12: *Hecatoceras longinquum*, holotype
UTGD 20826; other material UTGD 95132,
95131, 95134, 95133, 55538, 121203 and
121204;

1. A slightly oblique section of the holotype
   an isolated siphuncle, apex right, X2.

2. A cross-section of UTGD 95132, X4.

3. A close up of the ventral wall of the holotype
   siphuncle X12.

4. A silicified specimen showing the position of
   the siphuncle and the rate of expansion of the
   phragmocone, apex right, X2.

5. A sagittal section of UTGD 95131, showing the
   exogastric curvature, apex left, X3.

6. A close up of the ventral wall of the siphuncle,
   X15.

7. A close up of the dorsal wall of the siphuncle,
   X15.

8. A thin section of UTGD 95134, showing the siphonal
   deposits, apex right, X4.

9. A naturally weathered silicified specimen showing
   the calcite in the dorsal camerae, UTGD 95133,
   apex right, X1.5.

10. A sagittal section from Ida Bay, UTGD 55538,
    showing the siphuncle in contact with the ventral
    phragmocone wall, apex right, X1.5.

11. A close up of the ventral wall of the siphuncle
    in UTGD 121204, X8.

12. A thin section of UTGD 121203, showing the siphonal
    deposits, apex right, X3.

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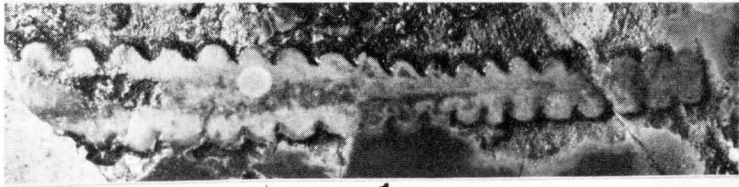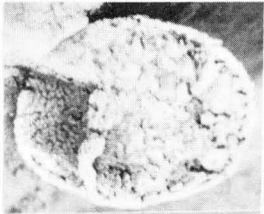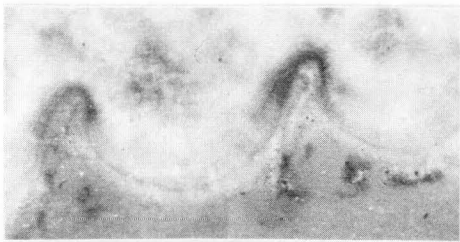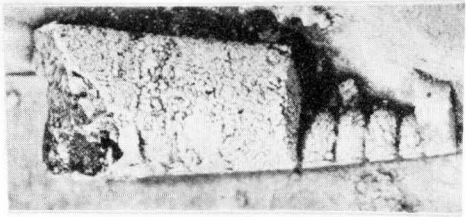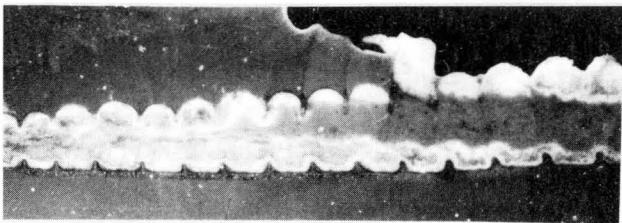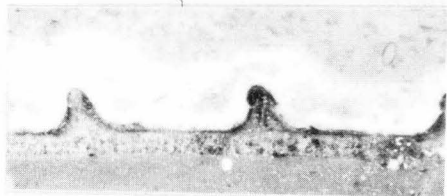
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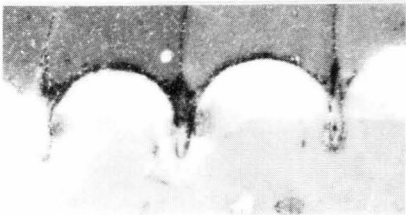
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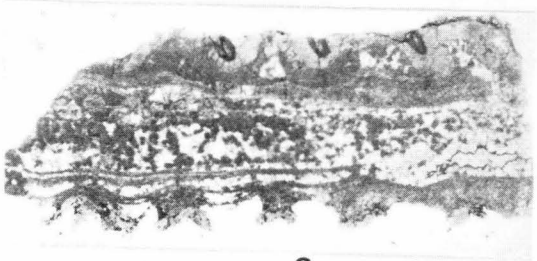
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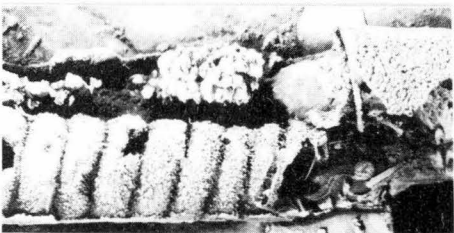
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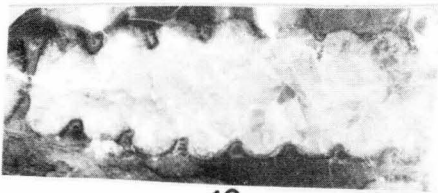
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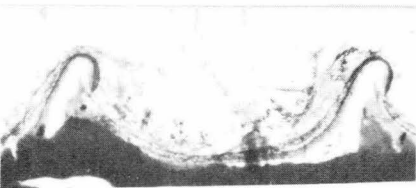
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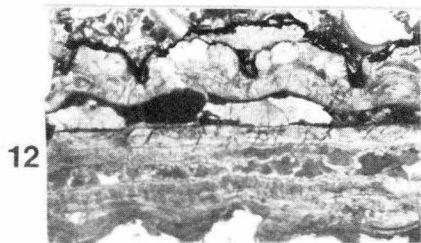
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Order   ELLESMEROCERATIDA

Suborder CYRTOCERININA   Flower, 1964a

Family   CYRTOCERINIDAE   Flower, 1946

This family was established by Flower (1946) for a single genus, *Cyrtocerina*. Its description in Flower (1964a) indicated that the members of the family were "... endogastric, breviconic shells with ventral siphuncles ...". If this part of the family description is changed to include genera where the siphuncle is removed from the venter, then this, without further modification, will enable *Centrocyrtocerina*, herein, to be assigned to the Cyrtocerinidae

Genus   CENTROCYRTOCERINA   n.gen.

Genotype:- *Centrocyrtocerina sharplesi* n.sp.

Derivation of Name:- It is similar to *Cyrtocerina* but has a more centrally positioned siphuncle.

The phragmocone is an endogastric, breviconic cyrtocone, with a compressed cross-section. The phragmocone is rapidly expanding. The siphuncle is one-fifth the height of the phragmocone. The siphuncle is non-expanded. The siphuncle is midway between the centre and the venter. The septa are only very slightly curved. The connecting rings are not adnate to the septa. The septal necks are achoanitic. The siphuncle is empty. The connecting rings are very thick and project into the siphuncle as triangular lobes. They are thinnest at the septal foramen and reach their maximum thickness just slightly adorally of the centre of the segment. The connecting rings are differentiated into three layers. There are no cameral deposits present.

Remarks:- *Centrocyrtocerina* is similar to *Cyrtocerina* as it is a

rapidly expanding brevicone, which has achoanitic septal necks and thick triangular,differentiated connecting rings, but differs from that genus as the siphuncle is not ventral in position, but is midway between the venter and the centre of the phragmocone.

Centrocyrtocerina sharplesi n.sp.

Plate 15   fig.1 - 5 ; Fig. 4.3(1)

The phragmocone is an endogastric, cyrtoconic brevicone, with a strongly compressed cross-section. The dorsum is more sharply rounded. There are 14 siphuncular segments in a length of 13mm. The siphuncle is one-fifth of the height of the phragmocone. The siphuncle is midway between the centre and the venter. The septa are only slightly curved with the point of maximum depth at the dorsal wall of the siphuncle. The radius of curvature of the septum is 50mm.

The siphonal formula is 1.4/1.5/4.1(+):1.4/1.5/4.1(+); 0.6 apically, while adorally it is 4.3/2.8/4.2(+):4.4/2.6/4.1(+); 1.0.

The connecting rings are not adnate to the septa.

The septal necks are achoanitic and are very short (>0.1mm).

The siphuncle contains no siphonal deposits. The connecting rings are very thick and project into the siphuncle as triangular lobes. They are thickest just adorally of the centre of the siphuncular segment and thinnest at the septal foramen. The connecting rings are structured with three distinct areas present :- firstly a layer on the siphonal surface, which is a lighter more dence material (0.3mm thick); on the cameral surface is a thin layer of darker material (0.05mm thick), and between these two layers is a layer of material which is lighter than the material on the cameral surface and which has a granular texture.

There are no definite cameral deposits visible but the camerae are filled with recrystallized calcite which may have originally been organic.

Material and Location:-One phragmocone, holotype UTGD54509. Specimen collected from stratigraphically above Newlands Quarry, State Grid. ref. Sheet 8211, 890878.

Remarks:- *C. sharplesi* is less gyroconic, and more strongly compressed than is *C. frizonense*. Although the preservation makes it difficult to be certain,the distance the siphuncle from the ventral wall of the phragmocone changes more rapidly in *C. Sharplesi* than in *C. frizonense*.

Centrocyrtocerina frizonense n.sp.

Plate 14   fig. 1 - 10 ; Fig. 4.3(2).

The phragmocone is an endogastric, gyroconic brevicone, with a slightly compressed cross-section. There are 40 siphunclar segments in a distance of 53mm. The siphuncle is $^1/5$ of the diameter of the phragmocone. The phragmocone is initially rapidly expanding, then the rate of expansion is reduced in late ontogenetic stages. The siphuncle is midway between the centre and the venter. The septa are only slightly curved with the point of maximum depth at the dorsal wall of the siphuncle. The radius of curvature is 25mm.

The siphonal formula for the 18th segment from the apex is 15/3.5/4.7:15.6/1.7/5.9; 1.2, while the adoral measurements are 18/3.7/5.4:18.7/2.3/6.1; 1.4.

The connecting rings are not adnate to the septa.

The septal necks are achoanitic and are very short (0.1mm).

The siphuncle contains no deposits.

The connecting rings are very thick and project into the siphuncle as triangular lobes. They are thickest just adorally of the centre of the siphuncular segment and thinnest at the septal foramen. There are three distinct areas in the connecting rings.

1. A layer on the siphonal surface is composed of light, granular material and is 0.3mm thick;

2. a thin dark layer on the cameral surface (0.1mm thick); and

3. between these two layers is material with a granular texture which is darker in colour than that on the siphonal surface. The middle layer has a lighter layer near that on the siphonal surface, which mimics that layer in both shape and structure.

There are no definite cameral deposits, but the camerae contain calcite on the free part of the septa, especially in the ventral camerae, which may be organic in origin.

Material and Location:- One phragmocone. UTGD121161. The specimen was collected 19 metres above the base of the Cashions Creek Limestone on the hill between Florentine Road and Frizons Road in the Florentine Valley (Locality B on Fig 3.4). The age is Chazy.

Remarks:- See the remarks for *Centrocyrtocerina sharplesi* for a discussion of the specific differences between *C. sharplesi* and *C. frizonense*.
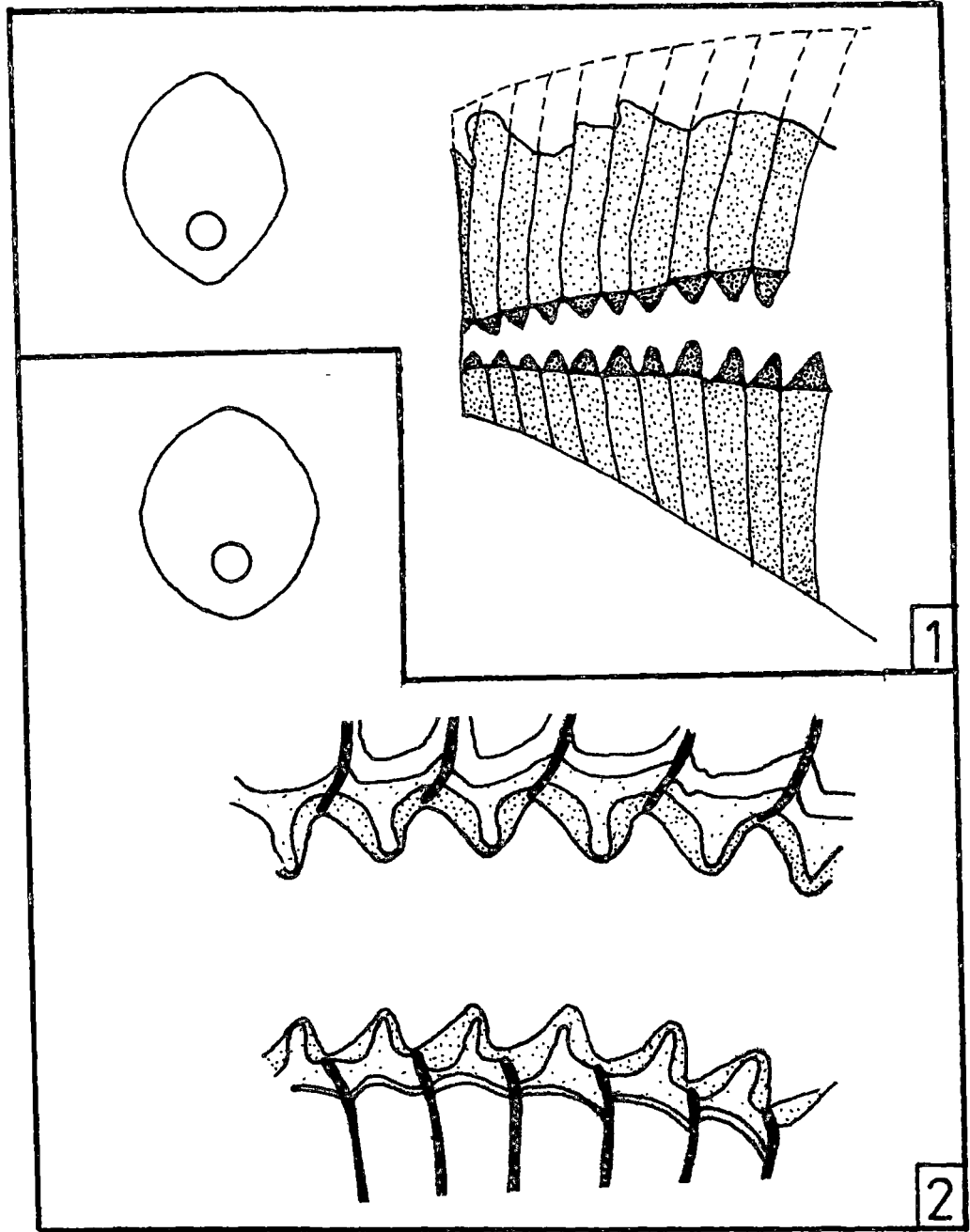
Fig. (4.3) :

1. *Centrocyrtocerina sharplesi* n.gen.,n.sp. : a
   cross-section of the holotype showing the position
   and relative size of the siphuncle. The longitudinal
   section illustrates the structures of the siphuncle;
   apex left, venter below, X10.

2. *Centrocyrtocerina frizonense* n.gen.,n.sp. : a
   cross-section of the holotype showing the position
   and relative size of the siphuncle. The enlargement
   of the siphuncle shows the septal necks and structure
   of the connecting rings; apex left, venter below, X10.

PLATE 14.

Centrocyrtocerina frizonense n.gen., n.sp.

Figs. 1-10: *Centrocyrtocerina frizonense* n.gen., n.sp.,
holotype UTGD 121161;

1. A sagittal thin section of the adoral part of the
holotype, apex right, X1.5.

2. A sagittal opaque section of the apical end of the
holotype, the apical end in 1 corresponds to the
adoral end in this section, apex left, X2.

3. An enlargement of the ventral camerae and the
siphuncle, apex right, X5.

4. An enlargement of the siphuncle at the apical end
of the siphuncle, apex left, X6.

5. A further enlargement of the siphuncle showing the
connecting rings, X12.

6. A close up of the connecting rings of the ventral
wall of the siphuncle, X20.

7. A close up of the dorsal side of the siphuncle,
X20.

8. A close up of the connecting ring illustrating the
differentiation, X25.

9. The dorsal wall of the phragmocone, X15.

10. A transverse section of the holotype, X2.
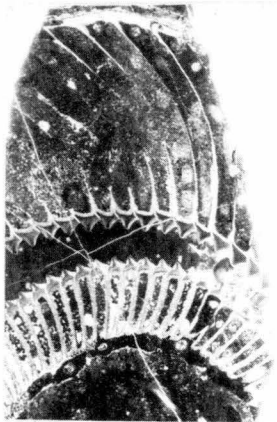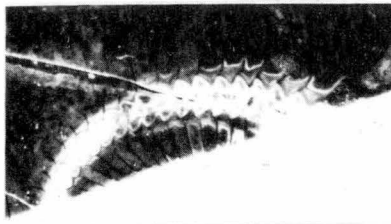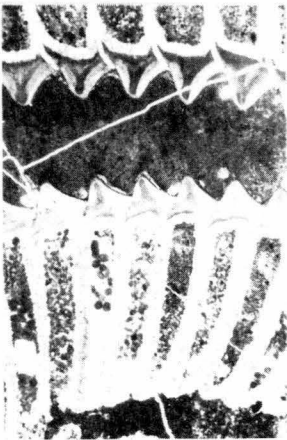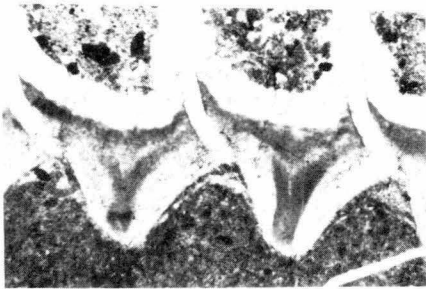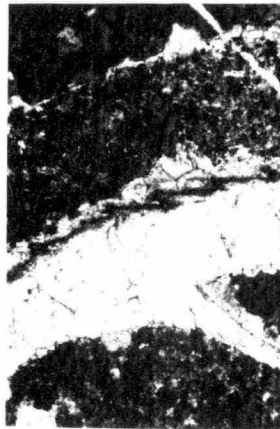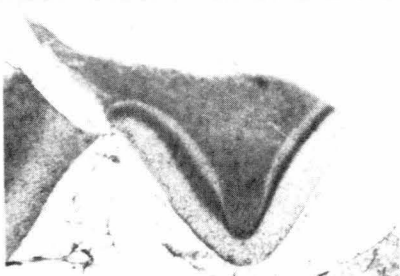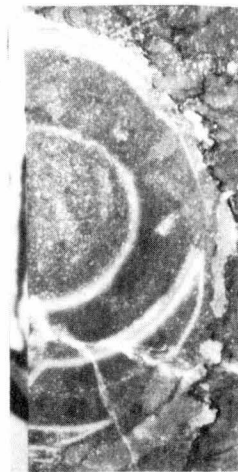
PLATE 15.

Centrocyrtocerina sharplesi n.gen., n.sp.;
Karmbergoceras duosiphonatum n.gen., n.sp.

Figs. 1-5: *Centrocyrtocerina sharples* n.gen., n.sp.,
holotype UTGD 54509;

1. A sagittal section of the holotype, apex left, X4.

2. A transverse section of the holotype, X8.

3. A close up of the siphuncle, apex left, X6.

4. An enlargement of the ventral wall of the siphuncle
    showing the connecting rings, X16.

5. An enlargement of the dorsal wall of the siphuncle,
    X16.

Figs. 6-13: *Karmbergoceras duasiphonatum* n.gen.,n.sp.
holotype UTGD 121180;

6. A sagittal section of an isolated siphuncle, note the
    two endosiphotubes, apex left, X4.

7. A transverse section at the adoral end of the specimen,
    X3.

8. An external view, X3.

9. A transverse section,apical facing cut, X3.

10. A transverse section, the opposite to 9 an adoral
    facing cut, X3.

11. A more apical section, apical facing cut, X3.

12. The opposite of 11, X3.

13. A close up of the dorsal wall of the siphuncle
    showing the septal necks, X17.
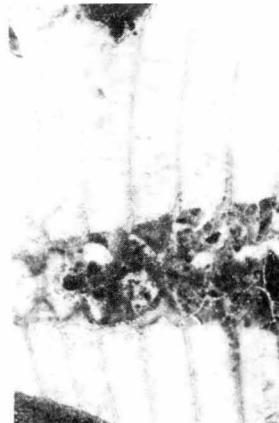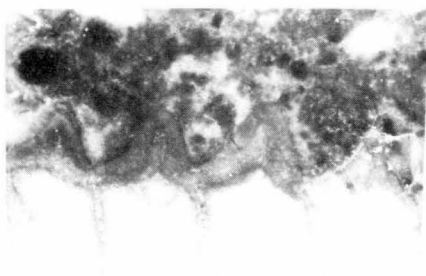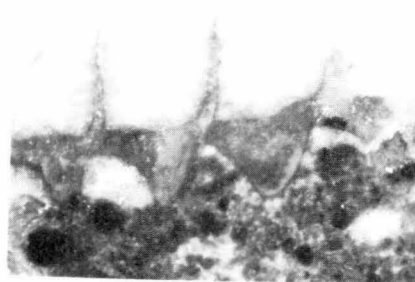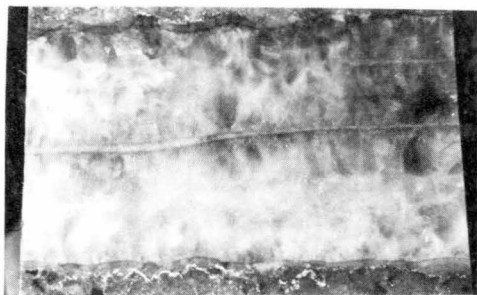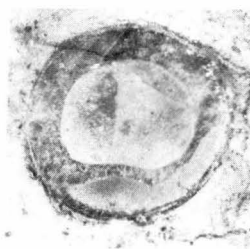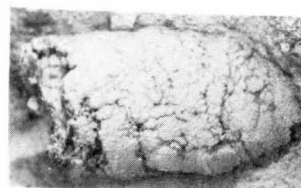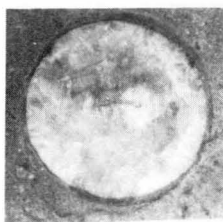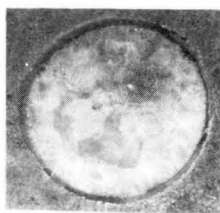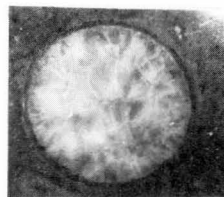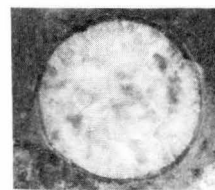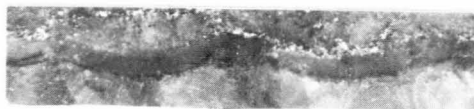
Order   ENDOCERATIDA

Family   PROTEROCAMEROCERATIDAE   Kobayashi. 1937

Genus   ALLOCOTOCERAS   Teichert and Glenister,
                                                      1953

Allocotoceras insigne   Teichert and Glenister, 1953.

Plate 17   fig.12 - 13 ; Fig. 4.4(3).

. The septal necks are hemichoanitic and 1.5mm long. The connecting rings are not clearly preserved. In a transverse cut 35mm from the apex of the holotype the endosiphuncle shows a central endosiphotube which is 3mm above the venter, 2mm wide, cresentic and cross-section and concave towards the dorsum. There is one vertical endosiphoblade which originates at the centre of the endosiphotube and projects in the sagittal plane towards the venter of the siphuncle.

Remarks:-   The above short description supplements that of Teichert and Glenister (1953).

Flower (1976c, p.21) stated "the holochoanitic siphuncle wall of *Allocotoceras* and the validity of its consequent assignment to the Endoceratidae has not been demonstrated". This familial assignment posed a dilemma which new material has helped resolve. Thin section of a new specimen of *Allocotoceras insigne*, UTGD121162, shows the details of the siphuncle wall. The combination of the small size, slight curvature and hemichoanitic septal necks in *Allocotoceras* suggest that it should be assigned to the Proterocameroceratidae.

The endosiphuncle of *Allocotoceras insigne* contains a cresentic endosiphotube which is concave toward, what on all available orientation data, is thought to be, the dorsum.

Allocotoceras is similar to *Karmbergoceras* but does not contain the two endosiphotubes, has a vertical, ventral endosiphoblade, and

has hemichoanitic rather than holochoanitic septal necks.

Genus   FELIXOCERAS   n.gen.

Genotype:- *Felixoceras curtainense* n.sp.

The siphuncle is slightly curved with the initial exogastric curvature reversing and becoming endogastric. The siphuncle is initially circular in cross-section, but when the siphuncle stops expanding it becomes compressed in cross-section. The septal ridges are prominent and slope apically from the venter to the dorsum. Septal necks and connecting rings are unknown.

The endosiphocone is compressed with the venter slightly more narrowly rounded. The ventral wall of the endosiphocone thins adorally more rapidly than does the dorsum. The endosiphotube is slightly dorsal of centre. The endosiphoblade pattern is not known.

Remarks:- As *Felixoceras* is only known from an isolated siphuncle determining the orientation is a problem. The criteria used to determine the orientation are that the venter is more evenly curved, has less prominent septal ridges and that the septal ridges slope apically from the venter to the dorsum. As the septal necks are unknown assignment to a family is difficult, but as *Felixoceras* is similar to Canadian genera of the Proterocameroceratidae it is tentatively assigned to that family.

The shape of the endosiphocone is similar to that found in the Late Canadian genera, *Phragmosiphon* and *Stenosiphon*. The shape of the endosiphocone and shape and size of the siphuncle is different from any Chazy endocerids yet described. The more prominent septal ridges,

less rapidly expanding siphuncle and more symmetrical endosiphocone distinquishes *Felixoceras* from *Phragmosiphon*. As the apex is not known in *Stenosiphon* comparison with *Felixoceras* is difficult. However, *Felixoceras* has a more compressed endosiphocone, much stronger septal ridges, and a more dorsally positioned endosiphotube than in *Stenosiphon*.

<center>

Felixoceras curtainense n.sp.

Plate 18   fig.9 - 13.

</center>

The phragmocone is unknown. The siphuncle is silicified but the septal necks and connecting rings are not preserved. The siphuncle is curved, but it changes its direction of curvature from exogastric to endogastric 25mm from the apex. The siphuncle is 86mm long and contains 17 siphuncular segments. The siphuncle has a circular cross-section for the first 25mm, then becomes compressed in cross-section over the remaining 61mm. The siphuncle is slowly expanding, with 10mm increase in height over the first 25mm, then increasing from 10mm to 11mm over the remaining 61mm. The septal ridges are prominent, five mm apart and slope apically from the venter to the dorsum at an angle of 80°.

The endosiphocone is laterally compressed, the adoral-most height is nine mm, the width is six mm. The endosiphocone expands from four mm to nine mm in a length of 16mm. The ventral wall of the endosiphocone thins adorally more rapidly than does the dorsum. The endosiphotube is slightly on the dorsal side of centre. The endosiphoblade pattern is unknown.

Material and Location:- One isolated siphuncle, holotype UTGD 121163 The specimen was collected from the top of the Cashions Creek Limestone at Felix Curtain Road. State Grid. Ref. Wedge 8112; 536814 (Locality F on Fig. 2.2). The age is Chazy.

Remarks:-   See remarks under genus.

Family   ENDOCERATIDAE   Hyatt, 1883

Genus   SUECOCERAS   Holm, 1896

Suecoceras robustum   Teichert, 1947

Plate 17   fig. 9 - 11 .

The description given in Teichert (1947) is considered adequate

and is not altered. The illustrations in Teichert (1947) have been

supplemented with further photographs of the holotype, especially a

cast of the endosiphocone.

Remarks:-   As the type, and only, specimen of *S. robustum* is an isolated

siphuncle it is difficult to verify its assignment to *Suecoceras*.

The siphuncle of *S. robustum* decreases in circumference after the apical

swelling, but as the siphuncle also becomes compressed the height does

not decrease as much as would be expected in *Suecoceras*.   Flower

(written comm., May 1981) indicated that *Yehlioceras* is valid, and that

it has a dorsal thickening in the endosiphocone. *S. robustum* has a

dorsal thickening in the endosiphocone and when the emended definition

of *Yehlioceras* is more widely known, *S. robustum* will probably prove

to be assignable to *Yehlioceras*.

Endoceratidae   n.gen. n.sp.

Plate 16 fig. 1 - 12

The phragmocone is unknown. The siphuncle is straight, slowly

expanding, sub-circular in cross-section. The venter is slightly

flattened. The septal ridges are prominent and slope apically from

the venter to the dorsum at 80?. The septal necks are holochoanitic

and do not curve to point into the siphuncle at their apical end. The

connecting rings are not preserved.

The endosiphuncle is composed of thick endocones which are at an angle of 10 degrees to the siphuncular axis. The endosiphotube is cresentic, depressed, central and slightly concave towards the venter. The endosiphotube opens into a depressed, slowly expanding endosiphocone, equidistant from dorsum and venter. The endosiphoblades are lateral, originating at the lateral corners of the endosiphotube and projecting to the edge of the endosiphuncle. The endosiphoblades vary in position within an individual specimen from directly lateral to slightly to the dorsal side.

Material and Location:- 13 isolated siphuncles UTGD121164,121165 ,121166 121167,121168 ,121169 ,121170 ,121171 ,121172 ,121173 ,121174 ,121175 , 121176,121177 . The specimens were collected from Blenkhorn's Quarry at Railton, locality 9 on fig. (1.2). The age is Whiterock.

Remarks:- This unnamed genus was found very late in this study, by undergraduates on an excursion and this has not allowed the detailed study that would be required to definitely establish a new genus. The depressed cross-section, holochoanitic septal necks and slowly expanding siphuncle indicates it is assignable to the Endoceratidae. The central endosiphocone and the lateral endosiphoblades are unlike any described genus. The endosiphoblade pattern and the shape and position of the endosiphotube is similar to *Lamottoceras* sp., Flower (1955a,Plate 78, fig. 5), but *Lamottoceras* has orthochoanitic septal necks. Endoceratidae n.gen, n.sp. is similar to *Kotoceras*, Kobayashi (1934) in having holochoanitic septal necks, depressed cross-section and a ventrally position siphuncle, but the dorsal position of the endosiphocone distinguishes *Kotoceras* from Endoceratidae n.gen. n.sp.

Family   PILOCERATIDAE   Miller, 1889

Genus   PILOCERAS   Salter, 1859

Piloceras tasmaniense   Teichert, 1947.

Plate 18   fig. 1 - 8 .

The endosiphocone is laterally compressed, with the dorsal and ventral ends sharply curved. The endosiphocone becomes, apically, a central, vertical endosiphotube which is four mm high, 0.2 mm wide 18 mm from the apex in UTGD121178. The endosiphoblades have not been clearly preserved in any specimen.

Remarks:-   The short description and illustrations of two additional specimens (UTGD20525,121178) from Adamsfield have been included as they show features not seen on the holotype. The Tasmanian species is a good *Piloceras* and the remarks of Teichert (1947) do not require addition or comment.

Family   MANCHUROCERATIDAE   Kobayashi, 1935

Genus   MANCHUROCERAS   Ozaki, 1927.

Manchuroceras steanei   Teichert, 1947

Plate 17   fig. 4 - 8 ,

The descriptions in Teichert (1947) and Teichert and Glenister (1953) are considered adequate and are not altered. The illustrations of Teichert (1947) and Teichert and Glenister (1953) are supplemented with photographs of a cast of the endosiphocone and additional material.

Remarks:-   *Manchuroceras steanei* is a good species of *Manchuroceras* as redefined by Kobayashi (1935). The reasons given by Teichert (1947) for differentiating between *M. steanei* and *M. excavatum* are valid and they are two distinct species. *Manchuroceras steanei* differs from

Metamanchuroceras wadeae in having a triradiate endosiphoblade pattern and a subtriangular cross-section of the endosiphocone.

Manchuroceras excavatum Teichert, 1947

Plate 17   fig. 1 - 3 .

The descriptions in Teichert (1947) are considered adequate and are not altered. The illustrations of Teichert (1947) are supplemented with photographs of a cast of the endosiphocone.

Remarks:-   *M. excavatum* is more closely related to *Metamanchuroceras* in the shape of the endosiphocone, but differs from *Metamanchuroceras* in the slope of the septal ridges and a more rounded dorsum in the endosiphocone.

Genus METAMANCHUROCERAS   n.gen.

Genotype:-   *Metamanchuroceras wadeae*   n.sp.

The phragmocone is unknown. The siphuncle is straight and probably belonged to a longicone. The cross-section is sub-circular. The siphuncle initially expands rapidly but later the expansion is slow. The septal ridges slope apically from the venter to the dorsum. The septal necks are unknown. The endosiphuncle initially fills the siphuncle, with a thin endosiphotube, then it opens out into an endo-siphocone which is flat on the venter and sub-circular on the dorsum, but becomes quadrate later in ontogeny.   After the endosiphocone becomes quadrate a large, lobate ridge develops on the dorsum and pro-jects into the endosiphocone.   It is not known if diaphragms are present in the endosiphotube.   The endosiphoblades pattern is diagonal, with four blades present.   The blades project from the corners of the quad-rate endosiphocone out to the edge of the endosiphuncle.

Remarks:- *Metamanchuroceras* is similar to a number of genera assigned to either the Piloceratidae or the Manchuroceratidae. In the diagnosis of the Manchuroceratidae, Kobayashi (1935) described them as breviconic, whereas *Metamanchuroceras* was probably longiconic; other than this difference *Metamanchuroceras* is typical of, and assigned to, the Manchuroceratidae.

Metamanchuroceras differs from *Manchuroceras* in having a dorsal lobate ridge in the endosiphocone, a quadrate endosiphoblade pattern and its long, slender siphuncle (after the initial rapid expansion). *Metamanchuroceras* differs from *Kerkoceras*, Chen and Liu (1974), in having a dorsal lobate ridge and in lacking the highly convex upper surface on the venter of the endosiphocone. *Coreanoceras* is slenderer than *Metamanchuroceras* and also has a triradiate endisiphoblade pattern. *Metamanchuroceras* differs from *Parapiloceras* in having a lobate ridge on the dorsum of the endosiphocone, more rapid expansion in the early stages and is not cyrtoconic.

The early stages of *Metamanchuroceras* are not unlike the early stages of the *Manchuroceras* species from Tasmania, but the endosiphocone of *Manchuroceras steanei* and *M. excavatum* show no sign of a dorsal lobate ridge and the ventral side of the endosiphocone is more convex than is typical of *Metamanchuroceras*. Thus, although it is possible that the species assigned to *Manchuroceras* from Tasmania belong to *Metamanchuroceras* until more material becomes available this cannot be demonstrated.

Metamanchuroceras wadeae   n.sp.

Plate 19   fig. 1 - 11 ; Fig. 4.4(4).

The phragomocone is not known. The siphuncle is straight, probably belonging to an orthoconic, longicone. The cross-section of the

siphuncle is subcircular. The siphuncle is 90 mm long and reaches a maximum diameter of 27 mm. The siphuncle expands to 20 mm in diameter in a length of 25 mm from the apex, beyond which the diameter increases to 27 mm in the next 65 mm. The septal ridges slope apically from the venter to the dorsum at 75°, and are 2.5 mm apart. The septa and septal necks are unknown.

The endosiphuncle has been silicified making some of the internal structures obscure. There is a thin endosiphotube in the endosiphocone for 15 mm from the apex. Then from 15 mm to 45 mm the tube expands into an endosiphocone, which is flat on the venter and is semicircular in cross-section on the dorsum. During this interval the cross-section of the endosiphocone becomes more quadrate. From 45 mm to 90 mm a dorsal lobate ridge develops and projects into the endosiphocone 4.0 mm at the adoral ends of the siphuncle. At 80 mm from the apex the distance from the outside of the endosiphuncle to the ventral floor of the endosiphocone is 6.0 mm.

There is a quadrate endosiphoblade pattern, with the blades first becoming apparent 45 mm from the apex. The blades originate at the corners of the quadrate endosiphocone and project diagonally to the edge of the endosiphuncle. After the origination of the lobate ridge on the dorsum the endosiphoblade originate at either side of this ridge and project dorsally.

Material and Location:- Only one siphuncle is known, holotype UTGD89060. The specimen was collected from the base of the Karmberg Limestone at Adamsfield, State grid ref., Wedge 8112; 440700. The age is Late Canadian.

Derivation of Name:- In honour of Dr. M. Wade whose help to the author was invaluable.

Remarks:- See remarks under genus.

Family ?   ALLOTRIOCERATIDAE   Flower, 1955b

Genus   OCTOCERAS   n.gen.

Genotype:- *Octoceras uniquum* n. sp.

Derivation of Name:- The holotype was collected from Eight Road West in the Florentine Valley.

The phragmocone is unknown. The siphuncle probably belonged to an orthoconic, longicone. The siphuncle is straight, circular in cross-section and slowly expanding. The septal necks are unknown. The endo-siphuncle contains an infula and three primary endosiphoblades. There are some tubes visible in the infula, but they are not visible over most of the specimen. The endosiphoblades are triradiate with one vertical blade from the dorsal side of the endosiphocone to the dorsal side of the endosiphuncle, and two lateral blades which originate at the corners of the endosiphocone and reach the outside of the endosipho-cone slightly to the dorsal side of centre. Other endosiphoblades are present but they can only be seen in the most apical cut and it is not clear if they occur throughout the specimen. The two blades project from the ventral side of the infula towards the ventral side of the endosiphuncle.

Remarks:- *Octoceras* is similar to many genera of endoceroid described by Flower (1968b, 1976c). However, there is a problem in deciding the orientation of *Octoceras*, the venter and dorsum cannot be determined with any confidence in the available specimen. In the above description the specimen has been assumed to have a ventral infula and dorsal blades, as in this orientation it is similar to many other known endoceroid genera. The alternative orientation is however possible. Even in

this orientation it would still be a new genus as it differs from both *Najaceras* and *Meniscoceras,* the only genera with similar orientation and structure that have been described.

If the infula is ventral in *Octoceras* it is assignable to the Allotrioceratidae, but until its orientation is definitely known the familial assignment must remain uncertain.

Octoceras is similar to *Williamsoceras ankliferum* in having a vertical dorsal blade, but the lateral blades are not found in *W. ankliferum* and the dorsal blade does not bifurcate at its dorsal end in *Octoceras.*

Octoceras uniquum   n.sp.
Plate 20   fig. 1 - 5 ; Fig. 4.4(2).

The phragmocone is unknown. The siphuncle probably belonged to an orthoconic, longicone. The siphuncle is straight, slowly expanding and circular in cross-section. The siphuncle is 45 mm long and the diameter increases from 15 mm to 23 mm. The septal ridges cannot be seen. The septal necks are not known.

The endosiphuncle has been silicified and some of the structures have been lost or obscured. Within the endosiphuncle is a ventral infula and a triradiate endosiphoblade pattern. The infula is higher than it is wide, with the infula 11.0mm high and 6.0mm wide 15mm from the apical end of the specimen. The tubes in the infula are not well preserved but can be seen in some parts of the specimen. The endosipho-cone slowly expands, with it being 2mm high and 8.0mm wide 15mm from the apical ends of the specimen. In the endosiphuncle (excluding the infula) is a triradiate endosiphoblade pattern, with one vertical blade originating at the centre of the dorsal side of the endosiphocone and

extending to the edge of the endosiphocone, the other two blades are lateral. The lateral blades originate at the corners of the endosipho-cone opposite the lateral sides of the endosiphuncle and reach the edge of the endosiphuncle just dorsally of the centre. There are also two blades present on the apical most cut which project towards the venter from the infula. These two blades are not preserved further adorally in the specimen.

Material and Location:- Only one siphuncle is known, holotype UTGD81165. The specimen was collected from the Cashions Creek Limestone at Eight Road West in the Florentine Valley, locality N on fig. 2.2. The age is Chazy.

Remarks:- See remarks under genus.

Family   BOTRYCERATIDAE   Flower, 1968d
Genus   PROBOTRYCERAS   n.gen.

Genotype:- *Probotryceras westfieldense* n.sp.

The phragmocone is straight, probably subcircular in cross-section. The siphuncle is approximately one-third the diameter of the phragmocone. The siphuncle is tubular circular in cross-section and is in contact with the ventral wall. The septa are gently curved. The septal necks are holochoanitic and at their apical end curve to point into the siphuncle. The connecting rings are thick and cover the siphonal sur-face of the septal necks.

The endosiphuncle contains two groups of endosiphotubes which open into a slowly expanding endosiphocone. The endosiphoblade pattern is not clear, but there is a dorsal blade, either side of the sagittal line, which bifurcates as it nears the edge of the endosiphuncle. The ventral endosiphoblades are probably a set of U-shaped blades (opening ventrally)

either side of the sagittal line and extending to near the groups of tubes at the dorsal closure of the blades.

Remarks:- Flower (1968d) established a new family and genus for an endoceroid with two groups of endosiphotubes in the endosiphuncle. Flower (1968d, p. 3) considered this feature to be "remarkable" and stated that "No forms or close affinities are known...". *Probotryceras* also has two groups of endosiphotubes but differs from *Botryceras* in that the endosiphotubes are central, much smaller relative to the siphuncle and in having a complex endosiphoblade pattern. *Karmbergoceras* also has two endosiphotubes but the tubes are cresentic in transverse section and become further apart apically. *Probotryceras* also differs from *Karmbergoceras* in having holochoanitic septal necks and thick connecting rings.

Probotryceras westfieldense n.sp.

Plate 20   fig. 6 - 12 .

Only the ventral wall of the phragmocone has been preserved. The phragmocone was probably an orthoconic longicone, with a circular cross-section. The siphuncle is straight, one-third the diameter of the phragmocone and slowly expanding. There are 15 camerae in a distance of 50 mm. The septa are gently curved and the adoral angle between the free part of the septa and the siphuncle wall is 50°. The siphuncle expands from 20 mm to 25 mm in its length. The septal necks are holochoanitic, four mm long and curve to point into the siphuncle (for 0.5mm) at their apical end. The connecting rings are thick, originate between the apical end of one septal neck and the adoral end of the next and are the same length as the septal necks. The connecting rings thicken towards, and are rounded at, their apical end. They are two-layered with a thin light layer on the siphonal

surface and a thicker dark layer against the septal neck. There are fine lamellae in the darker layer which parallel the septal necks.

The endosiphuncle has been largely recrystallized and the endosipho-blade pattern has been obscured. The specimen is only the anterior of the siphuncle and shows two groups, of centrally positioned, endo-siphotubes which open into a slowly expanding, central, subcircular endosiphocone. At the adoral end the height of the endosiphocone increases from four mm to eight mm in 22mm. The two groups of tubes are 10mm from the venter and are one mm apart in the lateral plane. The endosiphuncular blade pattern is probably symmetrical about the sagittal plane. The dorsal endosiphoblades originate at the dorsolat-eral corners of the endosiphocone and project at 30° to the sagittal plane; they bifurcate at three mm from the edge of the endosiphuncle. The ventral endosiphoblades are U-shaped with the closed end of the U central, the open ends five mm apart and reaching the edge of the endosiphuncle ventrolaterally.

Material and Location:- One siphuncle and incomplete phragmocone, holotype UTGD121179. The specimen was collected from 40 metres above the base of the Lower Limestone Member at the Westfield section in the Florentine Valley, Locality a on fig (3.6). The age is Chazy.

Remarks:- See remarks under genus.

       Family   UNCERTAIN

       Genus   KARMBERGOCERAS   n.gen.

Genotype:- *Karmbergoceras duosiphonatum* n.sp.

The phragomocone is unknown. The siphuncle is straight, slowly expanding and circular in cross-section. The phragmocone was probably an orthoconic, longicone. The septal ridges slope adorally from the

venter to the dorsum. The septal necks are holochoanitic, with the apical end of one neck in contact with the adoral end of the next neck. No connecting rings can be seen. No endosiphoblades are visible in the endosiphuncle. The endosiphuncle contains two separate endosiphocones and endosiphotubes. The main endosiphocone is centrally positioned, subcircular in cross-section, and has a ventral endosiphowedge within the endosiphuncle. The second endosiphocone is eccentric, less rapidly expanding and does not extend to the apex. This second endosiphocone is midway between the centre and dorsum and to the right side of the vertical plane (when looking apically).

Remarks:- *Karmbergoceras* is assigned to the Endoceratida as it has endosiphuncular deposits and holochoanitic septal necks. The familial assignment is a problem, because, although it is superficially assignable to the Endoceratidae, the two, or more, endosiphotubes are a feature only known in the Allotrioceratidae, therefore until more information becomes available a familial assignment is not made.

The presence of the two endosiphotubes was at first considered to be pathological, but if the main tube was damaged and a second tube was established, the first tube would not continue beyond the point of damage, and would show signs of damage (which it does not).

The orientation of the specimen is also a problem as the phragomocone has been destroyed and there is conflicting evidence in the endosiphocone. The slope of the septal ridges would suggest that the siphuncle is one orientation, while the endosiphowedge suggests the alternative orientation. In the above description, in the absence of conclusive evidence, it has been assumed that the endosiphowedge in the main endosiphocone was ventral.

In the size and shape of the siphuncle *Karmbergoceras* closely

resembles *Allocotoceras*, but *Allocotoceras* has a dorsal endosiphowedge, only one endosiphotube and the septal necks are semi-holochoanitic. two endosiphocones are known in *Alloctrioceras* but they are lateral, sub-equal, and divided by a septum within the endosiphuncle.

When the details of the internal structure of the similar long slender, silicified siphuncle (e.g., *Retroclitendoceras*, *Clitendoceras* and *Escharendoceras*) are known the dual endosiphotubes may be found to be more common, but at the present state of knowledge it is considered as a generic characteristic. This assertion is supported by Flower (1968d) establishing *Botryceras* where the endosiphotube are divided anteriorly into two groups. *Karmbergoceras* is not similar to *Botryceras* as the tubes become closer together apicad, whereas in *Karmbergoceras* the two tubes diverage apicad and are closest at the adoral end of the specimen.

Karmbergoceras duosiphonatum n.sp.

Plate 15   fig. 6 - 13 ;   Fig. 4.4(1).

The phragmocone is unknown. The siphuncle is straight, slowly expanding and circular in cross-section. The phragmocone was probably an orthoconic, longicone. The siphuncle is 45mm long and expands from 6mm to 10mm in height. The septal ridges slope adorally from the venter to the dorsum at 80°. The siphuncle appears to be expanded but the point of maximum expansion is where the septa reach the siphuncle, and the septal necks are convex inwards. The septal ridges are 2mm apart. The septal necks are holochoanitic, 3.5mm long, and the apical end of one neck is in contact with the adoral end of the next neck. The connecting rings are unknown.

The endosiphuncle contains no endosiphoblades. There are two

endosiphotubes within the specimen, both are thin, cresentic in section and concave towards the venter. The main tube is central and opens rapidly from 0.2mm to 4.0mm at 30mm to 45mm from the apical end of the specimen. In the apical 30mm of the specimen the endosiphotube is constant in height. At the adoral most section the venter endosiphocone is 2mm above the endosiphuncle and is 5mm high. The second endosiphuncle is dorsal of the main tube and to the right of the centre (when looking apically) and expands from 0.2mm to 1.0mm between 30 and 45mm from the apical end of the specimen. This tube is 6mm from the venter in the adoral most cut. The second tube is only preserved in the adoral most 19mm. The two tubes are 1.5mm and 0.5mm apart at 30mm and 45mm respectively from the apical end of the specimen.

Material and Location:- Only one siphuncle is known, holotype UTGD121180. The specimen was collected from 290 metres above the base of the Karmberg Limestone at Sunshine Road in the Florentine Valley (locality b on fig. 3.1). The age is Whiterock.

Derivation of Name:- As the endosiphuncle contains two unconnected endosiphotubes.

Remarks:- See remarks under genus.

ENDOCERATIDA   gen et sp. indet.A

Plate 16   fig. 13 - 16 .

The phragmocone is unknown. The siphuncle is straight, slowly expanding and slightly depressed in cross-section. The siphuncle is 40mm long. The height increases from 8mm to 11mm, and the width from 9mm to 13mm. The septal necks and connecting rings are unknown. The septal ridges were either very indistinct or have been completely

obliterated.

The endosiphuncle is largely recrystallized obscuring many features of interal structures. The endosiphoblades are in a triradiate pattern with two ventral blades about 55° either side of the sagittal line, projecting without bifurcation to the edge of the endosiphuncle. The dorsal blade originates at the junction of the two ventral blades, slightly to the dorsal side of centre, and projects to the left side (looking apically) of the sagittal line to the edge of the endosiphuncle.

Material and Location:- One isolated siphuncle UTGD 121181 . The specimen was collected from the middle of the Cashions Creek Limestone at Manning-Frizons Road, Locality B on fig. (3.4). The age is Early Chazy.

Remarks:- The above specimen has not been assigned to a genus or species as no information is available on the characters essential for identification. The triradiate endosiphoblade pattern and depressed cross-section are reminiscent of *Coreanoceras* and *Emmonsoceras*, but until a well-preserved specimen is found its relationships cannot be definitely determined. As the endosiphuncle contains blades but does not appear to have an infula on the venter or dorsum it is not related to the recently described Whiterock and Chazy genera (Flower, 1968b, 1976c).

Fig. (4.4) :

1. *Karmbergoceras duosiphonatum* n.gen.,n.sp. :
   showing the positions at which the transverse cuts
   were made and reconstructions of the cross-sections
   and the longitudinal section; apex left, venter
   below, X3.

2. *Octoceras uniquum* n.gen.,n.sp. : a schematic
   cross-section and longitudinal section of the
   holotype. The orientation of the specimen is
   unclear, but the assumed venter is down, apex
   left, X2.

3. *Allocotoceras insigne* : shows the position of
   the transverse sections and a reconstruction of
   the cross-section. The longitudinal reconstuction
   is based on the two cross-sections; apex left,
   venter below, X1.

4. *Metamanchuroceras wadeae* n.gen.,n.sp. : the position
   of the transverse cuts shown on plate 19. The
   longitudinal reconstruction is based on these cuts;
   apex left, venter below, X1.

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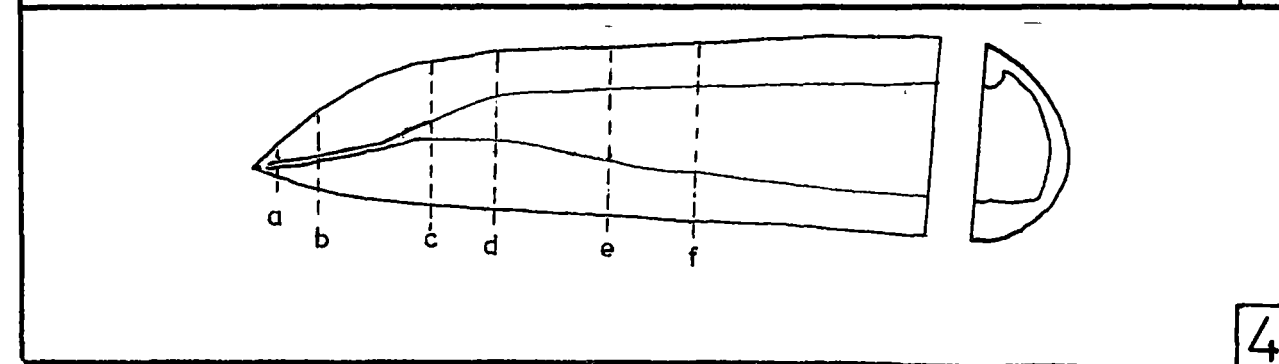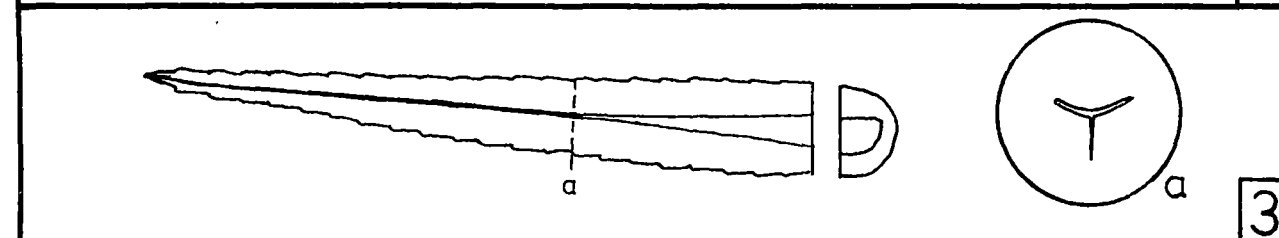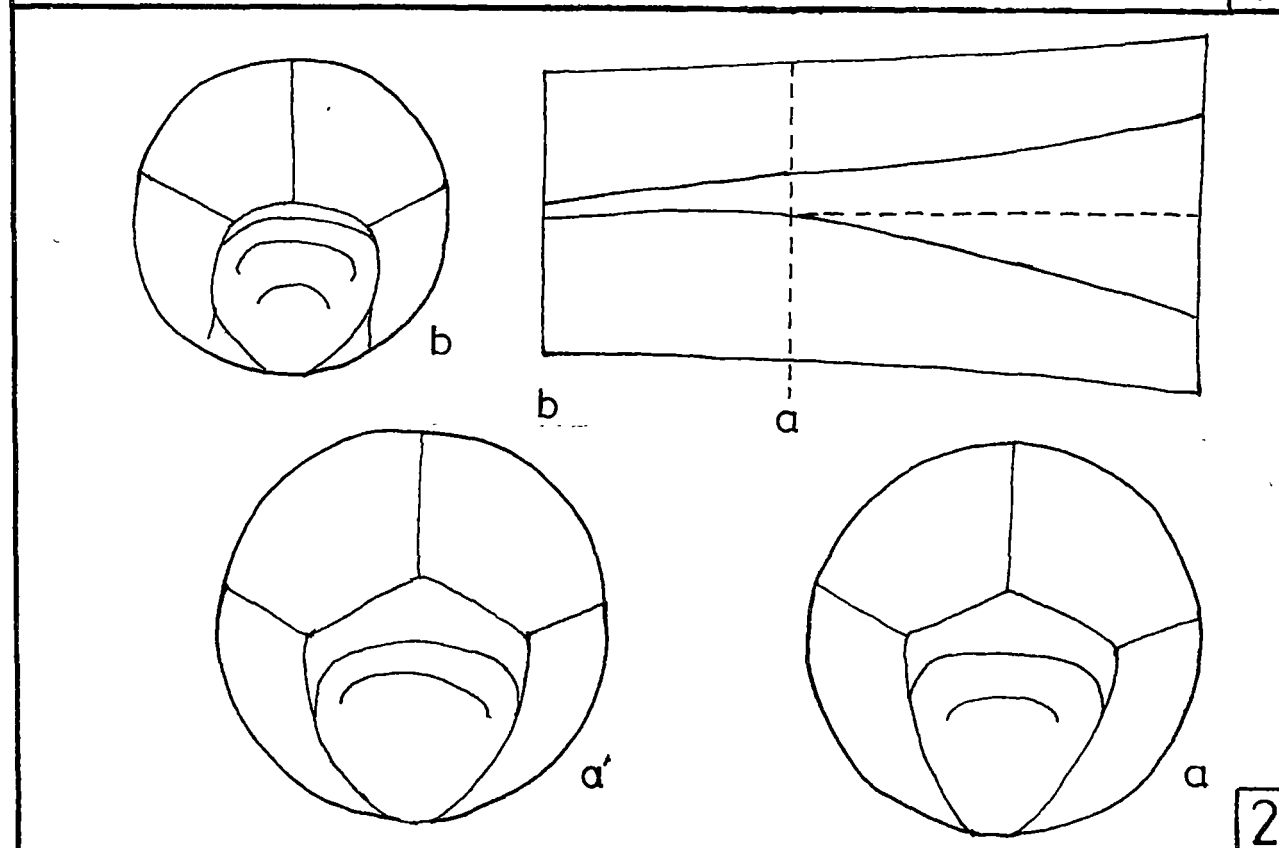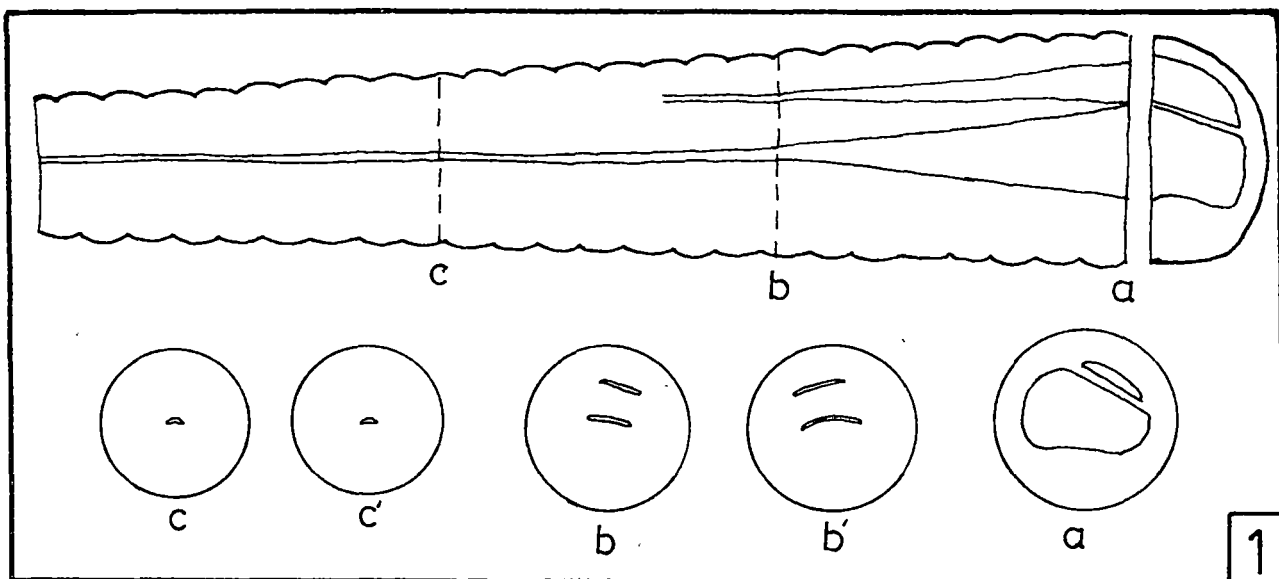
PLATE 16.

Endoceratidae n.gen.n.sp.; Endoceratida gen.,sp.
indet A.

Figs. 1-12:   Endoceratidae n.gen.,n.sp. UTGD 121164,
121165, 121166, 121167 and 121168;

1. Apical most transverse cut, adorally facing X2.

2. Opposite cut to 1, apically facing X2.

3. The adoral most cut of UTGD 121164, adoral facing,
X2.

4. A sagittal cut of UTGD 121165, showing the endocones,
apex right, X2.5.

5. A transverse cut of UTGD 121167, showing the
endosiphocone, adoral facing cut, X1.5.

6. Opposite cut to 5, X1.5.

7. Apical most transverse cut of UTGD 121167, apically
facing cut, X1.5.

8. Next adoral cut (15mm forward) adoral facing cut,
X1.5.

9. Opposite cut to 8, X1.5.

10. The adoral most cut (11 mm forward), adoral facing,
X1.5.

11. An external view of the same specimen between cuts
in 7 and 8, apex left, X1.5.

12. A thin section of UTGD 121168 showing the ventral
septal necks, apex left, X25.

Figs. 13-16: endoceratidae gen.,sp. indet A, UTGD 121181;

13. The apical most natural transverse break, apically
facing cut, X2.

14. The adoral most cut, apically facing cut, X2.

15. An external view of the specimen showing the two
natural breaks, X1.5.

16. The adorally facing cut in the adoral most break, X2.

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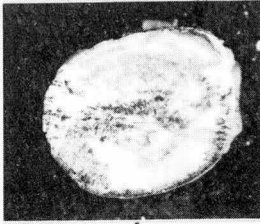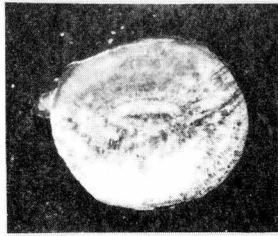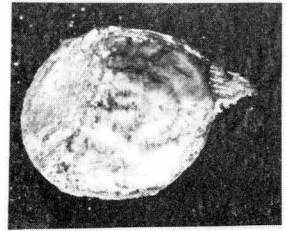
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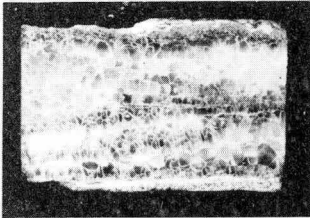
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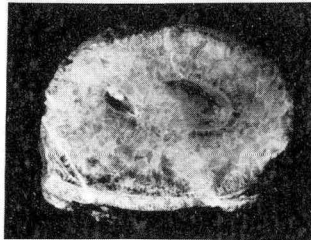
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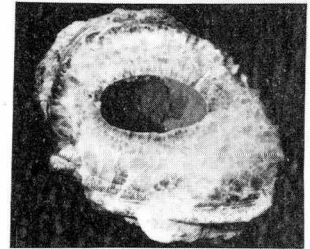
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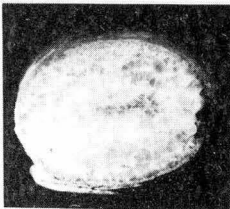
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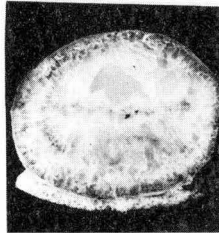
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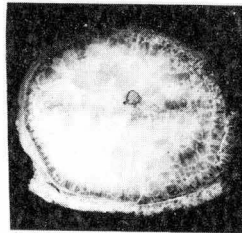
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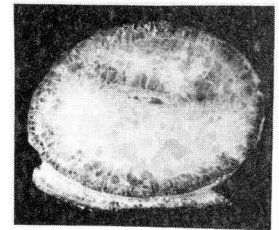
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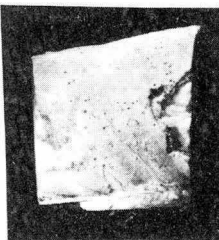
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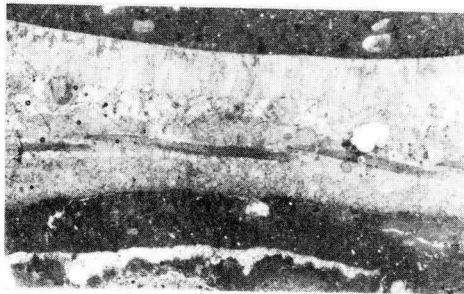
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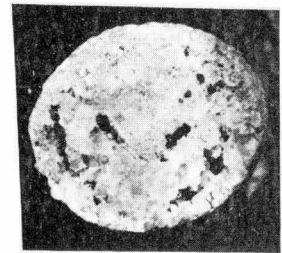
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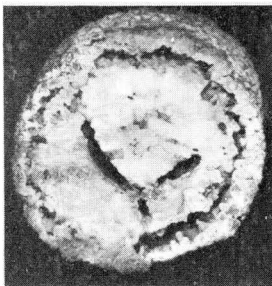
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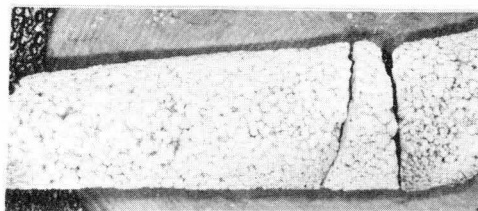
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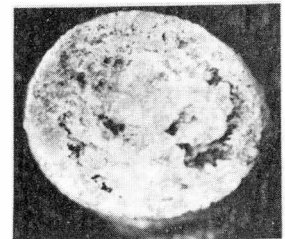
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PLATE 17.

Manchuroceras excavatum; *M.steanei*; *Suecoceras robustum*; *Allocotoceras insigne* (note fig.2 dorsum down).

Figs. 1-3: *Manchuroceras excavatum* UTGD 85623;

1. A dorsal view of the spiess of the holotype, apex left, X2.
2. A lateral view of spiess, DORSUM DOWN, X2.
3. An adoral looking view of spiess, X2.

Figs. 4-8: *Manchuroceras steanei,* UTGD 85625 and 20514;

4. A dorsal view of the spiess of the holotype, apex right, X2.
5. An adoral looking view of the spiess, X2.
6. A lateral view of the spiess, apex right, X2.
7. A lateral view of the spiess of UTGD 20514, apex right, X2.
8. An adoral look view of the spiess, X2.

Figs. 9-11: *Suecoceras robustum,* UTGD 85626;

9. A lateral view of the spiess of the holotype, apex right, X4.
10. An adoral looking view of the spiess, X4.
11. A dorsal view of the spiess, apex right, X4.

Figs. 12-13: *Allocotoceras insigne,* UTGD 21181 (holotype), and 121162;

12. An adoral facing transverse cut of the holotype, X4.
13. A thin section of the wall of the siphuncle in UTGD 121162, showing the septal necks, apex right, X10.

Note: All spiess are latex moulds.

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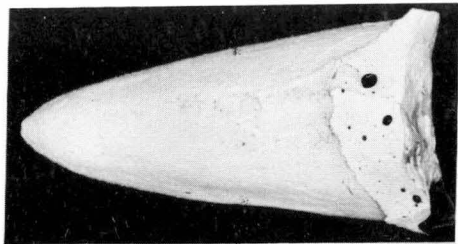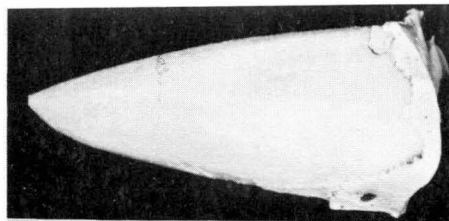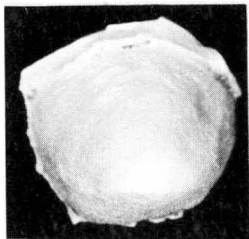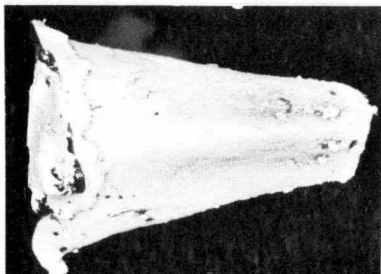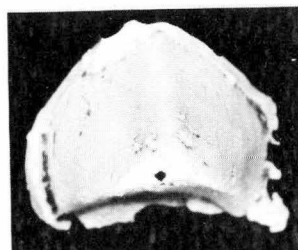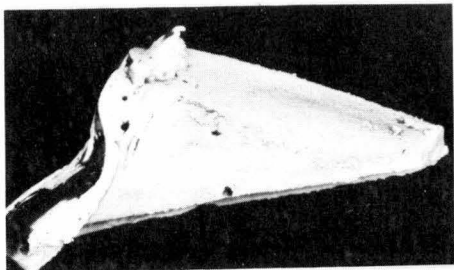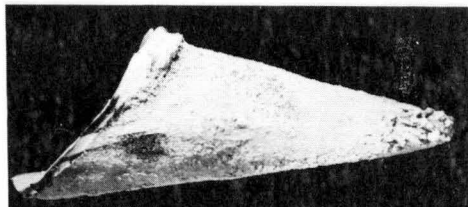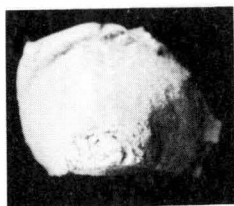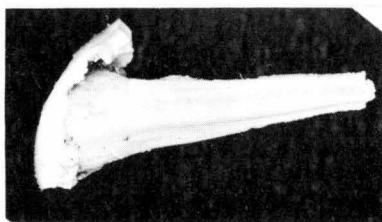
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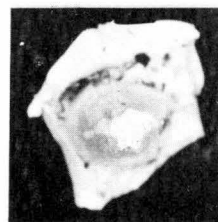
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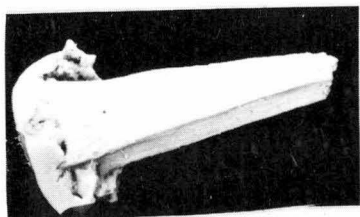
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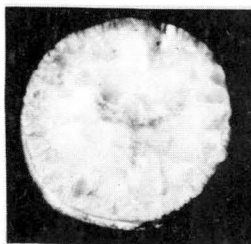
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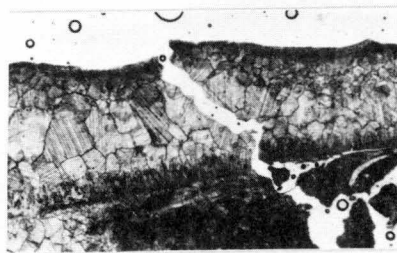
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PLATE 18.

Piloceras tasmaniense; Felixoceras curtainense
n.gen.,n.sp.

Figs. 1-8:   *Piloceras tasmaniense*, UTGD 85630, 20525,
and 121178;

1. An X-ray of the holotype which shows the shape of the
endosiphocone, venter left, X1.

2. An external view of UTGD 121178, venter right, X1.5.

3. The adoral most view, adoral facing cut, X2.

4. Next apical cut, apical facing cut, X2.

5. The adoral facing cut of 4, X2.

6. The apical most cut, apical facing cut, X2.

7. The adoral facing cut of 6, X2.

8. A view down an endosiphocone in UTGD 20525, showing
the vertical endosiphotube, X1.5.

Figs. 9-13:   *Felixoceras curtainense* n.gen.,n.sp.,
UTGD 121163.

9. A lateral view of the spiess of the holotype, apex
right, X2.

10. A view down the endosiphocone, X2.

11. A lateral view of the silicified isolated siphuncle,
apex left, X1.

12. A ventral view of the holotype siphuncle, apex left,
X1.1.

13. A view of the spiess looking adorally, X2.

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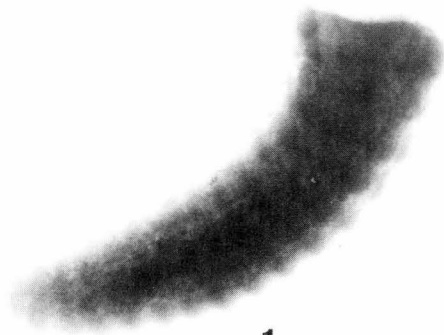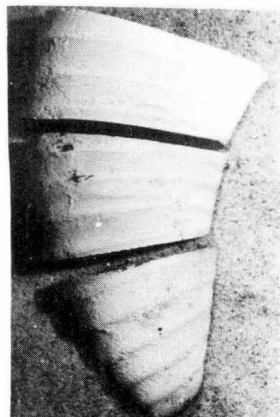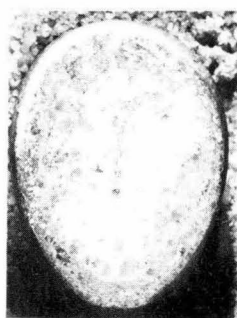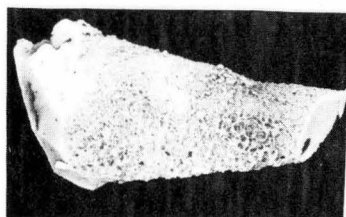
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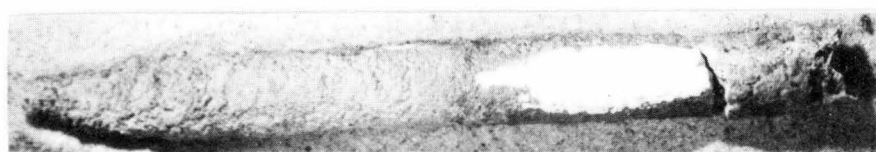
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PLATE 19.

Metamanchuoceras wadeae n.gen., n.sp.

Figs. 1-11: *Metamanchuroceras wadeae,* n.gen., n.sp.
holotype UTGD 89060;

1. A lateral external view of the holotype siphuncle, apex right, X1.

2. The apical most cut, apically facing cut, X1.5.

3. The opposite cut to 2, X1.5.

4. The next adoral cut, apically facing cut, X1.5.

5. The opposite side of 4, X1.5.

6. The next adoral cut, apically facing cut, X1.5.

7. The opposite side of 6, X1.5.

8. The next adoral cut, apically facing cut, X1.5.

9. The opposite cut to 8, X1.5.

10. The next adoral cut, apically facing cut, X1.5.

11. The opposite cut to 10, X1.5.

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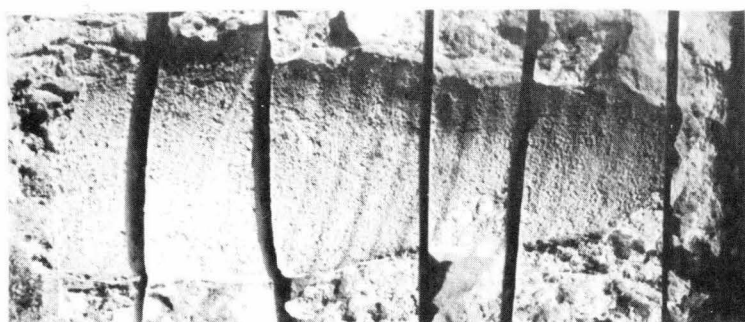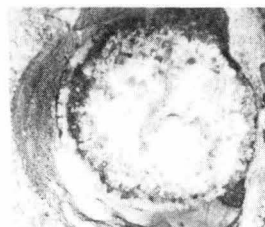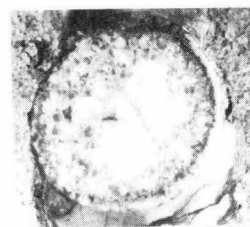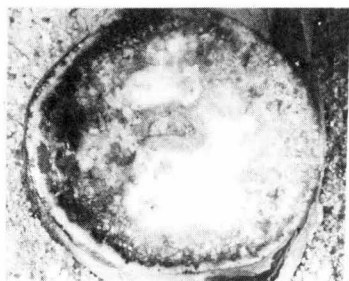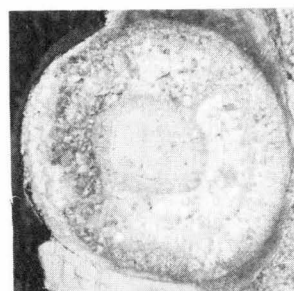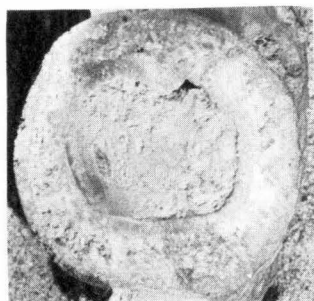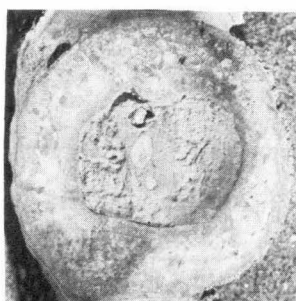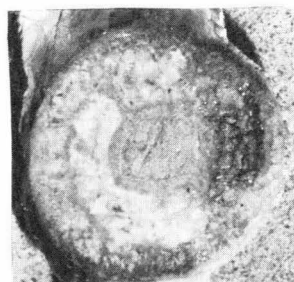
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PLATE   20.
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Octoceras uniquum n.gen.,n.sp.; *Probotryceras westfieldense,* n.gen., n.sp.

Figs. 1-5:   *Octoceras uniquum* n.gen., n.sp., UTGD 81165;

1. A lateral section of the holotype siphuncle, apex left, X3.

2. An enlargement of the infula in the apical most cut, X4.

3. The apical most transverse cut, apically facing cut, X2.

4. The adoral most cut, apically facing cut, X2.

5. The opposite facing cut to 4, X2.

Figs. 6-12:   *Probotryceras westfieldense* n.gen.,n.sp., holotype UTGD 121179;

6. A sagittal section of the holotype, apex left, X1.5.

7. The adoral most transverse section, adorally facing cut, X1.

8. The apical most transverse section, apically facing cut, X1.

9. A thin section of the ventral wall of the siphuncle apex right, X3.

10. A close up of the endosiphotubes, X10.

11. An enlargement of the septal necks showing the close contact between successive camerae, X30.

12. An enlargement of the holochoanitic septal necks, X10.

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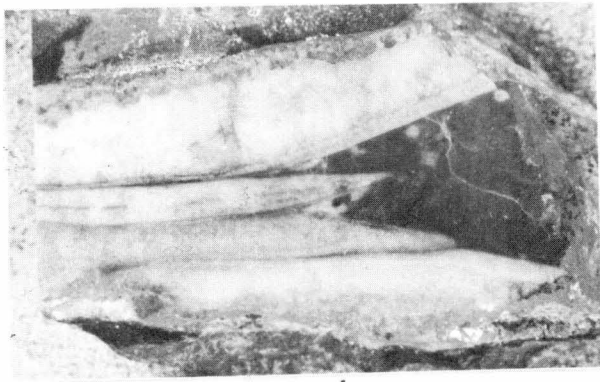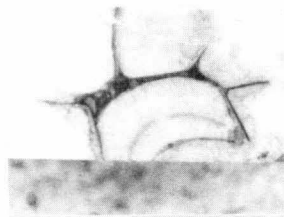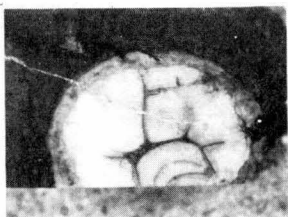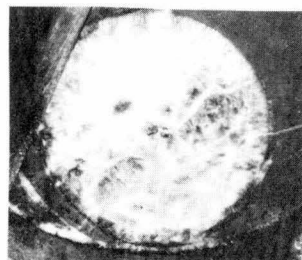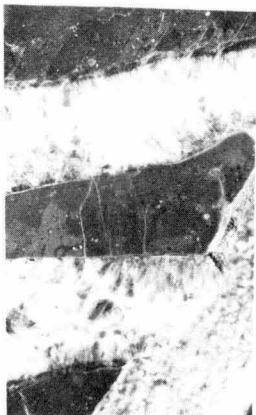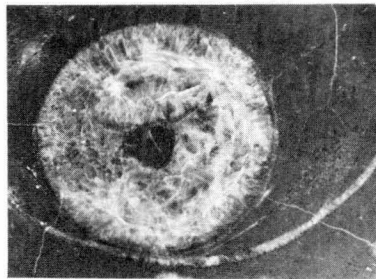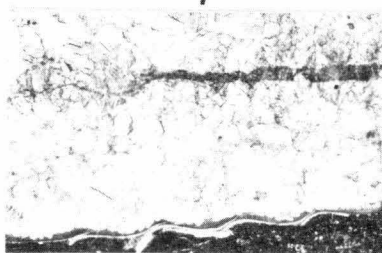
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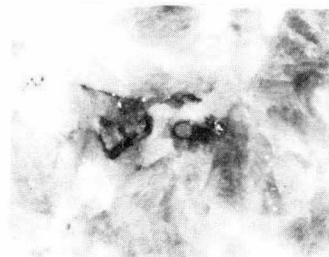
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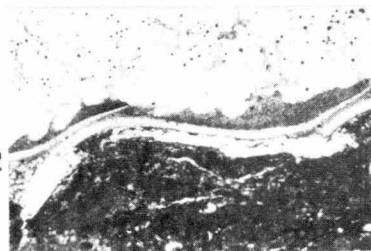
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Order   MICHELINOCERATIDA

Family   MICHELINOCERATIDAE   Flower, 1945

Genus   ANASPYROCERAS   Shimizu and Obata, 1935

Anaspyroceras ? *anzaas*   Teichert and Glenister, 1953

The descriptions and illustrations in Teichert and Glenister (1953) are not amended or supplemented.

Remarks:- Teichert and Glenister (1953) assigned the specimens from Zeehan to *Anaspyroceras*, but noted that Flower (1943) had considered that *Anaspyroceras* probably grades into *Metaspyroceras*. *Anaspyroceras* mainly differs from *Metaspyroceras* in the relation of the suture to the annulations on the shell. *A.* ? *anzaas* has a suture which is not quite parallel to the annulations, but does not vary much from parallel. The external ornament is also similar to some species of *Metaspyroceras,* but until more material of this species is available it is left (tentatively) assigned to *Anaspyroceras.*   Teichert and Glenister (1953) also described *Anaspyroceras* sp. from the Gordon River but this specimen is so poorly known that its assignment is impossible to assess.

Genus   ORTHOCERAS   Bruguière, 1789

Orthoceras   sp.

Plate 21   fig.9 - 13 ; Fig. 4.5(3).

Only the phragmocone is known. The phragmocone is an unornamented, slowly expanding, orthoconic, longicone with a circular cross-section. The siphuncle is central tubular and one-tenth of the diameter of the phragmocone, with a slight constriction at the septal foramen. There are seven siphuncular segments in a length of 40mm. The septa are strongly curved, with the point of maximum depth at the centre of the phragmocone. The siphonal formula at the fourth segment from the apical end

of the specimen is 5.9(+)/0.9/6.4: 5.7(+)/1.2/6.3; 6.0.

The connecting rings are not adnate to the septa.

The septal necks are orthochoanitic and have a length of 0.3mm.
There are no siphuncular deposits. The connecting rings are thin.
There are no cameral deposits.

The conch wall has been recrystallized and only the mural part
of the septa is still visible. The conch wall thickness, including the
mural part of the septum, is 0.7mm.

Material and Location:- Only one phragmocone has been found, UTGD121182.
The specimen was collected from the top of the Karmberg Limestone at
Sunshine Road in the Florentine Valley (locality e on fig. 3.1). The
age is early Chazy.

Remarks:- As this specimen is only known by a phragmocone and has been
silicified it is difficult to be certain of the generic assignment,
but the orthochoanitic septal necks, tubular siphuncle and lack of both
siphonal and cameral deposits strongly suggest that this specimen belongs
to *Orthoceras*. The preservation makes comparison of the specimen with
other species of *Orthoceras* difficult so it is not assigned to a species,
awaiting more and better material.

Genus   SINOCERAS   Shimuzu and Obata, 1935
Sinoceras ?   sp.
Plate 21   fig. 1 - 8 .

Only phragmocones are known. The phragmocone is a slowly expanding,
orthochoanitic, longicone with a circular cross-section. The external
ornamentation is unknown. The siphuncle is central in position, tubular,
with five siphuncular segments in a distance of 12mm on UTGD 121183.
The phragmocone is 9.0mm in diameter and the siphuncle is 1.0mm in

diameter on UTGD121186.

The connecting ring is not adnate to the septum.

The septal necks are orthochoanitic and are approximately one quarter of the length of the siphuncular segment.

Organic siphuncular deposits are probably not present. The connecting rings are thin. There are deposits in the camerae but they may be inorganic in origin.

Material and Location:- Four partially preserved phragmocones, UTGD121183,121184 ,121185 , and121186 . The specimens were collected from 280 metres above the base of the carbonate sequence at Surprise Bay, State Grid. ref. sheet 8210; 708728. The age is Richmond.

Remarks:- The specimens which have been collected are orthochoanitic orthocones, with septal necks one-quarter of the length of the siphuncular segment; this indicates that they are probably assignable to *Sinoceras*. It should be noted that the specimens are very small (only 9.0mm in dia-meter) for members of that genus.

The preservation of this material is poor, but unusual. The specimens are preserved in a thin (60mm) band of phosphate-rich carbon-ate in a sequence of deep water limestones. The specimens appear to have been imploded by hydrostatic pressure before deposition as the shells are broken up, with a large number of fragments present in the sediment and the majority of the specimens preserved have crushed shells.

Family   MYSTERIOCERATIDAE   Sweet, 1964

Sweet (1964) established the Mysterioceratidae for *Mysterioceras* alone. This had been suggested as a possible course of action by Flower (1962b, p. 16) in his discussion of *Mysterioceras*. Sweet (1964)

stated that the conchs are "characterized by cyrtochoanitic mature siphuncle

..." The septal necks either have a very short brim or no

brim at all and are more properly sub-orthochoanitic. So after taking

into account the above comment, the establishment of the family for

Mysterioceras alone is supported.

Genus   MYSTERIOCERAS   Teichert and Glenister, 1953

   Mysterioceras australe   Teichert and Glenister, 1953

    Plate 22   fig. 1 - 7 ; Fig. 4.5(4).

The septal necks are sub-orthochoanitic not truly cyrtochoanitic.

The siphonal formula for the paratype UTGD20883b apically is

4.3/1.2/4.6(+):3.9/1.9/4.4(+); 3.0, while adorally it is 4.6/1.3/5.3:

4.2/2.0/5.0; 3.0.

The siphuncular deposits are parietal, originating at the apical

end of the septal neck and grow apical along the connecting ring until

it meets the adoral end of the next deposit, forming a continuous deposit.

Remarks:- The above short description of paratype (UTGD20883b) is

included as a supplement to those given in Teichert and Glenister (1953).

Flower (1962b, p.16) questioned the reality of the siphonal deposits

and also posed the question that "when two segments join, further longi-

tudinal growth ceases and deposits merely thicken with further growth,

or whether, as in *Striatoceras*, the younger deposit continues, growing

apicad over the preceding deposit"? The present study has shown that

the siphuncular deposits exist and are essentially as described by

Teichert and Glenister (1953) but as to the second question the author

prefers the hypothesis that the deposits do not grow over one another

but just thicken. The only evidence for this is that, although in the

paratype the siphonal deposits are relatively thick, they have not grown

over one another. However, this is not to say that in mature specimens

this could not happen.

One species of *Mysterioceras* has been described from each of China and Russia. Lai (1965) described *M. shengi* from the Nancheng Shale in Shengi province. Examination of the description and illustration of this species shows that in shape, position and size of the siphuncle it is assignable to *Mysterioceras*, but as the siphuncular deposits are not well known and these are required for certain assignment to this genus, an assignment to *Mysterioceras* cannot be made. Balashov (1962) described *M. tunguskense* but this species has a siphuncle which is considerably higher than it is long (although the expansion of the connecting ring and shape of the septal neck is typical of *Mysterioceras*) and this would suggest that this species does not belong in *Mysterioceras* where the siphuncle is considerably longer than it is high.

Mysterioceras australe ?
Plate 22 , fig. 8 - 11 ; Plate 26 fig. 9 - 13 .

UTGD121187   The phragmocone is a slowly expanding orthoconic longicone, with a circular cross-section. There are six segments in a length of 24mm. The siphuncle is slightly expanded, with the point of maximum expansion at the centre of the segment. The septa are gently curved.

The siphonal formula for the third segment from the apical end of the specimen is 5.9/1.4/6.8:5.5/2.1/6.5; 4.0.

The connecting rings are not adnate to the septa.

The septal necks are sub-orthochoanitic, with the necks 0.2mm long, and the brims 0.05mm long ventrally, while dorsally the corresponding measurements are 0.2mm, and 0.05mm.

No definite siphonal deposits are present but there is recrystal- lized calcite present in the siphuncle which may be the remnants of a

siphuncular lining.

The connecting rings are thin.

The cameral deposits are preserved only in the ventral camerae, where they are both episeptal and hyposeptal deposits which have developed to a similar extent and fill the camerae. In the dorsal camerae is recrystallised calcite, but no structure attributable to cameral deposits is preserved.

Material and Location:- One partially preserved phragmocone UTGD121187 The specimen was collected from approximately 200 metres along Sunshine Road above the base of the Karmberg Limestone near Maydena. The age is Whiterock.

UTGD55562. The phragmocone is a slowly expanding orthoconic longicone, with a circular cross-section. There are four segments in a length of 10mm. The siphuncle is slightly to the venter of the centre of the phragmocone. The siphuncle is slightly expanded, with the point of maximum expansion at the centre of the segment. The septa are gently curved.

The siphonal formula of the most apical segment is 4.1/0.7/5.2: 3.8/1.2/5.0; 2.4. The adoral segments are not preserved.

The connecting rings are not adnate to the septa.

The septal necks are suborthochoanitic, with the necks 0.15mm long, and the brims 0.05mm long ventrally, while dorsally the corresponding measurements are 0.15mm and 0.05mm.

There are no siphonal deposits preserved. The connecting rings are thin. There are no cameral deposits preserved.

The dorsal shell structure is preserved and consists of a thin inner layer, which is covered by the mural part of the septa, a thick

central layer of recrystallized calcite and a very thin outer layer of more finely crystallized calcite.

Material and Location:-   One partially preserved phragmocone UTGD55562. The specimen was collected from the Lower Limestone Member, Settlement Road.   State Grid. Ref., Sheet 8112; 545885.

Remarks:-   The unannulated phragmocone wall, the sub-orthochoanitic septal necks and the shape and position of the siphuncle of these specimens are very similar to *Mysterioceras australe*.   These specimens are not assigned to *M. australe* because the siphonal and cameral deposits are not well enough preserved, and this would be required for positive specific assignment.

Family   PROTEOCERATIDAE   Flower, 1962a

Genus   .EPHIPPIORTHOCERAS   Foerste, 1925

Ephippiorthoceras decorum   Teichert and Glenister, 1953

As the description and illustration of this species in Teichert and Glenister (1953) are considered adequate, the species is not redescribed or refigured.

Remarks:-   Teichert and Glenister (1953) assigned the Tasmanian species to *Ephippiorthoceras* on the basis of the suture, compressed phragmocone and the external shape of the siphuncle.   Verification of this assignment awaits more detailed knowledge of the siphonal deposits of the type species.

Genus   GORBYOCERAS   Shimizu and Obata, 1935

Gorbyoceras settlementense   n.sp.

Plate 23   fig.1 - 3, 5, 6 ; Fig. 4.5(6).

The phragmocone is a slowly expanding annulated, orthoconic,

longicone, with a circular cross-section. The siphuncle is one-seventh the diameter of the phragmocone. There are 21 segments in a length of 100mm. The siphuncle is midway between the centre and the venter. The siphuncle is expanded, with the ventral wall of the siphuncle more expanded than those on the dorsal side. The annulations are strongly developed and slope apically from the venter to the dorsum. The annulations are rounded and are 6.0mm long and 2.0mm high at the adoral end of the holotype. The septa are gently curved, with the point of maximum depth at the centre of the phragmocone.

The siphonal formula at the adoral end of the specimen (excluding the height of the annulations) is 5.4/2.2/9.7:5.1/3.1/9.1; 4.6.

The connecting rings are not adnate to the septa.

The septal necks are cyrtochoanitic but the brims are very short (0.15mm). The septal necks are 0.5mm long both dorsally and ventrally.

There are no deposits within the siphuncle. The holotype siphuncle is full of, probably, inorganic calcite.

The connecting rings are thin.

There is calcite in the camerae, but it is erratic in distribution and may be inorganic. If it is organic, the deposits would appear to be mural or episeptal deposits.

Material and Location:- Four phragmocones, holotype UTGD121188, and paratype UTGD121189,121190 , and121191. The specimens were collected from the upper Cashions Creek Limestone and Lower Limestone Member of the Benjamin Limestone at both Westfield and Settlement Road in the Florentine Valley. The age is Blackriver-Early Trenton.

Remarks:- The annulated orthocones are difficult taxonomically as many of the genera are only poorly known. Genera such as *Tofangoceras*,

Monomuchites and (before Flower's (1946) redescription of the type species) *Gorbyoceras*. The material under study was assigned to *Gorbyoceras* as it has prominent annulation and longitudinal lirae, and an expanded siphuncle. *Gorbyoceras settlementense* differs from most described species (at least those sagittally sectioned) in having a markedly eccentric siphuncle. *Gorbyoceras settlementense* most closely resembles *G. duncanae* (Flower, 1946) in having an eccentric siphuncle which is expanded more on the venter than the dorsum. *Grobyoceras settlementense* differs from *G. dunanae* in having a smaller, slightly less expanded siphuncle and the septal necks are not as cyrtochoanitic.

If a detailed revision of the annulated orthocones was undertaken the current scope of many genera would probably change. Until this is done the majority cannot be reliably used.

Gorbyoceras settlementense ?

Plate 23   fia. 4, 7 - 12 .

In many sections in Tasmania annulated orthocones with expanded siphuncles have been found. The majority of specimens are poorly preserved, but some material collected is assignable to *Gorbyoceras settlementense?*. These specimens in some cases will be illustrated on plate 23 , but descriptions are not given as the specimens are either poorly preserved or very close to *G. settlementense*. The annulated orthocones under this heading will be discussed by locality.

<u>Ida Bay</u>:   UTGD20856, 25066 and 25068.   The specimens from Ida Bay are almost certainly conspecific with the Florentine Valley material, but until more material can be collected the assignment cannot be definitely shown.

<u>Mole Creek</u>:   UTGD121192, and 121193. This is the only other locality which contains any number of specimens, but they are poorly preserved.

The phragmocone is destroyed by stylolitization in many specimens and the siphuncle may be more centrally positioned. The Mole Creek material also will probably be shown to be conspecific with the Florentine Valley material.

Bubs Hill: UTGD80896. Only the one specimen of an annulated ortho-cone with expanded siphuncular segments is known from Bubs Hill. It has the external aspect of *G. settlementense*, but the siphuncle is slightly larger and more expanded and with more material will probably prove to be a new species of *Gorbyoceras*.

Queenstown: At the Smelter's Quarry, Queenstown, a poorly preserved annulated orthocone has been found. It has been only doubtfully assigned to *Gorbyoceras* sp. as the siphuncle is not clearly preserved and an assignment to *Anaspyroceras* could not be ruled out.

Genus   GORDONOCERAS   Teichert and Glenister, 1953

The specimen collected in this study suggests that the lines of the generic description "... situated half way between the centre of the conch and the convex shell wall" should be changed to "...situated half way between the centre of the conch and the dorsum".

Gordonoceras bondi   Teichert and Glenister, 1953
Plate 24   fig. 1 - 11 ; Fig. 4.5(1).

The phragmocone is a gently cyrtoconic, longicone which is circu-lar in cross-section, and expands slowly. The siphuncle is one-fifth of the diameter of the phragmocone. The siphuncle is midway between the centre and the dorsum. The siphuncle has 21 segments in a length of 48mm. The ventral wall of the siphuncle is evenly expanded. The dorsal wall expands rapidly apical of the septal foramen then tapers

more slowly to the next septal foramen. The siphuncular segments slope
adorally from the venter to the dorsum. The septa are shallowly curved
with the point of maximum depth at the centre of the phragmocone.

The siphonal formula at the apical end of the specimen is
3.8/0.8/1.9:3.5/1.5/1.5; 1.8, at the adoral end it is 5.8/1.0/2.6:
5.3/2.0/2.1; 2.5.

The connecting rings are not adnate to the septa.

The septal necks are cyrtochoanitic with short brims.

The siphonal deposits orginate at the apical side of the septal
foramen then grow adorally along the connecting ring. The deposits
are thicker in the expanded part of the segment. When the deposit
reaches the next adoral deposit it continues to grow over it, forming
a continuous lining. The siphonal deposits develop simultaneously on
the venter and dorsum, but the ventral deposits then develop more
quickly.

The connecting rings are thin.

The cameral deposits are extensive, but have been recrystallized.

Material and Location:- Three phragomocones UTGD121194,121195 , and
121196.   The specimens were collected from 280 metres above the base
of the Upper Limestone Member of the Benjamin Limestone at Westfield
in the Florentine Valley (locality c on fig (3.6)). The age is Eden.

Remarks:- Teichert and Glenister (1953) established the species on
material from an unknown locality in the Gordon River. In the present
study conspecific material has been collected from the Florentine
Valley. The specimens from the Florentine Valley have been described
to supplement those descriptions given in Teichert and Glenister (1953).

Teichert and Glenister (1953, p.40) stated that "In the absence

of more reliable information, the concentration of the cameral deposits on the concave side seems to suggest endogastric curvature". Unfortunately they labelled the convex side of the phragmocones as the venter in the explanation to Plate 4, fig. 2, thus contradicting the above statement. Flower (1962a,p33) continued this confusion by stating of *Gordonoceras* that it was "Gently exogastric, slender..., siphuncle between the centre and venter...". In the Florentine Valley material the siphonal deposits are concentrated on the concave side of the siphuncle and it is suggested that this is the venter and that *Gordonoceras* is unusual in having a dorsal siphuncle.

Family   PSEUDORTHOCERATIDAE   Flower and Carter, 1935

Sub-family   CAYUTOCERATINAE   Flower, 1939b

Flower (1962a, p.33) considered that *Stromatoceras* belonged to the Proteoceratidae and that it was homeomorphic with genera assigned to the Pseudorthoceratidae. Following the description of *Eostromatoceras* Chen (1976) and *Fitzgeraldoceras* details of the siphuncular deposits are better known. These deposits are of two different types and are typical of those in the Cayutoceratinae, but not of the Proteoceratidae and it is considered that homeomorphy cannot be reasonably demonstrated.

Genus   STROMATOCERAS   Teichert and Glenister, 1953

Stromatoceras eximium   Teichert and Glenister, 1953

The species is not redescribed or illustrated as no new material was collected, and the treatment by Teichert and Glenister (1953) is considered adequate.

Remarks:- For a discussion of *Stromatoceras* and comparison with other

genera see the remarks under *Fitzgeraldoceras*.

Genus   FITZGERALDOCERAS   n.gen.

Genotype   *Fitzgeraldoceras juneense*,   n.gen., n.sp.

The phragmocone is a slowly expanding slightly cyrtoconic, longicone. The siphuncle is moderate in size and slightly on ventral of centre. The siphuncular segments are expanded, the maximum height being reached in the adoral third of the segment. The septal necks are cyrtochoanitic and the necks and brims are short and of equal length. There are two types of siphuncular deposits, 1. parietal deposits growing adorally from the septal foramen along the connecting ring, and 2. a continuous deposit consisting of joined parietal deposits, which form equally apically and adorally of the septal foramen. Cameral deposits are well developed ventrally with both episeptal and hyposeptal deposits present and nearly filling the camerae; dorsally only episeptal deposits are developed on the adoral side of the septa, forming first near the dorsal phragmocone wall. The connecting rings are thin.

Remarks:- *Fitzgeraldoceras* has affinities with a number of genera including *Stromatoceras*, *Eostromatoceras* and *Metastromatoceras*. *Fitzgeraldoceras* is most like *Metastromatoceras* in size and position of the siphuncle but is cyrtochoanitic and has two distinct layers of siphonal deposits. In *Stromatoceras* the siphuncle is closer to the venter, smaller and has more extensively developed siphonal deposits on both the venter and dorsum. *Eostromatoceras* has a much larger, subventral siphuncle and more extensively developed siphonal deposits. An unusual feature of *Fitzgeraldoceras* is the strong development of the cameral deposits on the venter while dorsally deposits only grow

on the free part of the septum near the dorsal phragmocone wall. This same feature may be present in *Metastromatoceras*, but it is difficult to determine from the published illustrations.

Fitzgeraldoceras juneense n.sp.

Plate 25   fig. 1 - 8 ; Fig. 4.5(5).

In both the specimens only the phragmocone is preserved. It is an exogastric cyrtoconic longicone, subcircular in cross-section. The phragmocone wall of the holotype has been destroyed by stylolitization. The holotype is 59mm long and contains 21 camerae. The siphuncle is small, approximately one-fifth of the diameter of the phragmocone, expanded, and slightly ventrad of centre. The septa are thin, evenly curved with the siphuncle at the point of maximum depth.

The siphuncular segments reach their point of maximum expansion at one-third of the segment length apically from the septal foramen. The siphuncle at the adoral-most segment is 4mm long, 1.3mm high at the foramen and 2.8mm high at the point of maximum expansion, which is 1.1mm from the adoral foramen. The corresponding measurements at the most apical segment are 2.5mm, 0.7mm, 1.8mm and 0.9mm. The connecting rings are not adnate to the septa. The septal necks are cyrtochoanitic. The necks and brims are of similar length. Adorally the neck is 0.2mm, while the brim is 0.2mm on the venter and dorsally the neck is 0.2mm, while the brim is 0.2mm. The corresponding measurements apically are 0.2mm, 0.1mm, 0.2mm, and 0.2mm.

The siphonal deposits consist of two types: 1. parietal deposits growing mainly adorally from the septal foramen along the connecting ring; 2. a continuous deposit developed only on the venter. This continuous deposit was formed when the second generation of parietal

deposits grew equally apically and adorally from the foramen until they joined.

The connecting rings are thin and homogeneous. Ventrally both episeptal and hyposeptal deposits are developed extensively, nearly filling the camerae; dorsally only episeptal deposits occur. The dorsal episeptal deposits first appear at the dorsal end of the free part of the septum then grow down towards the siphuncle.

Location and Material:-   Two phragmocones: Holotype UTGD55529, paratype UTGD21962. The specimens were collected from the Fitzgerald Quarry near Maydena; probably Karmberg Limestone, Whiterock(?).

Remarks:-   See remarks under genus.

Family   STRIATOCERATIDAE   Flower, 1939a

Teichert (1964c)considered this family as a junior synonym of the Greenlandoceratidae and he transferred it to the Discosorida. The siphuncular deposits are parietal deposits typical of the Michelino-ceratida and therefore the family is considered to belong to that Order. In Shimizu and Obata (1935) *Striatoceras* has page priority over *Greenlandoceras* and as these genera are considered homonyms (Flower, 1962a;Teichert, 1964c)the genus *Greenlandoceras* is now considered as a junior homonym of *Striatoceras*. Article 39 of the International Code of Zoological Nomenclature (1964) states that if a family's nominal type genus is a junior homonym then the family group is invalid, therefore Greenlandoceratidae is invalid. Flower (1939a)established Striatoceratidae to contain *Stratoceras* and this must now be considered the valid family name.

Genus   STANDARDOCERAS   n.gen.

Genotype:-*Standardoceras burretti* n.sp.

Derivation of Name:- The specimens were collected from Standard Hill at Mole Creek.

The phragmocone is a slowly expanding orthoconic, longicone, subcircular in cross-section. The siphuncle is one-fifth the size of the phragmocone and near the phragmocone's ventral wall, but not in contact. The siphuncular segments are expanded and slope apically from the venter to the dorsum. The septal necks are cyrtochoanitic and the necks and brims are short with the necks being nearly twice the length of the brims. The connecting rings are not adnate to the septa on the dorsum, but the apical part of the connecting ring is adnate to the adoral face of the septum for some distance on the venter. The siphuncular deposits are parietal deposits which develop to a similar extent on both the venter and the dorsum. These deposits grow adorally from the septal foramen along the connecting ring until they meet the apical end of the next deposit, thus forming a continuous lining in the siphuncle.

The connecting rings are thin.

Cameral deposits are present. The recrystallization of the material filling the camerae make it difficult to be certain, but both episeptal and hyposeptal deposits are developed to equal extent in the dorsal camerae.

Remarks:- *Standardoceras* belongs to the Striatoceratidae, as the siphuncular segments are expanded, with the slope of the segments apicad from the venter to the dorsum and parietal deposits form in the septal foramen and grow adorally along the connecting ring. *Standardoceras* differs

from *Striatoceras* in lacking the strongly striated shell (although the
shell may have fine striations, as only transverse sections are available).
the siphuncle is also smaller relative to the phragmocone and the slope
of the siphuncular segment from the venter to the dorsum is greater.

Standardoceras burretti

Plate 26   fig. 1 - 10 ; Fig. 4.5(2).

The phragmocone is a slowly expanding orthoconic, longicone, which
is sub-circular in cross-section. The venter is slightly flattened.
There are ten siphuncular segments in a distance of 45mm. The siphuncle
is highly and evenly expanded. The siphuncular segments slope apically
from the venter to the dorsum at an angle of 70 degrees to the siphun-
cular axis. The septa are moderately curved with the point of maximum
depth at the centre of the phragmocone, the radius of curvature of the
septa is 21mm.

The siphonal formula is 4.5+/2.3/16.4:2.7+/4.9/15.6; 4.5 apically,
while adorally it is 2.3+/2.5/18.8:1.8+/5.2/17.4; 4.5.

Dorsally the connecting rings are not adnate to the septa.
Ventrally only the apical surface of the connecting ring is adnate to
the adoral surface of the septa for a distance of 1.0mm.

The septal necks are cyrtochoanitic and the necks and brims are
short. Dorsally the necks are 0.6mm and the brims are 0.3mm long,
while ventrally the corresponding measurements are 0.5mm and 0.3mm.

The siphonal deposits are well-developed and are parietal. They
initially grow in the septal foramen then adorally along the connecting
ring until they meet the apical end of the next deposit, then they fuse
to form a continuous lining. The deposits may grow to completely fill
the siphuncle, but the apical portion of holotype has not been preserved.

The deposits have been largely recrystallized, but some of the original fine laminar structure is still preserved. These fine lamellae are parallel to the siphonal surface of the connecting ring.

The connecting rings are thin (0.1mm) and appear to be homogeneous.

There are cameral deposits present, but the recrystallization makes it difficult to determine their exact extent. In the dorsal camerae both episeptal and hyposeptal deposits are formed and they are formed to a similar extent. On the ventral not enough of the camerae has been preserved for the extent of the deposits to be determined.

The shell wall is preserved but has been coarsely recrystallized so that the structure can no longer be seen; it is 0.3mm thick.

Material and Location:- Two partially preserved phramogocones, holotype UTGD91053 and paratype UTGD 121197 . The specimens were collected from the lower part of the Standard Hill Member of the Chudleigh Limestone at Standard Hill near Mole Creek. The age of the Limestone is Chazy.

Derivation of Name:- For Dr. C.F. Burrett who collected the specimen.

Remarks:- See generic remarks .

MICHELINOCERATIDA   gen.,sp. indet. A

Plate 26   fig. 1 - 2 .

The phragomocone wall has been destroyed on the only specimen available, so the size, curvature and relative morphology cannot be determined.

The siphuncle is slightly expanded. There are eight siphuncular

segments in a distance of 30mm. The septa are only moderately curved. The siphuncular segments measure 2.0mm at the septal foramen, 2.9mm at the expanded part of the segment and are 3.4mm long.

The septal necks are orthochoanitic and are 0.3mm long.

The connecting rings are thin.

There are no definite siphuncular deposits. The camerae contain calcite, but its irregular distribution suggests that it is inorganic in origin.

Material and Location:- One partially preserved phragmocone, UTGD81148. The specimen was found in the Cashions Creek Limestone, along Eight Road West in the Florentine Valley.

Remarks:- Although this specimen is morphologically similar to both *Mysterioceras* and *Gorbyoceras*, the lack of preservation of the phragmocone wall and the siphonal deposits makes assignment to one of these genera impossible. As only the morphology of the siphuncle is known it cannot be adequately compared with any other Michelinocerid known from Tasmania or elsewhere.

MICHELINOCERATIDA   gen.,sp. indet. B.

Plate 26   fig. 3 - 8 .

The phragmocone is a slowly expanding orthoconic longicone, with a sub-circular cross-section. There are five segments in a length of 14mm. The siphuncle is slightly expanded, with the point of maximum expansion at the centre of the segment. The siphuncular segment slopes apically from the venter to the dorsum. The septa are gently curved, with the point of maximum depth at the dorsal wall of the siphuncle.

The siphonal formula for the second segment from the apical end of the specimen is 4.0/1.6/6.5:3.6/2.4/6.2; 2.9.

The connecting rings are not adnate to the septa.

The septal necks are orthochoanitic, 2.0mm long ventrally, and 2.0mm long dorsally.

The siphuncle contains recrystallized calcite, but this may be of inorganic origin as it is not consistent between segments.

The connecting rings are thin.

The cameral deposits have been recrystallized, but in the dorsal camerae episeptal deposits are well developed. Hyposeptal deposits do not, however, appear to have been formed.

Material and Location:- One partially preserved phragmocone UTGD20739. The specimen was collected from the Gordon Limestone, Railton. Exact locality unknown, but probably near Goliath Quarry.

Remarks:- The lack of preservation of the siphonal deposits and of most of the cameral deposits makes assignment of this specimen difficult. Of the genera known from Tasmania it is most like *Mysterioceras*, but the siphuncle is much shorter relative to its width than is typical of that genus. Until more and better material is collected this specimen is not assigned to a genus or species.

Fig. (4.5) :

1. *Gordonoceras bondi* : a cross-section showing
   the position and relative size of the siphuncle.

2. *Standardoceras burretti* n.gen.,n.sp. : a cross-
   section showing the position and the relative
   size of the siphuncle.

3. *Orthoceras* sp. : a cross-section showing the
   position and relative size of the siphuncle.

4. *Mysterioceras australe* : a cross-section of
   the holotype showing the position and relative
   size of the siphuncle. A schematic longitudinal
   section showing the siphonal and cameral deposits;
   apex right, venter below, X5.

5. *Fitzgeraldoceras juneense* n.gen.,n.sp. : a cross-
   section of the holotype showing the position
   and the relative size of the siphuncle. A schematic
   longitudinal section of the cameral and siphonal
   deposits; apex left, venter below, X4.

6. *Gorbyoceras settlementense* n.sp. : a cross-
   section showing the position and the relative
   size of the siphuncle. A schematic longitudinal
   section showing the annulated phragmocone and
   the shape of the siphuncle; apex right, venter
   below, X3.

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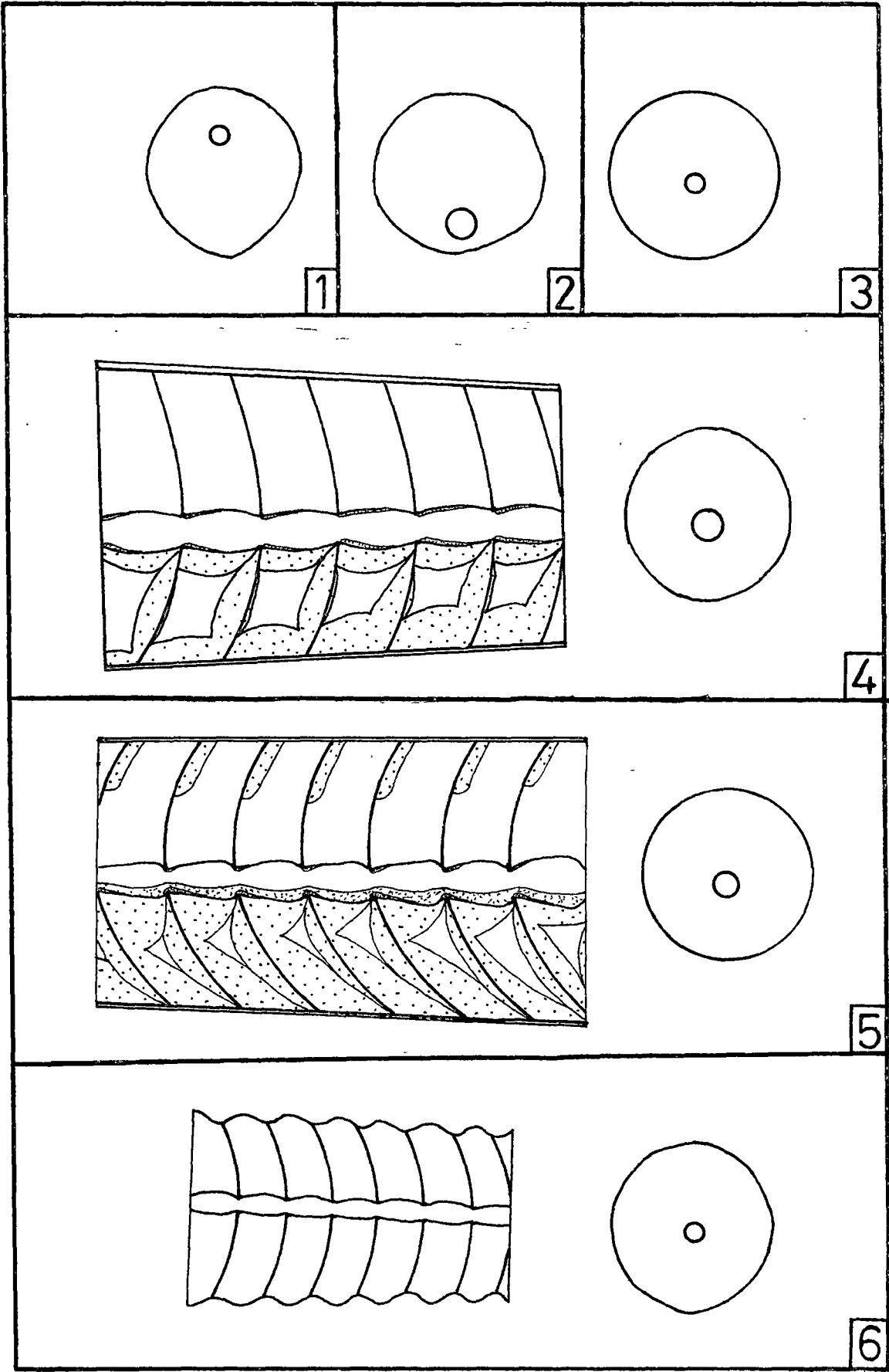
PLATE 21.

Sinoceras? sp.; *Orthoceras* sp.

Figs. 1-8: *Sinoceras?* sp. UTGD 121183, 121184,
121185 and 121186;

1. A thin section of a sagittal section of
UTGD 121183, apex left, X 3.

2. An enlargement of the siphuncle, X 10.

3. A transverse section of UTGD 121184, X 5.

4. An enlargement of the septal necks in
UTGD 121183, X 20.

5. The siphuncle in UTGD 121185, showing the
tubular siphuncle, apex left, X 5.

6. An enlargement of the septal foramen and
connecting ring, X 12.

7. a siphuncle of UTGD121184, showing the septal
necks, X 7.

8. A sagittal section of UTGD 121186, showing
broken septa and an unbroken septum towards the
apex of the specimens, apex right, X 1.5.

Figs. 9-11: *Orthoceras* sp. UTGD 121182;

9. A close up of the dorsal side of the siphuncle
showing the septal neck, X20.

10. A sagittal thin section of UTGD 121182, apex
right, X1.5.

11. a transverse section of the phragmocone, X3.

12. An enlargement of the ventral wall of the
siphuncle, X20.

13. A close up of the siphuncle showing the
slightly expanded siphuncular segments, X9.

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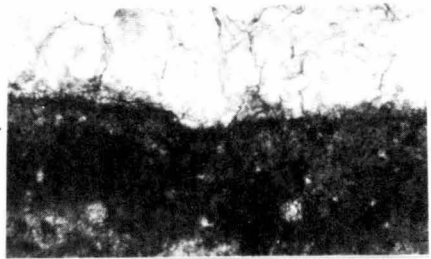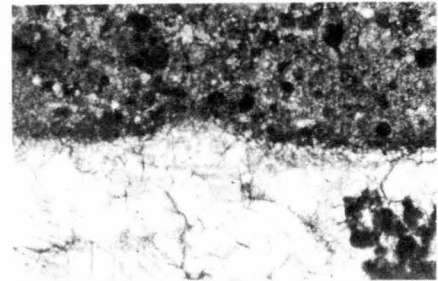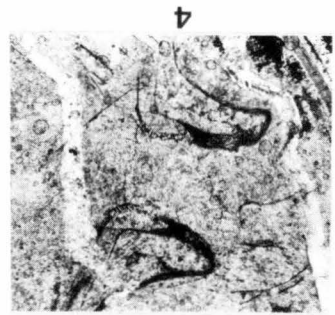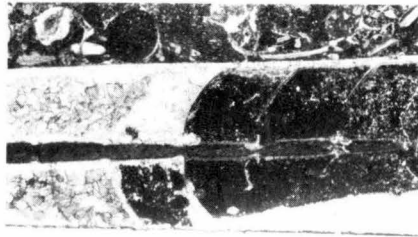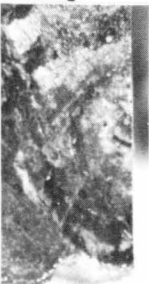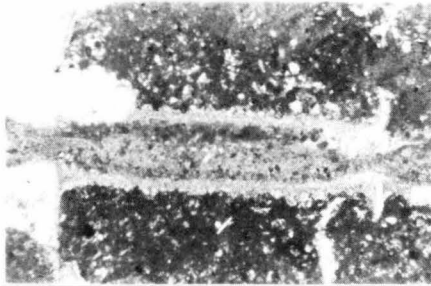
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PLATE 22.

Mysterioceras australe; Mysterioceras australe?

Figs. 1-7: *Mysterioceras australe*, UTGD 208836
            (paratype);

1. A sagittal thin section of the paratype, apex
    right, X5.

2. An enlargement of a siphuncular segment at the
    apical end of the specimen, note the siphonal
    deposits, X12.

3. The ventral camerae showing the cameral deposits,
    X6.

4. An enlargement of the siphuncular segment adoral
    of those in 2 also showing the siphonal deposits,
    X8.

5. A close up of the dorsal side of the siphuncle at
    the septal foramen, X20.

6. An enlargement of the wall of the phragmocone, X8.

7. An enlargement of the ventral side of the siphuncle,
    X20.

Figs. 8-11: *Mysterioceras australe?* UTGD 55562;

8. A sagittal thin section, apex left, X2.

9. An enlargement of the siphuncle in an opaque
    section, X8.

10. A close up of the siphuncle in thin section
    showing the septal necks, X20.

11. An enlargement of the wall of the phragmocone,
    X10.

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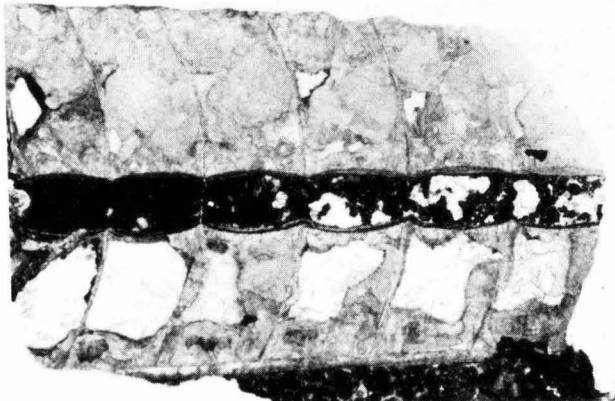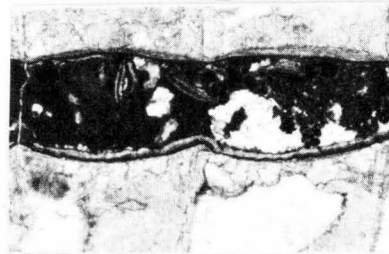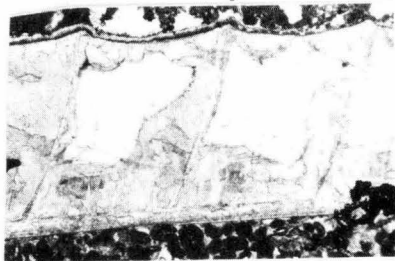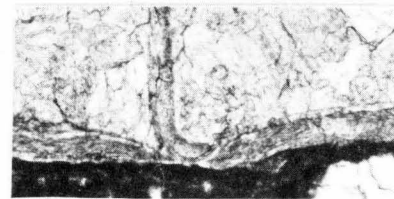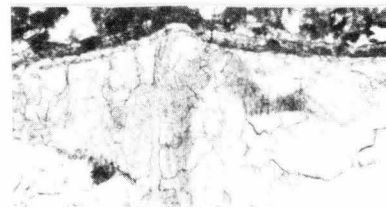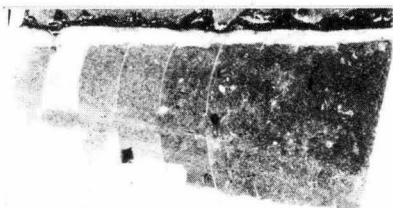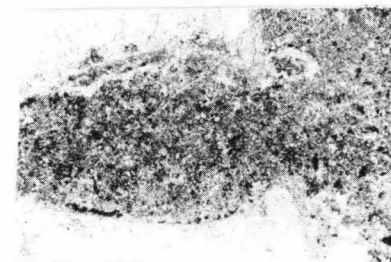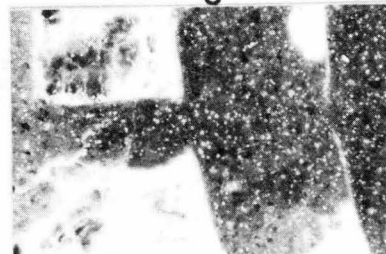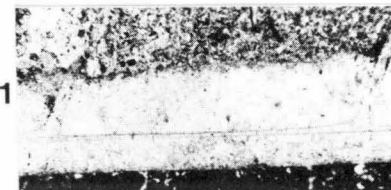
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PLATE   23.

Gorbyoceras settlementense n. sp.;
Gorbyoceras settlementense?

Fgis. 1-3, 4, 6:   Gorbyoceras settlementense n.sp.,
                   holotype UTGD 121188, paratype
                   UTGD 121190;

1.   A sagittal section of the holotype, apex right, X3.
2.   An enlargement of the siphuncle in the holotype, X10.
3.   A transverse section of the holotype, X4.
5.   A sagittal section of the paratype UTGD 121190,
      apex right, X2.5.
6.   An enlargement of the siphuncle in the paratype, X20.

Fig. 4:   Gorbyoceras settlementense?, Mole Creek,
          UTGD 121192;

4.   A sagittal section of UTGD 121192, apex right, X3.

Figs, 7-9, 11:   Gorbyoceras settlementense?, Ida Bay,
                 UTGD 25066, 29856;

7.   A sagittal section of UTGD 20856, apex right, X2.
8.   An enlargement of the septal foramen on the dorsal
      side of the siphuncle, X20.
9.   A close up of the ventral septal neck, X20.
11.   A sagittal section of UTGD 25066, apex left, X2.

Figs. 10,12:   Gorbyoceras settlementense?, Bubs Hill,
               UTGD 80896;

10.   A naturally weathered transverse section of
      UTGD 80896, X2.

12.   A close up of the siphuncle, apex left, X10.

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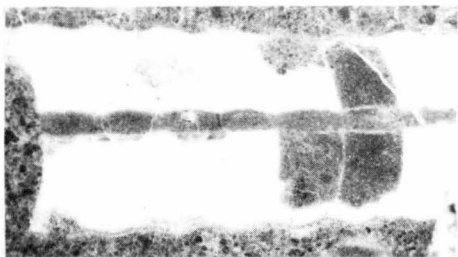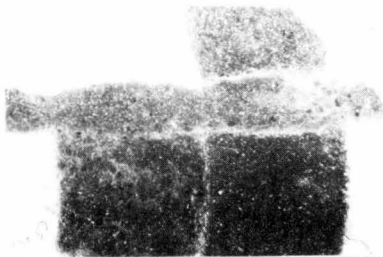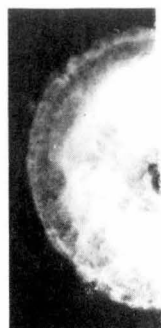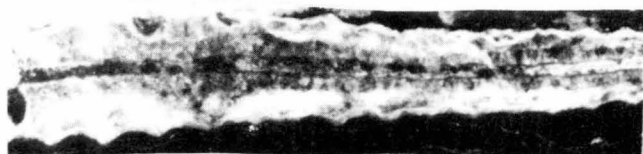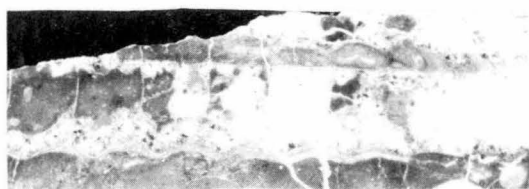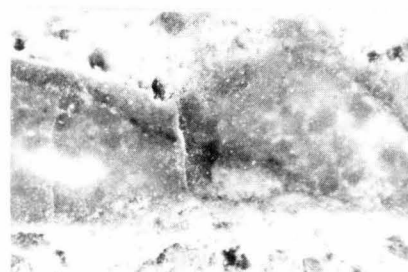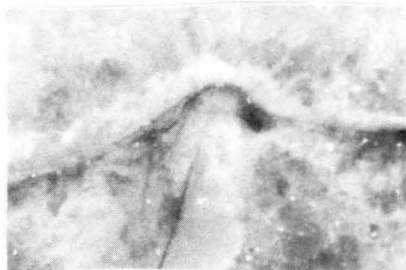
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PLATE 24.

Gordonoceras bondi.

Figs. 1-11: *Gordonoceras bondi,* UTGD 121194, 121195,
121196 and 121205;

1.   A sagittal section of UTGD 121194, note the siphuncle
      is to the dorsal side of centre, apex left, X3.

2.   A transverse section of the same specimen, X3.5.

3.   A close up of the siphuncle, showing the siphonal
      deposits, X8.

4.   An enlargement of the dorsal side of the siphuncle,
      X22.

5.   A close up of the ventral side of the siphuncle, X22.

6.   A sagittal section of UTGD 121195, apex right, X3.

7.   A close up of the siphuncle, X11.

8.   An enlargement of the ventral side of the siphuncle,
      X20.

9.   An enlargement of the dorsal side of the siphuncle,
      X20.

10.   An enlargement of the dorsal septal neck in
      UTGD 121195, X20.

11.   A naturally weathered section of UTGD 121205,
      apex right, X2.

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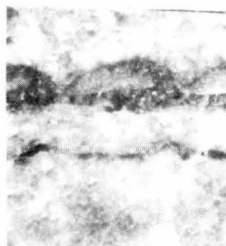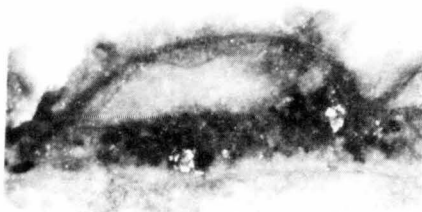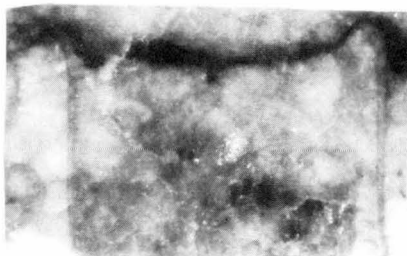
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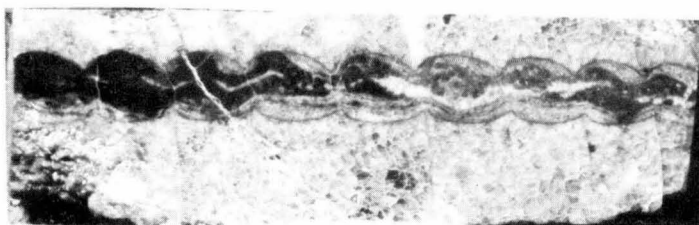
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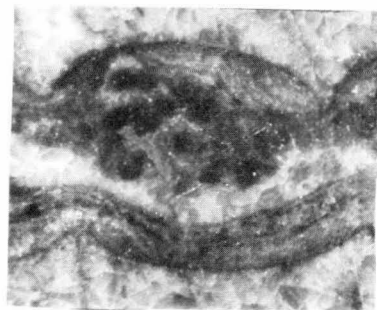
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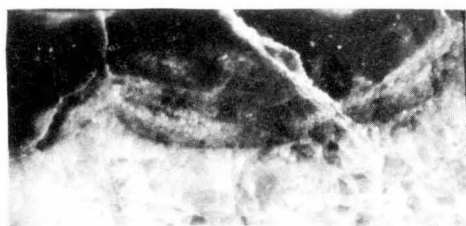
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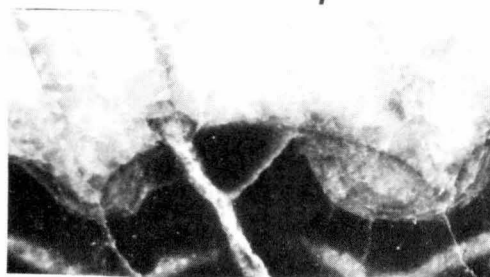
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PLATE 25.

Fitzgeraldoceras juneense, n.gen.,n.sp.

Figs. 1-8: *Fitzgeraldoceras juneense,* n.gen.,n.sp.
holotype UTGD 55529, paratype UTGD 21962;

1. A sagittal thin section of the holotype, apex left,
X3.

2. An enlargement of the siphuncle, X10.

3. A sagittal opaque section of the holotype, apex
right, X6.

4. A close up of the ventral camerae showing the
cameral deposits, X6.

5. An enlargement of the ventral side of the siphuncle,
showing the two different siphonal deposits, X12.

6. A thin section of a slightly off centre sagittal
section of UTGD 21962, X20.

7. An opaque sagittal section of the paratype UTGD 21962,
apex right, X4.

8. An enlargement of the siphuncle in the paratype, X12.
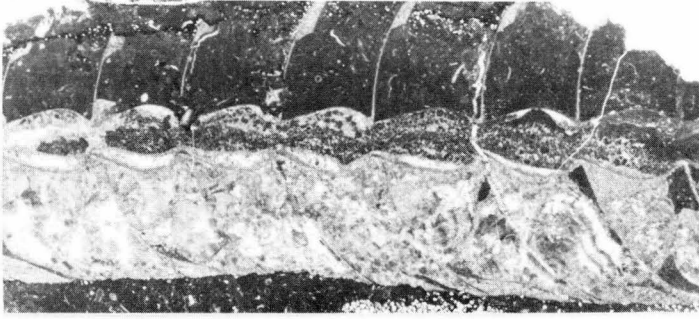
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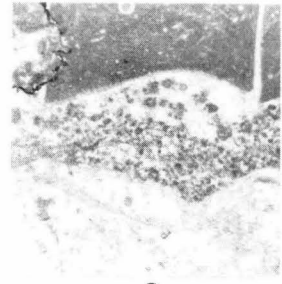
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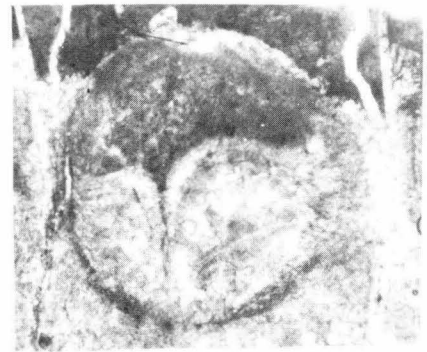
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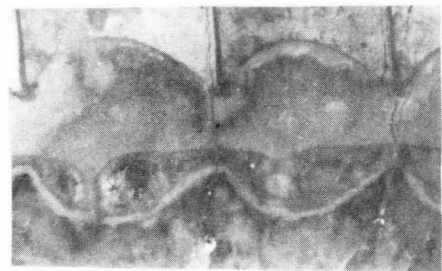
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PLATE 26.

Standardoceras burretti n.gen.,n.sp.

Figs. 1-10: *Standardoceras burretti*, n.gen.,n.sp.,
holotype UTGD 91053, paratype UTGD 121194;

1.   A sagittal thin section of the holotype, apex left,
X1.5.

2.   A close up of the siphuncle X4.

3.   An enlargement of the ventral septal foramen, X24.

4.   An enlargement of the dorsal septal foramen, X25.

5.   A more apical segment of the holotype, apex left,
X6.

6.   An enlargement of the dorsal septal foramen, note
the join between two siphonal deposits, X25.

7.   An enlargement of the ventral septal foramen in the
apical segment , X25.

8.   An enlargement of the point of contact between two
different siphonal deposits, X25.

9.   The siphuncle of the paratype UTGD 121194;
The siphonal deposits have been highly recrystallised,
apex right, X3.

10.   An enlargement of the dorsal wall of the siphuncle, X8.

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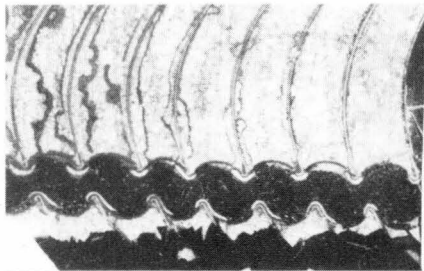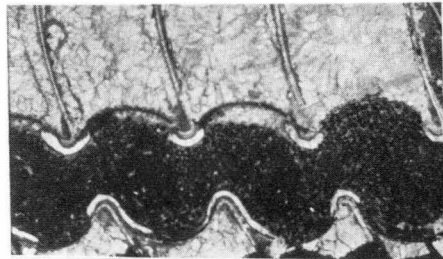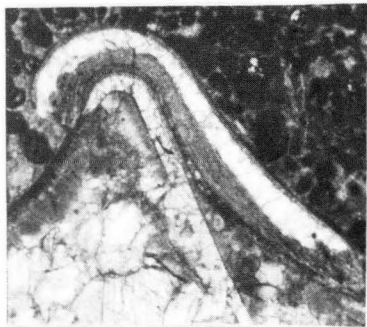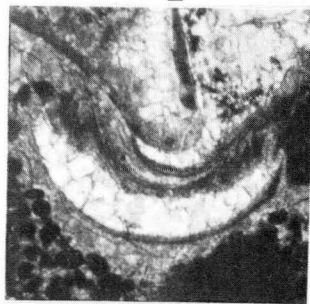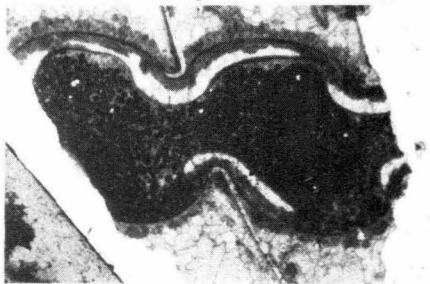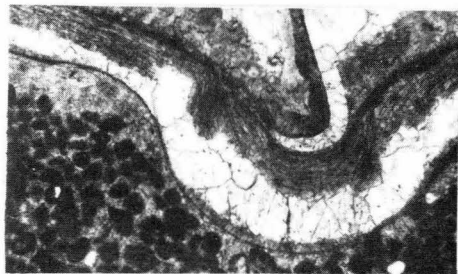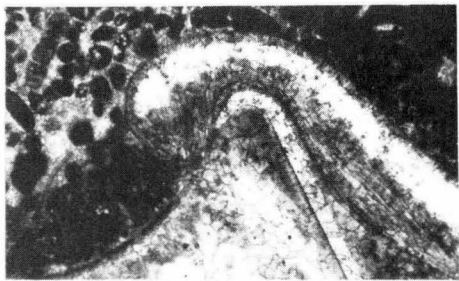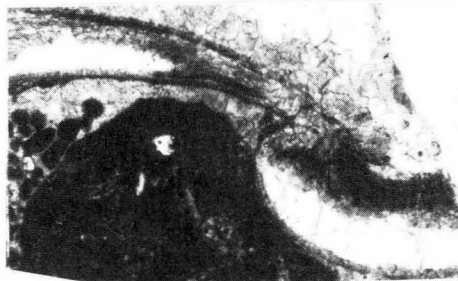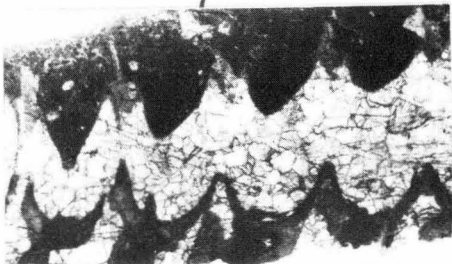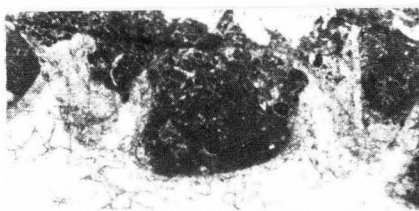
PLATE 27.

Michelinoceratida gen., sp. indet A, B;
Mysterioceras australe?

Figs. 1-2: Michelinoceratida gen., sp.indet A, UTGD 81148;

1. A sagittal section of UTGD 81148, apex left, X2.

2. An enlargement of the siphuncle, X7.

Figs. 3-8: Michelinoceratida gen., sp. indet. B,
UTGD 20739;

3. A sagittal slight off centre thin section of
UTGD 20739, apex left, X2.5.

4. An enlargement of the siphuncle in an opaque section,
X10.

5. A transverse section of UTGD 20739, X2.5.

6. A close up of the siphuncle at the apical end
of the thin section, X10.

7. The septal foramen showing the septal neck, X20.

8. A sagittal opaque section, apex right, X1.5.

Figs. 9-13: *Mysterioceras australe?* UTGD 121187;

9. A sagittal opaque section of UTGD 121187, apex left,
X1.5.

10. A thin section of the same specimen, apex left, X1.5.

11. An enlargement of the siphuncle in the opaque
section, X10.

12. A close up of the ventral camerae and the siphuncle,
X4.

13. An enlargement of the dorsal septal foramen showing
the septal necks, X20.

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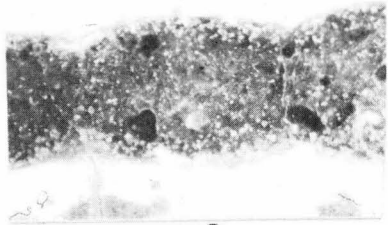
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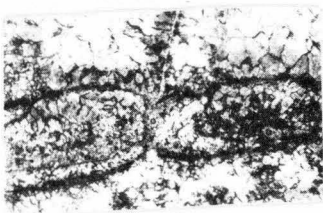
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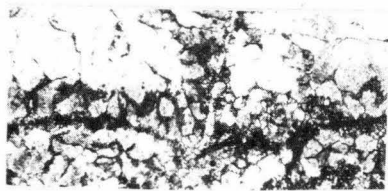
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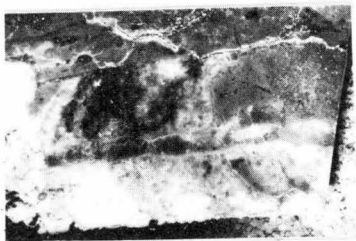
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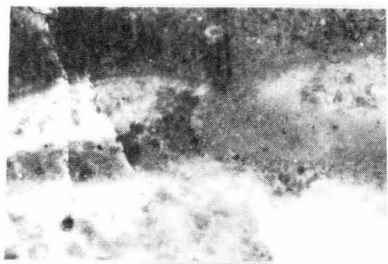
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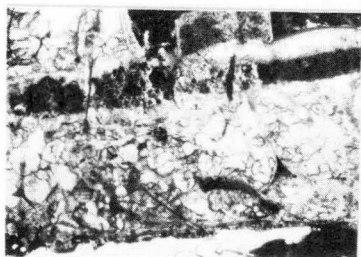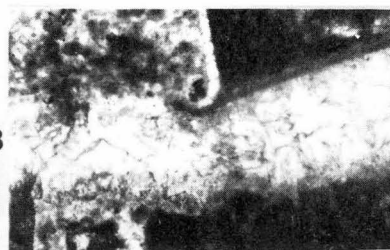
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Order   ONCOCERATIDA

Family   ONCOCERATIDAE   Hyatt,   1884

Genus   BELOITOCERAS   Foerste, 1924

Flower (1946, p.307) suggested that *Oncoceras* and *Beloitoceras* were probably not natural species groups. Flower considered that not enough information was available at the time to enable a revision of these genera. Since 1946 this situation has not changed, and therefore the two genera are still considered as separate. The lack of information on the internal structure of many of the species of these two genera is still a problem and does not allow comparison of the Tasmanian species with many of the previously described species.

The Tasmanian material assignable to this family belongs to either *Beloitoceras* or *Miamoceras*, as they are currently defined. Assignment to a genus is difficult as the diagnostic features are found in the body chambers of these genera, and no body chambers have been collected in Tasmania. Assignment to either *Beloitoceras* or *Miamoceras* is made mainly on the shape of the siphuncle, which is slightly different in the holotypes of the two genera. These assignments may be proven incorrect when the vital information on the body chambers becomes available.

Beloitoceras kirtoni   Teichert and Glenister (1953)
Plate 28   fig. 6 - 8 ; Fig. 4.6(3).

Genotype:- *Beloitoceras kirtoni*, Smelter's Quarry, Queenstown.

Other localities:- Smelter's Quarry, Zeehan.
The description given in Teichert and Glenister (1953) is not emended.

Remarks:- *Beloitoceras kirtoni*, Teichert and Glenister (1953), is

similar to other species of *Beloitoceras* in the position and morphology of the siphuncle, but *Beloitoceras* is typically highly curved. The Tasmanian species is only slightly curved and this may indicate that it does not belong to *Beloitoceras*. The distinctive features of *Beloitoceras* are on the body chamber and as no body chambers have been found in Tasmania the species is left assigned to *Beloitoceras*.

Beloitoceras(?) *molense*   n.sp.
Plate 29   fig.1 - 11 ; Fig. 4.6(2).

No body chambers are preserved. The phragmocone is an exogastric cyrtocone.   It is subcircular, with the dorsum slightly flattened. There are 15 siphuncular segments in a distance of 27mm. The siphuncle is close to the venter, but not in contact, it is one-tenth of the diameter of the phragmocone. The siphuncle is slightly expanded, with the point of maximum height central on the dorsum, while on the venter it is closer to the apical end of the segment. The septa are gently curved with the siphuncle to the venter of the point of maximum depth.

The siphonal formula is 0.6/0.3/7.6:0.4/0.8/7.3, 1.5 apically and 0.9/0.8/-:0.4/1.6/-, 2.2 at the most adoral segment.

Ventrally the adoral portion of the connecting ring is adnate to the septum for a short distance (0.1mm). On the dorsum the connecting ring is not adnate to the septum.

The septal necks are orthochoanitic and of equal length throughout the specimen, 0.4mm.

The siphuncle contains no siphuncular deposits. The connecting rings are thick, with the maximum thickness at the septal necks and

thinning slightly towards the centre of the segment.

The specimen contains recrystallized calcite in the camerae, but its nature and distribution would suggest that there were no cameral deposits.

In thin section details of the phragmocone wall structure has been preserved, it is discussed in detail on page 243. The phragmocone wall consists of three layers. 1. An inner layer, which may be the mural part of the septum. 2. The main thick layer which is divided into two parts by a dark zone which occurs approximately in the centre; and 3. an outer layer which consists of a number of overlapping sheets which project adorally and having their leading edges produce a ridge (or spines) on the exterior of the phragmocone. The third structure can only be seen in the thin section; on the external wall where there was no matrix this layer appears to have been destroyed, as examination of the surface with an S.E.M. did not show the structure.

Location and Material:- Only one phragmocone is known, the holotype UTGD94619. Specimen collected on the north side of the small hill (locality S on fig. (3.17)) near Mole Creek Limestone Quarry; Den Member. Age probably Eden-Maysville.

Remarks:- This species has been tentatively assigned to *Beloitoceras*, although there are many differences from the typical members of that genus, especially in the structure of the siphuncle. The shape of the phragmocone is atypical for *Beloitoceras*, but is within the range of species assigned to that genus. The small size is also unusual. It may belong to a new genus. The siphuncle of this species is less expanded and longer relative to its height than any species of *Beloitoceras* which has been sagitally sectioned.

Beloitoceras sp.

Plate 30   fig.1 - 3 .

No body chambers are preserved. The phragmocone is an exogastric cyrtocone. It is subcircular and compressed in cross-section. There are 8 segments in a distance of 40mm. The siphuncle is close to the venter, but not in contact, it is 1/12 the diameter of the phragmocone. The siphuncle is slightly expanded, with the point of maximum expansion at the centre of the segment. The septa are gently curved with the siphuncle ventrad of the point of maximum depth.

The siphonal formula is 2/1.5/35:1.8/2.3/34.4, 3.9 apically and 2.5/2/37:21/3.4/36, 5 at the most adoral segment.

The area of adnation cannot be clearly seen but it is probably short on the apical portion of the connecting ring with the adoral side of the septum. The septal necks also cannot be clearly seen but are most probably cyrtochoanitic. The siphuncle would appear to be empty.

There are no cameral deposits.

Material and Location: One naturally weathered phragmocone, UTGD121198 . The specimen was collected from the Lower Limestone Member of the Benjamin Limestone at the Eleven Road section in the Florentine Valley (locality A on fig. (3.8)). This is Blackriver in age.

Remarks: The preservation of the only known specimen means that comparison with other species of *Beloitoceras* is extremely difficult, thus no attempt to assign it to a species has been made. The size of the siphuncle and shape of the siphuncular segments distinguishes this specimen from the other Tasmanian species.

Genus   MIAMOCERAS   Flower 1946

Miamoceras bubsense   n.sp.

Plate 30   fig. 4 - 8 ; Fig. 4.6(4).

No body chambers are preserved. The phragmocone is an exogastric cyrtocone.   The rate of expansion of the phragmocone is moderate but variable, with the height increasing from 14.6mm to 21mm in 22mm on the holotype. The phragmocone is subcircular and compressed in cross-section.   There are 10 siphuncular segments in a length of 22mm. The siphuncle is close to the venter, but not in contact and is one-seventh the diameter of the phragmocone. The siphuncle is expanded with the point of maximum height being at the adoral end of the segment.   The septa are only gently curved, with the siphuncle ventrad of the point of maximum depth.

The siphonal formula for the holotype is 1.8/0.8/12:1.2/1.9/11.5, 2.0 apically and 2.9/1.3/15:2.3/2.9/14;   2.5 six segment adorally from the apical segment, the most adoral segment was not measured as the ventral shell wall has been destroyed.

On the venter the connecting ring is adnate to both the apical and adoral surface of the septum for 0.2mm.   On the dorsum the adoral connecting ring is adnate to the apical side of the septum for 2mm, but the apical end of the connecting ring is not adnate to the septum.

The septal necks are cyrtochoanitic with the necks and brims both being short and of similar lengths.   Apically, the septal necks are 0.3mm, the brims 0.2mm on the venter while dorsally the necks are 0.2mm long and the brims 0.2mm long.   The corresponding adoral measurements are 0.3mm, 0.2mm, 0.3mm, and 0.2mm.

The siphuncle contains no siphuncular deposits.   The connecting

rings are moderately thick, 0.1mm, and homogeneous.

The specimens have been recrystallized to the point that it is not possible to tell if cameral deposits were present, but some camerae are completely filled with sediment which would indicate that there were probably no cameral deposits.

Location and Material: Three incomplete phragmocones, Holotype UTGD80914, paratypes UTGD80937, UTGD80954. The specimens were collected from the Bubs Hill Limestone at 614-640 metres above sea level at Bubs Hill (fig. 3.14). The age is probably Trenton.

Remarks:- This species of *Miamoceras* differs from the type species, *M. shideleri*, in the shape of the siphuncle, but detailed comparison is impossible as *M. shideleri* is known from internal moulds and only one lateral section of the siphuncle has been figured (Flower, 1946, Plate 40, fig. 1). Comparison of the shape of the siphuncle may be misleading as the expansion of the segments differs between the venter and the dorsum in this genus. *M. longum* described by Barskov (1972) from Kazakhstan is close to *M. bubsense* with the only differences being more strongly curved septa and a slightly less expanded siphuncle in *M. longum*. The differences between *Beloitoceras kirtoni* and *Miamoceras bubsense* are the siphuncular segments which are less, and more evenly, expanded and the siphuncle is smaller and closer to the venter in *Beloitoceras kirtoni*. As the body chambers are unknown in the Tasmanian material the generic assignments are difficult to establish.

Family   TRIPTEROCERATIDAE   Flower, 1941
Genus   ZEEHANOCERAS   n.gen.

Types Species: *Zeehanoceras teicherti* n.gen. n.sp.

Derivation of Name: Specimen was found at Smelter's Quarry, Zeehan.

Conch subcircular, flattened ventrally, slightly exogastric. The dorsum is more sharply curved than the venter, the siphuncle is small, approximately one-tenth of the diameter of the conch and positioned approximately half way between the venter and the centre. The siphuncular segments are expanded being three times as long as they are wide, they are more highly expanded on the dorsal side. Septal necks are short and suborthochoanitic. There may have been cameral deposits, but the specimen is highly recrystallized. The suture is not clear but there would appear to be a ventral and dorsal lobe and a lateral saddle. There are no siphuncular deposits.

Remarks:-   This genus is assignable to the Tripteroceratidae due to the depressed section, exogastric curvature, the expanded siphuncle and suborthochoanitic septal necks. *Zeehanoceras* differs from all other members of this family in the phragmocone cross-section and the relatively higher length to width ratio of the siphuncular segments.

Zeehanoceras differs from *Eotripteroceras* in having a smaller and more expanded siphuncle, also in the more flattened venter. The assignment of this genus to a family (and also an order) is made difficult, in that morphologically it appears to lie between *Eotripter-oceras* and *Allumettoceras* which occur in two different orders, the Michelinoceratida and Oncoceratida respectively. The assignment of *Eotripteroceras* to the Michelinoceratida is made on the basis of the tubular siphuncle, but the lack of cameral deposits makes this genus unusual in the Michelinoceratidae and would allow assignment to Tripteroceratidae but the siphuncle is not as expanded as usually occurs in this family. Balashov (1962) considered that *Eotripteroceras* belonged in the Bassleroceratidae of the Ellesmeroceratida, but the lack of complex connecting rings in *Eotripteroceras* would appear to

contradict this assignment. The author would favour an assignment of
Eotripteroceras to the Tripteroceratidae, while admitting that the
assignment is not final. Flower (1962a)considered that the Triptero-
ceratidae belonged to the Michelinoceratida. The author considers
this as unlikely, due to the depressed conch, small expanded sub-ventral
siphuncle and lack of cameral deposits, and favours an assignment to
the Oncocerida.

Zeehanoceras teicherti n.sp.

Plate 28   fig. 1 - 5 ; Fig. 4.6(1).

No body chambers are preserved. The phragmocone is an exogastric
cyrtocone. The rate of expansion of the phragmocone is variable,
but moderate with the height increasing from 7.0mm to 9.5mm in 18mm
on the holotype. The phragmocone is subcircular, with the venter
slightly flattened. There are 13 siphuncular segments in a distance
of 22mm. The siphuncle is between the center and the venter and is
one-tenth the diameter of the phragmocone. The siphuncle is expanded
with the point of maximum expansion at the adoral end of the segment.
The siphuncular segments are more highly expanded on the dorsum than
the venter. The septa are only very slightly curved, with the
siphuncle ventrad of the point of maximum depth.

The siphonal formula for the holotype is 1.1/0.4/5.5:1.0/0.7/5.3,
1.5 apically, while adorally it is 1.4/0.4/7.7:1.3/0.8/7.4, 1.7.

The connecting rings are not adnate to the septum on either the
venter or the dorsum.

The septal necks are short and suborthochoanitic. Apically the
necks are 0.1mm on the venter and 0.2mm on the dorsum, adorally the

corresponding measurements are 0.1mm and 0.2mm.

The siphuncle contains no deposits.

The connecting rings are not well preserved, but were probably moderately thick.

There may have been cameral deposits present, but the recrystallization the specimen has undergone has destroyed any structure so the presence or extent of the deposits cannot be demonstrated.

The suture is not clear, but there would appear to be ventral and dorsal lobes and a lateral saddle.

Material and Location: One phragmocone, holotype UTGD90871, from the larger Smelter's Quarry at Zeehan (A on fig. (3.22)).

Remarks:-   See remarks under genus.

Fig. (4.6) :

1. *Zeehanoceras teicherti* n.gen.,n.sp. : a cross-section of the holotype showing the position and relative size of the siphuncle. A schematic longitudinal section illustrating the shape of the siphuncle; apex left, venter below, X4.

2. *Beloitoceras ? molense* n.sp. : a probable cross-section showing the position and relative size of the siphuncle.

3. *Beloitoceras kirtoni* : a cross-section showing the position and relative size of the siphuncle.

4. *Miamoceras bubsense* n.sp. : a cross-section of the holotype showing the position and relative size of the siphuncle. A longitudinal section of the same specimen showing the shape and position of the siphuncle; apex left, venter below, X2.

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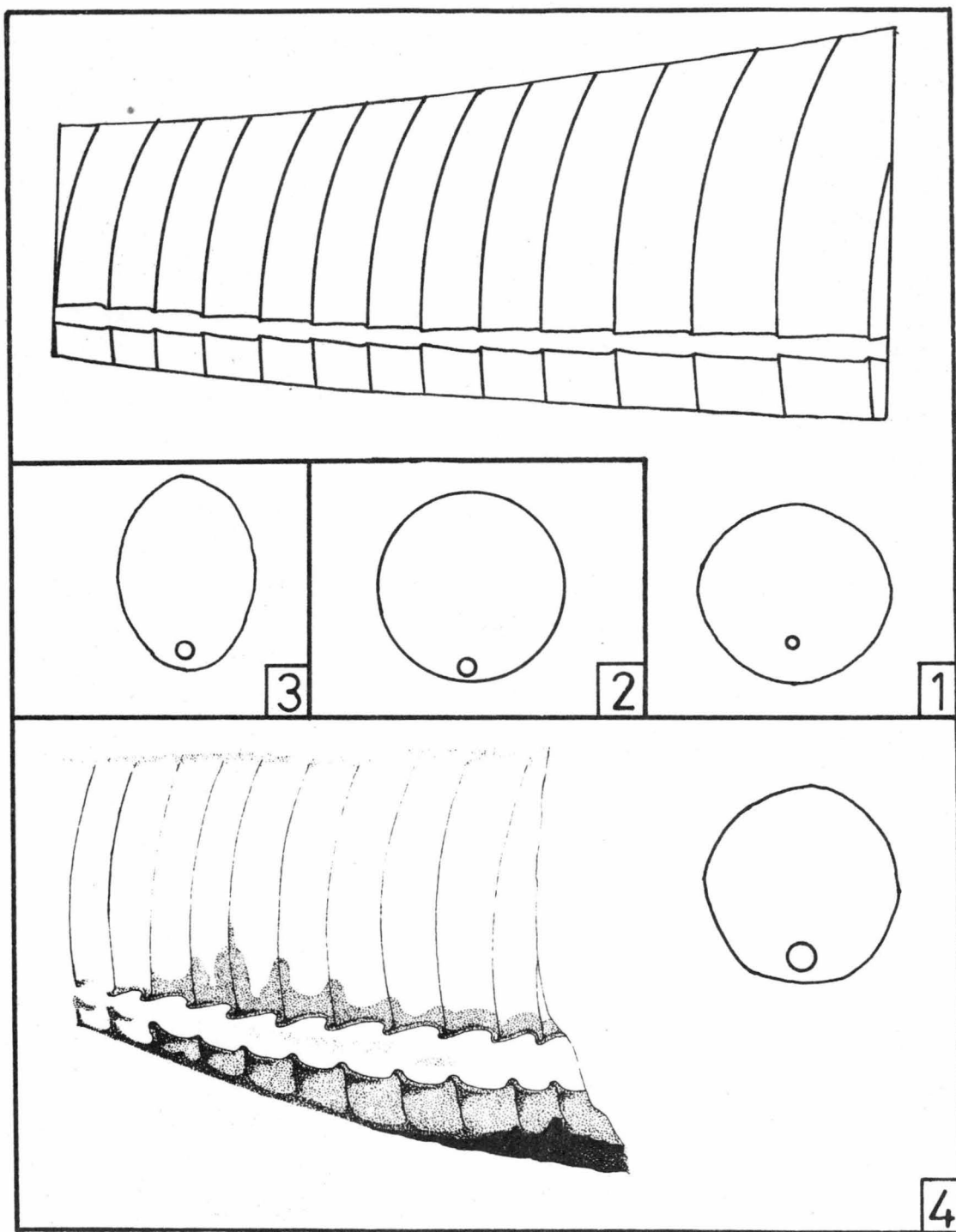
PLATE 28.

Zeehanoceras teicherti n.gen.,n.sp.;*Beloitoceras kirtoni*

Figs. 1-5: *Zeehanoceras teicherti* n.gen.,n.sp.,
holotype UTGD 90871;

1. A sagittal section of the holotype, apex left, X5.

2. An enlargement of the siphuncle and ventral camerae, X12.

3. A further enlargement of the siphuncle X25.

4. An external view of the holotype apex right, X2.5.

5. A transverse view of the holotype, X2.

Figs. 6-8: *Beloitoceras kirtoni*, UTGD 91040 and 23709;

6. An external view of UTGD 23709, apex left, X1.5.

7. An external view of UTGD 91040 showing the longitudinal ridges, apex right, X1.

8. A transverse section of UTGD 91040, X1.5.

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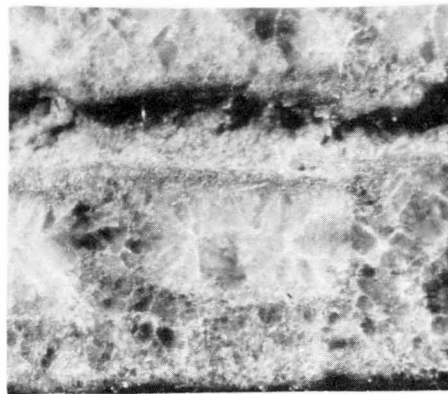
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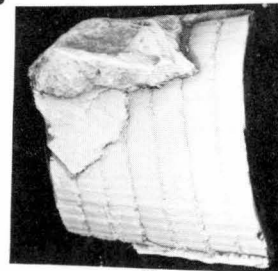
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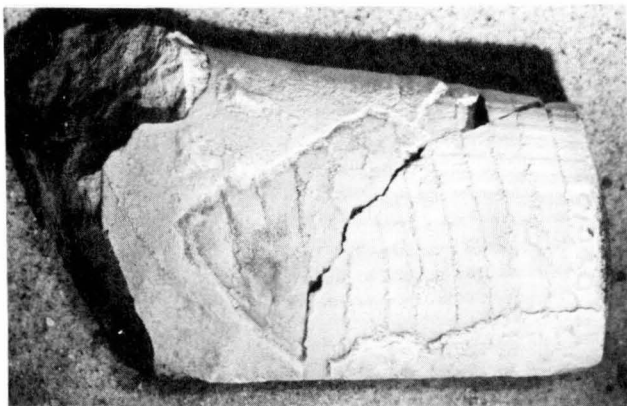
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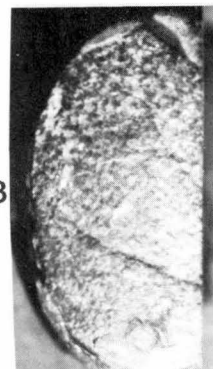
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PLATE 29.

Beloitoceras? molense n.sp.

Figs. 1-11: *Beloitoceras? molense* n.sp. holotype UTGD 94619;

1. A sagittal thin section of the holotype, apex left, X3.5.

2. An enlargement of the ventral camerae and siphuncle, X.10.

3. A further enlargement of the siphuncle, X20.

4. A close up of the connecting ring on the dorsal side of the siphuncle, X25.

5. A close up of the ventral septal neck, X30.

6. A close up of the dorsal septal neck, X30.

7. The shell wall structure on the venter of the holotype, X30.

8. The shell structure of the holotype apical of that in 7, X30.

9. An external view of the holotype, apex left, X3.

10. A transverse cut of the holotype, X2.

11. A close up of the external of the holotype showing the ridges produced in the outer layer of the shell, X15.

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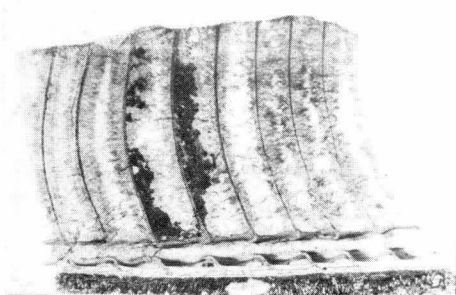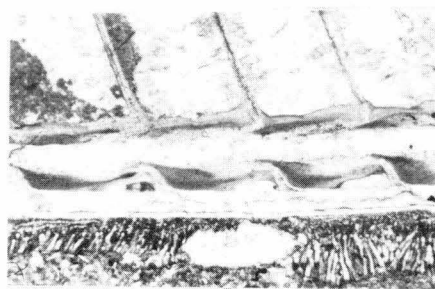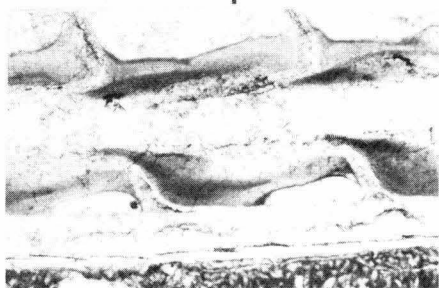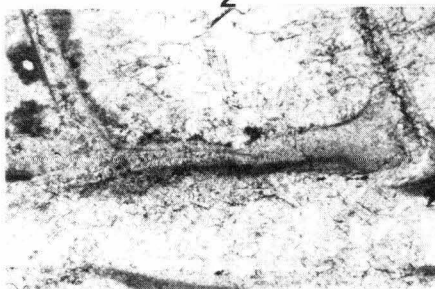
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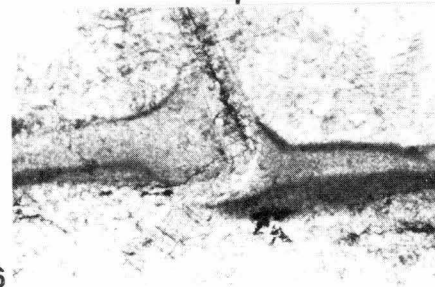
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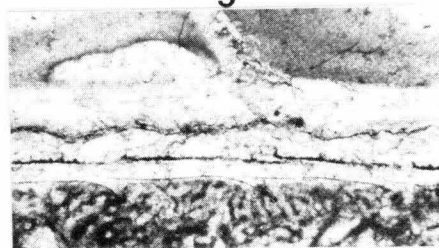
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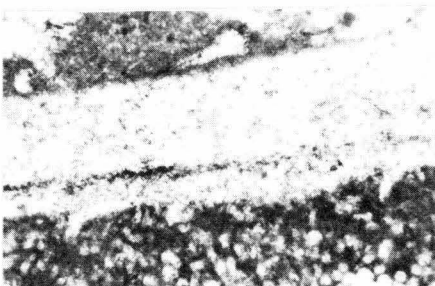
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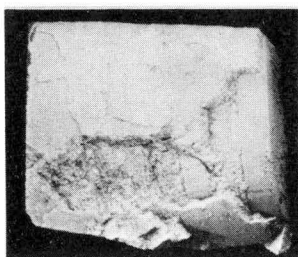
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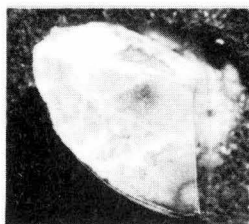
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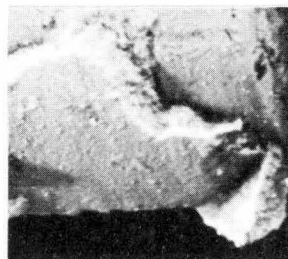
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PLATE 30.

Beloitoceras sp.; *Miamoceras bubsense* n.sp.

Figs. 1-3: *Beloitoceras* sp.   UTGD 121198;

1.   A sagittal section of UTGD 121198, apex left, X1.5.

2.   An enlargement of the ventral wall and siphuncle, X3.

3.   A further enlargement of the siphuncle, X12.

Figs. 4-8: *Miamoceras bubsense* n.sp.
         holotype UTGD 80914;

4.   A close up of the siphuncle at the adoral end of
      the specimen, X10.

5.   An enlargement of the siphuncle nearer the apical
      end of the specimen, X8.

6.   A close up of the septal neck on the dorsal side
      of the siphuncle, X25.

7.   The septal neck on the ventral side of the siphuncle,
      X25.

8.   A sagittal section of the holotype, apex left, X3.
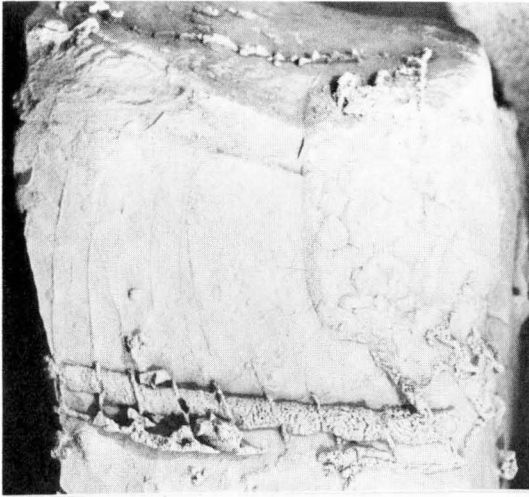
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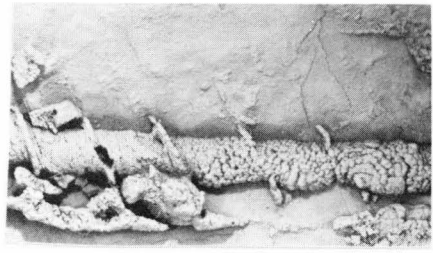
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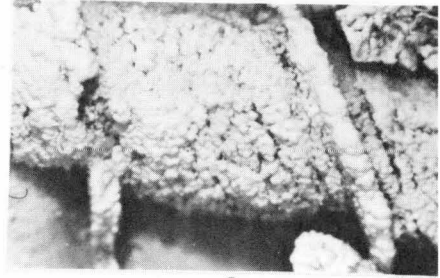
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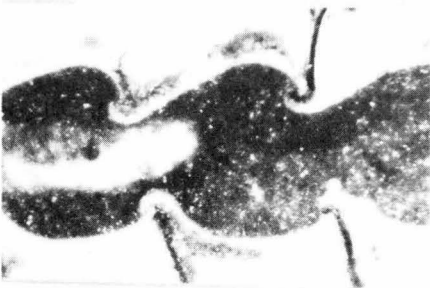
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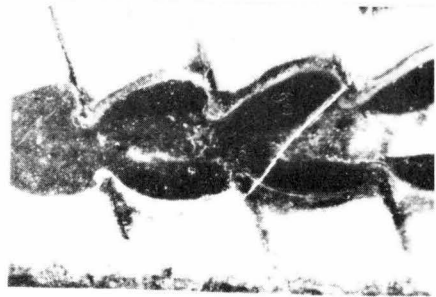
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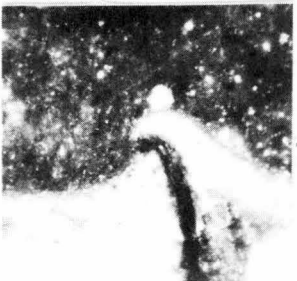
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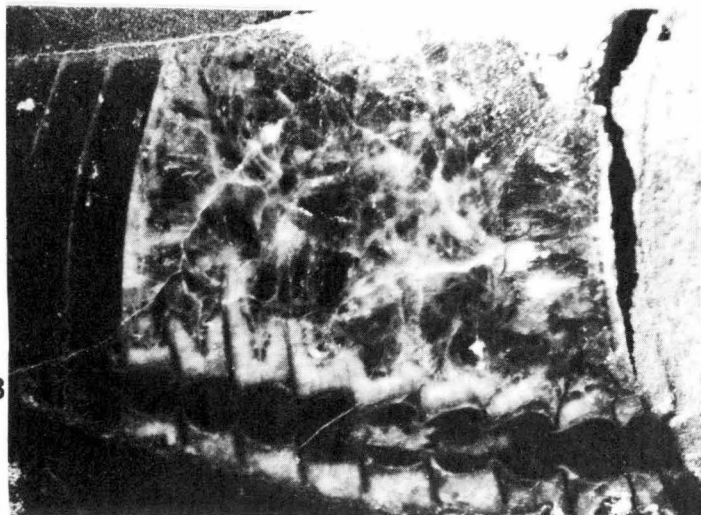
Order   TARPHYCERATIDA

Family   TROCHOLITIDAE   Chapman, 1857

Genus   DISCOCERAS   Barrande, 1867

Discoceras idaense (Teichert and Glenister, 1953)

Plate 31   fig. 1 - 9 .

1953 *Trocholitoceras idaense,* Teichert and Glenister, 1953, pp. 47-48, Plate 5, fig. 4-5.

As the description of this species given by Teichert and Glenister (1953, pp. 47-48) is considered adequate, the species is not re-described.

Remarks:- Teichert and Glenister (1953) described a new species of Tarphyceratida from the Ordovician of Tasmania. They assigned it to the Trocholitidae and the genus *Trocholitoceras.* They indicated that the specimen was difficult to assign, with features of both *Trocholitoceras* and *Discoceras* being present. Flower (1962b, p.16) considered that the species was assignable to *Trocholites,* stating that "*Trocholitoceras* is properly a late Canadian genus, but this species"(*Trocholitoceras idaense*) "is not typical, and lies within the wide variation in terms of cross-section and whorl enlargement found in *Trocholites*". The whorl cross-section and enlargement are within the bounds of these structures in *Trocholites,* but the Tasmanian species has the siphuncle in contact with the dorsal wall of the phragmocone for at least four whorls, whereas *Trocholites* has a sub-dorsal siphuncle.

Flower (1968b) established *Plectolites* which is similar in many respects to *Discoceras idaense,* but the rate of expansion of the whorls is much greater.

As the siphuncle is in contact with the dorsal phragmocone wall

and the whorl section is sub-quadrate the species is assigned to
Discoceras rather than *Trocholitoceras*.

<p style="text-align:center">*Discoceras reidi*   n.sp.</p>

<p style="text-align:center">Plate   32   fig.7 - 14 ; Fig. 4.7(1).</p>

The holotype is a discoidal, tarphycone, with a disc diameter of
30mm. It consists of three whorls all impressed dorsally. The umbilicus
is imperforate. The whorls are sub-rectangular in cross-section, but
the lateral and ventral walls are curved and there is no sharp angle
between them. On the holotype the height of the first whorl is 2.0mm,
the second is 5.0mm, and the third is 9.0mm. The ratio of height to
width of the whorl does not appear to change markedly with ontogeny,
although there is no cross-section through the holotype,which has all
three whorls preserved. The paratype UTGD121201. (Plate32, fig.14)
has an inner whorl height of 6mm, a width of 8mm and a dorsal impressed
zone of 1.5mm, the corresponding measurements on the outer whorl are
11mm, 15mm, and 2mm.

The siphuncle is small, tubular in contact with the dorsal wall
of the phragmocone and has a width of 1.7mm, height of 1.5mm and length
of 1.0mm.

The septal necks cannot be clearly seen but are probably ortho-
choanitic.

On the external surface of the shell there are strong ribs, which
originate at the umbilical seam. The ribs swing backwards across the
flanks and then form a deep sinus at the centre of the ventral surface.
The ribs are 2.0mm apart on the flank of the third whorl and 1.0mm
apart on the flank of the second whorl.

The suture cannot be clearly seen on any specimen.

The living chamber is partially preserved in UTGD121201 (Plate32
fig.14) but there does not appear to be any change in the height to
width ratio from that of the septate part of the conch.

No cameral deposits have been observed.

Material and Location:- There are two phragmocones (paratype with some
of the living chambers preserved) collected, holotype UTGD80889, and
paratype UTGD121201. The specimens were collected from 200 metres
above sea-level on the slopes of Bubs Hill (locality 2 on fig (1.2)).
UTGD85488 partially preserved phragmocone from the smaller Smelter's
Quarry (locality B on fig. (3.22)) at Zeehan. The age is probably Upper
Trenton-Lower Eden.

Derivation of Name:- The holotype specimen was collected by K.O. Reid.

Remarks:- *Disoceras reidi* differs from the other Tasmanian species
of *Discoceras, D. idaense,* in being more strongly ribbed and having the
whorl wider relative to its height.

Comparison of *Discoceras reidi* with other species of *Discoceras* has
shown that it most closely resembles *D. depressum* Sweet (1958) in the
position of the siphuncle and whorl cross-section, but *D. depressum*
does not have the strong ribbed ornamentation. This comparison is
also true of *D. verbeeki,* Frech but that species is not well known.

Family   ESTONIOCERATIDAE   Hyatt, 1900
Genus   PYCNOCERAS   Hyatt, 1894

Pycnoceras adamense   n.sp.

Plate 32   fig. 1 - 6 ; Fiq. 4.7(2) .

The holotype is a discoidal, tarphycone, with a disc diameter of
13mm. It consists of two whorls, which are slightly impressed dorsally

in early ortogenetic stages and becoming less impressed in later stages. The whorl is oval in cross-section, with a more tightly curved ventral wall than dorsal. The most adoral segment is 5.5mm in height, and 4.5mm in width on the holotype. The first whole is 3mm in diameter and the second is 5mm.

The siphuncle is small, tubular and ventral.

The external ornament is not clearly preserved, but would appear to have been smooth or only very finely ribbed.

The suture is simple and transverse, with only faint lateral lobes and a slight dorsal saddle.

No cameral deposits are known.

Material and Location:- There are 5 partially preserved phragmocones, holotype UTGD24502, paratypes UTDG24495, 24498, 24494, 24506. The specimens were collected from the base of the Karmberg Limestone at Adamsfield. The age is Upper Canadian.

Remarks:- *Pycnoceras adamense* differs from the only other species of *Pycnoceras*, *P. liratum*, known in Australia, in having a different whorl cross-section and the siphuncle in contact with the ventral wall. The closest species to *P. adamense* is the genotype *P. apertum*, but there is a more rounded cross-section and a ventrally placed siphuncle in *P. adamense*. The marginal position of the siphuncle differentiates *P. adamense* from the majority of other species of *Pycnoceras*.
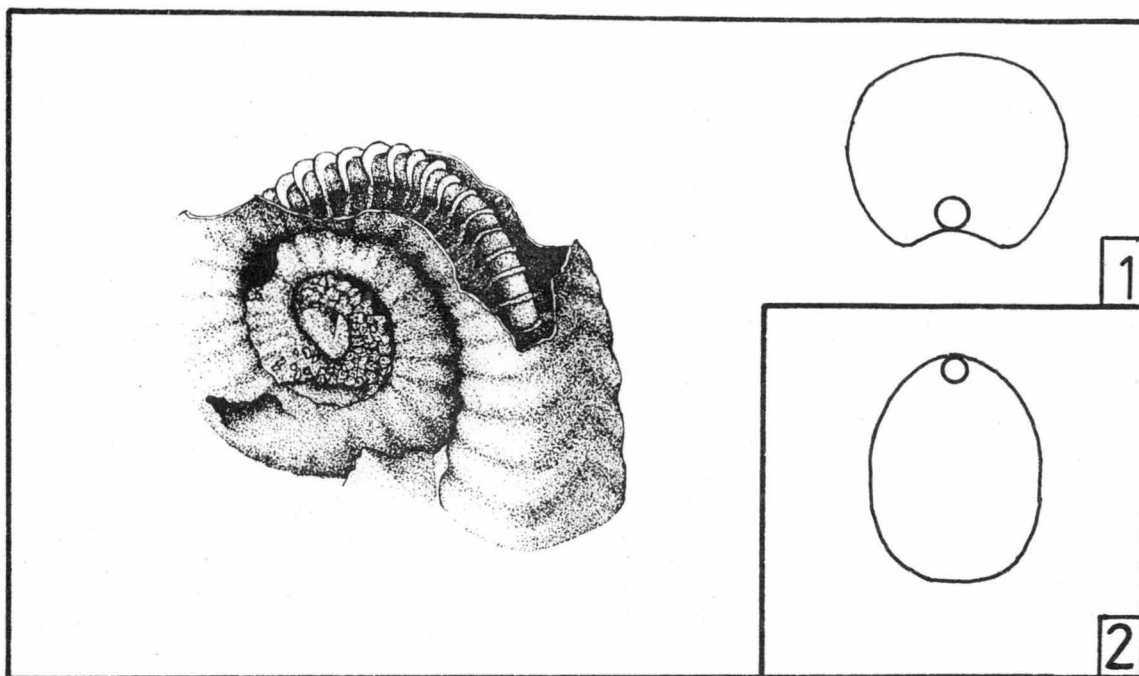
Fig.(4.7) :

1. *Discoceras reidi* n.sp. : a cross-section of the
   holotype showing the position and relative size
   of the siphuncle. A slightly oblique lateral
   veiw of the holotype showing the ribbing,
   siphuncle and rate of expansion of the whorl;
   X2.

2. *Pycnoceras adamense* n.sp. : a cross-section of
   the holotype showing the position and relative
   size of the siphuncle.

PLATE 31.
_____

Discoceras idaense; "Gasconsoceras" insperatum

Figs.1-9:*Discoceras idaense*, UTGD 20883 (holotype),
    other material UTGD 81145, 121199 and 121200;

1.   An external view of the holotype, X1.

2.   A sagittal section of the holotype, X1.

3.   A close up of a transverse section of the third whorl, X1.5.

4.   A transverse section of the entire holotype specimen, X1.

5.   An enlargement of the siphuncle, X4.

6.   An enlargement of the transverse section showing the position of the siphuncle, X5.

7.   An external view of UTGD 121199, X2.

8.   An external view of UTGD 121200, X2.

9.   A sagittal section of UTGD 81145, X1.5.

Figs. 10-12:   *"Gasconsoceras" insperatum*,
        UTGD 121202, and the holotype Tasmanian Museum specimen number B775;

10.   A sagittal section of UTGD 121202, X1.5

11.   An external view of the same specimen, X1.5

12.   An X-ray photograph of the holotype, X1.

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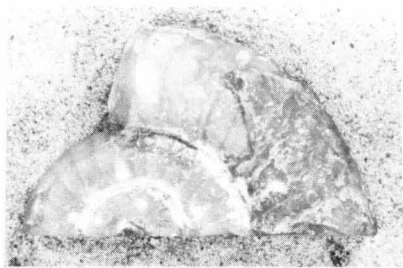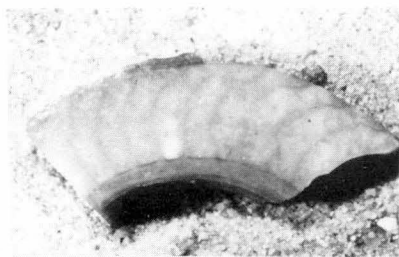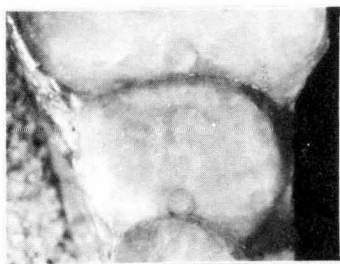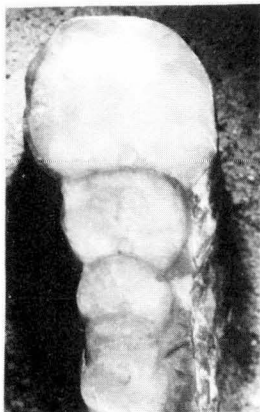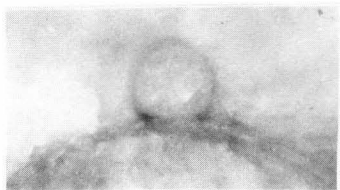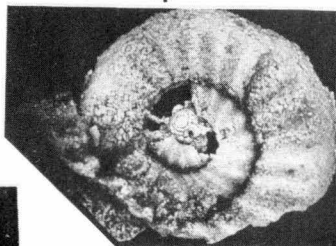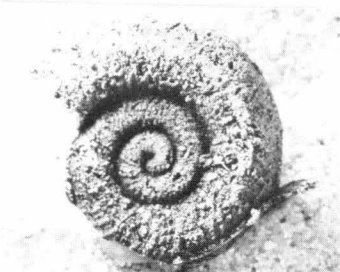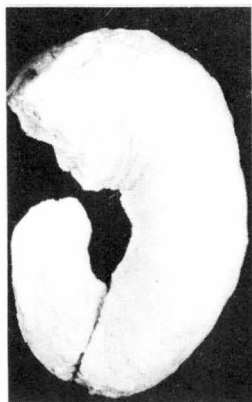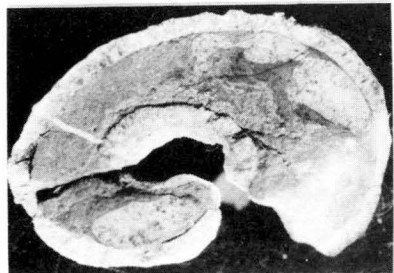
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PLATE 32.

Pycnoceras adamsense n.sp.;
Discoceras reidi n.sp.

Figs. 1-6: *Pycnoceras adamsense,* n.sp., holotype
UTGD 24502, paratype UTGD 24495, 24494
and 24506;

1. An external lateral view of the holotype, X2

2. A ventral view of the holotype, X3

3. The opposite ventral view of the holotype, X3

4. A dorsal view of the paratype UTGD 24495, X4

5. A lateral external view of the paratype
UTGD 24494, X3.5.

6. A transverse section of paratype UTGD 24506,
X 4

Figs. 7-14: *Discoceras reidi* n.sp., holotype
UTGD 80889, and paratype UTGD 121201,
85488;

7. A lateral view of the paratype UTGD 85488, X2.

8. A transverse section of the same specimen, X1.5.

9. A lateral external section of the holotype, X1.5.

10. A ventral section of the holotype, the siphuncle
is visible, X1.5.

11. A ventral view of the external showing the
ribbing, X2.

12. A lateral view of UTGD 121201, X1.

13. An oblique dorsal view of same specimen, X1.5.

14. A transverse section of the same specimen, X1.5.
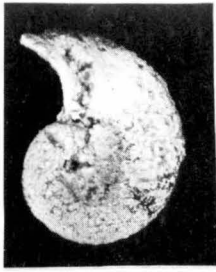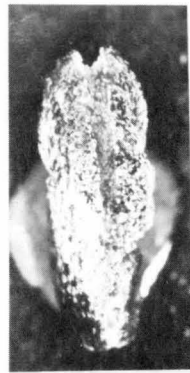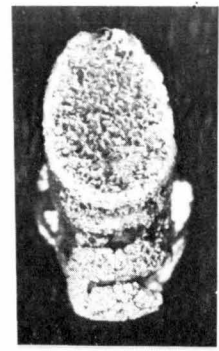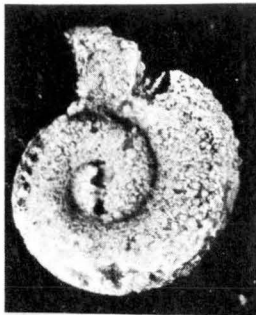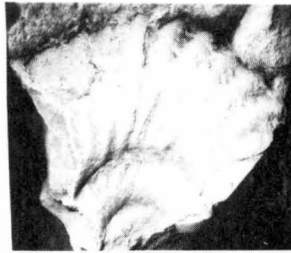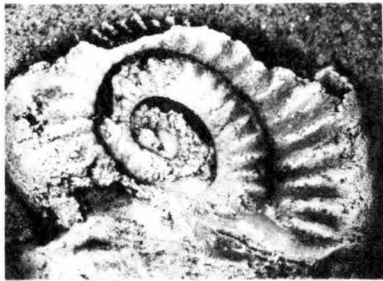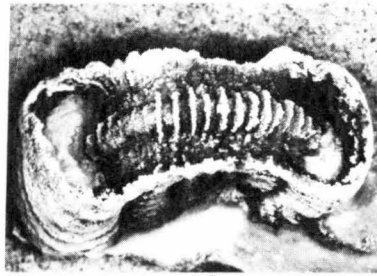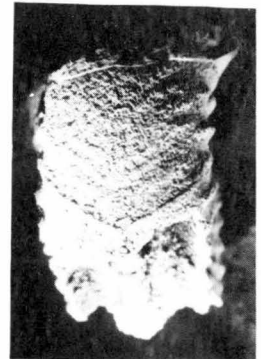
MISCELLANEA.

Teichert and Glenister (1953) described a specimen from the Gordon River which they assigned to the Middle Silurian genus *Gasconsoceras*. They based their suggested age for the Gordon River limestones on the presence of this species. Examination of the X-ray photographs of the holotype of *Gasconsoceras insperatum* (plate 31, fig. 10-12) show that there are no internal structures which could be considered as septa. As the boundary between the endosiphocone and the matrix is very clearly seen in the X-ray photograph of *Piloceras tasmaniense* , the septa in *Gasconsoceras insperatum* would have been visible if present. Material collected from Smelter's Quarry Zeehan,which is probably conspecific, was sectioned and had no internal septation. Thus it is considered that *Gasconsoceras insperatum* is not a nautiloid but is a bellerophontid gastropod, probably related to the Early Ordovician genus *Modestospira* Yochelson (1964).

CHAPTER 5.

PHYLOGENY OF THE TASMANIAN ORDOVICIAN NAUTILOIDS

INTRODUCTION

The Ordovician sequences in Tasmania are virtually complete with carbonates, containing nautiloids, present from the Upper Canadian to the Maysville without any major breaks. This comparative completeness of the Tasmanian Ordovician sequence makes Tasmania a good place to trace phylogenies, as the exact stratigraphic relationships between genera can be obtained. Unfortunately the comparative rarity of nautiloids in the Tasmanian Ordovician has meant that the full potential of the sequence cannot be realised.

The most diverse and complete record of a phylogenetic trend in Tasmania is that of the Gouldoceratidae. This family is extremely well represented in the Florentine Valley and its exact relationships can be studied in detail.

A few of the new genera discussed have no clear phylogenetic affinities and in those cases general affinities only are examined.

DISCOSORIDA

Phylogeny of the Gouldoceratidae:- There are eight genera assignable to the Gouldoceratidae, a family which ranges in age from the Late Chazy to the Maysville. The family contains discosorids with straight to slightly exogastric phragmocones; expanded siphuncles, situated midway between the centre and venter to marginal; thick, two layered connecting rings and "endocone"-like siphonal deposits.

Three non-Tasmanian genera are possibly assignable to the Gouldo-
ceratidae, *Madiganella* from Central Australia, *Hoeloceras* from near
Oslo, Norway and an undescribed genus from Western Queensland.

Madiganella was described by Teichert and Glenister (1952) from
the Horn Valley Siltstone and has since been assigned to the Ruedemanno-
ceratidae (Flower and Teichert, 1957; and Teichert, 1964c). Cooper
(1981) suggested a Late Canadian age for the Horn Valley Siltstone,
not the Chazy or post-Chazy age previously assumed (Teichert and Glenister,
1952; Flower and Teichert, 1957). Therefore *Madiganella* predates
Ruedemannoceras and could not be the link between *Ruedemannoceras* and
Pseudogomphoceras as previously suggested (Flower and Teichert, 1957,
p.37). As *Madiganella* predates the Ruedemannoceratidae and the Gouldo-
ceratidae it, or one of its contemporaries, may be considered as a
plausible ancestor to either, or both, of these families. The connect-
ing rings of *Madiganella* do not show the complex zoning found in the
Ruedemannoceratidae and are more typical of those in the Gouldoceratidae,
but until more information is obtained on the early stages of *Madiganella*
its familial assignment remains uncertain.

Dr. M. Wade has collected a, as yet undescribed, discosorid which
is not unlike *Madiganella* in the shape, size and position of the
siphuncle, from the Late Canadian, Nora Formation of Western Queensland.
This genus may prove to be, or be related to, the ancestral stock of
both the Ruedemannoceratidae and the Gouldoceratidae.

The third non-Tasmanian genus which may be assignable to the
Gouldoceratidae, *Hoeloceras*, is the only one not related to the early
evolution of the family, but instead is a possible descendant of *Para-
madiganella*.

Sweet (1958) considered *Hoeloceras* to belong to the Lambeoceratidae

of the Actinoceratida. Flower (1976a) indicated that he considered
Hoeloceras a discosorid belonging to the Ruedemannoceratidae.

A free siphonal tube is preserved in *Hoeloceras*. Such a tube is an
unusual feature in the Nautiloidea but commonly occurs in the Gouldocera-
tidae, and more rarely in other families of the Discosorida. *H. askeri* has
siphuncular segments which slope adorally from the venter to the
dorsum. Also the connecting rings, although described as thin by
Sweet (1958) appear to be thick in the illustrations. The thickness
of the connecting rings in the Gouldoceratidae can be deceptive.
The connecting rings are sometimes preferentially removed and when
siphonal deposits are present a thin ring is suggested. The other
problem is that the rings are two-layered and the thin dark layer
on the siphonal surface can look like the complete connecting ring,
with the thicker, light layer on the cameral surface appearing
inorganic in origin. The combinations of the above features are
not restricted to the Gouldoceratidae, but strongly suggest that
with study *Hoeloceras* will be assignable to this family.

After the initial evolution the phylogeny of the Gouldoceratidae
follows two distinct lineages (fig. (5.1)).

The first of the two phylogentic trends in the Gouldoceratidae
is from *Madiganella* to *Florentinoceras* to *Anmoceras* to *Tasmanoceras*.
This trend is characterised by a change from cyrtochoanitic to
orthochoanitic septal necks, fig (5.2), an increase in the relative
size of the siphuncle, a more marginal position of the siphuncle
and increasing instability in the position of the siphonal tube.

The second trend is from *Madiganella* to *Paramadiganella* to
Gouldoceras to *Tigeroceras* to *Westfieldoceras*. In this trend the

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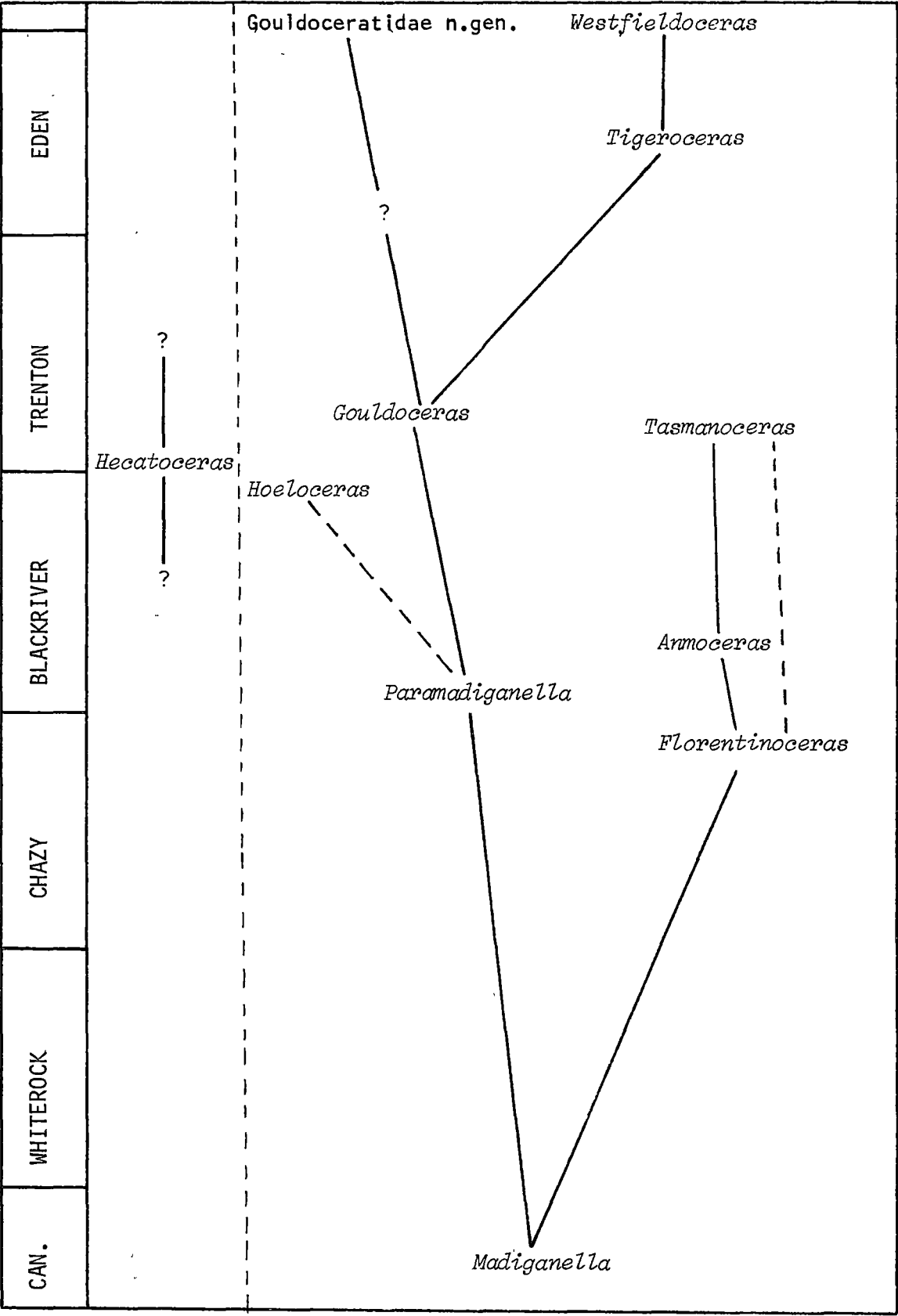
Fig. (5.1)   Phylogeny of the Gouldoceratidae. The diagram
illustrates the two trends within the Gouldoceratidae.
The dashed lines are tentative links. Although *Hecatoceras*
is included on the diagram it is not a member of the
Gouldoceratidae
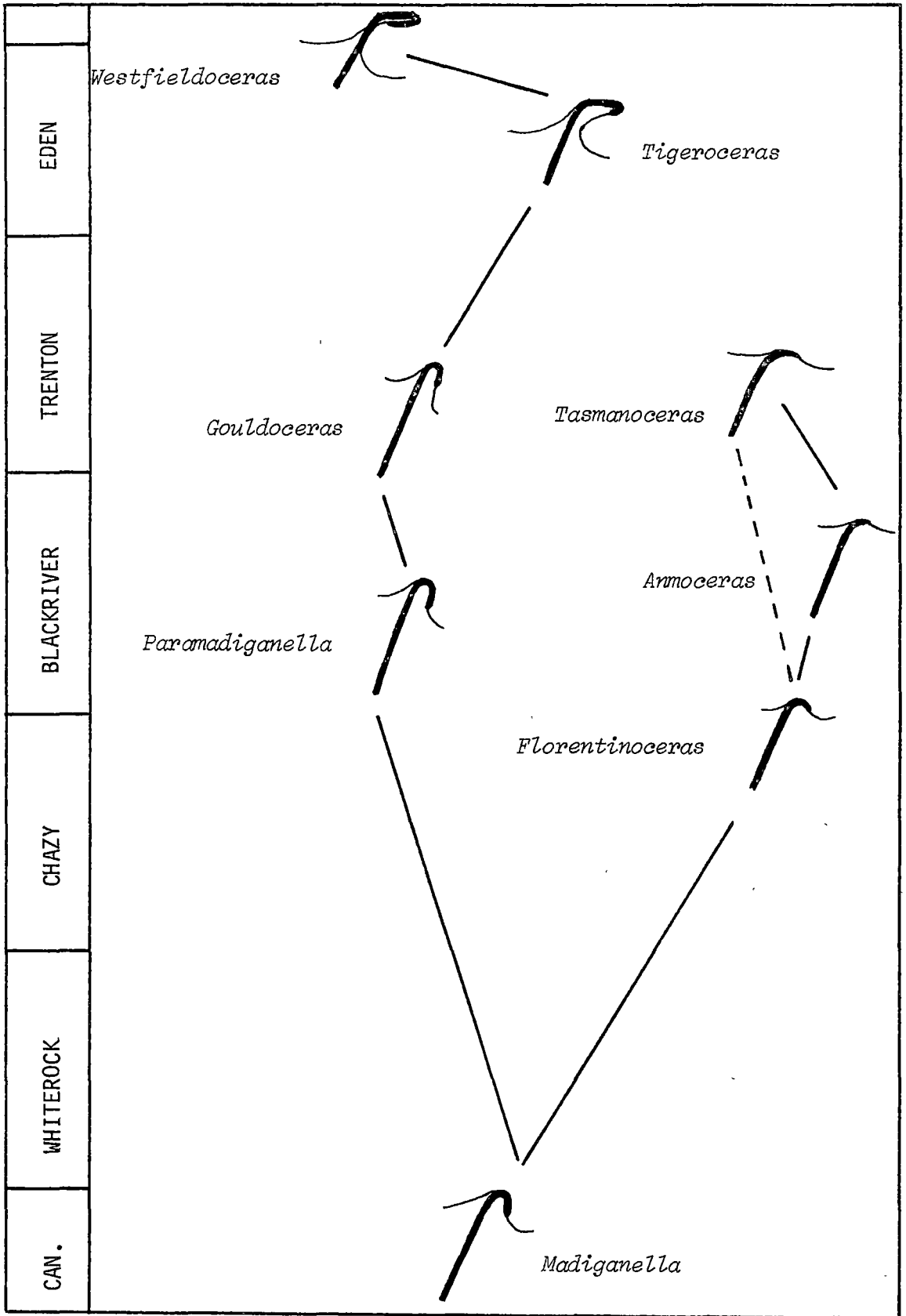
Fig. (5.2)   Variation in the shape of the septal necks in the Gouldoceratidae. This diagram illustrates the two trends in the shape of the septal necks in the Gouldoceratidae. The first trend, through *Florentinoceras*, is towards more orthochoanitic necks, the second trend, through *Paramadiganella*, is towards more cyrtochoanitic necks.

septal necks become more cyrtochoanitic, the free part of the septa at the septal foramen increasingly bends to point toward the apex, fig. (6.2) and the siphuncular segments change slope so that the segments slope adorally from the venter to the dorsum. These two trends in the Gouldoceratidae could conceivably be considered as two sub-families, but the sub-families are not established awaiting information on the Central Australian and Western Queensland discosorids.

The details of the phylogeny of the Gouldoceratidae follows.

1. *Madiganella* to *Tasmanoceras* trend:-

a) *Madiganella* to *Florentinoceras*:- The changes required to derive *Florentinoceras* from *Madiganella* are: a shortening of the siphuncular segments, the development of endocones (or extension throughout the siphuncle if *Madiganella* has endocones in its apical segments), a lengthening of the septal necks and a shortening of the brims.

b) *Florentinoceras* to *Anmoceras*:- This requires a lengthening of the siphuncular segments, an increase in the size of the siphuncle relative to the phragmocone, a marginal position for the siphuncle and more orthochoanitic septal necks (fig. (5.2)).

c) (i) *Anmoceras* to *Tasmanoceras*:- This requires a shortening of the siphuncular segments, a further increase in the relative size of the siphuncle and a more variable position of the siphonal canal, between the centre and the dorsal side of the siphuncle.

(ii) *Florentinoceras* to *Tasmanoceras*:- This alternative origin for *Tasmanoceras* is suggested because it does not require the reversal of the trend towards longer siphuncular segments. This trend requires an increase in the relative size of the siphuncle, a marginal position for the siphuncle, more orthochoanitic septal necks, and a more variable

position of the siphonal tube.

2. *Madiganella* to *Westfieldoceras* trend:-

a) *Madiganella* to *Paramadiganella*:- The changes required to derive *Paramadiganella* from *Madiganella* are not completely known, as the early segments of *Paramadiganella* are different from the later segments and the early segments of *Madiganella* are not adequately known. The late ontogenetic form of *Paramadiganella* is very similar to *Madiganella*, even to having a free tube in the siphuncle. The only major changes from *Madiganella* to *Paramadiganella* are a reduction in the size of the siphuncle, and less curved septa. A specimen of *Madiganella* in the author's collection, UTGD121206, indicates that there may also be an ontogenetic change in the position of the siphuncle. If, with more work, this is shown then the relationships between *Madiganella* and *Paramadiganella* will be further strengthened.

b) *Paramadiganella* to *Gouldoceras*:- This requires the ontogenetic change which occurs in *Paramadiganella* to be either lost or only retained in very mature segments. The siphuncle of *Gouldoceras* is much larger relative to the phragmocone and the phragmocone is slightly exogastric. In *Gouldoceras* the extensive development of fine "endocones" which mimic the shape of the siphuncle means that when the siphuncle is nearly full of deposits a "radial-canal" is left in the segment between the adjacent septal foramen. These "radial-canals" are more strongly developed on the dorsum where expansion of the siphuncular segments is greater.

c) *Gouldoceras* to *Tigeroceras*:- In *Tigeroceras* the septa near the septal necks have been bent apically relatively to the situation in *Gouldoceras* and so point apicad (fig (5.2)). In *Tigeroceras* the siphuncle is marginal, with the expanded part of the ventral segment

in contact with the phragmocone wall. The length of the septal brim is increased and dorsally is adnate to the septa.

d) *Tigeroceras* to *Westfieldoceras*:- This requires more apical bending of the septa near the septal foramen, a shortening of the septal necks and the brims are recumbent to the recurved portion of the septa (fig (5.2)). A further reduction in the relative size of the siphuncle and in the height of the siphuncular segments relative to their length also occurred.

e) *Gouldoceras* to Gouldoceratidae n.gen., n.sp.:- Gouldoceratidae n.gen., n.sp. is not well enough known to allow its position in the phylogeny of the family to be determined with certainty. The changes that would be required are an increase in the height of the siphuncular segments relative to the length, and a marginal position for the siphuncle.

f) *Paramadiganella* to *Hoeloceras*:- *Hoeloceras* is similar to the mature ontogenetic stage of *Paramadiganella*, with the only changes required being in the shape of the siphuncular segments, an increase in the area of adnation of the apical surface of the connecting ring with the adoral face of the septa and an increase in the relative size of the siphuncle. The phragmocone cross-section in *Hoeloceras* is more compressed than *Paramadiganella* which is subcircular except for a slightly flattened venter.

It is probable that both the Gouldoceratidae and the Ruedemannoceratidae evolved from *Madiganella*, or a related as yet unknown genus, and the bulk of the discosorids evolved from the Ruedemannoceratidae (fig. (5.3)). The Gouldoceratidae do not appear to have left any descendants.

The origin of the Discosorida has always been a problem, with
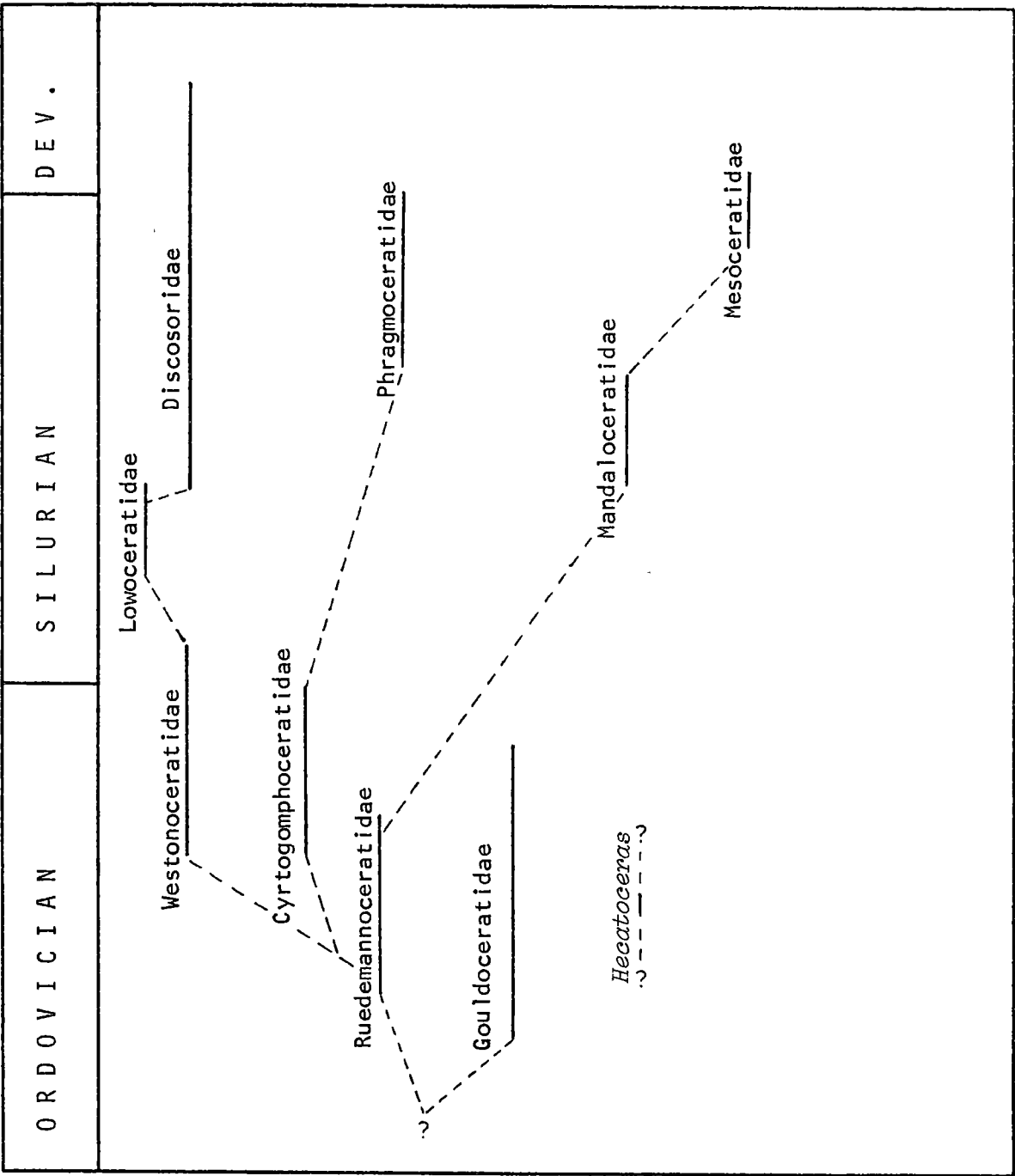
Fig. (5.3)   The range and probable interrelationships of the
families of the Discosorida. (modified, with additions,
from Flower and Teichert, 1957).

most workers suggesting an independent origin in the Plectonoceratina (Flower and Teichert, 1957; Teichert, 1964c and Chen *et al.*, 1979b). One feature inconsistent with this view is that the earliest known discosorid is Late Canadian and if they evolved from the Plectonoceratina, then Early and Middle Canadian discosorids should have been found. This suggests an origin in the Ellesmeroceratina, but as the earliest known discosorid has highly inflated siphuncular segments, the exact ancestor is not clear. The Gouldoceratidae have two-layered, thick connecting rings which are reminiscent of some of the Ellesmeroceratida. If the Discosorida evolved from the Ellesmeroceratida then the Baltoceratidae would have to be a major contender as the ancestral family, as they have thick connecting rings, straight conchs, and short septal necks which would enable a *Madiganella*-like morphology to be obtained by expansion of the siphuncular segments. The marginal position of the siphuncle in the Baltoceratidae is the major obstacle to this suggestion.

ACTINOCERATIDA

Phyletic position of *Armenoceras corbetti* :-   *Armenoceras corbetti* was early in the evolution of *Armenoceras,* and therefore is potentially important in the understanding of the origins of *Armenoceras.* Very few species have been described from Whiterock or older strata, *A. numatai* from the Wuting Limestone, Endo (1932) is the oldest described member of *Armenoceras,* but is only poorly known. Wade (1979b) illustrated a specimen of *Armenoceras* from the Coolibah or Nora Formation of Western Queensland, but did not describe or illustrate it in detail. Wade (1977a) suggested a Whiterock age for these formations, but Webby *et al.* (1981)   considered

the age to be Late Canadian-Earliest Whiterock. When the exact age of the Coolibah and Nora Formations is determined and the *Armenoceras* species are described, the origin of *Armenoceras* may be better understood.

Armenoceras corbetti does however shed some light on the problem, as it has dorsoventral differentiation of the siphuncle similar to that of the Wutinoceratidae, while being typical of *Armenoceras* in size, shape and position of the siphuncle. Therefore *A. corbetti* supports the derivation of *Armenoceras* from the Wutinoceratidae (Flower (1976a), and Chen *et al.* (1979a)).

Phyletic position of *Ormocerina*:- *Ormocerina* is a most unusual actinoceroid, because of its small size and the development of annulosphonate deposits only on the venter of the siphuncle. The siphuncular segments are twice as high as they are long and there are well-developed cameral deposits which suggest that *Ormocerina* may have evolved from a member of the Actinoceratidae. The small size of the phragmocone and the size and position of the siphuncle are more typical of the Ormoceratidae suggesting that by a slight increase in the height of the siphuncle relative to the length, *Ormocerina* could be derived from *Ormoceras*, or a related genus. As yet the problem of the affinities of *Ormocerina* cannot be determined with certainty, but *Adamsoceras* or *Ormoceras* would appear to be a close relative.

ELLESMEROCERATIDA

Phylogeny of the Cyrtocerinina :- In the current study one new genus belonging to this sub-order was found, *Centrocyrtocerina*. *Centro-Cyrtocerina* is gyroconic, belongs to the cyrtocerinidae and first appears in rocks of Chazy age. There is another species in the Trenton.

There are three families of the Ellesmeroceratida which have thick connecting rings projecting into the siphuncle as inflated lobes, these are the Bathmoceratidae, Eothinoceratidae and the Cyrtocerinidae. Flower (1964a,p.4) produced a phylogeny for cephalopod evolution to the close of the Canadian, in which he indicated that the Bathomoceratidae was derived from the Eothinoceratidae, while the cyrtocerinidae was derived independently from the Eothinoceratidae. Work since 1964 by Chen (1976) and the author does not change this picture but the details are now much better understood (fig (5.4)).

Chen (1976) described *Tangshanoceras* from the Late Canadian of China. It is essentially similar to *Eothinoceras,* but the siphuncle is removed from the venter and the phragmocone is slightly endogastric. *Tangshanoceras* is an ideal ancestor to both *Centrocyrtocerina* and *Cyrtocerina.* To derive *Centrocyrtocerina* from *Tangshanoceras* the trend to endogastric curvature is continued, resulting in a gyroconic phragmocone, and to further removal of the siphuncle from the venter.

Cyrtocerina could have been derived from *Tangshanoceras* by becoming breviconic and the siphuncle again becoming marginal in some species. The phragmocone became more endogastrically curved and the siphuncle departed from a marginal position (fig. (5.4)). The shape and structure of the connecting rings and septal necks are very similar in all the genera, a relationship which supports the proposed links between them.

MICHELINOCERATIDA

Affinities and Phylogeny of *Fitzgeraldoceras*:- *Fitzgeraldoceras* is assigned to the Cayutoceratinae, because it shows two generations of siphonal deposits. In the Ordovician of Australia and China there are three genera belonging to the Cayutoceratidae: *Fitzgeraldoceras,*
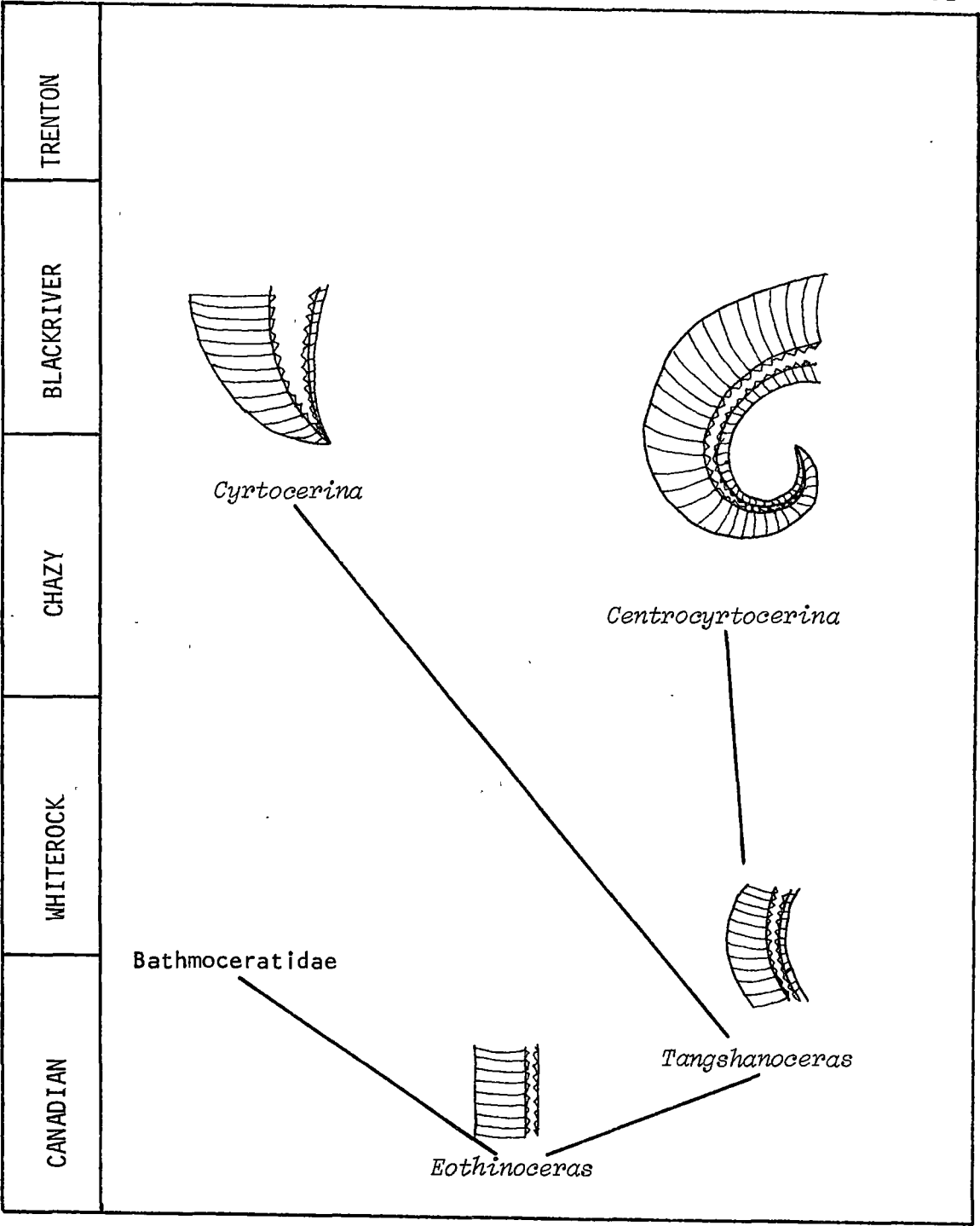
Fig. (5.4)   The phylogeny of the Cyrtocerinina.

Stromatoceras and *Eostromatoceras* (fig. (5.5)). Teichert and Glenister (1953) considered the age of *Stromatoceras* to be Middle Silurian. *Gordonoceras* has been shown to be Late Ordovician in age and as Teichert and Glenister's (1953) main reason for considering the age to be Silurian was the presence of *Gasconsoceras* (now thought to be *Modestaspira*, see Chapter 4). *Stromatoceras* is probably also Late Ordovician in age. However, a Silurian age cannot be ruled out as there are small outcrops of Silurian limestone in the Gordon River area from which the collections could have been made. It is possible to derive both *Eostromatoceras* and *Stromatoceras* from *Fitzgeraldoceras*, with only minor changes in morphology. To derive *Stromatoceras* from *Fitzgeraldoceras* the siphuncular segments need to have been shortened relative to their height, and the siphuncle to have moved closer to the venter. As *Stromatoceras* has recrystallized calcite in the camerae, and *Fitzgeraldoceras* and *Eostromatoceras* both have well developed cameral deposits it is suggested that *Stromatoceras* also had cameral deposits. *Eostromatoceras* may have been derived from *Fitzgeraldoceras* by increase in the size of the siphuncle relative to the phragmocone, and by reduction in the length of siphuncular segments relative to the height. As the siphuncular deposits of *Metastromatoceras* are not well known it is difficult to fit into the phylogeny, but the known structures are similar to *Stromatoceras*.

There is a large stratigraphic gap between the Ordovician genera of the Cayutoceratinae and the next genus in the Early Devonian. Flower (1962a) suggested that the Ordovician genera were homeomorphs of the Devonian ones. However, the large stratigraphic gap may be an artifact of the lack of study of the Silurian nautiloids of Australia and China, where the intermediate genera could be expected to be found. Until the Silurian nautiloids are better known the
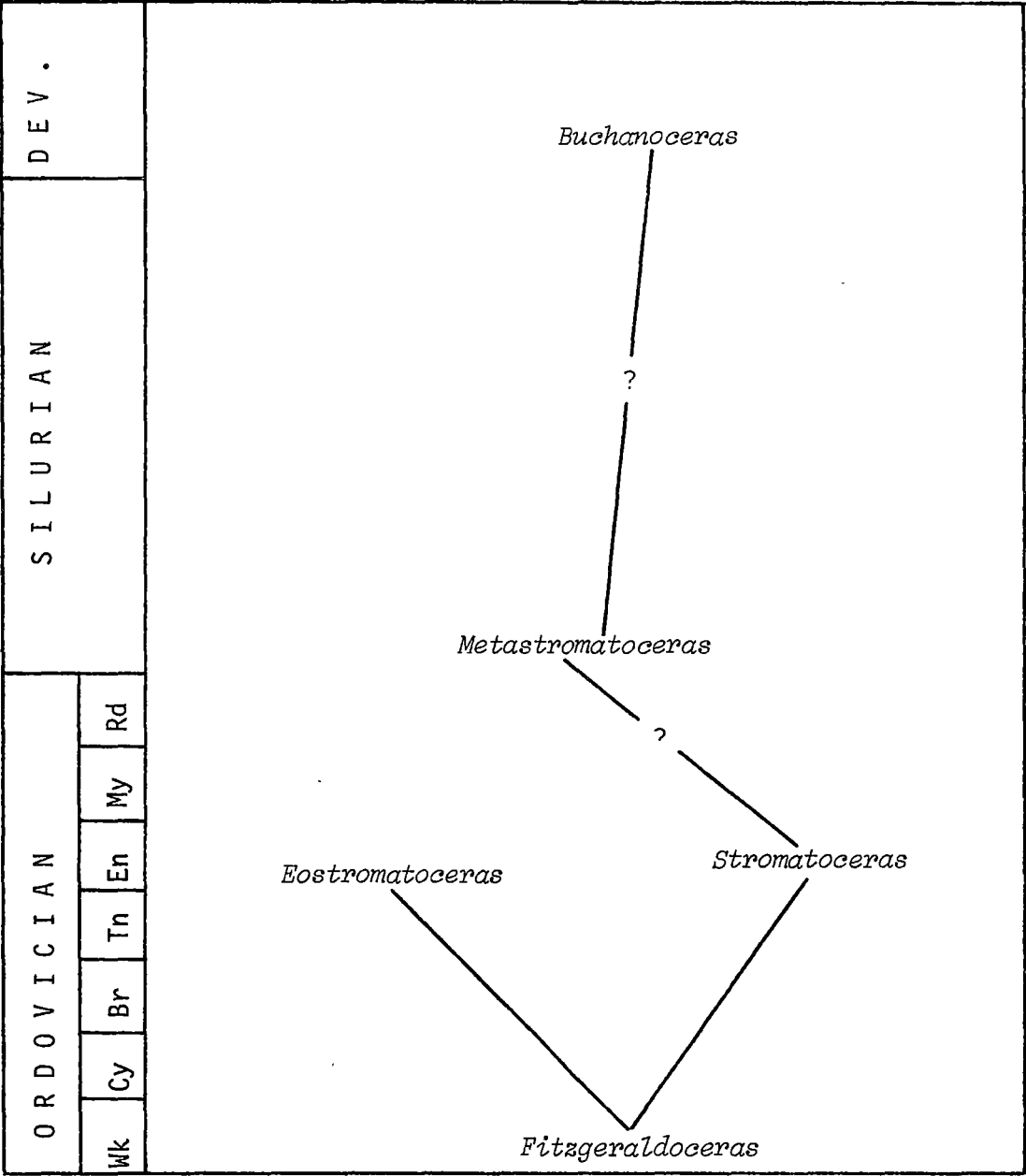
Fig. (5.5)   The phylogeny of the Cayutoceratinae. The link
between the Ordovician and Devonian members of this
family is only tentative and if the suggestion of
Flower (1962a),that they are homeomorphs,is correct
this link would not exist.

Ordovician genera are considered to belong to the Cayutoceratidae

and to be ancestral to the Devonian genera, fig. (5.5).

Phyletic position of *Standardoceras*:- *Standardoceras* is related to

Striatoceras in form and size of the siphuncle and in the type of

siphuncular deposits. The lack of evidence of external striations

of the phragmocone of *Standardoceras* is a difference with *Striatoceras*.

The exact relationship between the two genera is unclear, and awaits

more work of *Striatoceras*. The other genera assigned to the Striato-

ceratidae by Flower (1976a) have either annulated phragmocones or

have less expanded siphuncles than *Standardoceras* or *Striatoceras*.

These genera are similar in morphology to the early Michelinoceratida

and are the link between the typical members of that order and

Striatoceras and *Standardoceras* which have highly expanded siphuncular

segments.

ONCOCERATIDA

Phyletic position of *Zeehanoceras*:- Although *Zeehanoceras* is

assignable to the Tripteroceratidae it has a more tubular siphuncle

and is less depressed than the typical member. If, as argued else-

where, page   , *Eotriptoceras* belongs to the Tripteroceratidae, it

would make an ideal progenitor to *Zeehanoceras*. The changes required

to derive *Zeehanoceras* from *Eotriptoceras* are a relative decrease

in the size of the siphuncle, an increase in expansion of the siphuncle,

and a flattening of the venter of the phragmocone. How these two

genera are related to the rest of the Triptoceratidae requires a

more detailed study of this family of the Oncoceratida.

ENDOCERATIDA

Phyletic position of *Metamanchuroceras*:-   *Metamanchuroceras* is similar to *Manchuroceras* at its apical end, but is long and slender after the initial rapid expansion. The origin of *Metamanchuroceras* is obscure but most probably it had a similar ancestry to *Manchuroceras*, the conch becoming a longicone rather than a brevicone. The septal necks are unknown in *Metamanchuroceras* and information on their length will be essential in determining the validity of the above and following suggestions.

Metamanchuroceras develops a dorsal lobate ridge in the endosiphocone in its late ontogenetic stages. The Najaceratidae also first develops a dorsal mass in the endosiphuncle; this mass then grows towards the venter , then thickens to fill the endosiphuncle. If the dorsal lobate ridge in *Metamanchuroceras* developed earlier in the ontogeny it could produce a dorsal mass like that of the Najaceratidae. If this suggestion is correct then the Najaceratidae would have evolved from *Coreanoceras* through *Metamanchuroceras*, while the Allotrioceratidae would have developed from *Coreanoceras* through *Manchuroceras* (fig. (5.6) .   If the suggestion by Flower (1976c, p.16) is correct and *Manchuroceras* was derived from the Piloceratidae, then a member of this family would replace *Coreanoceras* in the above sequence.

Phyletic position of *Karmbergoceras*:-   *Karmbergoceras* has two endosiphotubes, which are not in the plane of symmetry, and the endosiphocone is also divided. As these features are nearly unique its origins are unclear. The general morphology of the endosiphuncle is similar to that of *Allocotoceras*, but *Allocotoceras* does not have the dual endo-
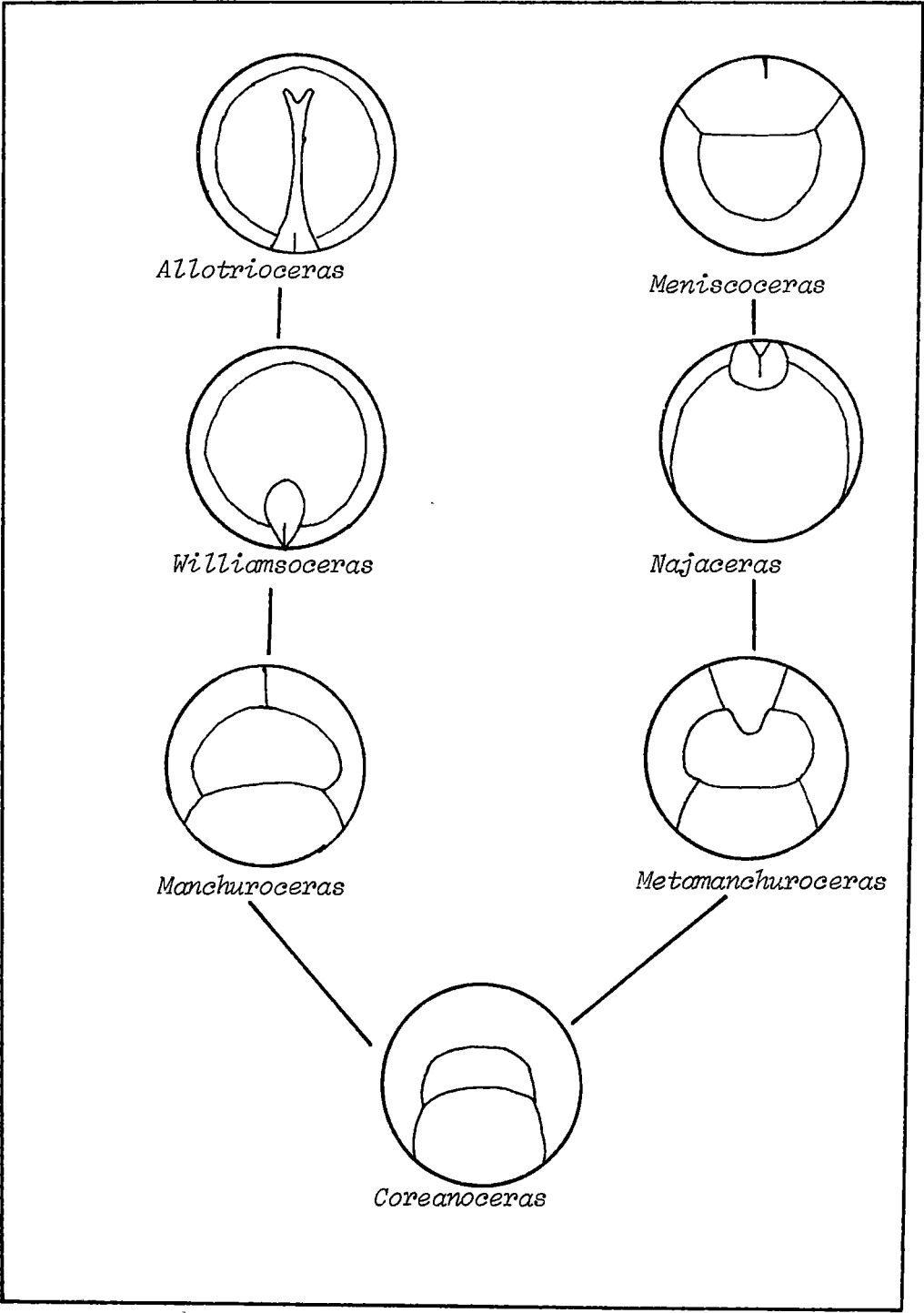
Fig. (5.6)   A possible phylogeny linking the Manchuroceratidae,
Najaceratidae and the Allotrioceratidae. *Metamanchuroceras*
is a possible link between the Manchuroceratidae and the
Najaceratidae, as the dorsal lobate ridge in this genus
could be the origin of the dorsal mass in *Najaceras*.

siphotubes. The Allotrioceratidae have two endosiphotubes and separated endosiphocones, but they differ from *Karmbergoceras* as the cones and tubes are laterally positioned and are formed by a sagittal dividing process, whereas in *Karmbergoceras* there is no process dividing the siphuncle. *Chihlioceras* has an endosiphuncle divided into three separate cones, but they are sagitally symmetrical and Grabau (1922, p. 52, Fig. 14) indicated that there was only one endosiphotube. However the possibility that *Karmbergoceras* descended from *Chihlioceras* or a related genus can not be completely dismissed. The relationship between *Karmbergoceras* and *Probotryceras* was discussed under that genus.

Phyletic position of *Probotryceras*:- Flower (1962d) described a new genus *Botryceras* which he considered so remarkable that he placed it in a new monogeneric family only tentatively assigned to the Endoceratida. *Botryceras* had two groups of endosiphotubes in the anterior part of the endosiphuncle. *Probotryceras* also has two groups of endosiphotubes anteriorly and is probably ancestral to *Botryceras*. The changes required to derive *Botryceras* from *Probotryceras* would be an increase in the number and size of the endosiphotubes in each group and a change in their position towards the dorsum. The septal necks, connecting rings and endosiphoblades are unknown in *Botryceras* and a detailed analysis will have to await this information. *Karmbergoceras* may be an ancestor to *Probotryceras* as it has two endosiphotubes, but they are different in form and position. The endosiphotubes in *Karmbergoceras* diverge apicad and the endosiphocone is divided into two segments.

Phyletic position of *Octoceras*:- As the orientation of the siphuncle of *Octoceras* is not positively known its affinities cannot be definitely determined. The most probable position for *Octoceras* is as a

descendant of either *Williamsoceras* or *Cacheoceras* as the endosiphoblade pattern is similar to that of these genera.

<u>Phyletic position of *Felixoceras*</u>:- The shape of the endosiphocone and the shape and size of the siphuncle suggest that *Felixoceras* is a descendant of the Late Canadian genus *Stenosiphon*. *Felixoceras* can be derived from *Stenosiphon* by the siphuncle becoming more compressed. The other details are unclear as the apical end of *Stenosiphon*, the endosiphoblade pattern in *Felixoceras* and the septal necks in both genera are unknown.

CHAPTER 6

NAUTILOID SHELL STRUCTURE

INTRODUCTION

The examination of thin sections of Tasmanian Ordovician Nautiloids has revealed that, although most material is recrystallized, a small number (nine) of specimens have the layers in the shell wall preserved. Teichert (1964d) and Flower (1964b) indicated that preserved shell structure in Palaeozoic nautiloids was very rare. Balashov (1964), Flower (1964b), Fischer and Teichert (1969) and Blind (1980) have illustrated details of the shell in a small number of specimens. In the current study specimens with shell structure preserved belonging to the Michelinoceratida, Oncoceratida and the Discosorida have been found. Thus including the present and previous studies the shell structure is now known in members of the Michelinoceratida, Oncoceratida, Endoceratida, Discosorida, Ellesmeroceratida and the Ecdyceratida. In the Endoceratida, Michelinoceratida and the Discosorida where the shell structure is known in more than one genus, there is a strong similarity between the structure within each order, but a more marked difference between orders. In the Michelinoceratida the structure of the shell wall of the Early to Middle Ordovician genus *Mysterioceras* is nearly identical to that in the Pennsylvanian specimens of *Pseudorthoceras* and *"Orthoceras" unicamera*.

PREVIOUS STUDIES

Flower (1964b) stated that "In the experience of the writer, only two examples of fossil material are known showing any suggestion of layering in the conch". Both of these examples are unusual in having only one layer in the shell and this layer showing lamellae inclined at a low angle to the walls. *Ecdyceras* is such a specialized genus that unusual layering of the wall of the conch is not unexpected, but that the

ellesmerocerid, *Eremoceras,* has a similar structure is more surprising.
Examination of the illustrations in Flower (1964a) shows an irregular
outer surface on the shell and it is possible that the outer layer (or
layers) have been removed.

The studies since Flower made these comments have shown that
fossil nautiloids had   shell wall structure   not unlike that in
Nautilus.

The first of these studies was Balashov (1964) where he described
and discussed the structure of the shell wall in two Ordovician endo-
ceratids. He considered that *Nanno belemnitiforme* has four layers in the
shell, but examination of the unretouched photographs of the same speci-
men in Balashov (1968) suggests that the reality of the very thin inner-
most layer must be questioned. However, the reality of the other three
layers described by Balashov (1964) is beyond question. *Nanno belemnitiforme*
has three layers, a thin outer layer, a thicker middle layer and a thick
inner layer, which is two-thirds as thick as the middle layer. The other
endocerid described by Balashov (1964) is *Suecoceras sp.;* it also has
three layers and is very similar to *Nanno belemnitiforme* except that the
inner layer is not as thick and there is no suggestion of the very thin
fourth layer. These structures are similar to those in *Nautilus* with
the major difference the relatively thick inner layer.

In the Pennsylvanian of Oklahoma there is an asphalt bed in which
the cephalopods have been preserved as aragonite, and the fine details
of the structures are preserved. These nautiloids have been studied
by Grégoire and Teichert (1965), Fischer and Teichert (1969) and Blind
(1980). The shell structure is the typical three layered type with a
thin outer layer, a thick middle layer and an inner layer that is thinner
than either of the other layers. The outer layer can be divided into two
sub-layers based on a colour difference. The outer sub-layer is lighter
and thicker than the inner sub-layer. The general shell structure and the

microstructure of the various layers in this material is very similar

to that in *Nautilus*. The shell structure of *"Orthoceras"* *unicamera* is

illustrated in Fischer and Teichert (1969; Plate 1, fig. 1), while

Fig. 6.1(2) is a drawing made from a photograph of *Pseudorthoceras*

in Blind (1980; fig. 2).

TASMANIAN NAUTILOIDS

All the Tasmanian nautiloids which have details of the shell

structure preserved are composed of calcite, probably inverted from

original aragonite. Although the calcite is coarsely crystallized the

boundaries between the various layers are clearly preserved. In some

specimens colour variations between layers are present, but no intra-

layer structures can be seen.

Michelinoceratida:- The shell structure has been preserved in two

specimens of this order in Tasmania, the paratype of *Mysterioceras*

australe (Plate 33, fig. 3) and a specimen tentatively assigned to the

same species (Plate 33, fig. 3); Fig. 6.1(3) The shell structure is

identical in both specimens. The shell consists of three layers with

a thin outer layer (0.05mm), a thick middle layer (0.23mm) and a thin

inner layer (0.04mm). The mural part of the septum is very thin (0.01mm)

and is one-third to one-half the length of the camerae. The number and

relative thickness of the layers of the shell in the Tasmanian specimens

is very similar to that from the Pennsylvanian Michelinoceratida of Okla-

homa. The two sub-layers in the outer layer of the material from Oklahoma

is not seen in the Tasmanian material, but as the difference is based

on a colour variation it would probably be lost during the transformation

from aragonite to calcite.

Fig. (6.1)   Schematic reconstructions of the shell
structure in Palaeozoic nautiloids. The drawings
have been taken from either the actual specimens
or published photographs. All are of the ventral
wall.

1. *Nautilus*, redrawn from a photograph in Blind
(1976, Fig. 7), X15

2. *Pseudorthoceras*, redrawn from a photograph
in Blind (1980, Fig. 2) , X600

3. *Mysterioceras australe?*, drawn from a thin
section of UTGD 55562, X60

4. *Paranadiganella banksi*, drawn from a thin
section of UTGD 121140, X60

5. *Beloitoceras? molense*, drawn from a thin
section of UTGD 94619, X70

6. *Nanno belemnitiforme*, redrawn from a photograph
in Balashov (1964, Fig. 1), X30

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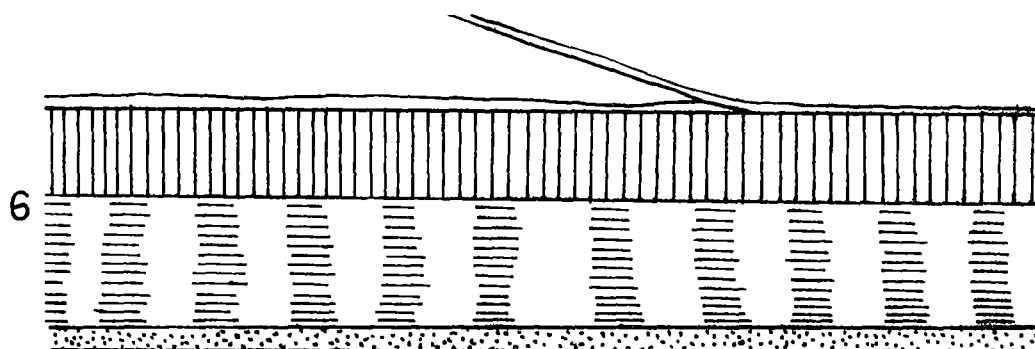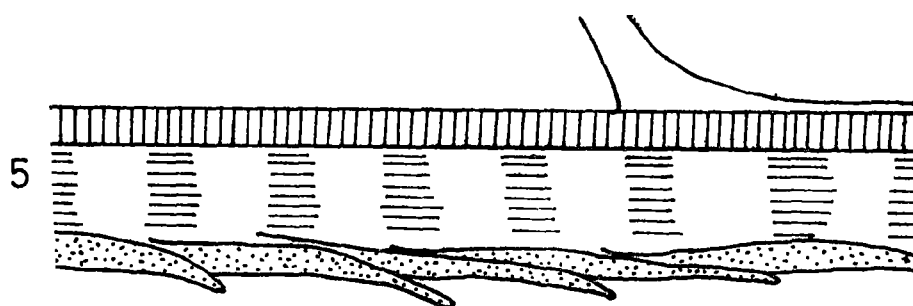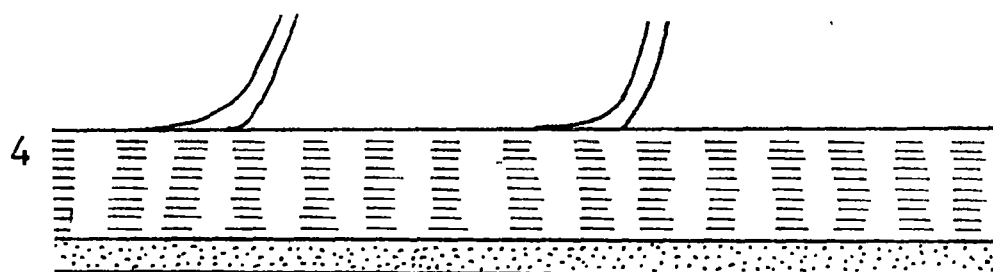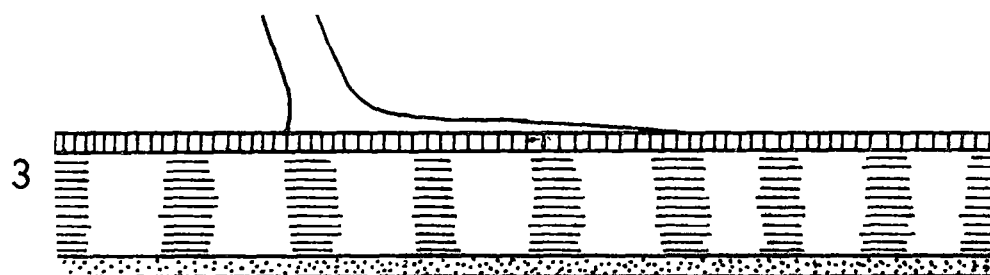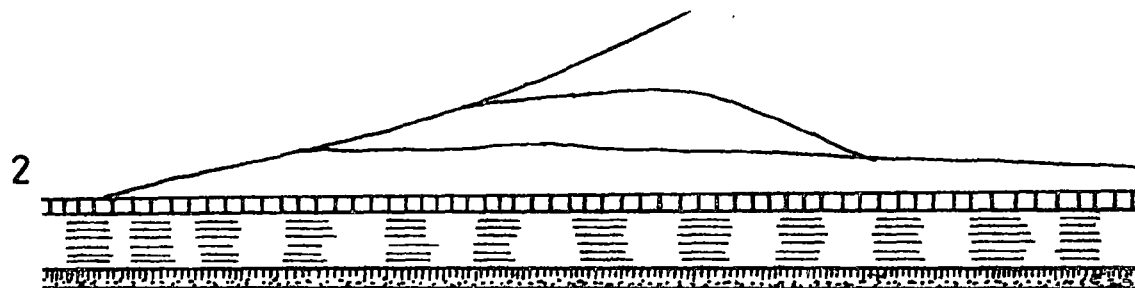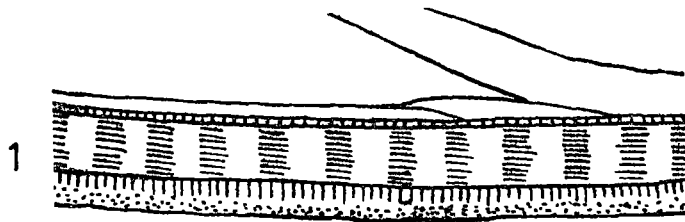
<u>Oncoceratida</u>:- Only one specimen belonging to this order with shell structure preserved is known from Tasmania, *Beloitoceras? molense* (Plate 33, fig. 12; fig. 6.1(5)). As this specimen is the only known Oncoceratida with shell structure preserved, comparison with other oncocerids is not possible. The shell is three layered with a thin outer layer which consists of overlapping rings with their adoral ends projecting into ridges (0.07mm), a thicker middle layer (0.17mm) and an inner layer which is approximately half the thickness of the middle layer (0.07mm). There is a dark band in the middle layer, but as it is erratic in position and preservation it is not clear that it is a primary structure of the shell. *Nautilus* deposits the outer layer of its shell using only the apertural edge of the mantle (Stenzel, 1964, K 77). This method of deposition does not seem adequate to explain the outer layer of *Beloitoceras? molense* where the outer layer is a series of rings with distinct boundaries and the adoral end of each ring projecting into an external ridge. This outer layer could have been deposited by a larger area of the apertural part of the mantle as a ring after which the mantle would deposit the next adoral ring inside of its predecessor.

<u>Discosorida</u>:- There are five specimens of discosorids known from Tasmania which have their shell structure preserved. These five specimens all belong to the Gouldoceratidae and two genera, *Paramadiganella banksi* (Plate 33, fig. 7-9; fig. 6.1(4) and *Tigeroceras florentinense* (Plate 33, fig. 5,6). The discosorids are different to all the other orders described in having only two layers in the shell wall rather than the typical three layers. Although the specimens of *Paramadiganella* are recrystallized to the point that the mural part of the septa is unclear and it could be argued that the inner layer has not been preserved but was present, *Tigeroceras* is not recrystallized to the same degree and has only two layers present. In *Paramadiganella* the outer layer is thin (0.08mm) and slightly darker in colour and the inner layer is much thicker (0.25mm) and lighter in

colour. In all specimens the mural part of each septum is recrystallized and the boundary between it and the inner layer is not clear in any specimen , but the outer surface of the mural part of each septum indicate that it probably extends the entire length of the camerae. In *Tigeroceras* the outer layer is thin (0.2mm) and has a granular texture, and the inner layer is thick (0.9mm) and consists of a number of lamellae alternating between light and dark layers which are not continuous but lense out along the specimen.

GENERAL COMMENTS

Although there are still only a very small number of nautiloids with the details of the shell preserved, the range of orders in which representative are known is great and thus a few general comments on the shell structure can be made.

The drawings of the shell structure in *Nautilus* in Blind (1976) show that it has a three layered shell (fig. 6.1(1)) with a thin outer layer (divided into two sub-layers), a thick middle layer and a thin inner layer. This structure is also observed in the majority of the fossil nautiloids discussed herein. The relative thickness of the layers of the shell varies between genera and orders, but the middle layer is always the thickest. The Buckhorn cephalopods are the only Palaeozoic nautiloids still composed of aragonite and the composition and microstructure of the shell is very similar to *Nautilus*.

The most primitive nautiloids in which shell structure is known do not have the typical three layered shell structure. These are the ellesmeroceratid, *Eremoceras* and the discosorids, *Paramadiganella* and *Tigeroceras* which have two-layered shells. This strongly suggests that the primitive shell structure in nautiloids was two-layered rather than the typical three layered shell, and that the inner layer evolved at a later stage. The Michelinoceratida developed the third shell layer by the

Early-Middle Ordovician and by the middle Ordovician the Endoceratida had a very thick third layer. The shell structure of the Ordovician Michelinoceratid, *Mysterioceras* is nearly identical to the Pennsylvanian genera from the Buckhorn Asphalt and both are very similar to *Nautilus*, suggesting that the three layered shell was the stable condition. A similar three layered shell is present in the Oncoceratida, but the only known specimen has an unusual structure in the outer layer. This may not be typical of the whole Oncoceratida, but until more material is found, no useful comment can be made.

The relative thickness of the entire shell is variable between the known specimens, but as it is also variable within one species this is not considered a very important feature.

The Ecdyceratida do not have the typical shell structure and appear to have only one layer, but as the structure of the entire couch is very unusual it is not surprising that the shell structure is also very different.

PLATE 33.

All specimens are oriented venter down.

Figs. 1-2: The ventral shell wall of *Beloitoceras? molense* UTGD 94619, showing the three layers of the shell and the mural part of the septa, apex left, 1. X60, 2. X40.

Fig. 3: The ventral wall of the paratype of *Mysterioceras australe* UTGD 20883b, the outer layer is clear,the inner layer is only poorly preserved, X60.

Fig. 4: Ventral wall of *Mysterioceras australe?* showing the three layers of the shell and the mural part of the septa, X55.

Figs. 5-6: The ventral wall of *Tigeroceras* UTGD 22042 showing the two layers of the shell;
5. The apical end of the specimen, X30.
6. The adoral end of the specimen, X30.

Figs. 7-9: The ventral wall of *Paramadiganella* UTGD 121139, 121140, and 121141, showing the two layers of the shell and the mural part of the septa, all X60.

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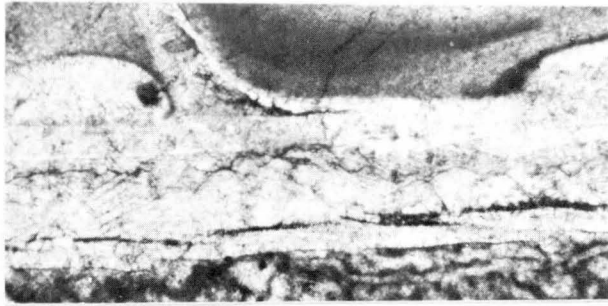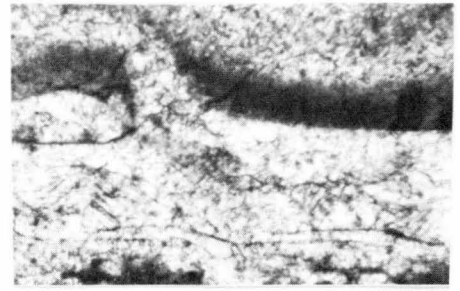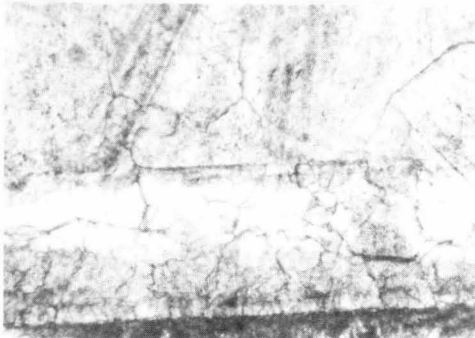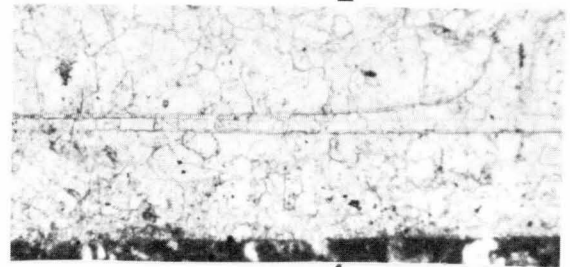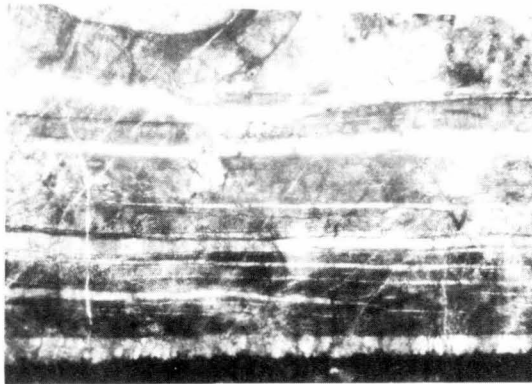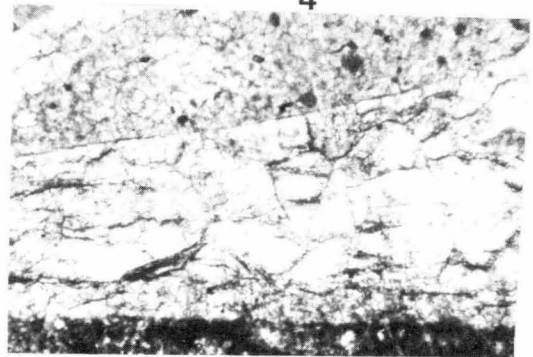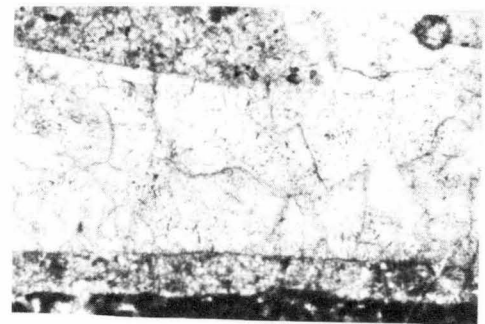
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CHAPTER 7

CONCLUSIONS

Although nautiloids are only a minor component of the Ordovician faunas of Tasmania and collection of significant numbers of specimens is very difficult, the available information enables a number of conclusions to be made.

All the nautiloids described in this study were collected from the, predominately carbonate, Gordon Sub-group. The Gordon Sub-group is widespread in the south, west and north of Tasmania. In the Florentine Valley, where the major collections were made, the Gordon Sub-group is over 2000 metres thick. The faunas from the other areas studied were related to the Florentine Valley section. This has allowed the Early Trenton age of Smelter's Quarry, Queenstown and of the lowest horizon at Wilson River to be demonstrated for the first time.

The international correlations are based on conodonts, brachiopods, and (in the lowest horizon) graptolites. The 17 Ordovician brachiopod biozones of Laurie (1982) are used as the basic biostratigraphic units for internal Tasmanian correlations.

There are 57 species of nautiloids known from the Ordovician of Tasmania, of which 26 are described for the first time in this study. These species belong to 38 genera, of which 17 are new, and 19 families of which one is new, and 7 orders. The number of families, genera and species in each order of nautiloids from Tasmania is given in fig. (7.1).

Fig (7.1)

	Families		Genera		Species	
	def.	tent.	def.	tent.	def.	tent.
Actinoceratida	2	–	4	1	5	3
Discosorida	1	–	8	1	11	2
Endoceratida	5	1	8	–	11	2
Michelinoceratida	5	–	9	1	8	5
Oncoceratida	2	–	3	1	4	1
Tarphyceratida	2	–	2	–	3	–
Ellesmeroceratida	1	–	1	–	2	–

The Tasmanian Ordovician nautiloids can be grouped into six bio-stratigraphic assemblages, which are established in the Florentine Valley and can be correlated throughout Tasmania. The composition of the assemblages is:

Assemblage 1, *Piloceras-Manchuroceras* assemblage: *Pycnoceras adamense* n.sp., *Manchuroceras excavatum, M. steanei, Suecoceras robustum, Piloceras tasmaniense, Metamanchuroceras wadeae* n.gen., n.sp., and *Allocotoceras insigne.*

Assemblage 2, *Wutinoceras-Adamsoceras* assemblage: *Wutinoceras pauci-cubiculatum,, W. multicubiculatum, Adamsoceras johnstoni, Karmbergoceras duosiphonatum* n.gen., n.sp., and *Endoceratidae* n.gen., n.sp.

Assemblage 3, *Discoceras-Gorbyoceras* assemblage: *Mysterioceras australe, Gorbyoceras settlementense* n.sp., *Fitzgeraldoceras juneense* n.gen., n.sp., *Standardoceras burretti* n.gen., n.sp., *Orthoceras* sp., *Discoceras idaense, Beloitoceras* sp., *Centrocyrtocerina frizonense* n.gen., n.sp., *Armenoceras corbetti* n.sp., *Ormocerina asymmetrica* n.gen., n.sp., *Paramadiganella banksi* n.gen., n.sp., *Florentinoceras calveri* n.gen., n.sp., *Anmoceras lauriei* n.gen., n.sp., *Octoceras uniquum* n.gen., n.sp., *Felixoceras curtainense* n.gen., n.sp.,

Probotryceras westfieldense n.gen., n.sp.

Assemblage 4, *Tasmanoceras-Hecatoceras-Gouldoceras* assemblage:

Anaspyroceras? anzaas, Discoceras reidi n.sp.,*Beloitoceras kirtoni,*

Miamoceras bubsense n.sp., *Zeehanoceras teicherti* n.gen., n.sp.,

Tasmanoceras pagei n.sp., *T. zeehanense, Hecatoceras longinquum,*

Gouldoceras synchonena, G. obliquum and *G. benjaminense* n.sp.

Assemblage 5, *Gordonoceras* assemblage: *Gordonoceras bondi.*

Assemblage 6, *Westfieldoceras* assemblage: *Westfieldoceras taylori* n.gen.,

n.sp., *Tigeroceras florentinense* n.gen., n.sp., *Armenoceras* ?sp. and

Gouldoceratidae n.gen., n.sp.

A small number of species cannot be definitely assigned to an assemb-

lage. These are: *Stromatoceras eximium, Ephippiorthoceras decorum,*

Sinoceras? sp., *Beloitoceras? molense* n.sp., *Centrocyrtocerina sharplesi*

n.gen., n.sp.

Assemblages 1, 5 and 6 are restricted to the Florentine Valley.

Assemblage 2 is widespread in Tasmania and is found at Blenkhorn's Quarry,

Railton (northwestern Tasmania) and the Hardwood River in south-western

Tasmania. Assemblage 3 occurs at Ida Bay in south-eastern Tasmania and

at Mole Creek in northern Tasmania. Assemblage 4 is the most widespread

in the Ordovician of Tasmania occurring at Ida Bay, Bubs Hill, Zeehan,

Queenstown (West Coast) and Mayberry (Northern Tasmania).

The international correlations of the nautiloid assemblages are with

the North American series as the conodonts and brachiopods have strong

affinities with those of North America. Assemblage 1 contains cephalopods

which correlate with the Late Canadian of North America and also with

Chinese faunas. This correlation is supported by the conodonts, which

belong to the *Prioniodus evae* Zone and the graptolites, which correlate

with the Late *Didymograptus extensus* in the Skiddaw Group. Assemblage

2 contains cephalopods which correlate with the Whiterock of North America

and the cephalopods of the Wuting Limestone of China. The conodonts

and brachiopods found in association with the cephalopods support this correlation., Assemblage 3 contains nautiloids that are either endemic or long-ranging cosmopolitan genera. The conodonts and brachiopods suggest a Chazy and Blackriver age for this assemblage. Assemblage 4 also contains only endemic or long-ranging genera, but the conodonts and brachiopods indicate an Early to Middle Trenton age. The age of assemblage 5 is difficult to determine as the only nautiloid present is endemic, and no brachiopods are found at this level. The age is considered to be Eden (in the sense of Sweet and Bergström (1971)) as the underlying assemblage (200 metres below stratigraphically) contains Early to Middle Trenton conodonts and the overlying assemblage (150 metres above) contains Maysville conodonts. Assemblage 6 also contains a predominately endemic cephalopod fauna, but the conodonts and corals suggest a Maysville age.

The Ordovician nautiloids of Tasmania have a high degree of endemism with all species, and the majority of the genera, restricted to Tasmania. The degree of endemism increases through the Ordovician, with the lowest provincialism in the Late Canadian and the highest in the Blackriver, fig. (7.2). In the Late Ordovician there is an even higher degree of provincialism but this may be a reflection of the lack of information in strata of this age in Tasmania.

The detailed stratigraphic collecting and the good control on the age of the nautiloids in the Ordovician of Tasmania allows detailed comments on the phylogeny of the genera described in this study to be made.

The Discosorida in Tasmania are represented by an endemic family, the Gouldoceratidae. There are eight genera belonging to this family in the Florentine Valley and a very detailed phylogeny can be determined. *Madiganella* from the Late Canadian of Central Australia is the most probable ancestor for the Gouldoceratidae. After the initial evolution from *Madiganella* the Gouldoceratidae can be divided into two separate trends.
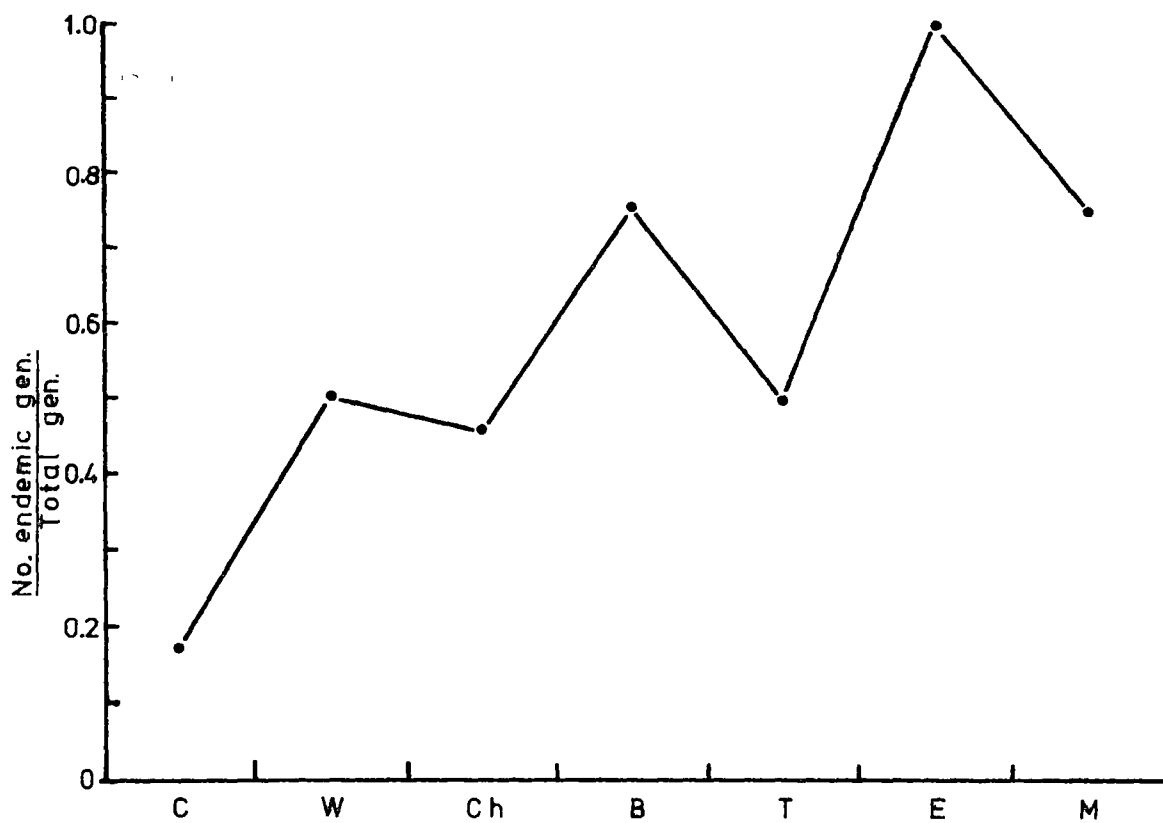
Fig. (7.2)   The variation in endemism of the Tasmanian

Ordovician nautiloids through time. C:- Canadian;

W:- Whiterock; Ch:- Chazy; B:- Blackriver: T:-Trenton

E:- Eden; M:- Maysville.

The first trend is from *Madiganella* through *Paramadiganella, Gouldoceras, Tigeroceras* to *Westfieldoceras*. In this trend the septal necks become more cyrtochoanitic, the free part of the septa at the septal foramen increasingly bends to point towards the apex and the siphuncular segments change slope so that the segments slope adorally from the venter to the dorsum. The second trend is from *Madiganella* through *Florentinoceras, Anmoceras* to *Tasmanoceras*. In this trend the septal necks change from cyrtochoanitic to orthochoanitic, the siphuncle increases in size relative to the phragmocone and becomes more marginal and the siphonal tube becomes variable in position. The other known genus that could be a member of the Gouldoceratidae is *Hoeloceras* from the Oslo region of Norway, but until the holotype can be re-examined this cannot be demonstrated. The Gouldoceratidae, if *Madiganella* is included, is the oldest family of the Discosorida and may be the ancestral family of that order. The presence of simple two-layered connecting rings, similar to those in the Ellesmeroceratida supports the contention that the Gouldoceratidae were derived from that order and suggest a possible origin in the Baltoceratidae.

The Actinoceratida of Tasmania are not as important in phylogenetic terms as the Gouldoceratidae with both *Wutinoceras* and *Adamsoceras* typical of those genera both in age and structure. *Armenoceras corbetti* is one of the oldest members of *Armenoceras* and shows the dorsoventral differentiation in adnation of the connecting rings typical of the Wutinoceratidae and supports the suggestion that the Armenoceratidae evolved from the Wutinoceratidae. *Ormocerina* is an unusual actinocerid and its exact phyletic position is unclear, but an origin in the Ormoceratidae seems most probable.

The only representative of the Ellesmeroceratida in Tasmania is *Centrocyrtocerina,* a gyroconic member of the Cyrtocerinina. The phylogeny of the Cyrtocerinina begins with *Eothinoceras* then through *Tangshanoceras* to *Cyrtocerina* and *Centrocyrtocerina,* with the amount of curvature in-

creasing and removal of the siphuncle from the ventral margin.

Two genera from Tasmania are of significance to the phylogeny of the Michelinoceratida, *Fitzgeraldoceras* and *Standardoceras*. *Fitzgeraldoceras* contains two generations of siphonal deposits and is assignable to the cayutoceratinae and is an ideal ancestor to both *Stromatoceras* and *Eostromatoceras*. Not enough information on *Metastromatoceras* is available to enable its position in the above phylogeny to be determined, but it may act as a link between the Middle Ordovician genera and the Early Devonian, *Buchanoceras*. *Standardoceras* is a member of the Striato-ceratidae and is closely related to *Striatoceras*, but until more inform-ation is available on *Striatoceras* the exact relationship is unclear.

The only new genus of the Oncoceratida in this study, *Zeehanoceras*, is assignable to the Tripteroceratidae. *Zeehanoceras* can be derived from *Eotriptoceras*, which is transferred from the Michelinoceratida to the Tripteroceratidae, with a decrease in the size of the siphuncle and a flattening of the venter of the phragmocone.

Five new genera of the Endoceratida are described in this study, *Octoceras Metamanchuroceras, Probotryceras, Felixoceras* and *Karmbergoceras*. *Felixoceras* is probably a Chazy descendant of *Stenosyphon*, but as *Stenosiphon* is poorly known this cannot be confirmed. *Octoceras* is also Chazy in age, but as its orientation is not known its phyletic position is unclear. *Metamanchuroceras* is a long slender Manchuroceratidae, which initially is rapidly expanding and similar to *Manchuroceras*. As *Meta-manchuroceras* has a dorsal lobate ridge in the endosiphocone it may be the link between the true Manchuroceratidae and the Najaceratidae.

Botryceras is an unusual endocerid in having two groups of endo-siphotubes; *Probotryceras* from the Late Chazy of Tasmania also has two groups of tubes and is the logical ancestor of *Botryceras*. *Karmbergoceras* is very unusual as it has two endosiphotubes, not connected by an infula, and a divided endosiphocone making the phylogenetic position of this genus unclear.

The structure of the shell has been preserved in some specimens from the Ordovician of Tasmania. When the Tasmanian material is combined with that from previous studies, information from the Michelinoceratida, Discosorida, Endoceratida, Oncoceratida, Ecdyceroceratida and the Ellesmeroceratida is available. *Nautilus* has a three-layered shell, which is similar to the majority of fossil nautiloids. The Michelinoceratida have three layers with thin outer and inner layers and a much thicker middle layer. The Endoceratida are three-layered but the inner layer is nearly as thick as the middle layer. The only representative known from the Oncoceratida also has three layers, but the outer layer is composed of overlapping rings in which the doral end projects as a ridge. However, the most primitive genera known do not have the typical three-layered shell as the inner layer is not present. This suggests that the third (inner) layer was added after the initial evolution of the nautiloids. The Ecdyceratida have many unusual features and the apparent shell structure is only a single layer. The present study has made the very complete Middle and Late Ordovician Tasmanian nautiloid faunas comparitively well known. The faunas of Western Australia were studied in some detail 30 years ago. The remainder of the Ordovician nautiloid faunas in Australia must now be studied to allow the already described faunas to reach their maximum potential. A detailed study of the Central Australian fauna is most urgent, as *Madiganella* is a possible ancestor to the Discosorida and has not been described since a preliminary study in 1952. The faunas being examined by Dr. M. Wade in Western Queensland also contains many important and unusual nautiloids and when this study is complete it will, in conjunction with the present study, allow a more detailed picture of nautiloid evolution to be obtained.

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APPENDIX   1

Fossil Catalogue

The Grid References Quoted in this list are all from the

1:100,000 series. They are quoted in the following sequence:-

8112:460700

Sheet number   Easting   Northing
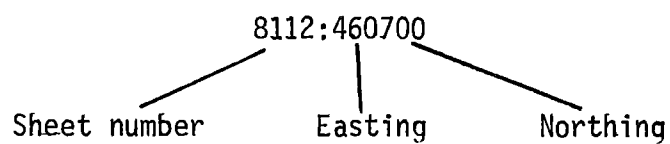
20525		*Piloceras tasmaniense* Adamsfield	8112:460700
20739		Michelinoceratida gen.,sp. indet. Goliath Quarry	8115512247
20856		*Gorbyoceras settlementense?* Ida Bay	8211:888874
20883	holo	*Discoceras idaense* Ida Bay	8211:873878
20883b	para	*Mysterioceras australe* Ida Bay	8211:873878
21181	holo	*Allocotoceras insigne* Adamsfield	8112:460700
21962	para	*Fitzgeraldoceras juneense* Fitzgerald Quarry	8212:642668
22042	holo	*Tigeroceras florentinense* Tiger Range	8112:503705
22089		*Armenoceras ?* sp. Tiger Range	8112:503705
23709		*Beloitoceras kirtoni* small Smelters Q. Zeehan	7914:625582
24494	para	*Pycnoceras adamsense* Adamsfield	8112:460700
24495	"	" " "	" "
24498	"	" " "	" "
24502	holo	" " "	" "
24506	para	" " "	" "
25066		*Gorbyoceras settlementense?* Ida Bay	8211:873878
25068		" " " "	" "
54509	holo	*Centrocyrtocerina sharplesi* Ida Bay	8211:890880
55529	holo	*Fitzgeraldoceras juneense* Fitzgerald Quarry	8212:692668
55553	holo	*Gouldoceras synchonena* Smelters Quarry Queenstown	8013:807416
55562		*Mysterioceras australe ?* Settlement Road	8112:545885
56471a		*Tasmanoceras* cf. *zeehanense* Mayberry	8114:455980
56471b		" " "	" "
59373		*Wutinoceras* cf. *multicubiculatum* Hardwood River	8012:100420
80889	holo	*Discoceras reidi* Bubs Hill	8013:987363
80896		*Gorbyoceras settlementense ?* Bubs Hill	8013:987363
80914	holo	*Miamoceras bubsense* Bubs Hill	8013:987363
80937	para	" " " "	" "
80954	"	" " " "	" "
81145		*Discoceras idaense* Settlement Road	8112:545885
81148		Michelinoceratida gen.,sp. indet. 8 Road West	8112:560740

81151	para	*Paranadiganella banksi* Settlement Road	8112:565880
81156	holo	*Armenoceras corbetti* Settlement Road	8112:567880
81165	holo	*Octoceras uniquum* 8 Road West	8112:560740
81791a	hypo	*Gouldoceras synchonena* Larger Smelters Q. Zeehan	7914:623582
81791b	"	" " " " " "	" "
81791c	"	" " " " " "	" "
81791d	"	" " " " " "	" "
85488		*Discoceras reidi* Larger Smelters Q. Zeehan	7914:623582
85624	holo	*Manchuroceras excavatum* Adamsfield	8112:460700
85625	holo	*Manchuroceras steanei* "	" "
85626	holo	*Suecoceras robustum* "	" "
85630	holo	*Piloceras tasmaniense* "	" "
89060	holo	*Metamanchuroceras wadeae* "	" "
90871	holo	*Zeehanoceras teicherti* Larger Smelters Q. Zeehan	7914:623582
91040		*Beloitoceras kirtoni* " " " "	" "
91053	holo	*Standardoceras burretti* Standard Hill, Mole Ck.	8114:466989
94297		*Wutinoceras* cf. *paucicubiculatum* Gordon Road	8112:510660
94619	holo	*Beloitoceras ? molense* Mole Creek	8114:460028
95131		*Hecatoceras longinquum* 300m L.L.M. Westfield	8212:591795
95132		" " " " "	" "
95793	holo	*Westfieldoceras taylori* U.L.M. Westfield	8212:594785
95796		Gouldoceratidae n.gen.,n.sp. "	" "
121127	holo	*Ormocerina asymmetrica* 140m L.L.M. Settlement Rd	8112:560885
121129	para	" " " " " "	" "
121129	holo	*Gouldoceras benjaminense* 450m L.L.M. Settlement Rd	8112:555880
121130	para	" " " " " "	" "
121131	para	" " " " " "	" "
121132	holo	*Anmoceras lauriei* 140m L.L.M. Settlement Rd	8112:560885
121133	para	" " " " " "	" "
121134	para	" " " " " "	" "
121135	para	" " " " " "	" "

122236	para	*Ammoceras lauriei* 140m L.L.M. Settlement Rd	8112:560885
121137	holo	*Florentinoceras calveri* 70m L.L.M. Westfield	8212:598798
121138	holo	*Paramadiganella banksi* 68m L.L.M. Settlement R.	8112:561887
121139	para	" " " " " "	" "
121140	"	" " " " " "	" "
121141	"	" " " " " "	" "
121142	"	" " " " " "	" "
121143	"	" " " " " "	" "
121144	"	" " " " " "	" "
121145	"	" " " " " "	" "
121146	"	" " " " " "	" "
121147		*Tasmanoceras zeehanense* 320m L.L.M. Westfield	8212:591795
121148		" " Eleven Road	8112:555781
121149		" " 340m L.L.M. Westfield	8212:591795
121150		" " 320m L.L.M. Westfield	8212:591795
121151		" " 320m L.L.M. Westfield	8212:591795
121152		" " 320m L.L.M. Settlement	8112:553882
121153		" " Eleven Road	8112:554781
121154		" " 330m L.L.M. Westfield	8212:591795
121155		" " 320m L.L.M. Westfield	8212:591795
121156	holo	*Tasmanoceras pagei* 450m L.L.M. Settlement Rd	8112:555880
121157		*Tasmanoceras* cf. *pagei* 380m L.L.M. Settlement	8112:556887
121158	para	*Westfieldoceras taylori* 400m U.L.M. Westfield	8212:594785
121159	para	" " " " "	" "
121160		Gouldoceratidae n.gen.,n.sp. " "	" "
121161	holo	*Centrocyrtocerina frizonense* Frizons Road	8112:546925
121162		*Allocotoceras insigne* Adams River	8112:437699
121163	holo	*Felixoceras curtainense* Felix Curtain Road	8112:536814

121164		Endoceratidae n.gen.,n.sp. Blenkhorns Quarry	8115:517248
121165		" " " " "	" "
121166		" " " , " "	" "
121167		" " " " "	" "
121168		" " " " "	" "
121169		" . " " " "	" "
121170		" " " " "	" "
121171		" " " " "	" "
121172		" " " " "	" "
121173		" " " " "	" "
121174		" " " " "	" "
121175		" " " " "	" "
121176		" " " " "	" "
121177		. " " " Frizons Road	8112:546925
121178		*Piloceras tasmaniense* Adamsfield	8112:460700
121179	holo	*Probotryceras westfieldense* 10m L.L.M. Westf.	8212:597798
121180	holo	*Karmbergoceras duosiphonatum* Sunshine Road	8212:645692
121181		Endoceratida gen.,sp. indet. Frizons Road	8112:545925
121182		*Orthoceras* sp. Sunshine Road	8212:645692
121183		*Sinoceras ?* sp. Surprise Bay	8210:700810
121184		" " " "	" "
121185		" " " "	" "
121186		" " " "	" "
121187		*Mysterioceras australe ?* Sunshine Road	8212:645692
121188	holo	*Gorbyoceras settlementense* Settlement Road	8112:557888
121189	para	" " " "	" "
121190	"	" " " "	" "
121191	"	" " Westfield (C82)	8212:598798
121192		*Gorbyoceras settlementense ?* Mole Creek	2114:453008
121193		" " " "	" "
121194		*Gordonoceras bondi* 280m U.L.M. Westfield	8212:592795

121195		*Gordonoceras bondi* 280m U.L.M. Westfield	8212:592795
121196		" " " " "	" "
121197	para	*Standardoceras burretti* Mole Creek	8114:466989
121198		*Beloitoceras* sp. Eleven Road	8112:547782
121199		*Discoceras idaense* Settlement Road	8112:557887
121200		" " Westfield	8212:591800
121201	para	*Discoceras reidi* Bubs Hill	8013:987363
121202		*"Gasconsoceras"insperatum* Larger Smelt. Q. Ze.	7914:623582
121203		*Hecatoceras longinquum* Eleven Road	8112:555781
121204		" " 340m L.L.M. Westfield	8212:591795
121205		*Gordonoceras bondi* 280m U.L.M. Westfield	8112:592795
121206		*Madiganella* sp. Horn Valley Siltstone, Cent. Australia.	

APPENDIX   2

A series of range charts illustrating the ranges of the Tasmanian

nautiloids by locality, Taxonomic order and Assemblage.

CHART 2.1 :- The ranges of the Tasmanian nautiloid species grouped

by taxonomic order.

CHART 2.2 :- The ranges of the Tasmanian nautiloid species grouped

by locality.

CHART 2.3 :- The ranges of the Tasmanian nautiloid species grouped

by biostratigraphic assemblage.

The ranges are given in terms of the North American stages; how these

relate to the Tasmania strata can be found in chapter 3.

ACTINOCERATIDA and DISCOSORIDA stratigraphic range chart

	CANADIAN	WHITEROCK	CHAZY	BLACKRIVER	TRENTON	EDEN	MAYSVILLE
ACTINOCERATIDA							
Wutinoceras multicubiculatum		●					
Wutinoceras paucicubiculatum		●					
Wutinoceras cf. *multicubiculatum*		?					
Wutinoceras cf. *paucicubiculatum*		●					
Adamsoceras johnstoni		●					
Armenoceras corbetti			●				
Ormocerina asymmetrica				●			
Armenoceras ? sp.							●
DISCOSORIDA							
Florentinoceras calveri				●			
Paramadiganella banksi				●			
Anmoceras lauriei				●			
Tasmanoceras zeehanense					●—●		
Tasmanoceras cf. *zeehanense*					●		
Tasmanoceras cf. *pagei*					●		
Hecatoceras longinquum					●—●		
Tasmanoceras pagei					●		
Gouldoceras synchonena					●		
Gouldoceras obliquum					●		
Gouldoceras benjaminense					●		

CHART 2.1

270

	CANADIAN	WHITEROCK	CHAZY	BLACKRIVER	TRENTON	EDEN	MAYSVILLE
Tigeroceras florentinense						•	
Westfieldoceras taylori							•
Gouldoceratidae n.gen.,n.sp.							•

ENDOCERATIDA

	CANADIAN	WHITEROCK	CHAZY	BLACKRIVER	TRENTON	EDEN	MAYSVILLE
Metamanchuroceras wadeae	•						
Manchuroceras excavatum	•						
Manchuroceras steanei	•						
Suecoceras robustum	•						
Piloceras tasmaniense	•						
Allocotoceras insigne	•						
Octoceras uniquum			•				
Felixoceras curtainense			•				
Probotyceras westfieldense				•			
Endoceratida n.gen.,n.sp.		•					

ONCOCERATIDA

	CANADIAN	WHITEROCK	CHAZY	BLACKRIVER	TRENTON	EDEN	MAYSVILLE
Beloitoceras sp.				•			
Beloitoceras kirtoni					•		
Miamoceras bubsense					•		
Zeehanoceras teicherti					•		
Beloitoceras ? molense							•

	CANADIAN	WHITEROCK	CHAZY	BLACKRIVER	TRENTON	EDEN	MAYSVILLE

MICHELINOCERATIDA

Orthoceras sp.

Fitzgeraldoceras juneense

Standardoceras burretti

Gorbyoceras settlementense

Mysterioceras australe

Anasyroceras anzaas

Gordonoceras bondi

Sinoceras ? sp.

TARPHYCERATIDA

Pycnoceras adamense

Discoceras idaense

Discoceras reidi

ELLESMEROCERATIDA

Centrocyrtocerina frizonense

Centrocyrtocerina sharplesi

CHART 2.2

	CANADIAN	WHITEROCK	CHAZY	BLACKRIVER	TRENTON	EDEN	MAYSVILLE
FLORENTINE VALLEY							
Wutinoceras cf. *multicubiculatum*		●					
Armenoceras corbetti			●				
Ormocerina asymmetrica				●			
Armenoceras ? sp.							
Florentinoceras calveri				●			
Paramadiganella banksi				●			
Anmoceras lauriei				●			
Tasmanoceras zeehanense				●———●			
Tasmanoceras cf. *zeehanense*					●		
Tasmanoceras cf. *pagei*					●		
Hecatoceras longinquum				●———●			
Tasmanoceras pagei						●	
Gouldoceras benjaminense						●	
Tigeroceras florentinense							●
Westfieldoceras taylori							●
Gouldoceratidae n.gen.,n.sp.							●
Metamanchuroceras wadeae	●						
Manchuroceras excavatum	●						
Manchuroceras steanei	●						
Suecoceras robustum	●						
Piloceras tasmaniense	●						
Allocotoceras insigne	●						

	CANADIAN	WHITEROCK	CHAZY	BLACKRIVER	TRENTON	EDEN	MAYSVILLE
Karmbergoceras duosiphonatum		●					
Octoceras uniquum			●				
Felixoceras curtainense			●				
Probotyceras westfieldense				●			
Endoceratida n.gen.,n.sp.		●					
Beloitoceras sp.				●			
Orthoceras sp.		●					
Fitzgeraldoceras juneense			?				
Gorbyoceras settlementense				●———●			
Gordonoceras bondi						●	
Pycnoceras adamense		●					
Discoceras idaense				●———●			
Centrocyrtocerina frizonense			●				

BUBS HILL

	CANADIAN	WHITEROCK	CHAZY	BLACKRIVER	TRENTON	EDEN	MAYSVILLE
Miamoceras bubsense					●		
Gorbyoceras settlementense?					●		
Discoceras reidi					●		

EUGENANA

	CANADIAN	WHITEROCK	CHAZY	BLACKRIVER	TRENTON	EDEN	MAYSVILLE
Gorbyoceras settlementense?			●				

	CANADIAN	WHITEROCK	CHAZY	BLACKRIVER	TRENTON	EDEN	MAYSVILLE

GORDON RIVER

	CANADIAN	WHITEROCK	CHAZY	BLACKRIVER	TRENTON	EDEN	MAYSVILLE
Gordonoceras bondi						?	
Ephippiorthoceras decorum						?	
Anaspyroceras sp.						?	
Tasmanoceras zeehanense						?	
Stromatoceras eximium						?	

HARDWOOD RIVER

	CANADIAN	WHITEROCK	CHAZY	BLACKRIVER	TRENTON	EDEN	MAYSVILLE
Wutinoceras cf. *multicubiculatum*		●					

IDA BAY

	CANADIAN	WHITEROCK	CHAZY	BLACKRIVER	TRENTON	EDEN	MAYSVILLE
Hecatoceras longinquum					●		
Mysterioceras australe				●			
Gorbyoceras settlementense				●――――――――――――●			
Discoceras idaense				●			
Centrocyrtocerina sharplesi						?	

MOLE CREEK

	CANADIAN	WHITEROCK	CHAZY	BLACKRIVER	TRENTON	EDEN	MAYSVILLE
Beloitoceras? molense							●
Standardoceras burretti				●			
Gorbyoceras settlementense?					●		
Discoceras sp.					●		
Tasmanoceras cf. *zeehanense*					?		

	CANADIAN	WHITEROCK	CHAZY	BLACKRIVER	TRENTON	EDEN	MAYSVILLE
QUEENSTOWN							
Gouldoceras synchonena					●		
Gorbyoceras sp.				●			
Beloitoceras kirtoni					●		
RAILTON							
Wutinoceras multicubiculatum		●					
Wutinoceras paucicubiculatum		●					
Adamsoceras johnstoni		●					
Endoceratida n.gen.,n.sp.		●					
SURPRISE BAY							
Sinoceras sp.						●	
ZEEHAN							
Gouldoceras synchonena					●		
Gouldoceras obliquum					●		
Tasmanoceras zeehanense					●		
Beloitoceras kirtoni					●———●		
Zeehanoceras teicherti					●		
Anaspyroceras? anzaas					●		
Discoceras reidi					●———●		

	CANADIAN	WHITEROCK	CHAZY	BLACKRIVER	TRENTON	EDEN	MAYSVILLE

ASSEMBLAGE 1

Pycnoceras adamsense ●

Manchuroceras excavatum ●

Manchuroceras steanei ●

Suecoceras robustum ●

Piloceras tasmaniense ●

Metamanchuroceras wadeae ●

Allocotoceras insigne ●

ASSEMBLAGE 2

Wutinoceras paucicubiculatum ●

Wutinoceras multicubiculatum ●

Adamsoceras johnstoni ●

Karmbergoceras duosiphonatum ●

Endoceratidae n.gen.,n.sp. ●

ASSEMBLAGE 3

Mysterioceras australe ●

Gorbyoceras settlementense ●————————————————●

Fitzgeraldoceras juneense ?

Standardoceras burretti ●———●

Orthoceras sp. ●

CHART 2.3

	CANADIAN	WHITEROCK	CHAZY	BLACKRIVER	TRENTON	EDEN	MAYSVILLE

Discoceras idaense ● (CHAZY) ● (BLACKRIVER)

Beloitoceras sp. ● (BLACKRIVER)

Centrocyrtocerina frizonense ● (CHAZY)

Armenoceras corbetti ● (CHAZY)

Ormocerina asymmetrica ● (BLACKRIVER)

Paramadiganella banksi ● (BLACKRIVER)

Florentinoceras calveri ● (CHAZY)

Armoceras lauriei ● (BLACKRIVER)

Octoceras uniquum ● (CHAZY)

Felixoceras curtainense ● (CHAZY)

Probotryceras westfieldense ● (CHAZY)

ASSEMBLAGE 4

Anaspyroceras anzaas ● (TRENTON)

Discoceras reidi ● (TRENTON)

Beloitoceras kirtoni ● (TRENTON)

Miamoceras bubsense ● (TRENTON)

Zeehanoceras teicherti ● (TRENTON)

Tasmanoceras zeehanense ●—● (BLACKRIVER–TRENTON)

Tasmanoceras pagei ● (EDEN)

Hecatoceras longinquum ●—● (BLACKRIVER–TRENTON)

278

	CANADIAN	WHITEROCK	CHAZY	BLACKRIVER	TRENTON	EDEN	MAYSVILLE
Gouldoceras synchonena					●		
Gouldoceras obliquum					●		
Gouldoceras benjaminense					●		
ASSEMBLAGE 5							
Gordonoceras bondi						●	
ASSEMBLAGE 6							
Westfieldoceras taylori							●
Tigeroceras florentinense							●
Armenoceras? sp.							●
Gouldoceratidae n.gen.,n.sp.							●

APPENDIX   3

<u>TECHNIQUES</u> ·

Preparation of specimens :

- The specimens were dorso-venrally sectioned using a diamond
  saw; 0.35mm in thickness.

- The cut sections were polished, firstly on a rotating·lap with
  220 powder, then on a glass plate with Al. powder, and finally
  a very high polish on a felt lap usins tin oxide.

- Any acid dissolution is with 10% acetic acid.

Photography of specimens :

- All polished opaque sections and thin sections less than 35mm
  in length were photographed using a Wild M400 Photomacroscope.

- All specimens greater than 35mm were photographed with a macro-
  lens on a Pentax K1000.

- Any specimen where a high polish was not possible olive oil
  was spread over the specimen before photography, this enables
  the fine detail to be seen.

- Non-sectioned material was prepared for photograph by first
  blackening the specimen (using a black felt pen in which the
  ink has been diluted with acetone) then coating the specimen
  with MgO.

Drawing of specimens :

- Thin sections were drawn using a projectina.

- All other specimens were drawn using a Camera Lucida attached
  to a Wild M8 microscope.

APPENDIX 4

Stait, B.A. and Laurie, J.R., 1980 : Lithostratigraphy and
biostratigraphy of the Florentine Valley Formation
in the Tim Shea area, South-west Tasmania. *Papers and
Proceedings of the Royal Society of Tasmania; volume
114* : pages 201-207.

This paper is mainly based on work done by Stait (1976)
as part of an honours thesis at the University of Tasmania.
The work in this thesis was revised and supplemented since
then in conjunction with John Laurie, who studied the brachiopods.

LITHOSTRATIGRAPHY AND BIOSTRATIGRAPHY OF THE FLORENTINE VALLEY FORMATION IN THE TIM SHEA AREA, SOUTHWEST TASMANIA

by Bryan Stait and John Laurie
Department of Geology, University of Tasmania

(with three text figures)

ABSTRACT

STAIT, B. and LAURIE, J., 1980 (31 v): Lithostratigraphy and biostratigraphy of the
Florentine Valley Formation in the Tim Shea area, southwest Tasmania. *Pap. Proc.
R. Soc. Tasm.*, 114: 201-207. ISSN 0080-4703. Department of Geology, University
of Tasmania, Australia.

The Florentine Valley Formation is defined. The Formation is subdivided into
three members; the Churchill Sandstone Member, the Pontoon Hill Siltstone Member, and
the Mt. Field Siltstone Member. Seven consecutive fossil assemblages based on brachio-
pods and trilobites can be recognised within the Florentine Valley Formation. Inter-
national correlation of the assemblages in the Florentine Valley Formation is based on
graptolites, that of the basal Karmberg Limestone on graptolites and conodonts. The
Formation ranges in age from Early Tremadoc to Late Arenig.

INTRODUCTION

The Florentine Valley lies approximately 100 km west of Hobart. Access to the
Valley is provided by the Gordon Road and by private logging roads owned and maintained
by Australian Newsprint Mills (see fig. 1).

The Florentine Valley Formation outcrops on the eastern and southern sides of the
Florentine Valley, along the eastern limb of the Florentine Synclinorium. The Floren-
tine Valley Formation is best exposed in the southern end of the Valley along the Gordon
Road, directly west of the Needles and along the Florentine Road at the Gap. A more
detailed discussion of the geological setting can be found in Corbett and Banks (1974).

Lewis (1940) described within his Junee Series from the Tim Shea-Maydena area a
fine-grained clastic sequence from which Kobayashi (1940) described a brachiopod,
gastropod and trilobites. He assigned an Early Ordovician age to this fauna. The
only previous description of the fauna from these beds was that of Etheridge (1904).
Later Brown (1948) described a small brachiopod fauna from near Maydena and the Gap.
To this she assigned an Early Ordovician age. Thomas (1960) and Quilty (1971) have
illustrated graptolites from the Florentine Valley Formation. Faunal lists can also
be found in Öpik (1951), Banks (1962) and Corbett (1963). Corbett and Banks (1974)
described the lithostratigraphy of the Florentine Valley Formation in three sections
(but did not establish formal members) and also established a preliminary biostrat-
igraphy.

LITHOSTRATIGRAPHY

Banks (1962) formally raised the Florentine Valley Mudstone to the formational
level. Corbett and Banks (1974) changed the name to the Florentine Valley Formation
and defined it as "that formation of sandstone and siltstone with lesser limestone and
chert which conformably overlies the Tim Shea Sandstone and Reeds Conglomerate and
underlies the Gordon Limestone Sub-Group" (fig. 2). No type section was named and no
boundaries were defined. Because no complete section of the Florentine Valley Forma-
tion exists it is necessary to define the base and the top of the Formation in different
sections. Along the Gordon Road the top is faulted away and along the Florentine Road
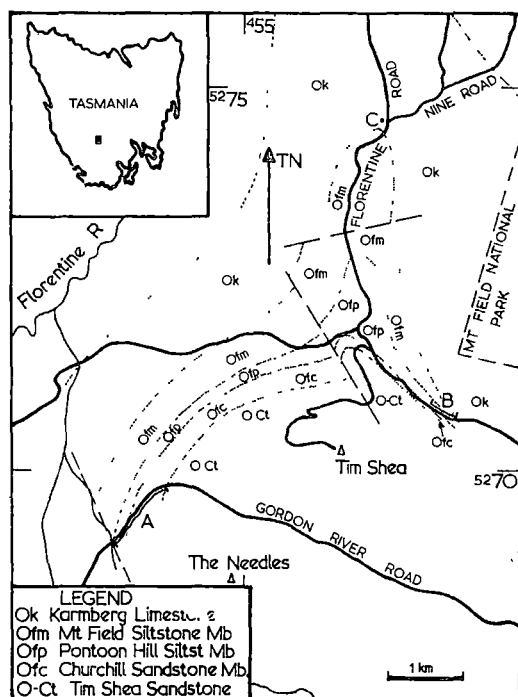
202

Florentine Valley Formation Southwest Tasmania

the base does not outcrop.

FIG. 1.- Map showing location of collected sections within the Florentine Valley.

The base of the formation is herein defined as occurring in a creek crossing the Gordon Road approximately 18 km from Maydena, just west of the Humboldt Divide, (State Grid. ref. Wedge 8112: 539698). This locality is on the western limb of the Tim Shea Anticline (see fig. 1). The base is chosen as the boundary between the coarse reddish sandstone typical of the Tim Shea Sandstone and the fine grey bioturbated sandstone above. The boundary is transitional. The top of the formation is defined as the base of the lowest lenticular body of limestone occurring in the cutting on the Florentine Road 150 metres east of the highest point on the road at the Gap (State Grid. ref. Wedge 8112:581707). The overlying formation is the Karmberg Limestone. This locality is on the eastern limb of the Tim Shea Anticline.

Corbett and Banks (1974) did not establish formal members, but following recent work by the authors it is now considered feasible to subdivide the Florentine Valley Formation into three members, as follows (fig. 3).

Churchill Sandstone Member (nov. (Nov.):- This is the basal member of the Florentine Valley Formation and occurs along the Gordon Road (State Grid. ref. Wedge 8112: Base 539698, top 535694). It consists of thickly-bedded, bioturbated grey sandstone containing rare gastropods, and is 75 m thick along the Gordon Road.

Pontoon Hill Siltstone Member (nov.):- This is the middle member of the Florentine Valley Formation, and is best exposed on the Gordon Road near the 12 mile post (19 km from Maydena), (State Grid. ref. Wedge 8112: Base 535694, top 529685). It consists of a basal white siltstone overlain by interbedded yellow siltstone and nodular siltstone, overlain in turn by dark grey calcareous siltstone and with interbedded yellow siltstone and nodular siltstone at the top. This member is 260 m thick along the Gordon Road and contains a diverse fauna of trilobites, brachiopods, gastropods, graptolites and ostracods.

Mt. Field Siltstone Member (nov.):- This is the uppermost member of the Florentine Valley Formation and is best exposed at the Gap. It consists of interbedded calc-siltstone, siliceous siltstone and fine siliceous sandstone overlain by finely bedded siltstone and is 55 m thick. It contains a diverse fauna of brachiopods, trilobites, gastropods, and graptolites. Underlying this member at the Gap are interbedded yellow siltstone and nodular siltstone of the Pontoon Hill Siltstone Member.

Corbett (1975) in describing the Upper Cambrian and Lower Ordovician sequences from the Denison Range, established the Denison Sub-Group, of which the uppermost formation is the Squirrel Creek Formation (fig. 2). Corbett (1975) divided the Squirrel

			UPPER LIMESTONE MEMBER
GORDON LIMESTONE SUB-GROUP	BENJAMIN LIMESTONE		LORDS SILTSTONE MEMBER
			LOWER LIMESTONE MEMBER
	CASHIONS CREEK LIMESTONE		
			WHERRETTS CHERT MEMBER
	KARMBERG LIMESTONE		
DENISON SUB-GROUP	SQUIRREL CREEK FORMATION	UPPER SANDSTONE MEMBER	FLORENTINE VALLEY FORMATION	MT FIELD SILTSTONE MEMBER
		SILTSTONE–LIMESTONE MEMBER		PONTOON HILL SILTST. MEMBER
		LOWER SANDSTONE MEMBER		CHURCHILL SANDST. MEMBER
	REEDS CONGLOMERATE		TIM SHEA SANDSTONE
	GREAT DOME SANDSTONE		
	SINGING CREEK FORMATION		

FIG. 2.- Denison Sub-Group and Gordon Limestone Sub-Group Stratigraphy
(modified from Corbett and Banks 1974).

Creek Formation into three members: a Lower Sandstone Member overlain by a Siltstone-Limestone Member, of interbedded grey to yellow calcareous siltstone, fine sandstone and impure nodular limestone, and an Upper Sandstone Member. The two lower members are quite similar lithologically to the lower two members of the Florentine Valley Formation. The Upper Sandstone Member consists of grey-green and buff coloured quartoze and micaceous sandstone with inter-bedded siltstone with glauconite bands, and differs from the Mt. Field Siltstone Member of the Florentine Valley Formation in the predominance of sandstone, the presence of glauconite and in its much greater thickness.

From collections of fossils made by Corbett from the lower two members of the Squirrel Creek Formation it would appear that they are biostratigraphically equivalent to those of the Florentine Valley Formation.

BIOSTRATIGRAPHY

Recent work by the authors on the trilobites (Stait) and brachiopods (Laurie, in press), has made possible an initial biostratigraphic subdivision of the Florentine Valley Formation. Formal zones are not erected because of a reliance on only two sections which, to a large extent, do not overlap.

Within the formation can be recognised seven assemblages based on the ranges of

204

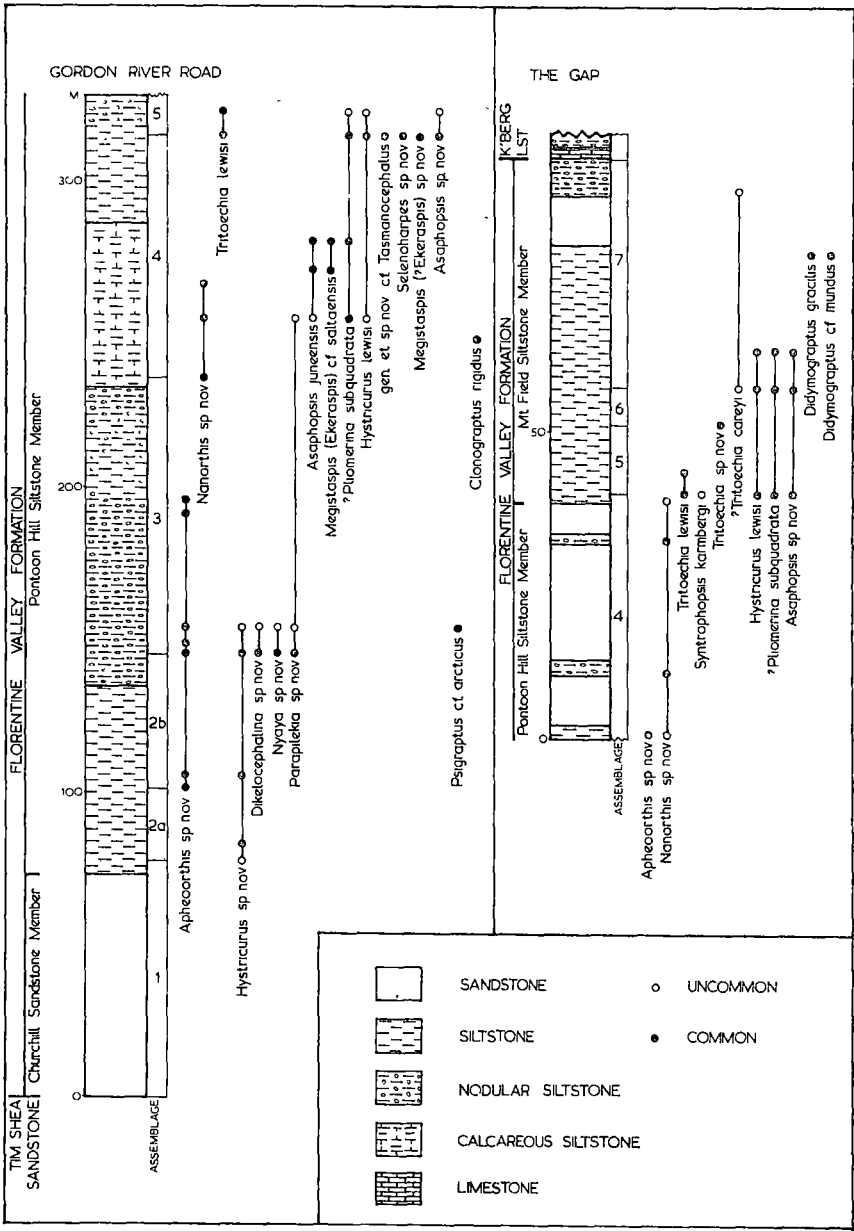Florentine Valley Formation Southwest Tasmania

FIG. 3.- Stratigraphic sections of the Florentine Valley Formation showing the litho-
logical units and the ranges of the faunal elements.

Bryan Stait and John Laurie

trilobites and brachiopod species (fig. 3).   The two sections used to establish these assemblages are correlatable via assemblage 5 which occurs in both.
    The assemblages are as follows:
Assemblage 1 :- *Lesueurilla* (identification, Dr. E. Yochelson pers. comm.)
Assemblage 2 :- *Hystricurus* sp. nov., *Westonia* sp., *Apheoorthis* sp. nov.
            2a:- *Hystricurus* sp. nov., *Westonia* sp.
            2b:- *Hystricurus* sp. nov., *Westonia* sp., *Apheoorthis* sp. nov.
Assemblage 3 :- *Hystricurus* sp. nov., *Parapilekia* sp. nov., *Dikelocephalina* sp. nov.,
            Nyaya sp. nov., *Apheoorthis* sp. nov., *Psigraptus* cf. *arcticus* Jackson
            (identification, Dr. R.B. Rickards pers. comm.)
Assemblage 4 :- *Parapilekia* sp. nov., *?Pliomerina subquadrata* (Kobayashi),
            Megistaspis (Ekeraspis) cf. *saltaensis* (Kayser), *Asaphopsis*
            juneensis Kobayashi, *Hystricurus lewisi* (Kobayashi), *Nanorthis* sp.
            nov., *Clonograptus rigidus* (Hall).
Assemblage 5 :- *?Pliomerina subquadrata* (Kobayashi), *Megistaspis (Ekeraspis?)* sp.
            nov., *Selenoharpes* sp. nov., *Asaphopsis* sp. nov., gen. et sp. nov.
            (aff. *Tasmanocephalus*), *Hystricurus lewisi* (Kobayashi), *Tritoechia*
            lewisi Brown, *Syntrophopsis karmbergi* Brown.
Assemblage 6 :- *?Pliomerina subquadrata* (Kobayashi), *Hystricurus lewisi* (Kobayashi),
            Asaphopsis sp. nov., *Tritoechia* sp. nov. 1.
Assemblage 7 :- *?Pliomerina subquadrata* (Kobayashi), *Hystricurus lewisi* (Kobayashi),
            Asaphopsis sp. nov., *Tritoechia careyi* Brown, *Didymograptus gracilis*,
            D. cf. *mundus*, *Clonograptus* sp., *Tetragraptus* sp.

    The UTGD catalogue members of the new species and genera can be found in Appendix 1, while the new classifications of specimens figured in Corbett and Banks can be found in Appendix 2.

    The top of assemblage 7 fortunately coincides with the top of the Florentine Valley Formation.   A diverse conodont fauna is found at the base of the Karmberg Limestone (Burrett and Stait, in prep.).   Approximately five metres above this is a fauna containing *Leptella* sp. nov.   This fauna correlates with the base of the Karmberg Limestone at Nine Road-Florentine Road junction (C. of fig. 1) which contains *Geragnostus* sp., *?Dimeropygiella* sp., aff. *Carolinites* sp., *Selenoharpes* sp., *Tasmanocephalus stephensi*, *Archaeorthis* sp. nov., *Tritoechia* sp. nov. 2, *Leptella* sp. nov.

    Correlation of the Florentine Valley Formation is obtained from examination of assemblage 3 and upper assemblage 7 - lower Karmberg Limestone faunas.   Assemblage 3 contains *Apheoorthis* and *Nyaya* which on the Siberian Platform occur in the Nyaika horizon (Sokolov and Tesakov, 1975).   Rozova (1968) placed the Nyaika horizon at the base of the Ordovician, while Yadrenkina (1974) had the Khantaika horizon as the basal horizon with the Nyaika horizon above it.   Assemblage 3 also contains *Psigraptus* cf. *arcticus* which occurs in Assemblage 3 of Cooper (1979) to which he assigned an age of Lancefieldian 1.5 (Early Tremadoc).   The Florentine Valley Formation is approximately 100 m thick below this assemblage and the base may thus be Late Cambrian, although there is no faunal evidence to support this.   Assemblage 4 contains *Clonograptus rigidus* which Cooper (1979) included in his Assemblage 4, to which he assigned a Lancefieldian 2 age (Late Tremadoc).

    The upper part of assemblage 7 - lower Karmberg Limestone contains the graptolites *Didymograptus gracilis* (assemblage 7) and *Phyllograptus anna* and *P. ilicifolius* (lower Karmberg Limestone).   The Karmberg Limestone graptolites indicate a correlation with the Upper *Didymograptus extensus* zone in the Skiddaw Group (Jackson, 1962), suggesting a Castlemanian age (Strachan 1972).

    The conodonts from the base of the Karmberg Limestone are correlatable with the

206

Florentine Valley Formation Southwest Tasmania

Upper *Prioniodus (Oepikodus) evae* Zone (Dr. C. Burrett pers. comm.), which Lindström (1971) regarded as very Late Early Arenig (*Didymograptus nitidus* Zone).

ACKNOWLEDGEMENTS

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Bryan Stait and John Laurie

APPENDIX 1

University of Tasmania Geology Department catalogue numbers for the specimens of the genera and species mentioned in the text. This list is to enable checks on the assignments to be made before the taxonomic work appears.

Trilobites

Hystricurus sp. nov., U.T.G.D. 95972-76.
Parapilekia sp. nov., U.T.G.D. 95987-89.
Dikelocephalina sp. nov., U.T.G.D. 95977-82.
Nyaya sp. nov., U.T.G.D. 95983-86.
?Pliomerina subquadrata, U.T.G.D. 95992, 96000-05, 96028-29.
Megistaspis (Ekeraspis) cf. *saltaensis*, U.T.G.D. 95993-95.
Asaphopsis juneensis, U.T.G.D. 95991.
Megistaspis (Ekeraspis?) sp. nov., U.T.G.D. 96002-05, 96014-15.
Selenoharpes sp. nov., U.T.G.D. 96007-10.
Asaphopsis sp. nov., U.T.G.D. 96034-38, 96054.
gen. et sp. nov. (cf. *Tasmanocephalus*), U.T.G.D. 95999, 96021-27.
Hystricurus lewisi, U.T.G.D. 96039-44, 96052, 96073.

Brachiopods

Apheoorthis sp. nov., U.T.G.D. 97335-47.
Nanorthis sp. nov., U.T.G.D. 93748-63.
Tritoechia lewisi, U.T.G.D. 97366, 68, 71, 74-76, 80, 82, 84, 85.
Tritoechia sp. nov. 1, U.T.G.D. 97397-413.
Tritoechia sp. nov. 2, U.T.G.D. 97427-42.

APPENDIX 2

The assignments given to material figured in Corbett and Banks (1974) in the present study.

Trilobites

"Asaphopsis" juneensis - *Asaphopsis* sp. nov.
Hystricurus paragenulatus - *Hystricurus lewisi*.
Hystricurus sp. - *Hystricurus lewisi*.
"Asaphellus" lewisi - *Megistaspis (Ekeraspis?)* sp. nov.
Hystricurus cf. *paragenulatus* - *Hystricurus lewisi*
Cybelopsis sp. - *?Pliomerina subquadrata*

Brachiopods

Finkelnburgia cf. *bellatula* - *Apheoorthis* sp. nov.
Apheoorthis sp. -*Apheoorthis* sp. nov.
?Nanorthis - *Nanorthis* sp. nov.
Nanorthis cf. *hamburgensis* - *Nanorthis* sp. nov.
Nanorthis sp. - *Nanorthis* sp. nov.
Apheoorthis cf. *meeki* - *Apheoorthis* sp. nov.
Apheoorthis cf. *emmonsi* - *Apheoorthis* sp. nov.
?Tritoechia careyi - *Tritoechia* sp. indet.

APPENDIX   5

Burrett, C.F., laurie, J.R., and Stait, B.A., 1981 : Gordon Sub-
        group (Ordovician) carbonates at Precipitous Bluff and
        Point Cecil, South-west Tasmania, Australia. *Papers and
        Proceedings of the Royal Society of Tasmania; volume 115*:
        Pages 93-99.

The very inaccessible Ordovician limestone on the south coast of
Tasmania were examined in 1979-80, in conjunction with Dr. Burrett
and John Laurie. Despite the detailed examination of these sections
no nautiloid specimens were collected.

GORDON SUBGROUP (ORDOVICIAN) CARBONATES AT PRECIPITOUS BLUFF AND POINT CECIL, SOUTHERN TASMANIA, AUSTRALIA

Clive Burrett, John Laurie and Bryan Stait
University of Tasmania

(with three text figures)

ABSTRACT

BURRETT, Clive, LAURIE, John and STAIT, Bryan, 1981 (30 ix): Gordon Subgroup (Ordovician) carbonates at Precipitous Bluff and Point Cecil, southern Tasmania, Australia. *Pap. Proc. R. Soc. Tasm.*, 115, 93-99 (with three figures). ISSN 0080-4703. University of Tasmania, Hobart, Tasmania, Australia.

The palaeogeographically and biostratigraphically important Ordovician carbonate sequence at Precipitous Bluff is at least 360 m thick. The lowest 130 m, the New River Beds, consist of bryozoan algal biospararenites of Chazyan to Blackriveran age. These beds were probably deposited in a high energy subtidal environment with minor periods of intertidal deposition. The upper 50 m of this lowest unit contains abundant *Calathium*, bryozoans and corals. The succeeding 230 m of biosparites, biomicrites, argillaceous carbonates and siltstones, the Precipitous Bluff Beds, are dominated by trilobites, brachiopods and bryozoans, range in age from Trentonian to Cincinnatian and were probably deposited in deeper water than the New River Beds.

The Prion Beach Beds at Point Cecil, five km south of Precipitous Bluff, are argillaceous micrites containing a trilobite/brachiopod fauna and include strata of Blackriveran and Trentonian age and are thus biostratigraphically correlated with the upper part of the New River Beds and at least part of the Precipitous Bluff Beds.

Vertical carbonates along New River Lagoon and sheared carbonates at Point Cecil suggest structural complications perhaps associated with a continuation of a large, possibly transcurrent fault, trending north along New River.

INTRODUCTION

This paper records the results of a reconnaissance geological survey of two palaeogeographically important areas of Ordovician carbonates. It will also form the basis for subsequent detailed biostratigraphic studies. Little geological work has been undertaken in this area mainly because of its isolation. Extremely thick vegetation makes geological work very difficult especially away from the cut tracks and no regional structural map can be produced at present.

Johnston (1888) showed 'Silurian' limestone along New River on his map and recorded a coral ('*Strombodes*') in limestone further north in the Cracroft River (State grid ref. Huon DN 6505). The next published work on the Ordovician limestone at Precipitous Bluff was that of Hughes (1957) who reported the chemical analysis of one sample and commented on its remarkable purity. No further work was carried out until 1979 when a party of the Australian and New Zealand School Exploration Society (ANZSES) led by Mr. Sean Kennedy collected small specimens at 10 m stratigraphic intervals (Banks in Hawkins 1980).

The argillaceous limestones east of Prion Beach along the western margin of Point Cecil were briefly investigated by Twelvetrees (1915), Blake (in Hughes, 1957), Banks (1962) and the ANZSES party (Kennedy in Hawkins, 1980).

The present study results from two trips to the Precipitous Bluff section (figs 1 and 2) and two trips to the Point Cecil sequence. Access to the general area is difficult but was facilitated by the use of a float plane landing in New River Lagoon and a helicopter landing (or hovering) near the Point Cecil locality allowing the removal of large specimens which could not otherwise be collected in any useful number.
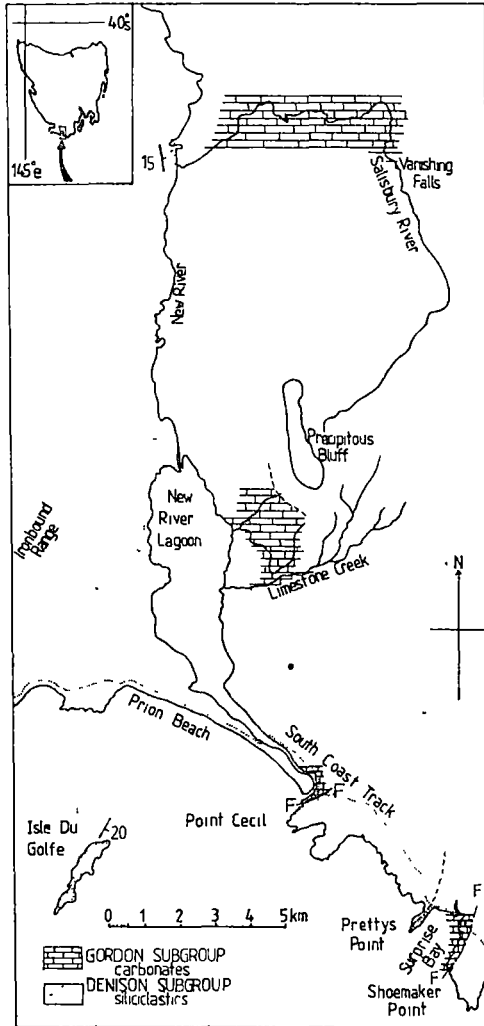
94

Ordovician Carbonates in Southern Tasmania

FIG. 1- Locality map showing part of Southern
Tasmania. Extension of Denison Subgroup to
north of Salisbury River and Isle du Golfe
confirmed by helicopter reconnaissance in
1977 and 1979.   F-F = Fault

FIG.2.- Map showing position of collect-
ing sites along walking track up
Precipitous Bluf.   Boundary between
New River Beds and Precipitous Bluff
Beds is shown just below 60118.
Possible extent of the Lower Parmeener
Supergroup (which contains Permian
brachiopods) is indicated by dots.

PRECIPITOUS BLUFF

The southwestern flanks of Precipitous Bluf are covered by forest that ranges from
fairly open to impenetrable.   The section was measured along a narrow bushwalking track
running up a ridge (State grid ref. Huon, DM664849-DM674861).   The thick bush prevents
tracing the rock types laterally.   Outcrop is very poor from New River Lagoon to the base
of a cliff above Damper Cave at grid ref. DM663852.   Dolerite, of probable Jurassic age
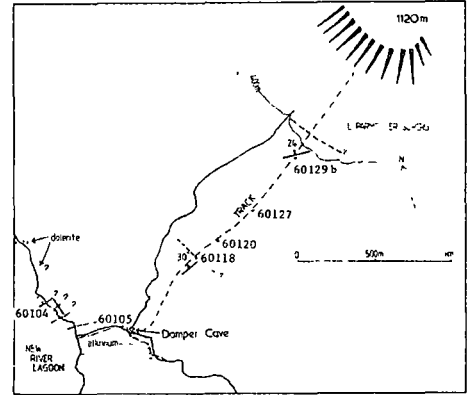
Clive Burrett, John Laurie and Bryan Stait

FIG.3.- Stratigraphic column of the Gordon Subgroup at Precipitous Bluff. The thickness of the stratigraphic gap (if any) between samples 60106 and 60105 is not known but could be as much as 250 m. Sample 60114 is dolointrasparite from an outcrop of vertically dipping carbonate. Sample 60115 is from the entrance (lower southern side) of Damper Cave. Sample numbers are catalogue numbers of the University of Tasmania, Geology Department rock collection.

outcrops along the eastern shore of New River Lagoon from the camp site at grid. ref. DM658851 to near the mouth of New River at DM648868. However one small outcrop of vertically-dipping limestone is present along the shore at grid. ref. DM655854.

The basal 130 m of the main sequence has excellent (about 80% outcrop) whereas the upper 230 m of the sequence contains many large stratigraphic gaps (see fig. 3). As only one narrow section was measured the sequence is not divided into formations, but rather, beds (Hedberg, 1976) are established awaiting a more complete survey of the regional geology.

Stratigraphy
        Siliciclastics of the Denison Subgroup (?Late Cambrian-?Mesial Ordovician) outcrop on the western shore of New River Lagoon and along the Ironbound Range (Twelvetrees 1915) but were not investigated in this study.

Presumably the lowest 12 m of the carbonate sequence are vertically dipping and consist of a small (20 m x 12 m) outcrop on the eastern shore of New River Lagoon at grid ref. DM655854 (fig. 2). Impenetrable bush prevents tracing of this outcrop further east and no indication of facing was found. Rock types include dolointramicrudites and dolointrasparites. Five oncolites were found in one 20 mm thick bed (fig. 3). One stromatoporoid was found in the western part of the outcrop associated with several specimens of *Maclurites* sp. and other gastropods. Because of their very limited outcrop these intraclastic limestones have not been named. The restricted fauna, the abundant dolomite and the presence of oncolites suggests, by analogy with well-studied sequences elsewhere in the Gordon Subgroup, a peritidal (most likely low intertidal) depositional environment.

No conodonts were found in these beds. Elsewhere in the Gordon Subgroup *Maclurites* is found only in carbonates of Chazyan age (Banks and Johnson 1957; Banks and Burrett 1980).

New River Beds (Gordon Sub-group)
        The *Maclurites*-containing carbonates mentioned above are probably separated from the basal units of the main carbonate sequence by a stratigraphic gap. The New River Beds (new name) are a sequence 130 m thick off cliff-forming, massively-bedded biocalcarenites and biomicrites outcropping on the lower western flanks of Precipitous Bluff between grid refs. DM661852 and DM665864. They dip generally towards the north, east and northeast at angles ranging from 0° to 32°.

The New River Beds are conformably overlain by the Precipitous Bluff Beds. Bedding averages 0.6 m in thickness, but many beds are lenticular. The New River Beds are mainly biospararenites, intraspararenites, biointraspararenites and biomicrites. Only one bed contains appreciable amounts (5%) of dolomite (sample UTGD 60113) though several horizons probably contain dedolomites.

Fauna and Flora - Fossils are difficult to see in the field due to recrystallization of the limestone, calcite veining and a covering of moss and lichen. However a major and obvious framework component (especially between samples UTGD 60111 and 60117) is the calcareous alga cf. *Calathium* which occurs as double-walled, cylindrical or conical structures averaging 35 mm in diameter. Corals including *Tetradium* and *Pycnolithus* (K. Kenna *pers. comm.*) are present in samples UTGD 60113 and 60114 respectively. In this section, bryozoa, echinodermata and various calcareous algae constitute, in varying proportions, the major bioclasts. Corals and ostracodes are significant, though minor constituents.

The biota is generally stenobiontic and in conjunction with the carbonate types suggests a generally subtidal, high energy environment. *Tetradium* and the dolomicrite of samples UTGD 60113 may represent intertidal conditions.

The basal 90 m of the New River Beds contain rare specimens of *Phragmodus flexuosus* Moskalenko, *Belodella copenhagenensis* (Ethington and Schumacher), *Drepanoistodus*

Clive Burrett, John Laurie and Bryan Stait

suberectus (Branson and Mehl), *Belodina monitorensis* (Ethington and Schumacher) and *Panderodus gracilis* (Branson and Mehl). This fauna suggests a Chazyan age. Sample UTGD 60116 contains *Tasmanognathus careyi* which suggests a Blackriveran age (Burrett 1979)

Precipitous Bluff Beds (Gordon Sub-group)

The Precipitous Bluff Beds (new name) are a sequence 230 m thick of thinly-bedded siliceous siltstones, calcareous shales, biomicrites and biospararenites outcropping along a ridge from grid refs DM665854 to DM673859. These beds conformably overlie the New River Beds and are overlain unconformably by fossiliferous marine rocks belonging to the Lower Parmeener Supergroup of Late Carboniferous-Permian age.

The contact between the New River Beds and the overlying Precipitous Bluff Beds is gradational but within a 3 m thickness decalcified siltstone replaces biomicrite and thereafter siltstones and shales are common in alternations with biocalcarenites and bio-micrites. Bedding thickness is variable (0.5 m - 50 mm) but beds are rarely thick.

Fauna - The 4 m thick basal siltstone is decalcified, buff-coloured and lithologically very similar to the Lords Siltstone Member in the Florentine Valley (Corbett and Banks 1974).

The brachiopod fauna includes most of the species found in the Lords Siltstone including *Strophomena* sp. nov.,*Sowerbyites vesciseptus* Percival, but also contains *Ptychopleurella* sp. nov., *?Leptellina* sp., *Clitambonites (Clitambonites)* sp., *Skenidioides* sp. nov., *?Hallina*, *Sowerbyella* cf. *anticipata* Percival and a new genus of resupinate leptellinid. *Sowerbyites vesciseptus* and *Sowerbyella anticipata* occur in Fauna III (Eastonian) of New South Wales (Percival, *pers. comm*).

Trilobites from this level include *Remopleurides* sp., *Pliomerina* sp. and *Amphilichas* sp. (Banks, *pers. comm.*). A drepanellid ostracode (new genus A) is also common.

Conodonts are present in sample UTGD 60118 and include *Phragmodus undatus* (Branson and Mehl) and *Plectodina aculeata* (Stauffer) and suggest an Early Trentonian (Rocklandian) age.

Sample 60128 contains *Aphelognathus* sp. and sample 60129 contains *Oulodus robustus* (Branson, Mehl & Branson), *Pseudobelodina* sp., and *Aphelognathus shoshonensis* Sweet and suggests a Late Edenian-Mesial Maysvillian age.

POINT CECIL AREA

Prion Beach Beds (Gordon Subgroup) and Denison Subgroup at Point Cecil.

The argillaceous carbonates at Point Cecil to the east of Prion Beach (see fig. 2) were first mentioned by Twelvetrees (1915). Blake (in Hughes, 1957), described them as dark limestones alternating with slates. Banks (1962, p.170) recorded *Ampyx* and a cryptolithid close to *Eirelithus* from this locality and suggested a Mesial Ordovician age. The argillaceous limestones are thinly-bedded, steeply-dipping (between 75°-90°) and are faulted against the underlying Denison Subgroup quartz arenites. The basal limestone beds contain abundant detrital quartz. Further to the east (at DM677774 on South East Cape, 1:100 000 Sheet No. 8210) the Denison Subgroup quartz arenites are shallowly dipping (between 25°-30°) to the west and are, from the evidence of trough cross-bedding, right way-up. The quartz arenites are approximately 150 m thick, contain minor oligomict microconglomerates and overlie a conglomerate sequence of unknown thickness.

The argillaceous limestone outcropping along the western side of Point Cecil from grid ref. DM678775 to grid ref. CM681782 is herein named the Prion Beach Beds. Shearing and folding preclude any estimate of their true thickness but it is unlikely to exceed 200 m. Several small north-east trending transcurrent faults are present, extending for several metres approximately parallel to strike ($N60^{o}E$). The drag dip on these trans-current faults indicates sinistral movement. About 150 m north-northeast of this shear

98

zone the limestones dip at 5° to the northwest.

Fauna - The Prion Beach Beds contain an abundant fauna of fragmentary trilobites. More complete trinucleid trilobites are found 20 m north of the base of these beds and are associated with a brachiopod fauna that includes *Sowerbyella* cf. *lepta* Percival. A drepanellid ostracode (new genus A) is also found at this level. Conodonts are generally poorly preserved in these beds but include *Phragmodus undatus* in a sample not stratigraphically precisely located and *Phragmodus inflexus* Stauffer in a sample 10 m above the base of the beds. The former indicates a Trentonian or younger age and the latter indicates a Blackriveran age.

CONCLUSIONS

The carbonate sequence at Precipitous Bluff is divisible into 2 main lithostratigraphic units. The lower biospararenitic New River Beds were probably deposited in a subtidal environment. These beds were deposited during the Chazyan and Blackriveran at the same time as peritidal carbonates were deposited in many other parts of the state (e.g. Ida Bay, Florentine Valley, Vale of Belvoir, Everlasting Hills: Burrett 1979; Calver 1977; Weldon 1974). The higher parts of the New River Beds were also deposited at the same time as the deeper-water Prion Beach Beds. The succeeding Precipitous Bluff Beds suggest a deeper water environment and were deposited at the same time as very shallow subtidal-peritidal carbonates were deposited at Ida Bay and in the Florentine Valley and at the same time as part of the even deeper Prion Beach Beds.

The brachiopods from the base of the Precipitous Bluff Beds include elements found in the Florentine Valley and at Mole Creek but also include species only previously known from New South Wales.

The conodont fauna also allows correlation with deeper-water sequences outside Tasmania. Several important conodonts such as *Pseudobelodina* sp., *Aphelognathus shoshonensis* and *Phragmodus inflexus*, that facilitate precise intercontinental correlation, are found in this area but have not been found elsewhere in Tasmania. Further work in this area will undoubtedly reveal an Ordovician sequence of great importance in intercontinental correlations.

The vertically dipping carbonates along New River Lagoon and the sheared and possibly overturned sequence near Point Cecil suggests structural complications perhaps associated with the continuation of the transcurrent Lake Edgar Fault along New River as suggested by Corbett (1970).

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APPENDIX   6

Stait, B.A. and Burrett, C.F., submitted : *Wutinoceras* (nautiloidea)

from the Setal Limestone (Ordovician) of Malaysia. *Alcheringa;*

Wutinoceras (Nautiloidea) from the Setul Limestone (Ordovician)
of Malaysia

BRYAN STAIT and CLIVE F. BURRETT

Wutinoceras robustum (Kobayashi & Matumoto), previously known only

from the Ordovician of North China has been found near the base of the

Setul Limestone in the Langkawi Islands, Malaysia and strengthens the

known faunal links between South East Asia and North China. This is

the first description of *Wutinoceras* from South East Asia and suggests

a Whiterock age for the lower sequence of the Lower Setul Limestone.

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Tasmania, Box 252C, Hobart, Australia 7001.   Received*

VERY FEW nautiloids have been described from the Ordovician Lower

Setul Limestone of the Langkawi Islands, Malaysia (Jones, 1973;

Kobayashi, 1958, 1959). We here describe a nautiloid faunule consist-

ing of a *Wutinoceras* species which was previously only known from Hebel

Province, North China. This is the first description of a *Wutinoceras*

from South East Asia; a genus that is widespread in Whiterock (Early

Middle Ordovician) equivalents in North America, Australian and China

(Flower, 1976).

The 4 nautiloid specimens were collected at the locality indicated

(Fig. 1) from near the base of the Lower Setul Limestone on the west

side of Palau Langgun. They were found as isolated specimens in a dark,

stylolitic micrite. Horn-shaped operculae of the gastropod *Teichiispira*

were the only non-nautiloid macrofossils found at this locality.

Teichiispira is probably restricted to strata of Canadian-Whiterock age

(Yochelson and Jones, 1968; Gilbert-Tomlinson, 1973). It is found in

close stratigraphic proximity with *Wutinoceras* in the Whiterock-age Karmberg Limestone in Tasmania.

Igo and Koike (1967, 1968) collected conodont samples from Palau Langgun but their precise localities are not known. Three 1.5 kg samples from the *Wutinoceras* locality were processed and yielded a meagre fauna of 6 conodont specimens. These include elements referred to *Scolopodus cf. bassleri* Furnish and *Scolopodus giganteus* Sweet and Bergstrom, by Igo and Koike (1967) and unidentifiable fragments of *Oistodus* spp. The 2 named species are restricted to Igo and Koike's (1967) *Scolopodus staufferi - S. giganteus* zonule which they suggested is of Early-Medial Ordovician age.

Scolopodus cf. bassleri Furnish is probably a new species of *Panderodus* conspecific with such forms as *?Panderodus* sp. of Serpagli 1974 (pl. 24, figs. 12-13) from the top of the San Juan Limestone, Argentina and *Panderodus striatus* (Stauffer) of Lee 1975 (pl. 1, fig. 14) from the Mandel Formation of North Korea. The top of the San Juan is either Late Arenig or Llanvirn and the Mandel is Medial Ordovician (Kobayashi, 1966). This new species of *Panderodus* is also found in the Whiterock Kamberg Limestone Formation and the Chazy Cashions Creek Formation in Tasmania (Banks & Burrett, 1980). *Scolopodus giganteus* Sweet and Bergstrom is found in the Pratt Ferry Formation of Llanvirn-Llandeilo age (Bergstrom, 1971) and in the correlatives of the Lower Setul Limestone on the Malaysian mainland (Metclafe, 1980). Thus the associated gastropod and conodonts generally support a Whiterock age for this occurrence of *Wutinoceras*.

Wutinoceras robustum (Kobayashi and Matumoto) has previously only been recorded from near the Nanpiao coalmines near Jehol (or Ch'eng-te or Chengde, in Pinyin) in Hopeh (Hebei) Province from strata of

uncertain age within the Ordovician but which were assigned to the Toufangian by Kobayashi and Matumoto (1942, p. 317). The discovery of *W. robustum* in Malaysia reinforces the known affinities of the South East Asia with the North Chinese faunas.

Specimens are housed in the University of Malaya Geology Department Research Fossil Collection and are prefixed by the rubric UMG.

Systematic palaeontology
Order ACTINOCERATIDA Teichert, 1933
Family WUTINOCERATIDAE Shimuzu and Obata, 1936

WUTINOCERAS, Shimuzu and Obata

WUTINOCERAS ROBUSTUM (Kobayashi and Matumoto)

Plate 1,   figs. 1-12

1942 *Jeholoceras robustum*, Kobayashi and Matumoto, p.315, Plate 30, Plate 31, fig. 6.

The conch was probably sub-circular and straight, but no specimen collected had the entire shell wall preserved. There are 6 siphuncular segments in a length of 36 mm. The siphuncle is approximately one third the diameter of the conch. The siphuncle is highly expanded with the most apical segment having a height of 13 mm at the point of maximum expansion, 5 mm at the foramen, and a length of 6 mm. The septa are highly curved with the deepest point probably being the centre of the conch.

On the venter the septa are adnate to the apical surface of the adoral connecting ring for 2.5 mm. On the dorsum the septa are first adnate to the adoral surface of the apical connecting ring, then to the apical surface of the adoral connecting ring for a short distance.

The septal necks are cyrtochoanitic and on both the venter and the

dorsum are recurved but free. The brims are slightly longer than the necks, with the most apical segment having a ventral neck 0.4 mm long, and a brim 1.2 mm long, while the dorsal neck is 0.6 mm long and the brim is 1.1 mm long.

The siphuncular deposits are typical annulosiphonate deposits. They develop more strongly adorally than apically from the foramen on the venter while the reverse is true of the dorsum.

The siphuncular canal system is reticulate. The central canal is 2 mm wide, while the radial canals are narrow, 0.2 mm.

The connecting rings are relatively thin for *Wutinoceras* being 0.1 mm thick.

Both episeptal and hyposeptal deposits are present but the preservation of the specimens does not allow the extent of the deposits to be determined.

Material and Location:- The material consists of three phragmocones, UMCA582, A583 and A584. The specimens were collected from the lower part of the Lower Setul Limestone on Pulau Langgun of the Langkawi Islands. Arrow marks locality on Fig. 1. The age is Whiterock.

Remarks:- Kobayashi and Matumoto (1942) established a new genus, *Jeholoceras*, on material from East Jehol (Chengde, Hebei Province). The diagnosis stated "... and neck rings composed of vertical lamellae which are protruded inward in different lengths", this is not a generic character as it is typical of genera with reticulate radial canals, resulting from the branching of the radial canals as they approach the perispatium. Flower (1957, p. 56) suggested that *Jeholoceras* is a junior synonym of *Wutinoceras*. Examination of the present collection supports this view as they have thick connecting rings, reticulate

radial canals, and free septal necks. After examination of the illustrations and description in Kobayashi and Matumoto (1942), and allowing for the deformation undergone by the type material, no differences indicative of a new species could be found.

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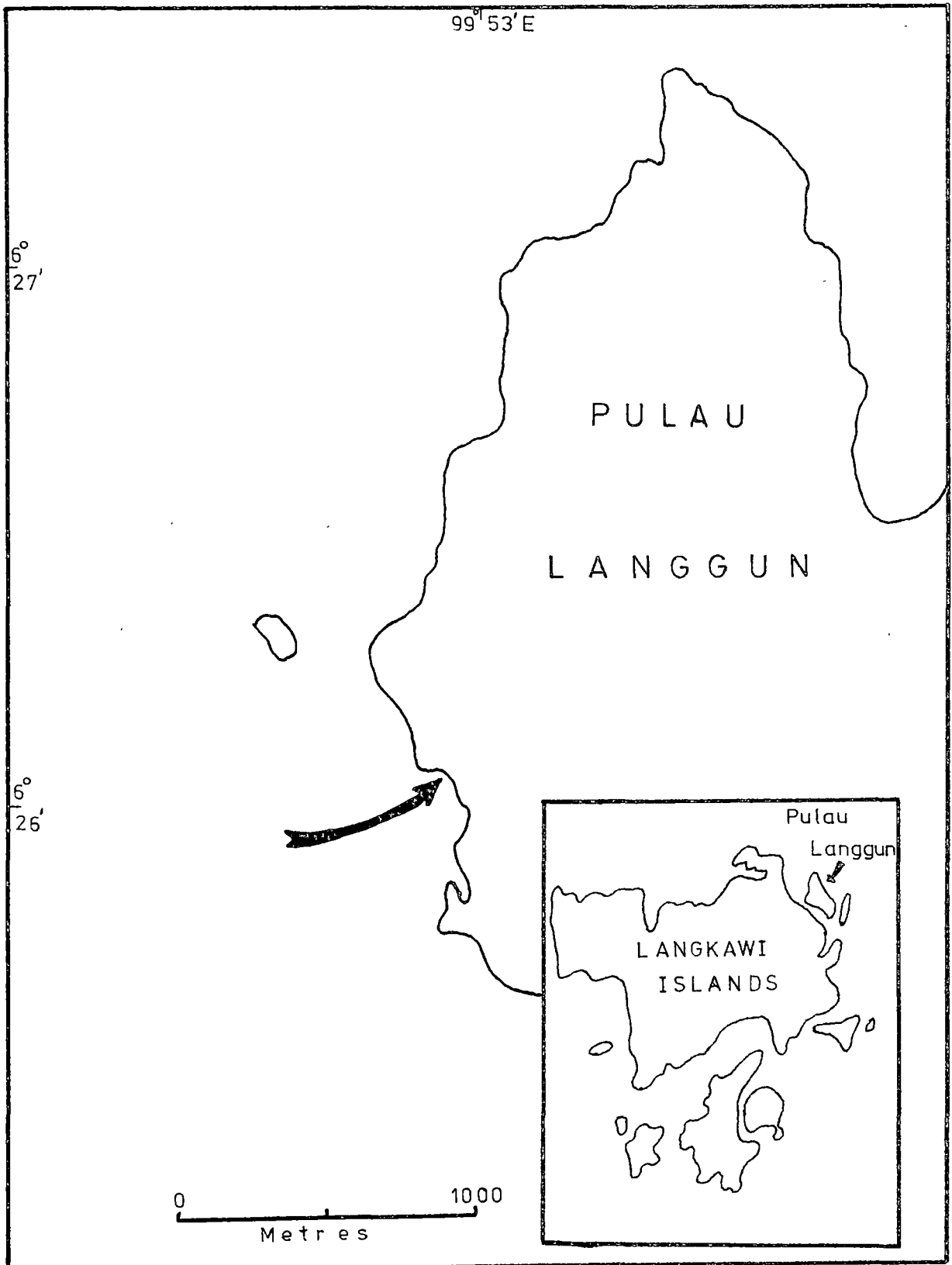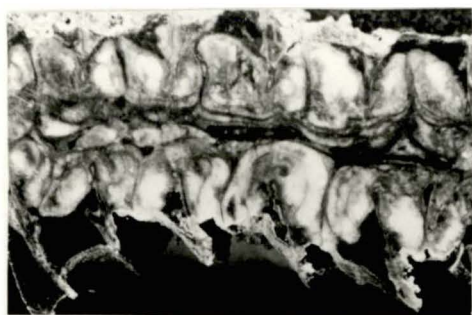
Fig. 1.   Collection locality on Pulau Langgun. Map modified from

Jones (1973).

Fig. 2. *Wutinoceras robustum* (all specimens oriented venter down).
A. Sagittal section of the siphuncle showing the central
canal and radial canals x2; B. An oblique section through
the siphuncle x2; C. Off-centre section of the siphuncle
showing the branching of the radial canals as they approach
the perispatium x2; D. Transverse section of the phragmo-
cone and siphuncle of the specimen C, x2; E. Enlarge-
ment of A showing the dorsal side of the siphuncle, x5;
F. Enlargement of A showing the central side of the
siphuncle, x5; G. Thin section of B showing the
siphuncular segments, x3; H. Enlargement of G showing
a siphuncular segment, x4; I. Enlargment of G showing
the connecting ring and septal neck, x10; J. Thin
section of A showing the siphuncle, x1.5; K. Enlarge-
ment of J showing the dorsal septal neck, x10;
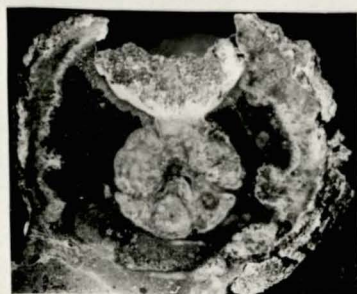L. Enlargment of J showing the ventral septal neck, x10.
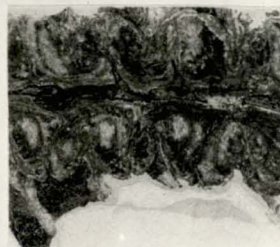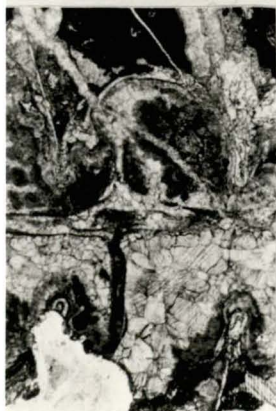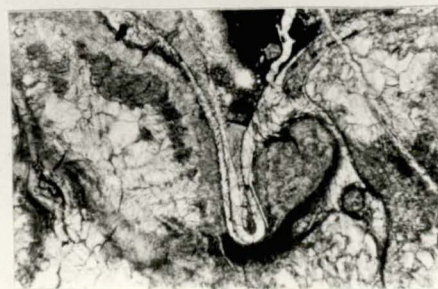
A B

C D

G E

J

F K

H I L