GEOLOGICAL SURVEY
OF
WESTERN AUSTRALIA

REPORT 5

DEVONIAN ATRYPID BRACHIOPODS FROM THE REEF COMPLEXES OF THE CANNING BASIN

by Kathleen Grey

1978

GEOLOGICAL SURVEY
OF
WESTERN AUSTRALIA

REPORT 5

DEVONIAN ATRYPID BRACHIOPODS FROM THE REEF COMPLEXES OF THE CANNING BASIN

by Kathleen Grey

Issued under the authority

of the

Hon. Andrew Mensaros M.L.A.

Minister for Mines

National Library of Australia card number and ISBN

0 7244 7429 3

FOREWORD

Arising out of the Geological Survey's mapping of the Devonian reef complexes of the Canning Basin are several studies on the abundant fossils contained therein. Some of this work has already been published, for example the corals, calcareous algae and conodonts; other groups are still under study.

The brachiopods have been monographed previously by Veevers in 1959 as the outcome of work in the area by the Bureau of Mineral Resources. However, there was felt a need for an up-to-date account of the atrypids, an interesting but intractable group which have received considerable attention in Europe and North America.

Miss Grey's detailed study of these fossils will be a useful addition to our knowledge of the Devonian rocks of this State.

J H Lord
DIRECTOR
3 December 1977

CONTENTS

ILLUSTRATIONS

TABLES

APPENDIX

DEVONIAN ATRYPID BRACHIOPODS FROM THE REEF COMPLEXES OF THE CANNING BASIN

by

Kathleen Grey

ABSTRACT

Frasnian atrypids are richly represented in reefal and peri-reefal rocks of the Canning Basin, Australia, but are poor in diversity with only four genera present. Existing taxa have been revised, after detailed morphological study, to conform with European and North American usage. Some of the atrypid genera or subgenera found in the area are known from the Early or Middle Devonian in other parts of the world. The ranges of these forms should therefore be extended to include their Late Devonian occurrence in Western Australia. Other typical Frasnian atrypid genera from other parts of the circum-equatorial Devonian belt are absent from the Canning Basin.

Atrypa reticularis teicherti Coleman is re-described, transferred to the subgenus *Atrypa (Kyrtatrypa)* and raised to species level. The holotype and some paratypes of *Atrypa parva* Coleman are juvenile forms of *teicherti*. *Atrypa multimoda* Coleman is a junior synonym of *Desquamatia (Synatrypa) kimberleyensis* (Coleman); the latter is re-described. *Spinatrypa aspera prideri* (Coleman) is re-defined and placed in the subgenus *Spinatrypina (Spinatrypina)*. Some specimens formerly described as *prideri* are placed in a new subspecies *nurunguni*a. The subspecies *Spinatrypa prideri larga* Roberts, described from the Bonaparte Gulf Basin is a spinatrypinid and is retained as a subspecies of *prideri*. Both *Atrypa parva* Coleman and *Atrypa* n. sp. Coleman consist of a multispeciate collection of juvenile forms.

INTRODUCTION

Devonian brachiopods were collected between 1967 and 1976 from the Bugle Gap and Napier Range areas by Dr P. E. Playford and Dr A. E. Cockbain as part of a study of the reef complexes of the Lennard Shelf region of the Canning Basin. Figures 1 and 2 show the location of the areas from which the samples were obtained. Detailed stratigraphic interpretation is still in progress, and this paper presents the results of a systematic study which is part of an overall assessment of the stratigraphy and environment.

Samples are from the following formations: Sadler Limestone (marginal-slope facies), Virgin Hills Formation (basin and marginal-slope facies), Pillara Limestone (platform facies), and Gogo Formation (basin facies). Terminology is based on the revised stratigraphic nomenclature of Playford and Cockbain (1976). The relationship of the various stratigraphic units is shown in Figure 3.

Sixty-five of the 105 samples examined contained atrypid brachiopods, although the preservation of many was too poor to allow any detailed identification. Specimens already housed in the palaeontology collection of the Geological Survey of Western Australia, together with the material from the University of Western Australia and from the Bureau of Mineral Resources, were also re-examined. Approximately 5 000 complete or nearly complete specimens were studied.

Many of the specimens examined can be identified as species originally described by Coleman (1951, 1952), but the descriptions require expansion, and the generic status of the various species is in need of revision as a result of recent publications on the Order Atrypida by workers in Europe and North America.

PREVIOUS WORK ON WESTERN AUSTRALIAN ATRYPIDS

Although earlier workers on the stratigraphy and faunas of the Canning Basin recorded or briefly mentioned the atrypids, the first important description was that of Hosking (1933). The first major systematic study was that by Coleman (1951, 1952) who made a detailed investigation of the atrypids, which was based on material collected by Teichert (1949). Coleman described two new species and three new subspecies, and placed them all in the genus *Atrypa* Dalman (1828). These were: *Atrypa multimoda, Atrypa parva, Atrypa reticularis teicherti, Atrypa desquamata kimberleyensis* and *Atrypa aspera prideri;* and an unnamed *Atrypa* n. sp.

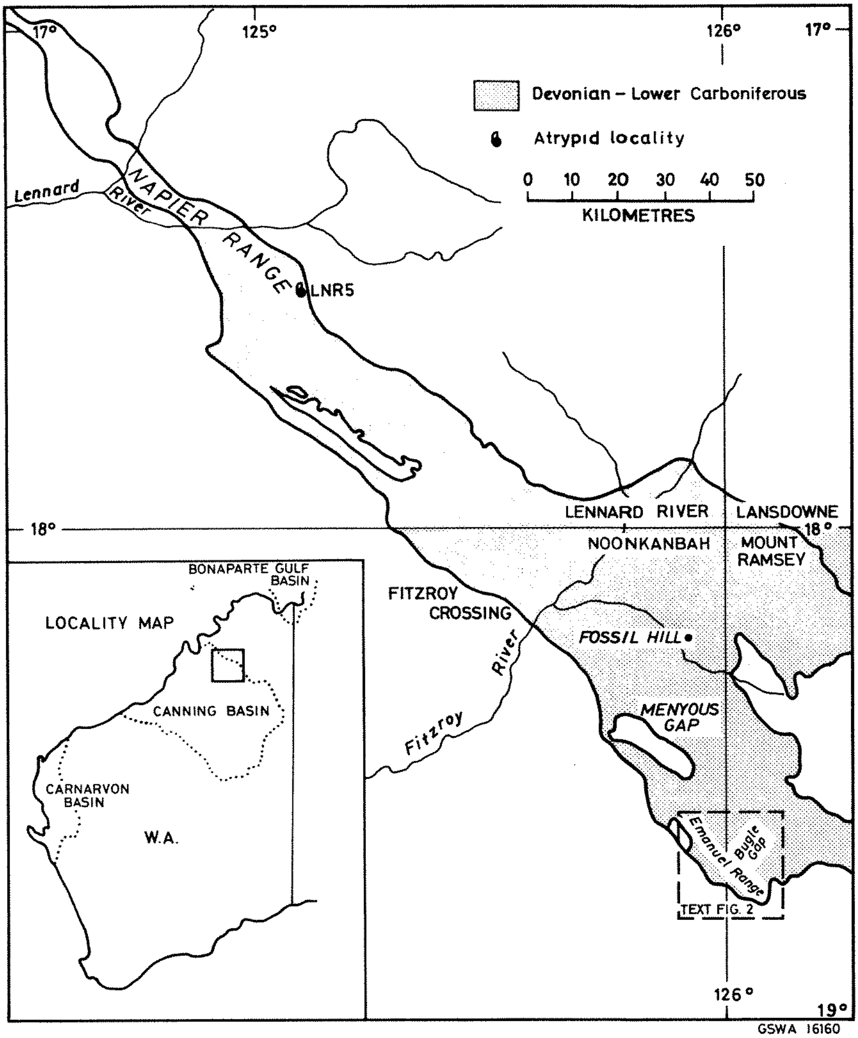


Figure 1. Devonian atrypid localities, Lennard Shelf, Canning Basin. (Details of localities given in Appendix A.)

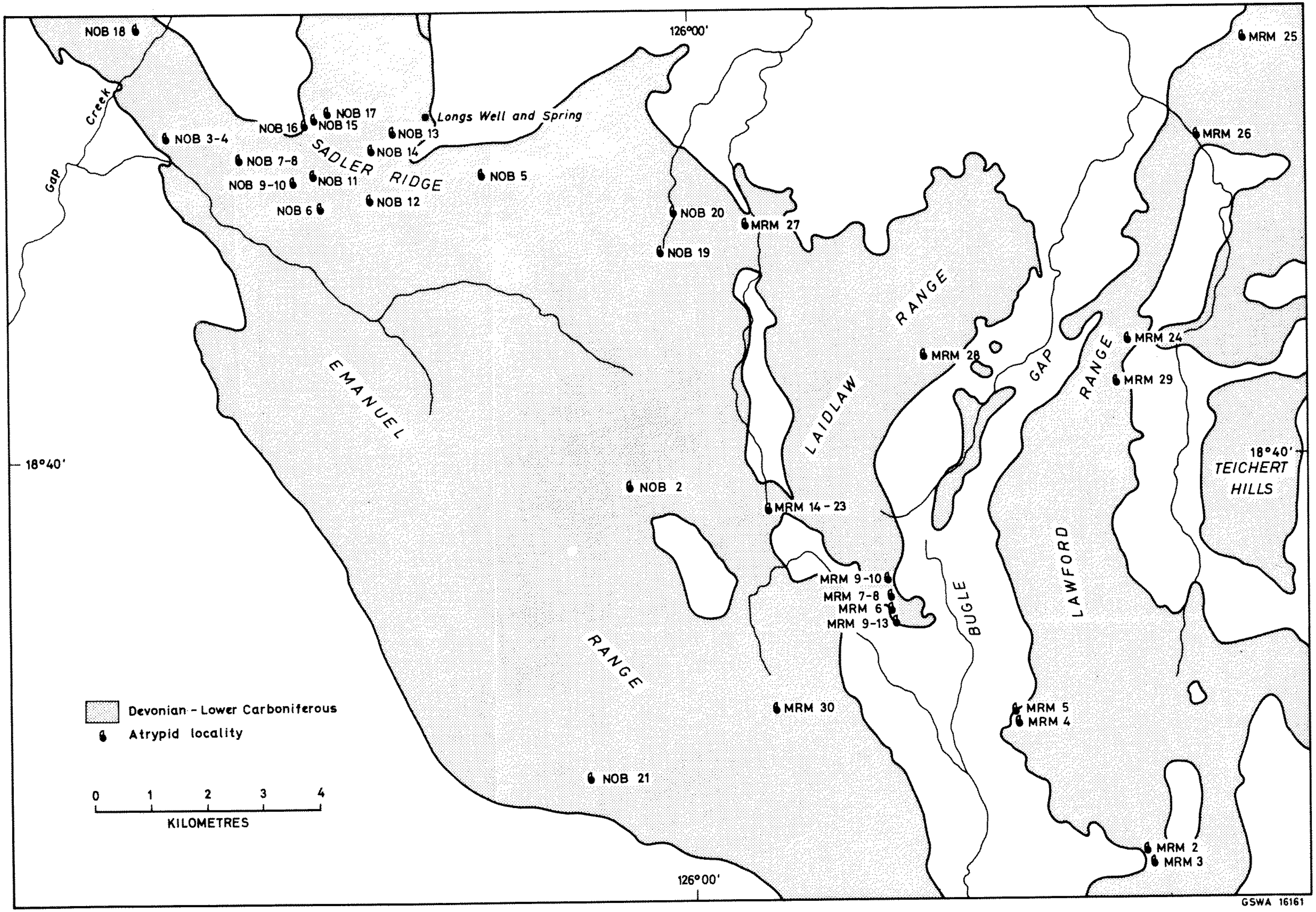


Figure 2. Devonian atrypid localities, Bugle Gap area, Canning Basin. (Details of localities given in Appendix A.)

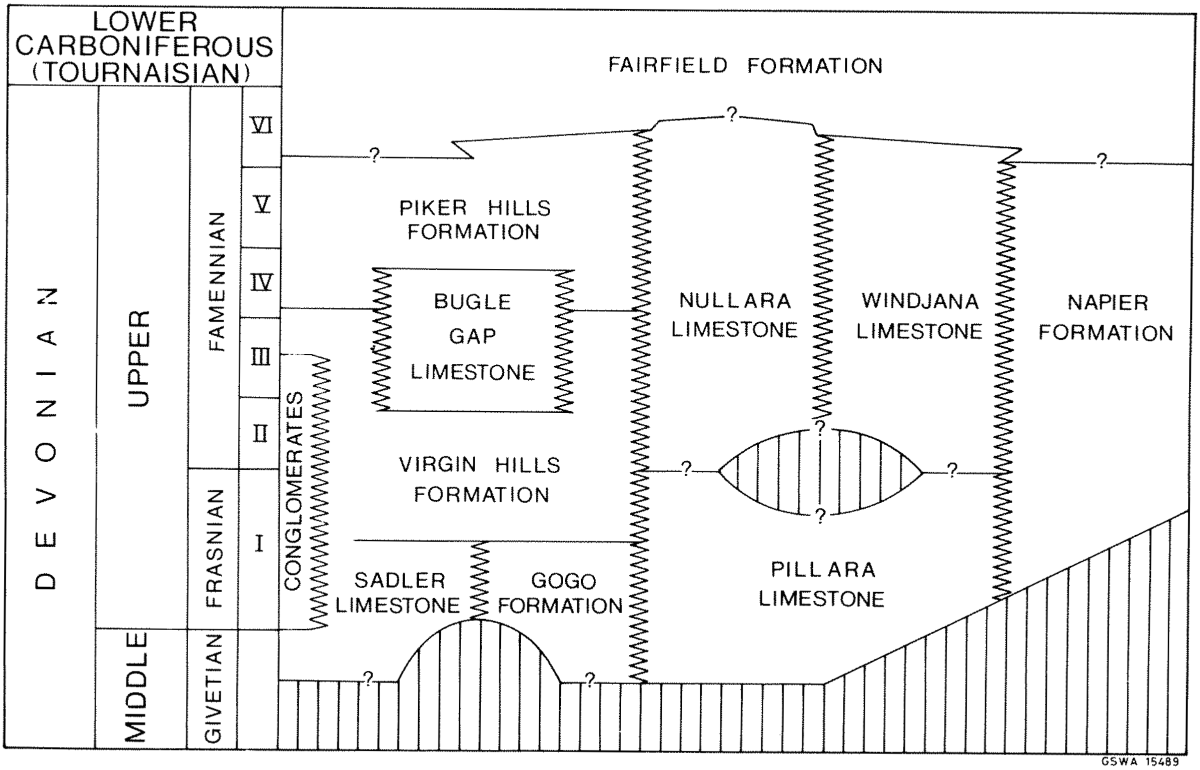


Figure 3. Revised stratigraphic nomenclature for the reef complexes of the Canning Basin (after Playford and Cockbain, 1976).

A comprehensive systematic study of the brachiopod fauna was published by Veevers (1959a, 1959b). The atrypids were included in this study, and, as a result of the examination of a large number of better preserved specimens, Veevers revised Coleman's species. Veevers (1959a, p.116) retained the subspecies *Atrypa reticularis teicherti* and gave additional information on the internal structure. *Atrypa multimoda* and *Atrypa parva* were placed in synonomy with *Atrypa desquamata kimberleyensis*, and *Atrypa aspera prideri* and was transferred to the genus *Spinatrypa* Stainbrook 1951. Veevers (1959b) also recorded *Spinatrypa aspera prideri* from the Gneudna Formation of the Carnarvon Basin.

A similar study of material from the Bonaparte Gulf Basin (Roberts, 1971) provided additional information on the atrypids of northwest Australia. Roberts raised *Atrypa desquamata kimberleyensis* Coleman to species level. He did not accept the synonomy proposed by Veevers, and he transferred the species to the genus *Desquamatia* (Alekseeva) subgenus (*Synatrypa*) Copper. He also erected the subspecies *Spinatrypa prideri larga*, "... distinguished from *S. prideri prideri* essentially on the basis of its larger size, gibbous brachial valve, and stronger median dorsal deflection of the anterior commissure" (Roberts 1971, p.174).

A BRIEF REVIEW OF THE ATRYPID LITERATURE

Only the more recent literature of relevance to the order Atrypida is considered in this very brief review. The subdivision of the Atrypida into families has presented taxonomists with a major problem, and many of the difficulties are still unsolved.

Copper (1965a, p.361) summarizes attempts to subdivide the group, and concludes that the most satisfactory classification is into four families: Atrypidae, Palaferellidae, Lissatrypidae, and Zygospiridae. The most recent and comprehensive summary of this classification is given by Copper (1973). He lists a total of 70 atrypoid genera and subgenera, 35 of which are placed in the Atrypidae.

This classification, which is used as a working basis by Copper, Struve, and Russian authors, differs considerably from that proposed in the *Treatise on Invertebrate Paleontology* (Boucot, Johnson and others, 1965). The classification outlined by Copper (1973) is followed in the present paper as being the most suitable and the most comprehensive published to date.

In the 1960s, a series of papers reflecting a growing interest in the use of atrypids as a stratigraphic tool was published. This work required a revision of ideas at the suprageneric level, and the erection of several new genera and subgenera.

Much of the early work was carried out by the Russians (Alekseeva 1960a, 1960b, 1962 and 1968; Rzhonsnitskaya 1960a, 1960b and 1964; Nikiforova and Andreeva 1961; Ivanova 1962; Tiasheva 1962 and Gratsianova 1967). This was paralleled by similar work in Poland (Biernat 1964) and by a series of papers examining the stratigraphic significance of the atrypids in Western Europe and North America; among these were papers by Struve (1961, 1964, 1966) and Godefroid (1970).

An important contribution was the work of Siehl (1962), which provided a basic terminology of atrypid morphology. This was further developed by Copper in a series of papers examining morphology and proposing taxonomic changes (Copper 1964, 1965a, 1965b, 1966a, 1966b, 1966c, 1967a, 1967b, 1967c, 1967d, 1967e, 1967f, 1967g, 1967h and 1973).

Atrypid classification has shown some considerable advances in the last few years, and it is now becoming obvious that a careful differentiation of species often provides a useful tool for stratigraphic and environmental interpretation.

AGE OF THE REEF COMPLEXES

Although a considerable amount of work has been published on the various groups of fossils present in the Canning Basin reef complexes, there are still some problems with precise correlation between the various facies. The reef complexes range in age from Givetian to Famennian and are overlain by the Fairfield Formation, which is late Famennian to early Tournaisian in age. Atrypid brachiopods were collected only from rocks of Frasnian age. No atrypids occurred in any samples of undoubted Givetian or Famennian age, and previous records of Famennian atrypids in Western Australia cannot be confirmed (Grey, 1977).

Ammonoids, and conodonts have proved to be the most useful fossils for correlation. Roberts and others (1972) gave a useful summary of the correlations which have been made so far. Of particular interest is their revision of the brachiopod zones proposed by Veevers (1959a).

AGE RANGE OF THE ATRYPIDS

A Frasnian age for the Canning Basin rocks containing atrypids is well established on the basis of conodont and ammonoid dating. However, the age-range indicated by the atrypids is not entirely consistent with a Frasnian age on the basis of the European and North American evidence. *Spinatrypina (Spinatrypina)* and *Spinatrypina (Exatrypa)* have both been recorded from Frasnian elsewhere (Copper 1973); however, *Atrypa (Kyrtatrypa)* ranges from Gedinnian to Eifelian (Copper 1973) and *Desquamatia (Synatrypa)* is restricted to the Eifelian by Copper (1973), although Biernat (1964) and Godefroid (1970) extend the range to the Givetian, and Alekseeva (1962) records species from the Frasnian of the Kuznetsk Basin. Specimens illustrated by Mansuy (1912) and Grabau (1931) from the Late Devonian of Asia are probably *Synatrypa*.

The occurrence of *Synatrypa* in rocks of undoubted Frasnian age in the Canning Basin indicates that the range of this subgenus should be emended. The anomalous occurrence of *Kyrtatrypa* also indicates that the known range of this subgenus should be extended to include its late appearance in Western Australia.

The Canning Basin atrypids are individually abundant, but low in generic diversity. In particular it is interesting to note the absence of certain species-groups in Australia e.g. *Iowatrypa*, *Costatrypa*, *Anatrypa*, *Neatrypa* and *Spinatrypa* s.s. have not been recorded. Elsewhere atrypids were both abundant and specifically more diverse during the Frasnian. The species *kuniandia* is the only characteristic Frasnian species-group presently known from Australia.

The lack of diversity and extended ranges of atrypid species-groups indicate that the Canning Basin (along with S.E. Asia) is a unique area, maintaining long-lived mid-Devonian, 'hardy' taxa in abundance. This phenomenon suggests the isolation of mid-Devonian atrypids in northwestern Australia and southeast Asia.

There is no evidence for the occurrence of atrypids in the Famennian of the Canning Basin as previously recorded by Coleman (1951) and Veevers (1959a) because the age of the samples in question is either doubtful or can be shown to be Frasnian (Grey 1977). This is in agreement with the known range throughout the rest of the world with the exception of a doubtful record from Indo-China (now North Vietnam) by Mansuy (1912).

PREPARATION TECHNIQUES

Two types of lithology are common in the samples examined; a hard, brown, fine-grained calcarenite with surface silicification, typical of the Sadler Limestone; and a white or grey, coarse-grained calcarenite, typical of the Pillara Limestone.

Fossils from the coarse-grained calcarenite were extracted by heating to a temperature of 500°C for about one hour. Each sample was then plunged into a bucket of iced water. The calcined matrix disintegrated to a friable, chalky rubble and whole fossils could be extracted. Further disintegration of the sample and cleaning of the specimens was effected with hammer and Burgess Vibro-tool. Most of the specimens obtained in this manner are decorticated.

Fossils from the fine-grained calcarenite are usually partially weathered out and about half of each specimen lies above the surface. Specimens are barely discernible on fresh surfaces of this type of matrix. Dilute hydrochloric acid was used to dissolve the carbonate and release the silicified material. This method produced some exceptionally well preserved specimens.

METHODS OF STUDY

Identifications are based on the examination of external features together with the serial grinding of selected specimens. Specimens were mounted in blocks of epoxy resin, and ground along a surface at right angles to the plane of the commissure, using a Croft Parallel Grinder. Acetate peels were taken at intervals of 0.1 mm, and enlarged photographic prints were made from selected peels for further study. Line drawings were prepared from the photographs. Figure 4 illustrates the measurements made; raw data for statistical measurements are filed at the Geological Survey of Western Australia.

Because the size and spacing of ribs and growth lines is critical in the determination of generic status it was decided to measure these features in addition to the more usual measurements of length, width and thickness. Several different methods of measurement have been adopted in the literature. One of the most common is to count the number of ribs in 10 mm at a fixed distance from the umbo, thus eliminating differences resulting from shell ontogeny. In statistical work this method presents a problem in that the

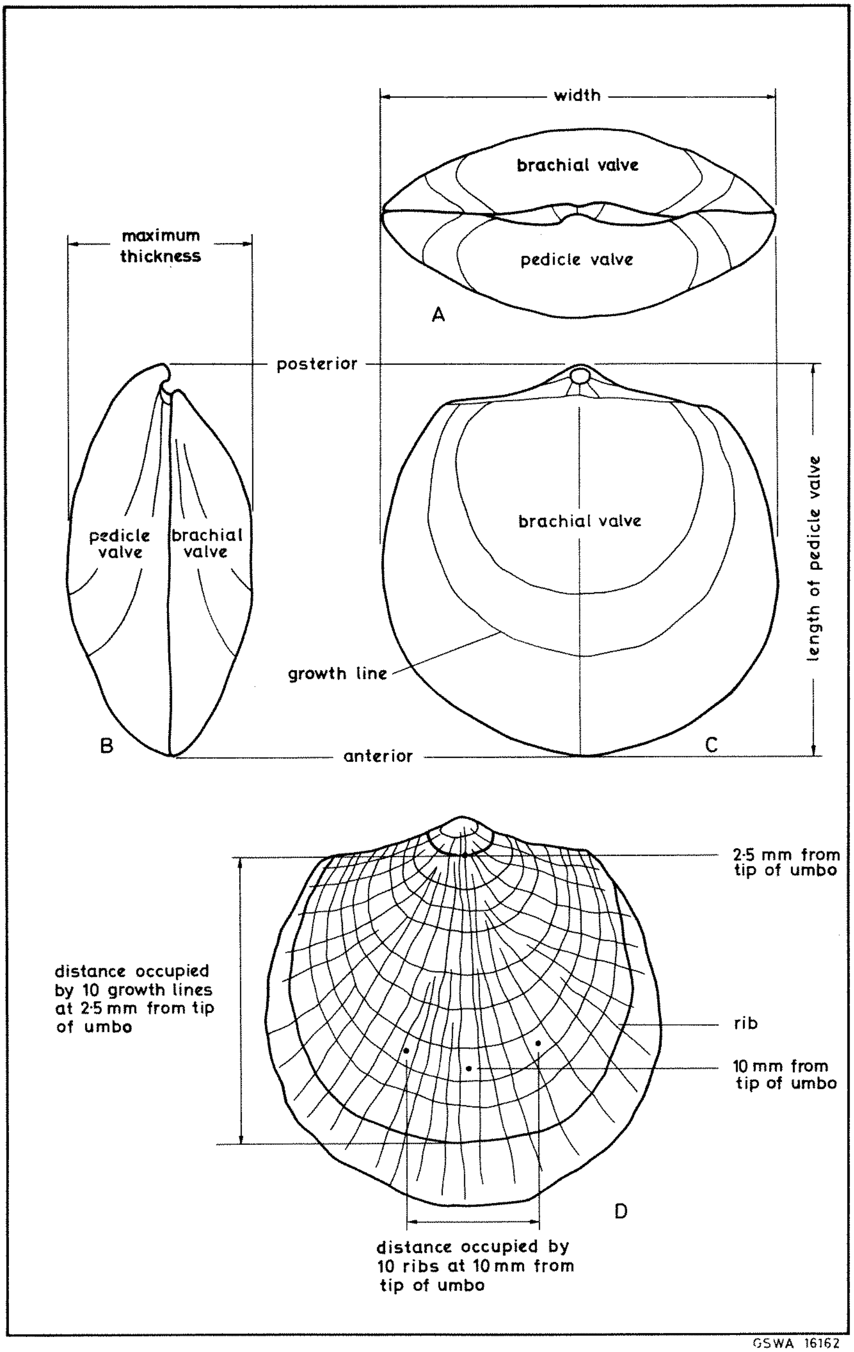


Figure 4. Measurements for statistical interpretation. (A) posterior view, (B) left lateral view, (C) brachial view (showing growth-lines only) and (D) ventral view showing ribs and growth-lines with method of measurement.

resulting numbers are integers and a discontinuous range of values is obtained. Instead of counting the number of ribs, the interval containing 10 ribs at 10 mm from the umbo was measured. This proved a more accurate method and gave a continuous range of values. For the sake of consistency 5 ribs were counted on each side of the mid-line of the valve.

A similar problem arises in the consideration of the number of growth lines. In this case the interval containing 10 growth lines was measured beginning at a point 2.5 mm from the umbo. In *Spinatrypina (Exatrypa) kuniandia* which has less than 10 growth lines on the shell surface, the distance measured was that occupied by 5 growth lines.

Results were plotted as graphs, and a regression line was fitted by the reduced major axis method. Statistical results are presented in the section on systematics. Figure 5 is a composite plot showing how the spacing of ribs and growth lines can be used to differentiate between the various atrypid forms present in the Canning Basin, and is an attempt to quantify the rib-lamella categories proposed by Copper (1967a).

ACKNOWLEDGEMENTS

Thanks are due to the following for their assistance. R. M. Bartlett and F. P. Paganelli who measured specimens and prepared peels. A. E. Cockbain who provided considerable assistance with statistical work. J.-C. Boegli, K. Hirschberg, V. Novak and N. van de Graaff for help with translations, and P. Copper who advised on the generic status of the atrypids and read the manuscript.

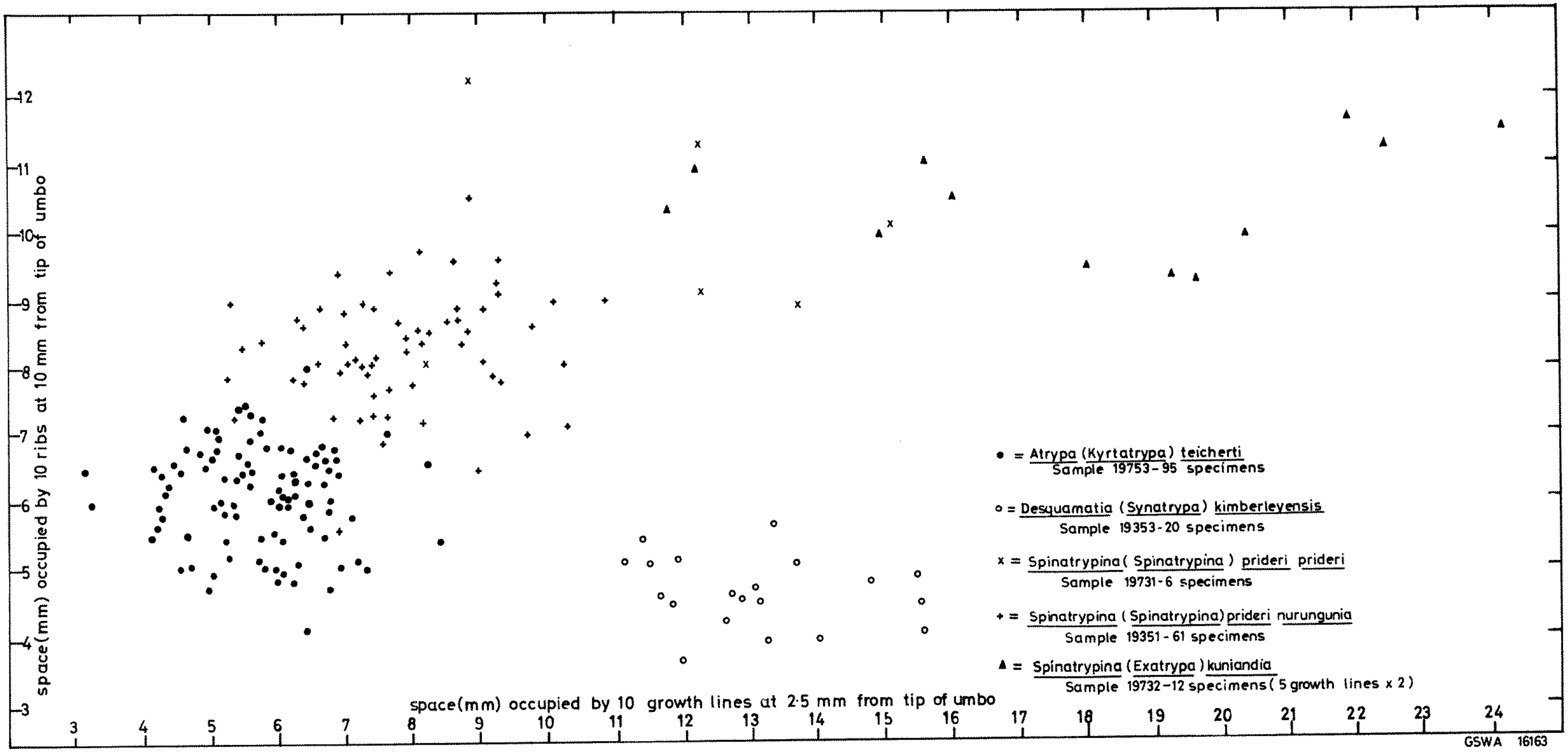


Figure 5. Scatter diagram showing growth-lines plotted against ribbing for different atrypid taxa present in the Canning Basin.

Phylum BRACHIOPODA
Class ARTICULATA
Order ATRYPIDA
Superfamily ATRYPACEA
Family ATRYPIDAE

Genus *ATRYPA* Dalman 1828
Subgenus *ATRYPA (KYRTATRYPA)* Struve 1966

ATRYPA (KYRTATRYPA) TEICHERTI (Coleman 1951)
Plate I, figs 1-2

not 1890 *Atrypa reticularis* Linnaeus; Foord; p.100, 101 (figs a and b)
1951 *Atrypa reticularis teicherti* Coleman; p.681-682, Pl.100 figs 1-10
1951 *Atrypa parva* Coleman; p.685 (in part), Pl.102, figs 18-22
1959 *Atrypa reticularis teicherti* Coleman; Veevers: p.116-119.

Type Materials: Holotype UWA 26273c, paratypes 26273a, b, d, e, all from locality T53 between small hills near Long's Well and reef limestone (see discussion below).

Other Material and Localities: Over 600 free, entire, calcareous shells from the Sadler Limestone: Loc. NOB 15, sample no.19752, Loc. no.816, sample no.19753. Also 4 specimens of *Atrypa parva* Coleman 1951, from the same locality as the holotype.

Description: Based on sample 19753 and type specimens. Shell size medium, elongate, sometimes globose, with strongly recurved ventral margins in mature specimens. Shell equibiconvex to dorsibiconvex, sometimes appears convexiplane in mature specimens. Curvature of brachial valve regular; pedicle valve flattening towards anterior commissure with greatest curvature in the region of the umbo. Beak small, erect in juvenile forms, tending towards adpressed condition in mature forms, although small area still visible in some cases. Details often poorly preserved. Area small in juvenile forms deltidial plates usually visible. Better preserved mature specimens show a wedge-shaped widening of the pedicle area towards the hinge margins. Circular pedicle foramen usually present in juveniles, poorly preserved in mature forms.

Ribs imbricate, moderately fine, slightly elevated at anterior margin, with troughs slightly wider than ribs. Ten ribs average 6.07 mm at 10 mm from the umbo, (105 specimens). Ribs increase in number by intercalation. Growth lines distinct; 10 growth lines average 6.02 mm at 2.5 mm from the umbo (96 specimens). Growth lines crowded at anterior margin, frills short. Weak pedicle sinus present in juveniles, becoming well-developed in mature forms, usually forming a distinct tongue.

Internally (Fig. 6) with thickened pedicle layer forming a false pedicle collar. Deltidal plates thin, difficult to detect. Teeth large, lobed, with large dental nuclei. Socket plates delicate; crural bases bulbous, with long, feathered crura. Jugum slightly curved; jugal plates vertical, with slight curvature. Poorly defined cardinal process present in notothyrial pit. Large, median septum present.

Dimensions: Measurements are summarized in Table 1. Figures 7, 8 and 9 demonstrate the range shown by this species and the rib/growth-line ratio is plotted in Figure 5.

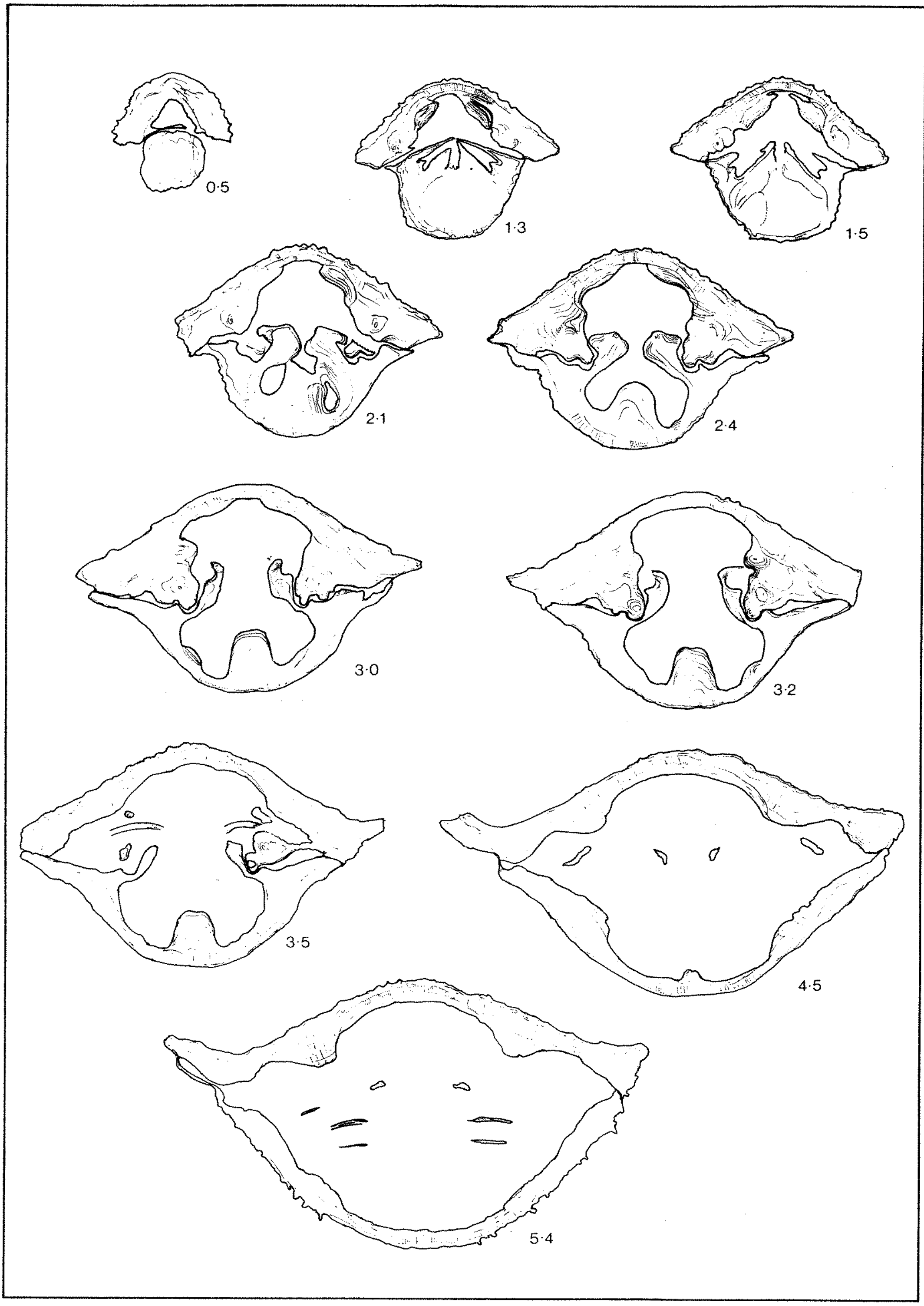


Figure 6. Serial peels of specimen F9453. *Atrypa (Kyrtatrypa) teicherti.*

TABLE 1. Measurements for specimens of *Atrypa (Kyrtatrypa) teicherti* (Coleman) from sample 19753.

	Number of specimens	Mean	Max.	Min.	Range	Standard deviation	Holotype
Length (mm)	111	17.14	26.84	7.18	9.70	4.12	21.5
Width (mm)	111	17.41	24.88	19.54	5.34	3.61	22.1
Thickness (mm)	111	9.76	19.54	3.48	16.06	3.19	12.6
Distance occupied by 10 ribs at 10 mm from tip of umbo (mm)	105	6.07	8.00	4.26	3.74	0.75	4.00
Distance occupied by 10 growth lines at 2.5 mm from tip of umbo (mm)	96	5.68	8.40	3.10	5.30	0.97	not measured

Remarks: Coleman (1951) erected the subspecies *teicherti* on the basis of five specimens showing distinctive characteristics. Veevers (1959a) examined a further 100 individuals and over 1 000 specimens are present in the GSWA collection. The strongly recurved ventral margin and well developed pedicle sinus and tongue make this form sufficiently distinctive for *teicherti* to be raised to species level.

At generic level *teicherti* is referred to the subgenus *Atrypa (Kyrtatrypa)* Struve 1966. The fine imbricate ribbing and short frills are distinctive of the genus *Atrypa*. The dorsibiconvex to equibiconvex shell convexity, and the wedge-shaped pedicle area, both found in *teicherti*, are present in *Atrypa (Kyrtatrypa) culminigera* Struve, the type species of the subgenus. The pedicle area is larger in *culminigera*; and the circular foramen, present in at least some specimens of *teicherti*, does not seem to be present in the type species. The internal features of *A. (K.) culminigera* have not been described. *Atrypa (Kyrtatrypa) teicherti* can be distinguished from other species in the subgenus, such as *culminigera* Struve (1966), *thomsonensis* Talent (1956), and *subtrigonalis* Biernat (1964), by the very strongly recurved ventral margin which is present in mature and gerontic forms. There is a superficial resemblance to the species *Atrypa (Planatrypa) petasa* Copper (1967d), but the latter has a planate pedicle valve. Copper (written communication, 1975) mentions that '... some Eifelian *Kyrtatrypa* which have short frills tend to mimic *Planatrypa*'.

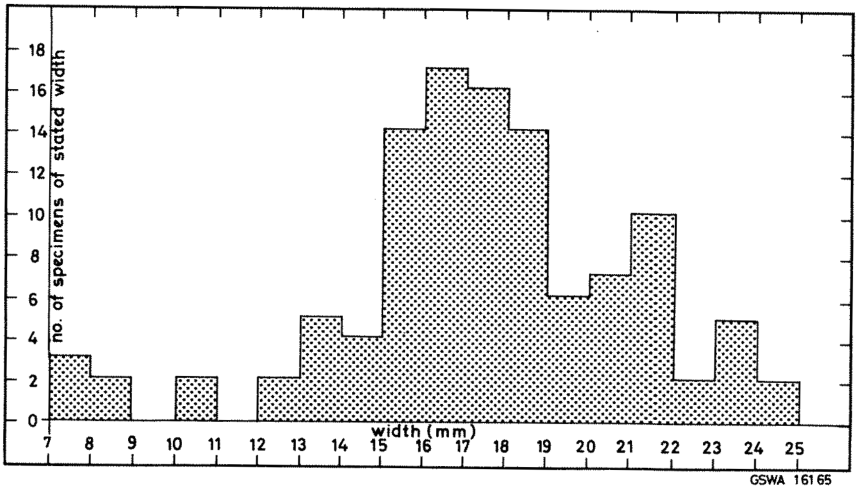


Figure 7. Frequency distribution of widths for 111 specimens of *Atrypa (Kyrtatrypa) teicherti* from sample 19753.

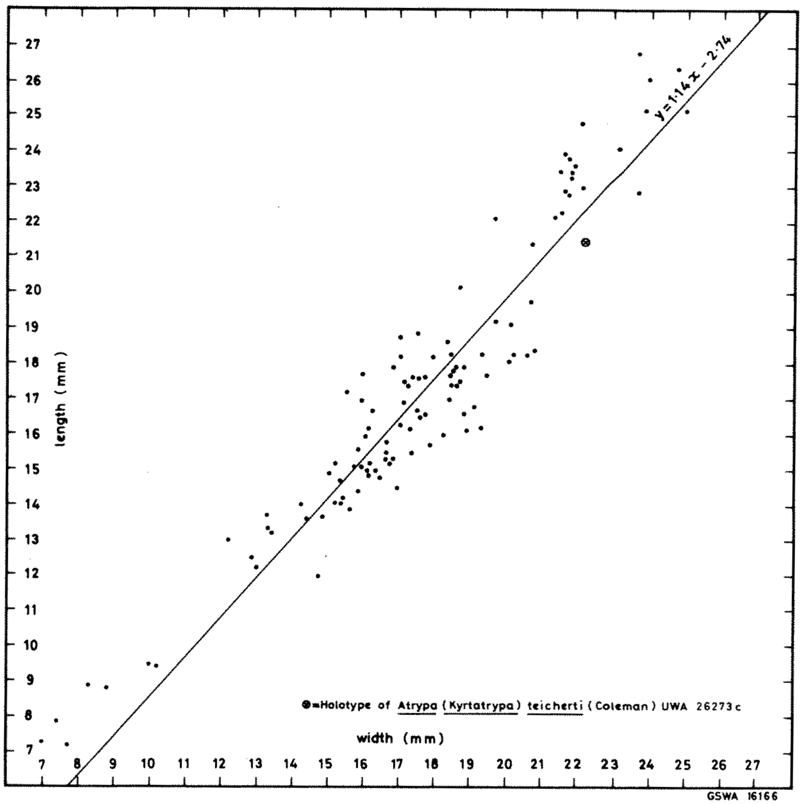


Figure 8. Scatter diagram and reduced major axis of length plotted against width for 111 specimens of *Atrypa (Kyrtatrypa) teicherti* from sample 19753.

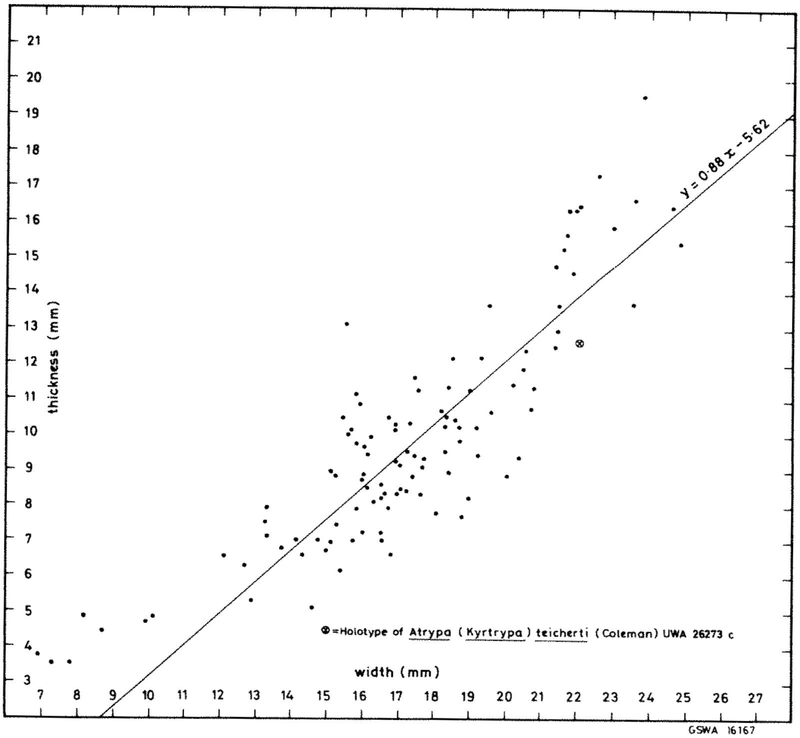


Figure 9. Scatter diagram and reduced major axis of thickness plotted against width for 111 specimens of *Atrypa (Kyrtatrypa) teicherti* from sample 19753.

Several of the specimens described as the species *Atrypa parva* by Coleman (1951, p.685) are juvenile forms of *teicherti*, and show the characteristic *Atrypa*-like ribbing and wedge-shaped pedicle interarea associated with this species. The following specimens described as *A. parva* by Coleman are here included in *teicherti:* UWA specimens 26294a (holotype), paratypes 26294c, 26293d, and possibly 26293a (the latter is too poorly preserved for positive identification).

The specimen of *Atrypa reticularis* illustrated by Foord 1890 and placed in synonomy with *teicherti* by Veevers (1959a) is probably *Desquamatia (Synatrypa) kimberleyensis*.

The five type specimens of *teicherti* (University of Western Australia catalogue numbers 26273a, b, c, d and 26893a) are part of a much larger brachiopod collection made by Teichert. Specimen 26893a is incorrectly numbered in Coleman's paper (1951 p.681 and plate caption for Plate 100, p. 684) because this number in fact refers to the specimen illustrated in Plate 102, Figure 7. This error was noted by Veevers who renumbered the specimen as 25893, adjusted the catalogue accordingly, but did not record the fact in the literature.

The number 25893 chosen by Veevers is also incorrect. The original entry for this number refers to a "brachiopod gen.et.sp.indet." from the top of Fossil Hill. This places the specimen in the Famennian Piker Hills Formation, from which atrypids have not been recorded. The lithology of the specimen is more typical of the Sadler Limestone than of the Piker Hills Formation. Teichert (1949) does not mention any occurrence of *A. reticularis* at Fossil Hill, and it is difficult to believe that the specimen in question is the one recorded as "brachiopod gen. et sp. indet."

The catalogue entry for 26273, the number referring to the holotype (26273c) and 3 paratypes (26273a, b and d), gives the number of specimens of *A. reticularis* collected by Teichert as 5. It is only in Veevers' later entry that the words "4 syntypes" appear. Coleman (1951, plate caption, p.684) indicates that the specimen in Figure 7 is from the same locality as 26273c and it seems reasonable to suppose that the correct number is really 26273e.

Coleman and Veevers are both confused about the type locality. There are no outcrops of Devonian "2 miles East of No.10 Bore" as described by

Coleman (1951 p.682 and 684). Teichert (1949, p.31) describes several localities as "south and southwest of No.10 Bore and Longs Well". The catalogue gives the type locality as "Between small hills near Longs Well and reef limestone - "Base of *Atrypa* stage". (D10 and D23)". The latter are field numbers and correspond to the published locality 53 in Teichert (1949). Both Coleman and Veevers refer to the type locality as T58 but from the evidence of the catalogue the location T53 must be the correct one.

Distribution and Age: Sadler Limestone, Frasnian. Localities T53, GSWA NOB 15 and NOB 16 only.

A Frasnian age is anomalous in view of the previously recorded range of Gedinnian to Eifelian (Copper, 1973), but on the basis of very strong evidence from conodont and ammonoid dating, the range of this subgenus should be extended to include its late appearance in Western Australia.

Genus *DESQUAMATIA* (Alekseeva, 1960a)
Subgenus *DESQUAMATIA (SYNATRYPA)* Copper 1966b

DESQUAMATIA (SYNATRYPA) KIMBERLEYENSIS (Coleman 1951)
Plate II, figs 1-3

1890 *Atrypa reticularis* Linnaeus; Foord: p.100-101, figs a and b
1933 *Atrypa desquamata* Sowerby; Hosking: p.72, figs 3, 4
1951 *Atrypa desquamata kimberleyensis* Coleman: p.683, Pl.101, figs 7-19
1951 *Atrypa multimoda* Coleman: p.682, Pl.100, figs 11-18, Pl.101, figs 1-6
1951 *Atrypa aspera prideri* Coleman (in part) Pl.102, fig. 7
1959a *Atrypa desquamata kimberleyensis* Coleman: Veevers (in part); p.119, figs 73a and 73b, not Pl.15, fig. 13
1971 *Desquamatia (Synatrypa) kimberleyensis* (Coleman) Roberts p.168-171, Pl.38, figs 1-22.

Type Material: Holotype UWA 26247a from Teichert's locality T53 (D10) "between small hills near Long's Well and reef limestone approx. S. of Long's Well, Fitzroy Basin, W.A." Paratypes 26553b, 26553l, 26550c, 26553f, 26553n, 26553j, 26464a, and 26247d from various localities in the Napier and Emanuel Range areas.

Other material and localities: Approximately 150 complete, well-preserved specimens, together with numerous fragments of variable preservation. Specimens were collected from the following localities.

(Sadler Limestone) Loc.MRM4, sample no.18693; Loc.MRM5, sample no. 18694; Loc.MRM21, sample no.19347; Loc.MRM22, sample no.19348; Loc.NOB2, sample no.19353; Loc.NOB6, sample no.19663; Loc.NOB10, sample no.19724; Loc. NOB11, sample no.19725; Loc.NOB12, sample nos.19726, 19727, 19730, 19732, 19735, 19736, 19738; Loc.NOB14, sample nos.19742, 19743, 19745, 19750; Loc. MRM29, sample 19777; Loc.NOB18, sample 19781; Loc.NOB19, sample no.19826.

(Pillara Limestone) Loc.MRM2, sample no.18660; Loc.MRM3, sample no. 18666; Loc.MRM6, sample no.19308; Loc.MRM8, sample nos.19310, 19311; Loc. MRM9 sample nos.19314, 19315; Loc.MRM11, sample no.19319; Loc.MRM12, sample 19322; Loc.MRM16, sample no.19331; Loc.MRM20, sample no.19346; Loc.MRM13, sample no.19324; Loc.NOB9, sample no.19720; Loc.NOB20, sample no.19830; Loc. LNR5, sample no.19972.

(?Pillara Limestone) Loc.MRM26, sample no.19615.

(Gogo Formation) Loc.NOB13, sample no.19741.

Description: Based on type specimens and material from sample 19353. Shell size medium to large, round to subquadrate with occasional transverse specimens. Mature specimens are often globose. Equibiconvex to dorsibiconvex. Both valves show greatest curvature near the umbo. Brachial valve with fairly regular curvature throughout; pedicle valve with a tendency to flatten towards the anterior commissure. Beak usually straight, erect to slightly curved, with a distinct interarea, and bearing a rounded foramen near the apical extremity. Some globose forms show an adpressed beak condition in which the interarea is partially or wholly obscured. Details cannot be discerned satisfactorily because of poor preservation. Pedicle sinus occasionally very weakly developed, pedicle tongue sometimes developed at anterior comissure in mature specimens. Some of the more globose or lateral forms have a tendency to develop minor ears along the posterior margin.

Ribs are semi-tubular, somewhat flattened, with shallow troughs. Ribs are fine and closely spaced, 10 ribs average 4.64 mm at 10 mm from the umbo (28 specimens). Increase is by bifurcation. Growth lines widely and regularly spaced, 10 growth lines average 13.03 mm at 2.5 mm from the umbo (20 specimens). Growth lines become crowded at margins and lamellae may form large erect to sub-erect frills, which are only occasionally preserved.

Internally (Fig.1) there is some thickening of the pedicle cavity, but no pedicle collar is present. Deltidial plates are thin and hollow. Teeth are massive, with rounded main and lateral lobes. Distinct dental nuclei are present, frequently developing into very large, triangular cavities. Socket plates are thin and regularly curved. Crura have a ventro-lateral projection and are medium to long, fairly bulky and are feathered. Jugal processes are stout, long and horizontal. Jugal plates are small and hooked. A plate-like cardinal process is present in the notothyrial pit.

Dimensions: Figures 11 to 15 illustrate the size range shown by this species. The apparent bimodal distribution of width/frequency shown in Figure 11 is probably an effect of sorting. Figures 14 and 15 show the relationship of the type specimens of *Atrypa multimoda* to *kimberleyensis*, and also show samples 19726 and 19727 which contain mature specimens with a mean width of 27.26 mm (min. 17.8, max. 37.9, range 20.1) for 15 specimens.

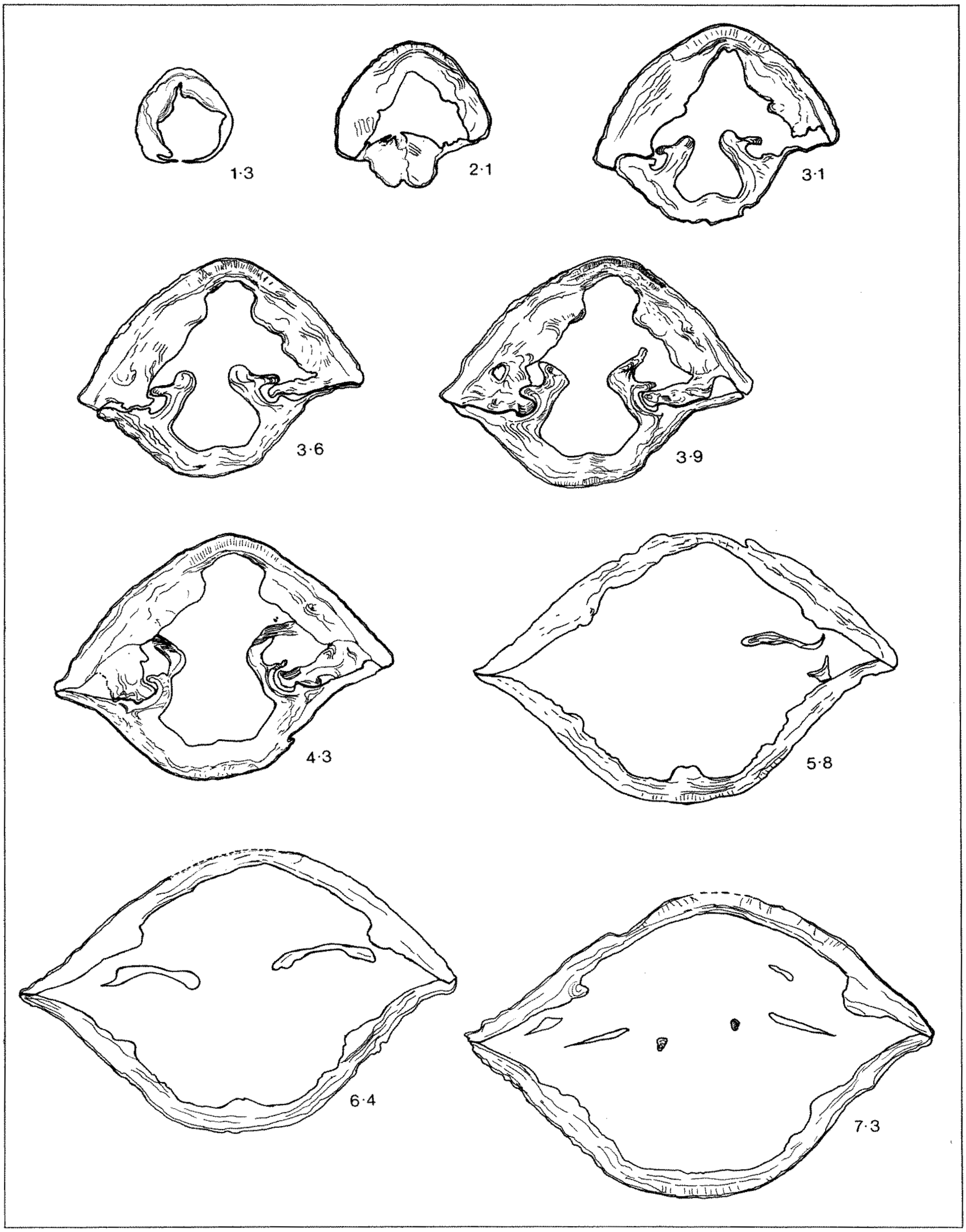


Figure 10. Serial peels of specimen F9454 *Desquamatia (Synatrypa) kimberleyensis.*

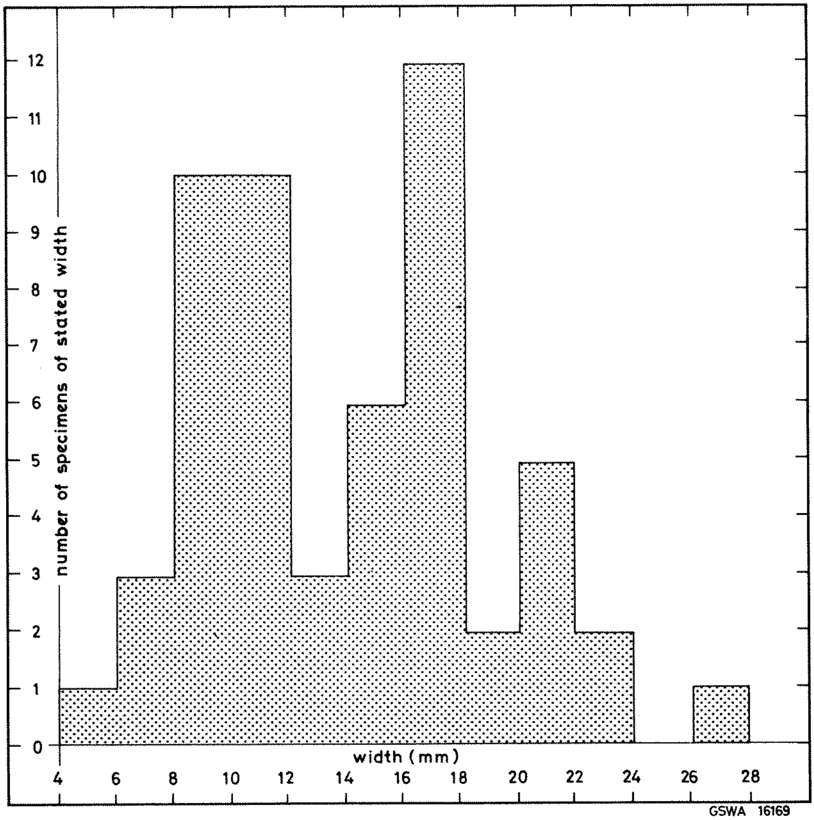


Figure 11. Frequency distribution of widths for 39 specimens of *Desquamatia (Synatrypa) kimberleyensis* from sample 19353.

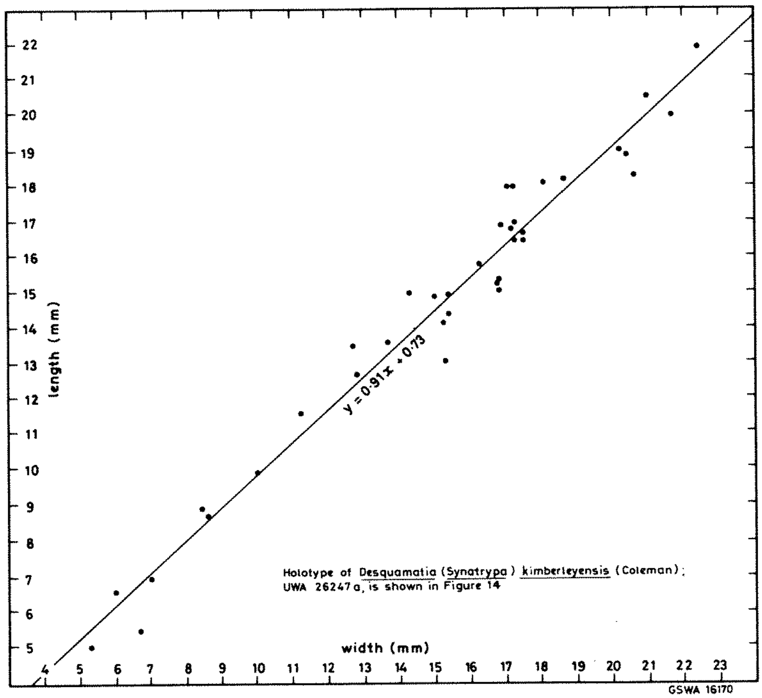


Figure 12. Scatter diagram and reduced major axis of length plotted against width for 38 specimens of *Desquamatia (Synatrypa) kimberleyensis* from sample 19353. (See Figure 14 for position of the holotype.)

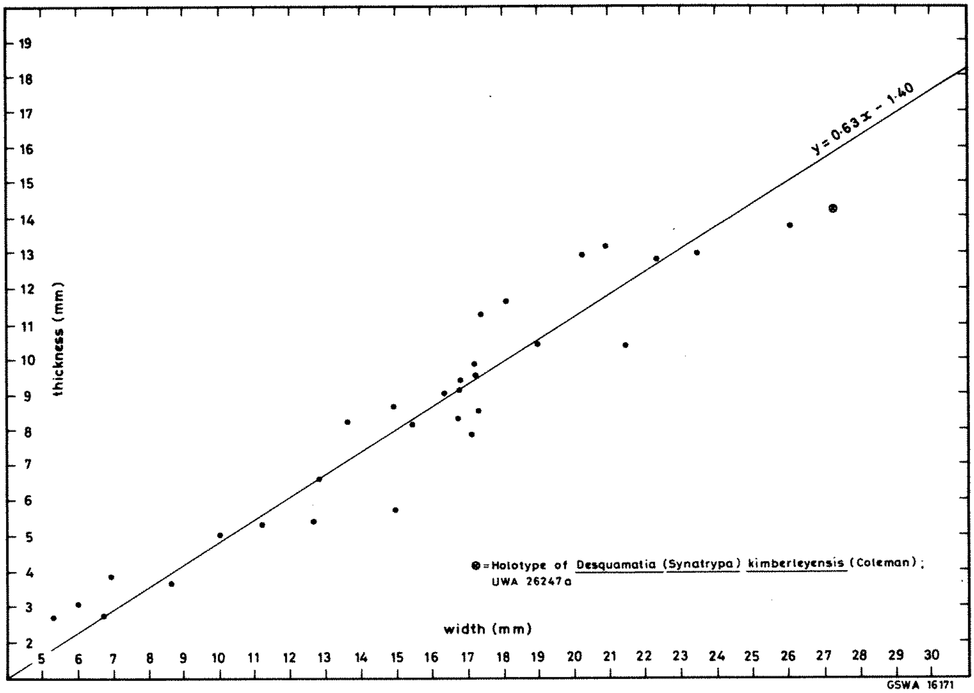


Figure 13. Scatter diagram and reduced major axis of thickness plotted against width for 30 specimens of *Desquamatia (Synatrypa) kimberleyensis* from sample 19353.

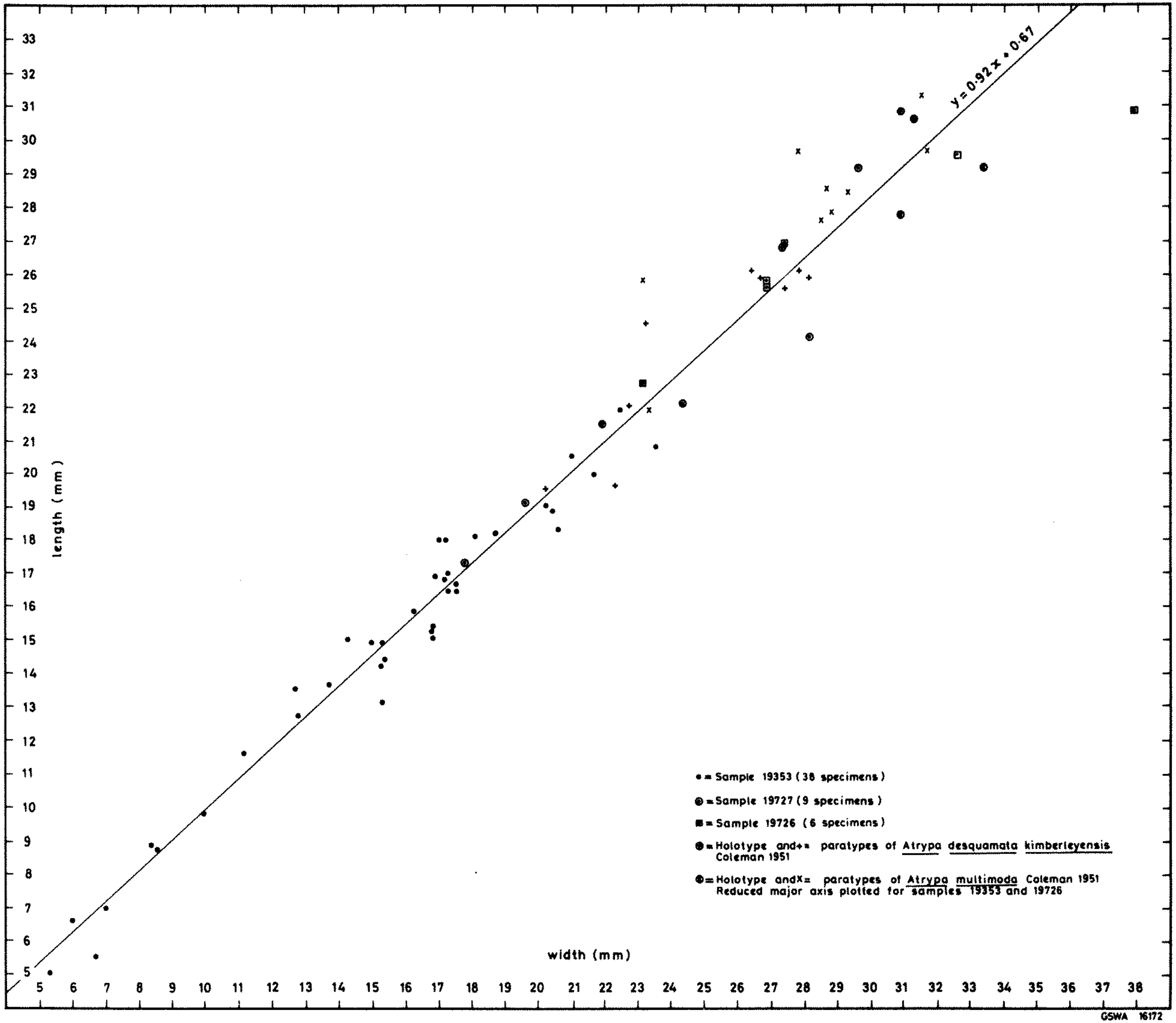


Figure 14. Scatter diagram and reduced major axis of length plotted against width for specimens of *Desquamatia (Synatrypa) kimberleyensis* showing relationship to specimens previously included in *Atrypa multimoda*

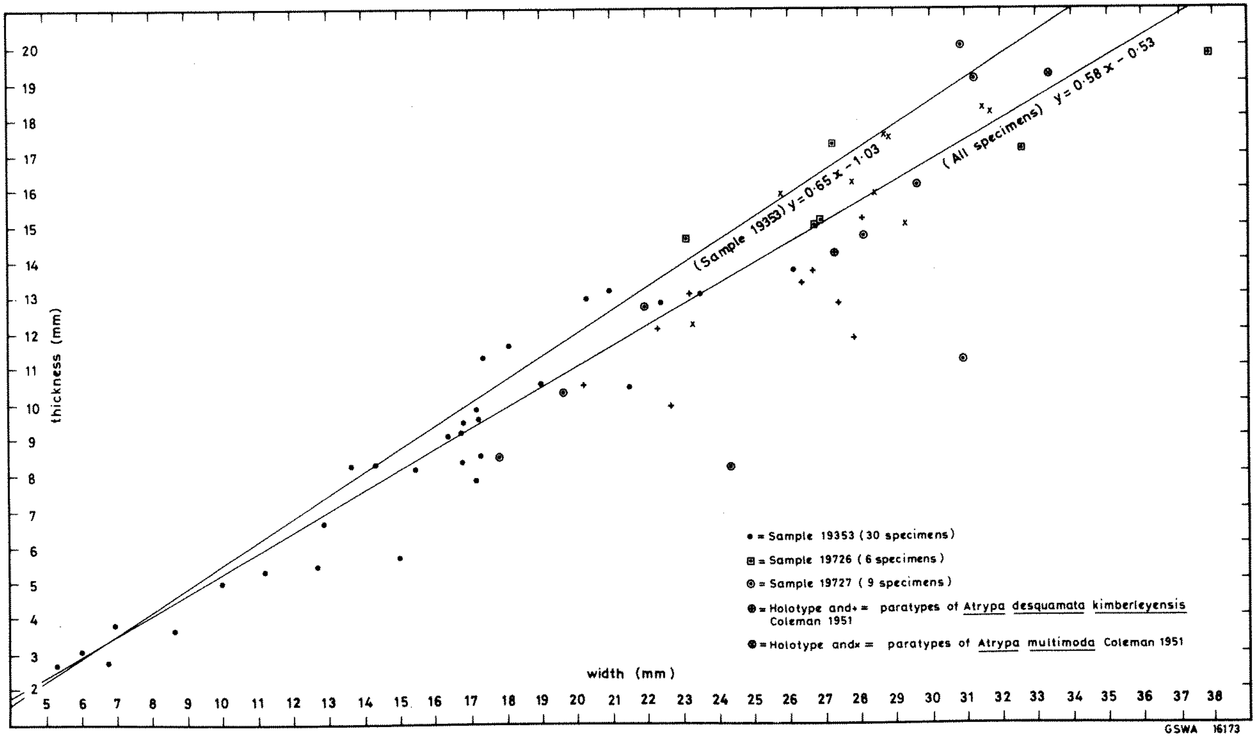


Figure 15. Scatter diagram and reduced major axis of thickness plotted against width for specimens of *Desquamatia (Synatrypa) kimberleyensis* showing relationship to specimens previously included in *Atrypa multimoda*.

TABLE 2. Measurements for specimens of *Desquamatia (Synatrypa) kimberleyensis* (Coleman) from sample 19353.

	Number of specimens	Mean	Max.	Min.	Range	Standard deviation	Holotype
Length (mm)	44	15.01	21.90	5.00	16.90	4.12	26.8
Width (mm)	39	15.67	26.10	5.30	20.80	4.93	27.3
Thickness (mm)	30	8.67	18.24	2.68	15.56	3.80	14.2
Distance occupied by 10 ribs at 10 mm from tip of umbo (mm)	28	4.64	6.02	3.66	2.36	0.61	not measured
Distance occupied by 10 growth lines at 2.5 mm from tip of umbo (mm)	20	13.03	15.54	11.06	4.48	1.42	not measured

Remarks: *Desquamatia (Synatrypa) kimberleyensis* is used here (with some slight modification) in the sense of Veevers (1959a). The inclusion of *Atrypa parva* Coleman, as suggested by Veevers is rejected since the specimens formerly included in this group can be shown to belong to either *Atrypa (Kyrtatrypa) teicherti* or to *Spinatrypina (Spinatrypina) prideri nurungunia.*

Coleman (1951, p.682) erected the species *Atrypa multimoda* for a group of specimens with an extreme range of variation and distinguished by the following characteristics: "1) the general transverseness of the shell, 2) the formation of minor ears at the extremes of the posterior margin, 3) the swollen bulbous character of the shell, 4) the absence of an area, or if it is present, the area is of very small extent". Veevers (1959a, p.119) includes *Atrypa multimoda* in *Atrypa desquamata kimberleyensis* Coleman, regarding the diagnostic features described by Coleman as being merely ontogenetic in significance. Roberts (1971, p.170) does not record *A. multimoda* from the Bonaparte Gulf Basin, but in his study of *Desquamatia (Synatrypa) kimberleyensis* prefers to follow Coleman in regarding *multimoda* and *kimberleyensis* as separate species.

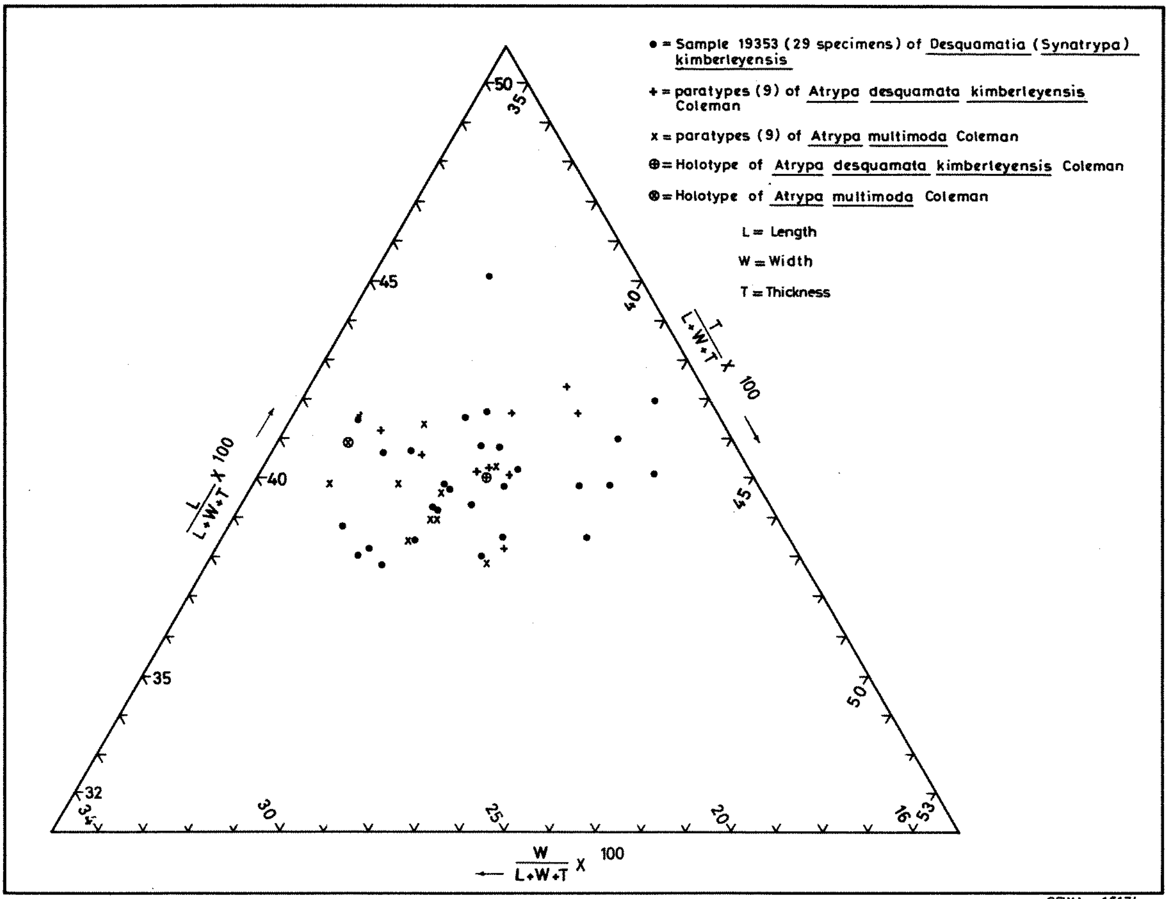
The principal difficulty in defining the ranges of *kimberleyensis* and *multimoda* lies in the extremely poor preservation of the type specimens, in particular the holotype of *multimoda.* In most of the type specimens the nature of the ribbing and growth lines has been destroyed by weathering and the umbo is frequently so badly damaged that the beak curvature and presence of the interarea cannot be determined. All these features are critical in determining the generic status of atrypids. The holotype of *kimberleyensis* is slightly better preserved, but also shows evidence of weathering.

A study of the ribbing and growth lines which are preserved in the types of *multimoda* shows a general similarity to the pattern displayed by the holotype of *kimberleyensis*. Coleman refers to the "... general transverseness of the shell" as a distinguishing characteristic of *multimoda*. Thirty-eight specimens of *kimberleyensis* were examined from the GSWA collection and in 27 of these the width was greater than the length, although the difference was seldom greater than 1 mm. In all but one of the type specimens of *kimberleyensis*, the width exceeds the length, although again the difference is only marginal in most cases. In the type specimens of *multimoda*, all but one specimen are wider, and in most cases the difference is less than 1 mm. The maximum difference occurs in the holotype and is 4.3 mm. However, as can be seen from the graphs showing plots of shell dimensions (Figs 14 and 15), the specimen lies well within the limits displayed by *kimberleyensis*.

The formation of minor ears, also claimed as significant by Coleman, is indeed noticeable in the holotype of *multimoda*, and is present to a lesser degree in some of the paratypes. In many specimens of both *multimoda* and *kimberleyensis* there is evidence of damage to the posterior lateral margins, and the presence or absence of ears remains doubtful. The holotype of *kimberleyensis* is slightly extended along one of the lateral margins, suggesting incipient ear formation. The "swollen, bulbous character of the shell" is also not as evident as is suggested by Coleman. A plot of the relative proportions of the type specimens of both *kimberleyensis* and *multimoda* together with specimens of *kimberleyensis* from the GSWA collection shows that although *multimoda* tends to lie in the wider and thicker portion of the field (Fig.16) it is still well within the range shown by *kimberleyensis*.

The poorly preserved umbos of the type specimens make examination of the critical beak area extremely difficult. Some of the specimens have a small interarea but the exact nature of this cannot be determined because of crushing. The holotype and some of the other types of *multimoda* seem to show an adpressed beak condition; but it is not possible to determine whether this is a feature resulting from distortion followed by weathering, or if the interarea becomes reduced in gerontic stages as a result of increasing globosity.

The evidence therefore suggests that *kimberleyensis* is a fairly variable species and that *multimoda* lies within the range of *kimberleyensis* and should be regarded as conspecific.



GSWA 16174

Figure 16. Length, width, and thickness, plotted as a percentage of their sum for *Desquamatia (Synatrypa) kimberleyensis* showing relative sizes of *kimberleyensis* and *multimoda*.

Roberts (1971, p.165) discusses the problem of the generic status of *kimberleyensis* in the light of revised European taxonomy. He concludes that the species should be transferred to the genus *Desquamatia* (Alekseeva) and belongs in the subgenus *Desquamatia (Synatrypa)* Copper 1966b because of similarities of ornament and the morphology of the posterior margin and ventral interarea.

Biernat (1964) describes the species *Desquamatia subzonata*, later designated type species of the subgenus *Synatrypa* Copper (1966b). This species lacks the large dental cavities present in at least some specimens of *kimberleyensis*, but in other respects the two species are similar. It is interesting to note that there is a close comparison between the growth stages described by Biernat, and those observed in specimens of *kimberleyensis*. In particular, the changes in the structure of the beak area are very similar.

The large dental cavities observed in some specimens, and the large, but only occasionally preserved, frills are somewhat unusual for *Synatrypa*. Gerontic specimens have some characteristics in common with the subgenus *Independatrypa* Copper 1973. There is a fairly strong resemblance to the species *Atrypa ovata* Schnur and *Atrypa zonata* Schnur, which were originally placed in the subgenus *Variatrypa* by Copper (1966b), and later transferred by him to the subgenus *Independatrypa* (Copper 1973). This resemblance is a superficial one because internally *kimberleyensis* lacks a pedicle collar, and has large dental cavities not described for either *Independatrypa* or *Variatrypa*. There is little resemblance to the type species of either subgenus.

Roberts (1971, p.170) gives a detailed comparison with several similar species, mainly from Europe. The most closely related species, however, appear to be from China (Grabau 1931) and North Vietnam (Mansuy, 1912). From the illustrations there seems to be a very close comparison with *Atrypa reticularis* (in Mansuy 1912 p.55, Pl.X, fig.1) and *Atrypa desquamata* (in Mansuy 1912 p.73, Pl.XIII, fig.7). *Atrypa desquamata* mut. *kansuensis* Grabau (1931) from Kansu and Kwangsi in China is remarkably similar to *kimberleyensis*, not only in general appearance, but also in shell dimensions. Internal features of *kansuensis* are not known, but there seems a strong possibility that *kimberleyensis* may be conspecific with *kansuensis*.

Distribution and age: Sadler Limestone, Pillara Limestone, Gogo Formation. Frasnian.

In Western Europe the range of the subgenus is given as Eifelian and possibly Givetian (Biernat, 1964; Godefroid, 1970; and Copper, 1973). Alekseeva (1962) records species from the Givetian and Frasnian of the Kuznetsk Basin. Specimens illustrated by Mansuy (1912) from Indo-China (now North Vietnam) and by Grabau (1931) from China are almost certainly *Synatrypa* and are of probable Frasnian age, although originally described as Famennian by Mansuy.

A Frasnian age for the Canning Basin specimens is well established on the basis of conodont and ammonoid evidence, and the range of the subgenus is here extended to include its late appearance in Western Australia.

Genus *SPINATRYPINA* Rzhonsnitskaya 1964
Subgenus *SPINATRYPINA (SPINATRYPINA)* Rzhonsnitskaya 1964

SPINATRYPINA (SPINATRYPINA) PRIDERI PRIDERI (Coleman, 1951)
Plate III, figs 1-4

1933 *Atrypa aspera* Schlotheim; Hosking, p.71 (in part) Pl.7 figs la-c, not fig.2
1951 *Atrypa aspera prideri* Coleman, p.684 (in part), Pl.102, figs 1-5, not figs 6-17
1959a *Spinatrypa aspera prideri* (Coleman); Veevers p.121 (in part), p.122, text fig. 74, Pl.15, fig.13
not 1959b *Spinatrypa aspera prideri* (Coleman); Veevers p.30, Pl.2, figs 1-10; text fig.11.

Type Material: Holotype UWA 26126*l* from the east side of the north entrance to Menyous Gap, Rough Range area, Kimberley Division, Western Australia. Paratypes 25255b from low hill of yellow limestone, in front of main limestone cliff, 2.4 km southwest of Longs Well, Fitzroy Basin, Western Australia and 26126k from same locality as the holotype.

Other Material and Localities: Approximately 200 complete, well-preserved specimens together with numerous fragments from the following localities:

(Sadler Limestone) Loc.MRM4, sample no.18693; Loc.NOB9, sample no.19721; Loc.NOB11, sample no.19725; Loc.NOB12, sample nos.19727, 19730, 19732. Numerous specimens of *Spinatrypina* which are too poorly preserved to be identified to specific level probably also belong in the sub-species prideri.

Description: Based on type specimens and material from samples 19727 and 19731. Shell medium sized, generally wider than long, and slightly flattened, although thickness varies considerably. Equibiconvex to dorsibiconvex. Greatest curvature between umbo and mid-valve on pedicle valve, brachial valve regularly curved throughout. Anterior commissure broadly sulcate.

Beak prominent; orthocline in juveniles to slightly apsacline in mature specimens, with a large, subapical foramen. Interarea usually poorly preserved; approximately 1 mm high and 10 mm wide at base, having a low triangular shape with well-defined, triangular deltidial plates.

Radial ribs tubular-imbricate, with ribs strongly tubular and with lamellae tending to hug the shell wall. Rib troughs slightly wider than crests, both slightly rounded in cross section. Ribs are fairly coarse, 10 ribs average 9.53 mm at 10 mm from the umbo (10 specimens). Ribs increase by bifurcation forming a narrow, inverted-v pattern; bifurcation tends to occur in series.

Ten growth lines average 11.72 mm at 2.5 mm from the umbo (6 specimens) and become crowded towards the anterior margin. Each rib increases slightly in width between individual growth lines, but increase in height is barely perceptible. At the growth edge of each lamellae the ribs are extended into short spiney projections, which are rarely preserved. These tend to flare slightly outwards and upwards in a trumpet shape. Only the portion of the lamellar edge forming the rib is raised above the shell surface; in the troughs the lamellae hug the shell surface closely.

Internally the pedicle cavity is not thickened, although in some single valves a thin ridge extends across the anterior margin of the pedicle cavity. Deltidial plates are hollow. Teeth massive with a stout, short dental plate and short lateral lobe. Dental nuclei present, developing into lateral cavities anteriorly. Socket plates thin with fairly regular curvature. Crural bases long, near vertical; crura thin and only slightly feathered, directed ventro-laterally.

Jugum thin, gently curved with short, curved jugal plate. Cardinal process weak to absent.

Dimensions: Because of the smallness of this sample the width/frequency diagram could not be plotted. The rib/growth-line ratio is shown in Figure 5. Figure 17 shows a sample containing 119 specimens of *prideri nurungunia* and 10 specimens of *prideri prideri*. The species were differentiated principally on differences in the rib/growth-line ratios and on the nature of the interarea. Width/thickness distribution is shown in Figure 18.

TABLE 3: Measurements for specimens of *Spinatrypina (Spinatrypina) prideri prideri* n. subsp. from sample 19731.

	Number of specimens	Mean	Max.	Min.	Range	Standard deviation	Holotype
Length (mm)	10	15.22	18.60	12.16	6.44	2.18	15.2
Width (mm)	10	16.90	21.50	12.88	8.62	3.00	17.3
Thickness (mm)	9	8.64	11.10	5.80	5.30	1.97	6.8
Distance occupied by 10 ribs at 10 mm from tip of umbo (mm)	10	9.53	12.22	8.08	4.04	1.32	Not measured
Distance occupied by 10 growth lines at 2.5 mm from tip of umbo (mm)	6	11.72	15.04	8.18	6.86	2.69	not measured

Remarks: The type specimen of *Spinatrypina (Spinatrypina) prideri* is extremely poorly preserved. The exterior is so badly weathered that the nature of the ribbing can hardly be distinguished. Two variations of

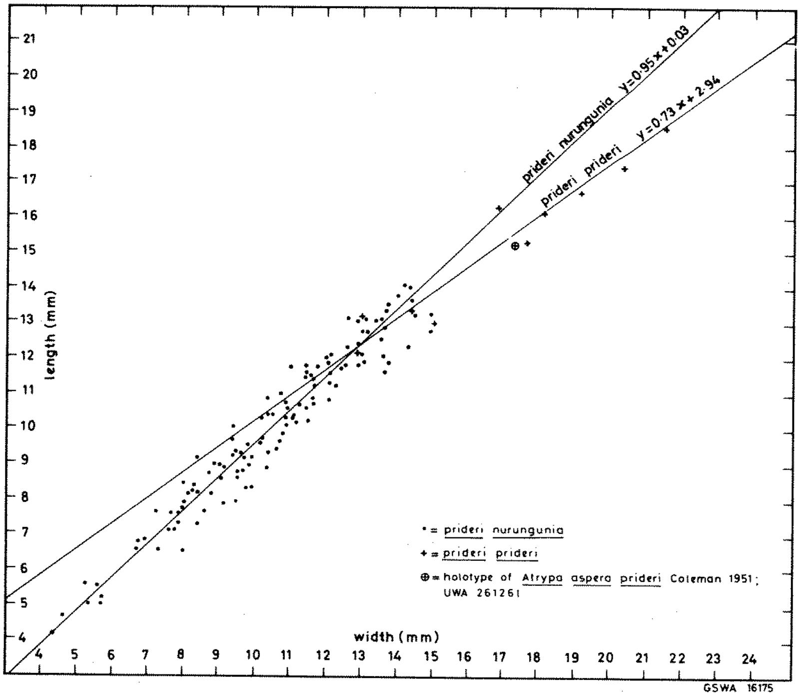


Figure 17. Scatter diagram and reduced major axis of length plotted against width for 119 specimens of *Spinatrypina (Spinatrypina) prideri nurungunia* and 10 specimens of *Spinatrypina (Spinatrypina) prideri prideri* from sample 19731.

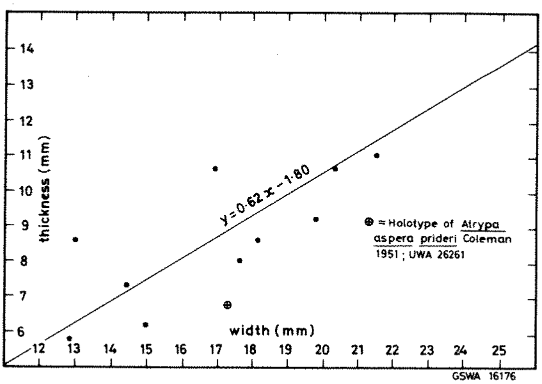


Figure 18. Scatter diagram and reduced major axis of length plotted against width for 10 specimens of *Spinatrypina (Spinatrypina) prideri prideri* from sample 19731.

Spinatrypina are present in the Lennard Shelf area, and both are represented among the paratypes described by Coleman under the name *prideri*. Such wide variations in adult forms are not uncommon in the atrypids (Copper 1966b), and, because the juvenile forms cannot be distinguished, the two variations are not regarded as separate species, but as subspecies.

The subspecies *prideri prideri* is here restricted to specimens of *Spinatrypina* which have a transverse shape, fairly coarse ribbing, and, in which, the growth lamellae hug the shell surface closely in the troughs and flare into a small trumpet shape on the ribs. The beak is orthocline to apsacline, and the interarea is wide, forming a low triangle. Specimens which are rounded in shape; which have finer ribbing and growth lines; in which the lamellae are more strongly imbricate and are detached from the shell surface in both troughs and ribs in a more uniform manner; in which the beak is orthocline to anacline and is strongly curved; and in which the interarea forms a high, narrow triangle, are here regarded as a new subspecies *Spinatrypina (Spinatrypina) prideri nurungunia* (see below).

Specimens which were described by Roberts (1971) from the Bonaparte Gulf Basin as *Spinatrypa prideri larga* are here considered to be a separate subspecies, *Spinatrypina prideri larga*, because of differences in ribbing type and because the beak is strongly anacline with a marked curvature (see description below).

The specimens illustrated by Coleman from the Carnarvon Basin (1951, Pl.102, figs 6-17) and by Veevers (1959b, Pl.2, figs 1-10) from the same area, are also believed to belong to a separate subspecies of *prideri* because of a tendency towards flatness and more rounded shape, because the ribbing is more elevated and angular, and because growth lamellae are more closely spaced than in *prideri*. More specimens are required before this form can be described fully.

The ribbing type of *prideri* is tubular-imbricate, not undulose-interrupted as in *Spinatrypa* (Copper 1966), and therefore the species correctly belongs in the genus *Spinatrypina* Rzhonsnitskaya. The ribbing is not sufficiently coarse to be included in the subgenus *Exatrypa*.

From an examination of the literature there seems to be a close resemblance between *Spinatrypina (Spinatrypina) prideri prideri* and some specimens of *Atrypa aspera* and *Atrypa bodini* described by Mansuy (1912) from

Indo-China. Grabau (1931) and Alekseeva (1962) also describe the species *bodini*, and from both the plates and the dimensions given it seems that Alekseeva may be correct in asserting that *bodini* and *prideri* are conspecific. It is interesting to note that Mansuy also records forms which he calls *Atrypa aspera* and *Atrypa douvillei*, and which are similar to *prideri nurungunia*, indicating that the divergence of form recorded from the Canning Basin is also recorded from Vietnam and southern China. The affinities of the Canning Basin faunas and those recorded from Asia require more detailed investigation because there seem to be several brachiopod species common to both areas.

Distribution and age: Sadler Limestone, Frasnian.

SPINATRYPINA (SPINATRYPINA) PRIDERI NURUNGUNIA n. subsp.
Plate IV, figs 1-3

1933 *Atrypa aspera* Schlotheim; Hosking, p.71 (in part) Pl.7, fig.2

1951 *Atrypa aspera prideri* Coleman, p.684 (in part), Pl.102, fig.6 and fig.8

1951 *Atrypa parva* Coleman, p.685 (in part), Pl.102, figs 23-24, 25-29

1959a *Spinatrypa aspera prideri* (Coleman); Veevers p.121 (in part)

not 1959b *Spinatrypa aspera prideri* (Coleman); Veevers p.30, Pl.2, figs 1-10; text fig.11.

Type Material: Holotype GSWA F9440, from sample 19732, locality NOB12, Sadler Ridge, Lennard Shelf. Paratypes F9441, F9442, F9443 from same locality; F9444; F9445, F9446, F9447 from sample 19731, locality NOB12, Sadler Ridge. F9546 from sample 19353, locality NOB2, east of Emanuel Range.

Derivation of Name: From a local aboriginal word *nurunguni* used by the Kuniandi and Bunaba tribes for the cave paintings found in the area (Playford 1959). The aborigines believed that the *nurunguni* were people and animals who wandered the earth during the far-off "dreamtime" and left their images in the caves.

Other Material and Localities: Approximately 500 extremely well preserved specimens together with numerous fragments. Specimens of *nurungunia* were identified from the following localities.

(Sadler Limestone) Loc.MRM21, sample no.19347; Loc.NOB2, sample no. 19353; Loc.NOB9, sample no.19721; Loc.NOB11, sample no.19725; Loc.NOB12, sample nos.19726, 19727, 19730, 19731, 19732, 19733, 19735, 19738; Loc.NOB14, sample nos.19745, 19746, 19750.

(Pillara Limestone) Loc.MRM16, sample no.19331; Loc.MRM24, sample no. 19364.

The following specimens housed in the UWA collection also belong to *Spinatrypina (Spinatrypina) prideri nurungunia:* UWA No.26261a, 26255a, 26255c, 26641a, 26294b, 26294d, 26292d. Specimens in the GSWA collection identified as *Spinatrypina (Spinatrypina) prideri nurungunia* are as follows: F5126, F5147, F5180, F5181, F5191. Some specimens of *Spinatrypina* which are too poorly preserved to be identified to species level probably also belong to the subspecies *nurungunia.*

Description: Based on type specimens and material from samples 19725, 19727, 19731, 19732, and 19752.

Shell size usually small, although a few large specimens are present in sample 19725. Length equal to width, usually globose. Usually equibiconvex, but ranges from ventribiconvex to dorsibiconvex. Curvature generally equal throughout both valves. In juvenile forms, the pedicle valve slopes steeply from the mid-line near the umbo to the lateral margins, in more mature specimens this slope appears gentler. Anterior margin rectimarginate in juveniles to sulcate in mature forms. Sulcus forms a wide, square tongue.

Beak prominent; orthocline in juveniles to anacline in mature specimens. Large,oval, hypothyrid foramen visible in well preserved specimens. Interarea forming a high triangle, approximately 1.5 mm high and 4.5 mm wide at base. Deltidial plates well defined, triangular.

Radial ribs tubular-imbricate; strongly tubular but with imbrications well-defined. Free edge of growth lamellae is not adpressed to the shell surface. Troughs and ribs of about equal width, but with strong relief and angular in cross section. Ribs are coarse, 10 ribs average 8.39 mm at 10 mm from the umbo (82 specimens from sample 19353). Ribs increase by bifurcation forming a tuning fork pattern. Bifurcations tend to occur in series. Mid-ribs appear straight throughout valve length and have h-shaped branching.

Ten growth lines average 7.31 mm at 2.5 mm from the umbo (98 specimens from sample 19353), and show crowding at the margin in mature specimens. Ribs increase in width towards the edge of each growth lamella, and, in well preserved specimens, flare upwards and outwards into spinose, trumpet shaped projections. The portion of the lamellar margin forming the rib is raised high above the underlying shell surface. In the troughs, the margin is also elevated, though not as much as on the ribs.

Internally (Fig.19) the pedicle cavity is slightly thickened. Deltidial plates tend to be short and hollow. Teeth are massive and have a short dental plate and a short, pointed lateral lobe. Dental nuclei are well developed and may form small cavities. Hinge plates are fairly massive and have a long lateral lobe. Crural bases short and stout with short, unfeathered crura. Jugum straight, thin; at least 8 spiralia present. Cardinal process occasionally weakly developed.

Dimensions: Table 4 shows the measurements for specimens of *nurungunia* from sample 19353 and the holotype from sample 19732. Growth-line/rib ratios are plotted in Figure 5. Figure 20 shows the width/frequency distribution and the ranges of the species are shown in Figures 17, 21, and 22.

TABLE 4: Measurements for specimens of *Spinatrypina (Spinatrypina) prideri nurungunia* n. subsp. from sample 19353 and holotype from sample 19732.

	Number of specimens	Mean	Max.	Min.	Range	Standard deviation	Holotype
Length (mm)	159	11.12	17.34	3.12	14.22	2.67	14.2
Width (mm)	159	10.55	17.54	3.48	14.06	2.78	14.3
Thickness (mm)	159	5.81	11.38	1.94	9.44	1.91	7.8
Distance occupied by 10 ribs at 10 mm from tip of umba (mm)	83	8.39	10.52	5.86	4.66	0.88	9.42
Distance occupied by 10 growth lines at 2.5 mm from tip of umbo (mm)	99	7.34	10.80	4.26	6.54	1.44	9.82

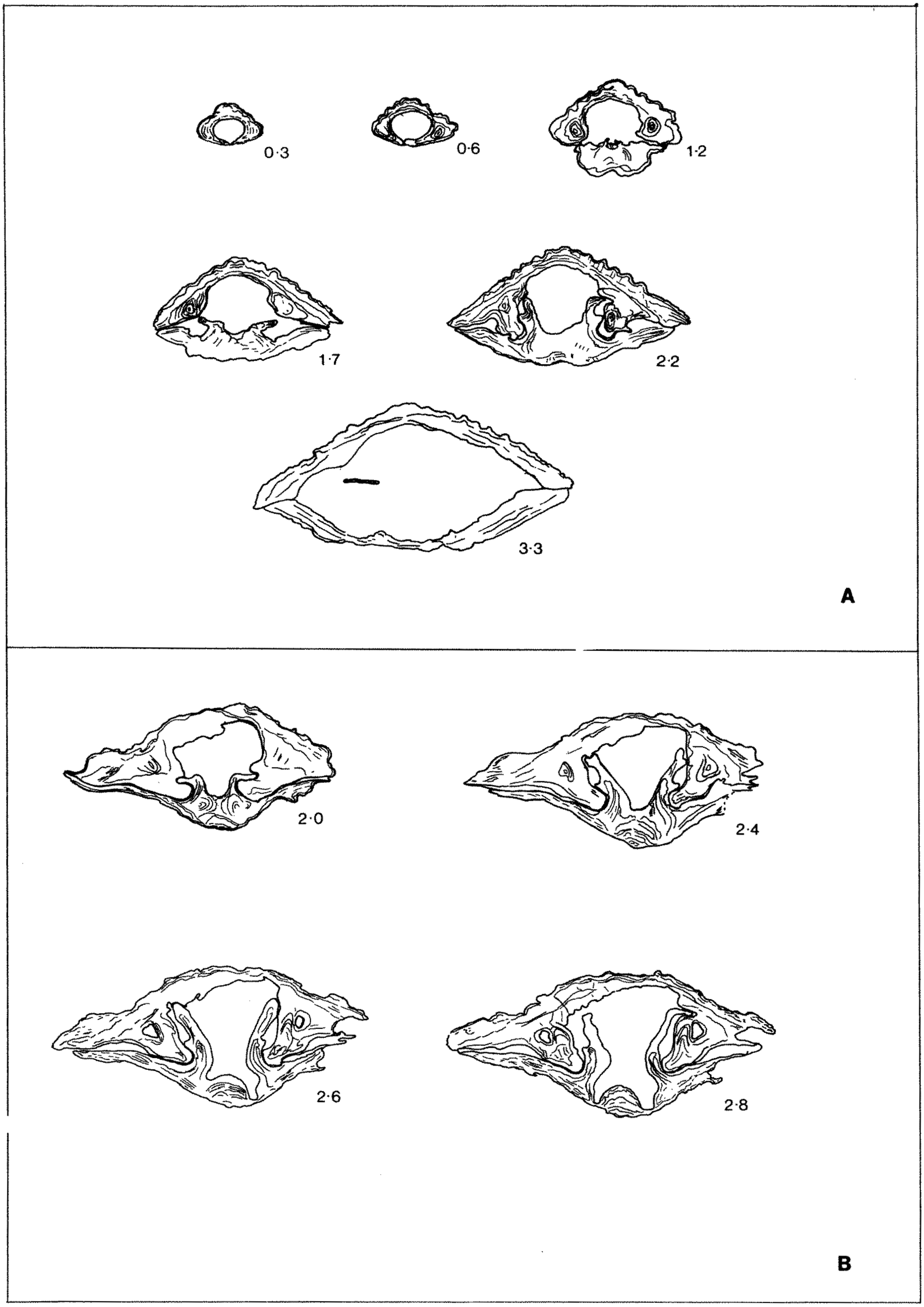


Figure 19. Serial peels of specimens of *Spinatrypina (Spinatrypina) prideri nurungunia* from sample 19353 (A-F9455; B-F9561)

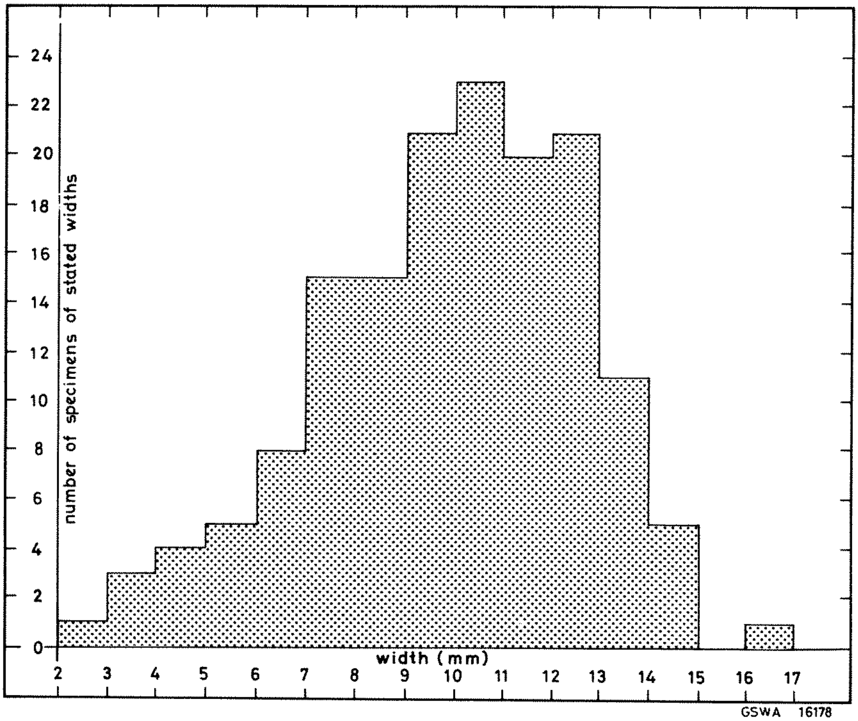


Figure 20. Frequency distribution of widths for 159 specimens of *Spinatrypina (Spinatrypina) prideri nurunguria* from sample 19353.

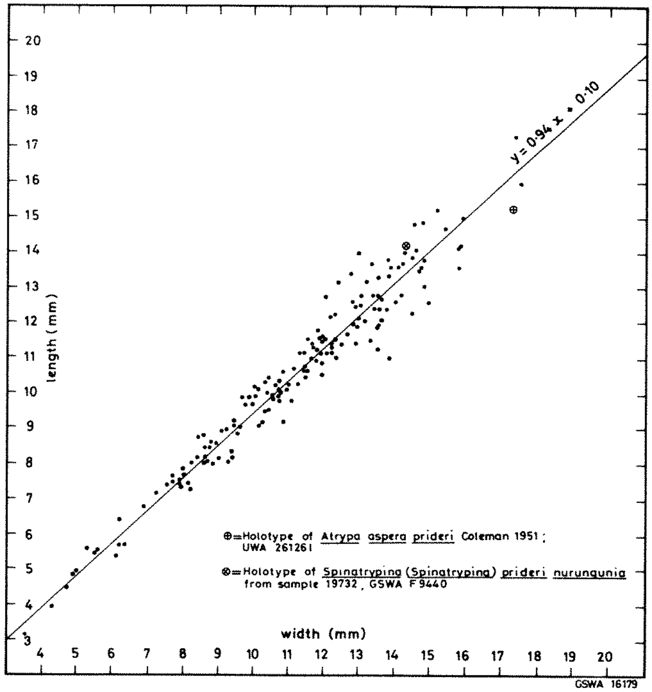


Figure 21. Scatter diagram and reduced major axis of length plotted against width for 159 specimens of *Spinatrypina (Spinatrypina) prideri nurungunia* from sample 19353.

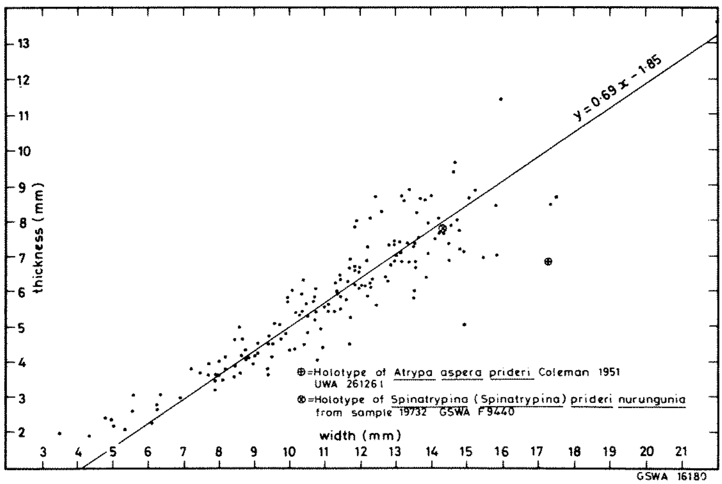


Figure 22. Scatter diagram and reduced major axis of thickness plotted against width for 159 specimens of *Spinatrypina (Spinatrypina) prideri nurungunia* from sample 19353.

Remarks: Preservation of some specimens is excellent. In particular, some individuals from sample 19732 are so perfectly preserved that they are still articulated. In these specimens, three dimensional details of the internal structures can be readily observed.

The criteria used in distinguishing between the subspecies *nurungunia* and *prideri* have already been discussed in the remarks on *prideri*. Intermediate forms between the two extremes are occasionally found, and the juvenile forms cannot be distinguished from each other. For this reason the two forms are considered to be subspecies.

The very close resemblance between *prideri nurungunia* and *Atrypa douvillei* Mansuy (1912) requires further investigation. From Mansuy's illustrations there is a strong similarity in shell shape and in the nature of the ribbing, both in its bifurcation and in the growth-line/rib ratio. Specimens called *Atrypa aspera* by Mansuy also show similarities with *prideri nurungunia*. Examination of the holotypes is necessary before an exact relationship can be determined, but *prideri nurungunia* may well prove to be a junior synonym of *douvillei*.

Distribution and age: Sadler Limestone, Pillara Limestone. Frasnian.

SPINATRYPINA (SPINATRYPINA) PRIDERI LARGA Roberts 1971

1971 *Spinatrypa prideri larga* Roberts, p.172, Pl.38, figs 23-45.

Type material: Holotype CPC10981 from the Westwood Member of the Cockatoo Formation at Westwood Creek, Bonaparte Gulf Basin. Paratypes CPC 10975-10981 from the same locality. Specimens were loaned by the Bureau of Mineral Resources for the purposes of this study.

Other materials and localities: See Roberts 1971, p.176 for details.

Dimensions: See Roberts 1971, p.174.

Remarks: The subspecies *prideri larga* Roberts is here transferred to the subgenus *Spinatrypina (Spinatrypina)*. It differs from the subspecies *prideri prideri* in several important features. In addition to those given by Roberts (1971, p.174), the beaks differ markedly; *prideri prideri* is orthocline to apsacline with a relatively large interarea, whereas the beak in *prideri larga* is orthocline in juvenile specimens, but becomes anacline to nearly hypercline in mature specimens. The interarea is smaller in *prideri larga* than in *prideri prideri*. Internally the two subspecies are rather similar, although the lateral cavities are probably better developed in *prideri prideri*.

No specimens of *Spinatrypina (Spinatrypina) prideri larga* have been recorded from the Lennard Shelf area, and there is no evidence that this subspecies occurs outside the Bonaparte Gulf Basin.

Distribution and age: Cockatoo Formation, Frasnian.

Subgenus *SPINATRYPINA (EXATRYPA)* Copper 1967b

SPINATRYPINA (EXTRYPA) KUNIANDIA new species
Plate V, figs 1-3

1951 *Atrypa aspera prideri* Coleman, Pl.102, figs 9-10.

Type Material: GSWA registered no.F9448, from sample no.19732, Loc.NOB 12, Sadler Ridge, Lennard Shelf. Paratypes: GSWA F9449, F9450, F9451, F9452 from the same sample.

Derivation of Name: From the Kuniandi tribe of aborigines who lived in the area to the east of the Fitzroy River.

Other Material and Localities: Well preserved material has so far only been obtained from sample 19732. Fragments and poorly preserved specimens occur in the following samples.

(Sadler Limestone) Loc.NOB12, sample no.19736; Loc.NOB14, sample no. 19745, 19746.

(Pillara Limestone) Loc.MRM7, sample no.19309 (possibly *kuniandia*); loc.NOB5, sample no.19650.

(?Pillara Limestone) Loc.MRM26, sample no.19615 (possibly *kuniandia*).

The only specimen in the collections of GSWA and UWA which can be regarded as belonging to *Spinatrypina (Exatrypa) kuniandia* is UWA 26261c, which was illustrated by Coleman as *Atrypa aspera prideri* in Plate 102, figures 9 and 10. No specimens were observed in the collections held by the BMR.

Description: Based on type specimens from sample no.19732. Shell size medium, very transverse with length approximately 2/3 width, usually flattened. Equibiconvex to dorsibiconvex; brachial valve regularly curved throughout, pedicle valve tends to flatten towards anterior margin. Lateral slopes may be steeper near umbo in pedicle valve. Anterior margin rectimarginate to gently and broadly sulcate.

Beak not very prominent, orthocline to apsacline. Small rounded sub-apical foramen present, protruding slightly above level of rest of interarea. Interarea forms a low, wide triangle, approximately 1 mm high to 8 mm wide. Deltidial plates absent or minute.

Radial ribs undulose interrupted, with flattened ribs strongly defined and prominent, strongly-deflected growth lamellae. Rib troughs and crests of about equal width, both rather shallow, rib crests slightly flattened. Ten ribs average 10.33 mm at 10 mm from the umbo (13 specimens). Ribs increase by occasional bifurcation. Increase occurs in an irregular manner and usually occurs in the middle of the growth lamella forming an inverted Y-shape.

Most specimens have fewer than ten growth lines so the distance occupied by 5 growth lines at 2.5 mm from the umbo was measured and averaged 8.73 mm (13 specimens). Crowding occurs near the margin. Ribs increase slightly in width on each growth lamella. Growth lines are strongly deflected along edges forming a frilly extension. Frills probably only short in extent though margins are damaged. Edges of growth lamellae appear to be elevated equally above both ribs and troughs.

Internal structure poorly known. Pedicle valve seems to have some apical thickening and minute or absent deltidial plates. Teeth robust, but other internal features unknown (no serial peels have been examined because of the small number of specimens). Crural bases appear short and robust. Cardinal process present in the notothyrial pit. Strong median septum present with a median groove. Muscle scars are not well preserved in most specimens, but the ventral muscle field is large and is bordered by a pitted area. Details of crura, jugum and spiralia not preserved.

Dimensions: Size range is shown in Figures 5, 23, 24 and 25. No width/frequency plot is given because of the small number of specimens measured. Only 5 growth lines were measured because the wide spacing meant that most specimens had less than 10 present. In Figure 5 the growth-line/rib ratio is plotted using the growth-line measurement multiplied by two in an attempt to be consistent with the other taxa shown on the diagram. The actual measurements for the rib/growth-line ratios are shown in Figure 25.

TABLE 5: Measurements for specimens of *Spinatrypina (Exatrypa) kuniandia* n. sp. from sample 19732.

	Number of specimens	Mean	Max.	Min.	Range	Standard deviation	Holotype
Length (mm)	17	13.04	17.30	5.20	12.10	3.93	15.1
Width (mm)	17	16.16	24.40	5.50	18.90	5.57	18.5
Thickness (mm)	11	5.79	7.70	2.40	5.30	1.97	7.4
Distance occupied by 10 ribs at 10 mm from tip of umbo (mm)	12	10.43	11.80	9.20	2.60	0.86	11.0
Distance occupied by 5 growth lines at 2.5 mm from umbo (mm)	13	8.73	12.10	5.70	6.40	2.08	7.8

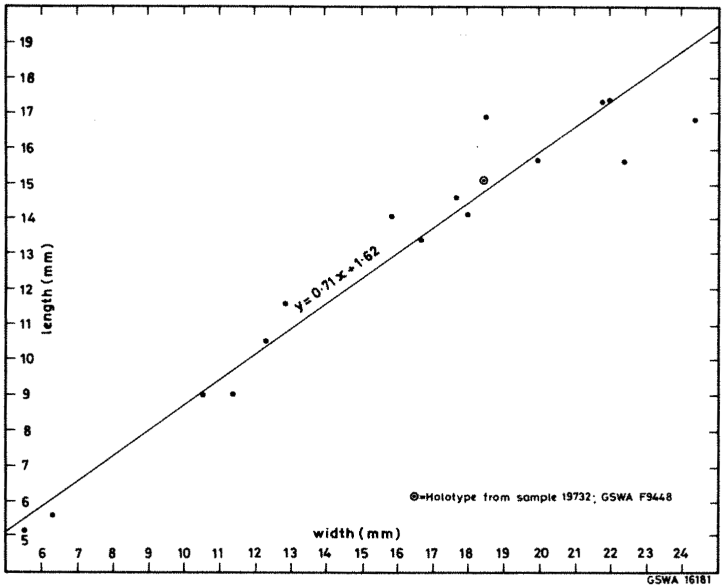


Figure 23. Scatter diagram and reduced major axis of length plotted against width for 17 specimens of *Spinatrypina (Exatrypa) kuniandia* from sample 19732.

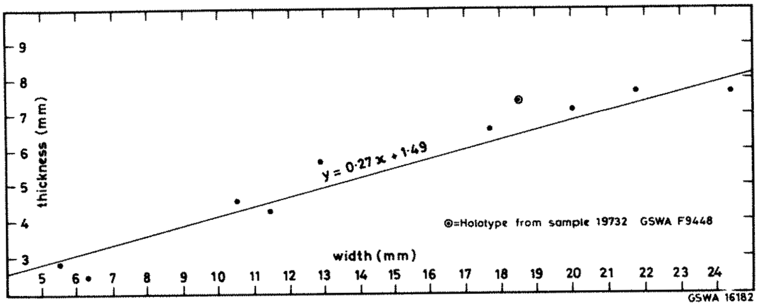


Figure 24. Scatter diagram and reduced major axis of thickness plotted against width for 11 specimens of *Spinatrypina (Exatrypa) kuniandia* from sample 19732.

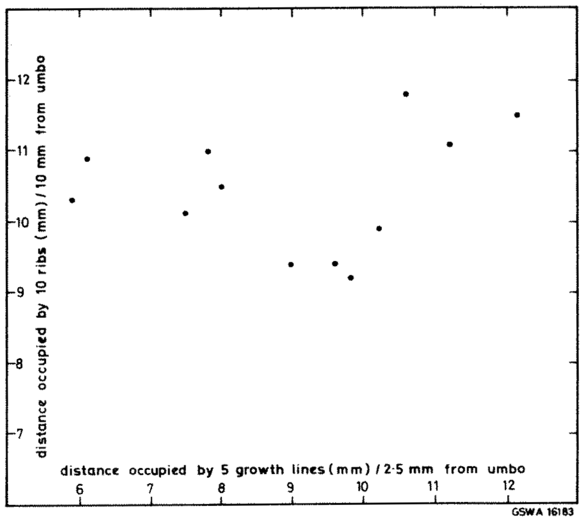


Figure 25. Scatter diagram showing relationship between growth lines and ribbing for 13 specimens of *Spinatrypina (Exatrypa) kuniandia* from sample 19732.

Remarks: The presence of this very transverse form has probably added to the confusion surrounding the nature of the species *Spinatrypina (Spinatrypina) prideri* (Coleman). It differs from the latter in having a greater transverse shape, a very small, rounded subapical foramen, a smaller interarea, and principally in the presence of extremely coarse tubular-imbricate ribbing, a feature typically associated with the subgenus *Exatrypa* Copper (1967b).

The new species *kuniandia* most closely resembles *Spinatrypina (Exatrypa) tubaecostata* Paeckelmann 1913. It can be distinguished from *tubaecostata* by its more transverse shape and shallower ribbing. The ribbing is coarser and shallower, and the shell is more transverse than in the other species of *Exatrypa* illustrated by Copper (1967b).

Distribution and Age: Sadler Limestone, Pillara Limestone. Frasnian.

REFERENCES

ALEKSEEVA, R.E., 1960a, A new subgenus *Atrypa (Desquamatia)* Family Atrypidae Gill: Akad. Nauk SSSR 131 (2), p.421-424 (In Russian).

______ 1960b, On the genus *Spirigerina* Orbigny: Palaont. Zhurn. 4, p.63-68 (In Russian).

______ 1962, Devonian Atrypida from the Kutznetsk and Minussinsk Basins and the eastern part of the northern Urals: Izd, Akad. Nauk SSSR, p.1-196 (In Russian).

______ 1968, *Sibirispira* - A new genus of the Order Atrypida: Akad. Nauk SSSR, Doklady, v. 179 (1), p.198-201 (In Russian).

BIERNAT, G., 1964, Middle Devonian Atrypacea (Brachiopoda) from the Holy Cross Mountains, Poland: Acta Palaeontologica Polonica, v.IX (3), p.277-337.

BOUCOT, A.J., JOHNSON, J.G., PITRAT, C.W., and STATON, R.D., 1965, Suborder Atrypidinae, *in* R.C. Moore (ed.), Treatise on invertebrate paleontology, Part H, Brachiopoda: Lawrence, Kansas. Kansas University Press and Geol. Society of America, p.632-649.

COLEMAN, P.J., 1951, *Atrypa* in Western Australia : Jour. Paleontology, v.25, p.677-690, Pl.100-102, figs 1-3.

______ 1952, Addendum to '*Atrypa* in Western Australia': Jour. Paleontology, v.26, p.861.

COPPER, P., 1964, European mid-Devonian correlations: Nature v.204, no.4956, p.363-364.

______ 1965a, Unusual structures in Devonian Atrypidae from England: Palaeontology, v.8 (2), p.358-373.

______ 1965b, A new Middle Devonian atrypid brachiopod from the Eifel, Germany: Senckenbergiana Lethaea, v.46 (4), p.309-325.

______ 1966a, European Mid-Devonian correlations: Nature, v.209, no.2057, p.982-984.

______ 1966b, The *Atrypa zonata* brachiopod group in the Eifel, Germany: Senckenbergiana Lethaea, v.47 (1), p.1-55.

______ 1966c, Ecological distribution of Devonian atrypid brachiopods: Palaeogeog. Palaeoclimat. Palaeoecol. v.2 (3), p.245-266.

______ 1967a, The shell of Devonian Atrypida (Brachiopoda): Geol. Mag. v.104, p.123-131.

______ 1967b, Frasnian Atrypidae (Bergisches Land, Germany): Palaeontolographica A, v.126, (3-6), p.116-140.

______ 1967c, Morphology and distribution of *Kerpina* Struve (Devonian Atrypida): Palaeontologische Zeitschrifte, v.41 (1-2), p.72-74.

______ 1967d, *Atrypa (Planatrypa)*, a new Devonian brachiopod species-group: Neues Jahrbuch fur Geologie und Palaontologie, Abh.128 (3), p.229-243.

______ 1967e, Pedicle morphology in Devonian atrypid brachiopods: Jour. Paleontology. v.41, no.5, p. 1116-1175.

______ 1967f, Brachidial structures of some Devonian atrypid brachiopods: Jour. Paleontology, v.41, no.5 p.1176-1183.

______ 1967c, *Spinatrypa* and *Spinatrypina* (Devonian Brachiopoda): Palaeontology, v.10 (3), p.489-523.

______ 1967h, Adaptations and life habits of some Devonian atrypid brachiopods: Palaeogeog. Palaeoclimat. and Palaeocol. v.3, p.363-379.

______ 1973, New Siluro-Devonian Atrypoid Brachiopods: Jour. Paleontology, v.47 (3), p.484-500.

DALMAN, J.W., 1828, Uppstallning och Beskrifning af de i Sverige funne Terebratuliter: Kongl. Svenska Vetenskapsakad. Handl. for 1827, p.85-155.

FOORD, A.H., 1890, Description of fossils from the Kimberley District, Western Australia: Geol. Mag. N.S. 3, (7) p.98-106.

GODEFROID, J., 1970, Caracteristiques de quelque Atrypida du Devonien Belge: Annales de la Société Géologique de Belgique, v.93, p.87-126.

GRABAU, A.W., 1931, Devonian Brachiopods of China: Palaeont. Sin. 3(3), 538p.

GRATSIANOVA, R.T., 1967, Brachiopods and stratigraphy of the Lower Devonian of the Altai Mountain Chain: Akad. Nauk SSSR. Siberian Div. Inst. Geol. Geophys. 160p (In Russian).

GREY, K., 1977, Review of the reported occurrence of Famennian (Late Devonian) atrypid brachiopods: West. Australia Geol. Survey Ann. Rept 1976.

HOSKING, L.F.V., 1933, Distribution of Devonian Rocks in the Kimberley Division; and Description of a recent collection of Devonian fossils from the Kimberley Division: Royal Soc. West. Australia Jour., v.19, p.67-76.

IVANOVA, E.A., 1962, Ecology and development of Silurian and Devonian brachiopods of the Kuznetsk, Minussinsk and Tuvinsk Basins: Akad. Nauk SSSR, Trudy Paleontol. Inst. 83, p.1-150 (In Russian).

MANSUY, H., 1912, Etude geologique du Yun-nan Oriental. Pt 2. Paleontologie: Service geol. de l'Indochine v.1, fasc. 2.

NIKIFOROVA, O.I., and ANDREEVA, O.N., 1961, Ordovician and Silurian stratigraphy of the Siberian Platform and its palaeontological basis (Brachiopoda): Vses. Nauchno issled. Geol. Inst. Trudy 56, 412p (In Russian).

PAECKELMANN, W., 1913, Das oberdevon des Bergischen Landes Abh. preuss. geol. Landesanst. v.70, p.1-356.

PLAYFORD, P.E., 1959, Aboriginal rock paintings of the West Kimberley region, Western Australia: Royal Soc. West. Australia Jour. v.43, p.111-122.

PLAYFORD, P.E., and COCKBAIN, A.E., 1976, Revised stratigraphic and facies nomenclature in Devonian reef complexes of the Canning Basin: West. Australia Geol. Survey Ann. Rept 1975.

ROBERTS, J., 1971, Devonian and Carboniferous brachiopods from the Bonaparte Gulf Basin, Northwestern Australia: Australia Bur. Mineral Resources Bull.122.

ROBERTS, J., JONES, P.J., JELL, J.S., JENKINS, T.B.H., MARSDEN, M.A.H., McKELLAR, R.G., McKELVEY, B.C., and SEDDON, G., 1972, Correlation of the Upper Devonian rocks of Australia: Geol. Soc. Australia Jour. v.18 (4), p.467-490.

RZHONSNITSKAYA , M.A., 1960a, Order Atrypida. *in* Sarycheva, T.G. (ed.), Osnovi Paleontologii: p.257-264. (In Russian)

______ 1960b, The genus *Gruenewaldtia* from the Devonian of the SSSR: Stat. Paleont. Biostratigr. Sbor., v.20, p.45-50.

______ 1964, Stratigraphy and Brachiopoda of the Devonian of the margins of the Kuznetsk Basin: Vses. Nauchno issled. Geol. Inst. Trudy, SSSR, 93, p.91-112 (In Russian).

SCHNUR, J., 1851, Die Brachiopoden aus dem Uebergangsgebirge de Eifel: Progr. Ver. Hoh. Brg. Prov. Gewerbesch. Trier. 1-16.

SIEHL, A., 1962, Der Greifensteinerkalk (Eiflium, Rheinisches Schiefergebirge) und seine Brachiopoden fauna; I. Geologie; Atrypacea und Rostrospiracea: Palaeontographica A v.119, p.173-221.

STAINBROOK, M.A., 1945, Brachiopoda of the Independence Shale of Iowa: Mem. Geol. Soc. Amer. v.14, p.1-74.

______ 1951, Substitution for the preoccupied brachiopod name of *Hystricina:* Jour. Washington Academy of Science, v.41 (6), p.196.

STRUVE, W., 1961, Zur Stratigraphie der sudlichen Eifler Kalkmulden (Devon: Emsium, Eifelium, Givetium): Senckenbergiana Lethaea, v.42 (3-4). p.391-345.

______ 1964, Erörterung des Alters der Refrath-Schichten und Darstellung einiger devonischer Atrypinae: Senckenbergiana Lethaea, v.-45(6), p.523-532.

______ 1966, Einige Atrypinae aus dem Silurium und Devon: Senckenbergiana Lethaea, v.47 (2), p.123-163.

TALENT, J.A., 1956, Siluro-Devonian brachiopods from Marble Creek, Thomson River, Victoria: Royal Soc. Victoria Proc. v.68, p.73-84.

TEICHERT, C., 1949, Observations on stratigraphy and palaeontology of Devonian. Western portion of Kimberley Division: Australia Bur. Mineral Resources Rept 2, p.1-55.

TIASHEVA, A.P. *in* TIASHEVA, A.P. and OTHERS, 1962, Brachiopods, ostracods and spores of the Middle and Upper Devonian of Bashkir: Izd. Akad. Nauk SSSR, Bashkir. filial, Gorno-geol. inst. 5-138 (In Russian).

VEEVERS, J.J., 1959a, Devonian brachiopods from the Fitzroy Basin, Western Australia: Australia Bur. Mineral Resources Bull.45.

______ 1959b, Devonian and Carboniferous brachiopods from Northwestern Australia: Australia Bur. Mineral Resources Bull.55.

LOCALITY DETAILS

Sample No.	Formation	Loc. No.	Co-ordinates	Species
18660	Dp	MRM 2	E408900 N2649610	*Desquamatia (Synatrypa) kimberleyensis*
18666	Dp	MRM 3	E408930 N2650000	*Desquamatia (Synatrypa) kimberleyensis*
18693	Dd	MRM 4	E406240 N2652520	Atrypids gen. and sp. indet. *Spinatrypina* sp. indet. *Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina (Exatrypa) kuniandia*
18694	Dd	MRM 5	E406270 N2652530	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina* sp. indet.
19308	Dp	MRM 6	E403900 N2655090	*Desquamatia (Synatrypa) kimberleyensis*
19309	Dp	MRM 7	E403890 N2655260	*Spinatrypina (Exatrypa) kuniandia*
19310	Dp	MRM 8	E403920 N2655130	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina* sp. indet.
19311	Dp	MRM 8	E403920 N2655130	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina* sp. indet.
19314	Dp	MRM 9	E403890 N2655290	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina* sp. indet.
19315	Dp	MRM 10	E403890 N2655290	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina* sp. indet.
19319	Dp	MRM 11	E403940 N2654860	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina* sp. indet. atrypid gen. and sp. indet.
19322	Dp	MRM 12	E403940 N2654780	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina* sp. indet. atrypid gen. and sp. indet.
19324	Dp	MRM 13	E403970 N2654690	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina* sp. indet. atrypid gen. and sp. indet.
19325	Dd	MRM 14	E401520 N2657090	*Spinatrypina* sp. indet.
19327	Dp	MRM 15	E401400 N2657040	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina* sp. indet.
19331	Dp	MRM 16	E401420 N2657060	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina (Spinatrypina) prideri nurungunia* *Spinatrypina* sp. indet. atrypid gen. and sp. indet.

19333	Dp	MRM 17	E401180 N2657010	atrypid fragments gen. and sp. indet.
19336	Dp	MRM 18	E401350 N2656930	atrypid fragments gen. and sp. indet.
19338	Dp	MRM 19	E401200 N2657010	atrypid fragments gen. and sp. indet.
19346	Dp	MRM 20	E401150 N2656880	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina* sp. indet. atrypid gen. and sp. indet.
19347	Dd	MRM 21	E401080 N2656960	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina (Spinatrypina) prideri nurungunia* *Spinatrypina* sp. indet. atrypid gen. and sp. indet.
19348	Dd	MRM 22	E401110 N2656940	*Desquamatia (Synatrypa) kimberleyensis* atrypid gen. and sp. indet.
19349	Dd	MRM 23	E401130 N2656930	atrypid gen. and sp. indet.
19353	Dd	NOB 2	E398600 N2657700	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina (Spinatrypina) prideri nurungunia*
19364	Dr/Dd	MRM 24	E409610 N2662540	*Spinatrypina (Spinatrypina) prideri nurungunia*
19368	Dr	MRM 25	E410750 N2665930	*Spinatrypina* sp. indet.
19395	Dp	NOB 3-4	E390240-390340 N2663210-2663110	atrypid fragments gen. and sp. indet.
19615	?Dr	MRM 26	E410010 N2663890	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina (Exatrypa) kuniandia?*
19650	?Dp	NOB 5	E396240 N2662790	*Spinatrypina (Exatrypa) kuniandia*
19659	Dp	MRM 27	E401450 N2662130	atrypid fragments gen. and sp. indet.
19663	Dd	NOB 6	E392920 N2664380	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina* sp. indet.
19706	Dp	NOB 7	E391040 N2663180	atrypid fragments gen. and sp. indet.
19707	Dp	NOB 7-8	E391040-391370 N2663180-2663390	*Spinatrypina* gen. and sp. indet.
19711	Dp	NOB 8	E391370 N2663390	atrypid fragments gen. and sp. indet.

19719	Dp	NOB 9	E392540 N2662760	atrypid fragments gen. and sp. indet.
19720	Dp	NOB 9	E392540 N2662760	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina* sp. indet.
19721	Dd	NOB 9	E392540 N2662760	*Spinatrypina (Spinatrypina) prideri prideri* *Spinatrypina (Spinatrypina) prideri nurungunia*
19724	Dd	NOB 10	E392500 N2662960	*Desquamatia (Synatrypa) kimberleyensis*
19725	Dd	NOB 11	E392940 N2662990	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina (Spinatrypina) prideri nurungunia*
19726	Dd	NOB 12	E393730-394240 N2662480-2663500	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina (Spinatrypina) prideri nurungunia*
19727	Dd	NOB 12	E393730-394240 N2662480-2663400	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina (Spinatrypina) prideri nurungunia* *Spinatrypina (Exatrypa) kuniandia*
19730	Dd	NOB 12	E393730-394240 N2662480-2663400	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina (Spinatrypina) prideri nurungunia*
19731	Dd	NOB 12	E393730-394240 N2662480-2663400	*Spinatrypina (Spinatrypina) prideri prideri* *Spinatrypina (Spinatrypina) prideri nurungunia*
19732	Dd	NOB 12	E393730-394240 N2662480-2663400	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina (Spinatrypina) prideri prideri* *Spinatrypina (Spinatrypina) prideri nurungunia* *Spinatrypina (Exatrypa) kuniandia*
19733	Dd	NOB 12	E393730-394240 N2662480-2663400	*Spinatrypina (Spinatrypina) prideri nurungunia*
19735	Dd	NOB 12	E393730-394240 N2662480-2663400	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina (Spinatrypina) prideri nurungunia*
19736	Dd	NOB 12	E393730-394240 N2662480-2663400	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina (Exatrypa) kuniandia*
19738	Dd	NOB 12	E393730-394240 N2662480-2663400	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina (Spinatrypina) prideri nurungunia*
19741	Dg	NOB 13	E394370 N2663790	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina (Spinatrypina) prideri nurungunia*

19742	Dd	NOB 14	E393300-394120 N2663300-2663500	*Desquamatia (Synatrypa) kimberleyensis*
19743	Dd	NOB 14	E393300-394120 N2663300-2663500	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina* sp. indet.
19745	Dd	NOB 14	E393300-394120 N2663300-2663500	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina (Spinatrypina) prideri nurungunia* *Spinatrypina (Exatrypa) kuniandia*
19746	Dd	NOB 14	E393300-394120 N2663300-2663500	*Spinatrypina (Spinatrypina) prideri nurungunia* *Spinatrypina (Exatrypa) kuniandia*
19750	Dd	NOB 14	E393300-394120 N2663300-2663500	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina (Spinatrypina) prideri nurungunia*
19752	Dd	NOB 15	E392510 N2663780	*Atrypa (Kyrtatrypa) teicherti*
19753	Dd	NOB 16	E292780 N2663800	*Atrypa (Kyrtatrypa) teicherti*
19756	Dd	NOB 17	E392920 N2663950	atrypid gen. and sp. indet.
19781	Dd	NOB 18	E390400 N2665120	*Desquamatia (Synatrypa) kimberleyensis*
19826	Dd	NOB 19	E399660 N2661960	*Desquamatia (Synatrypa) kimberleyensis* *Spinatrypina* sp. indet.
19830	Dp	NOB 20	E399720 N2662150	*Desquamatia (Synatrypa) kimberleyensis*
19860	Dp	MRM 28	E404400 N2659140	atrypid fragments gen. and sp. indet.
19877	Dp	MRM 29	E408500 N2659250	atrypid gen. and sp. indet.
19900	Dp	NOB 21	E398430 N2651360	atrypid gen. and sp. indet.
19908	Dp	MRM 30	E401690 N2652950	atrypid fragments gen. and sp. indet.
19972	Dp	LNR 5	E295300 N2794600	*Desquamatia (Synatrypa) kimberleyensis*

Dp - Pillara Limestone
Dd - Sadler Limestone

Dr - Virgin Hills Formation
Dg - Gogo Formation

P L A T E S

PLATE I

ATRYPA (KYRTATRYPA) TEICHERTI (COLEMAN)

page 13

All figures (x2). Geographic data of localities are given in the appendix.

Figure 1. UWA 26273c a) ventral b) dorsal c) lateral d) posterior e) anterior. T53, Sadler Limestone. Holotype

2. GSWA F9540 a) ventral b) dorsal c) posterior d) lateral e) anterior. NOB 16, Sadler Limestone

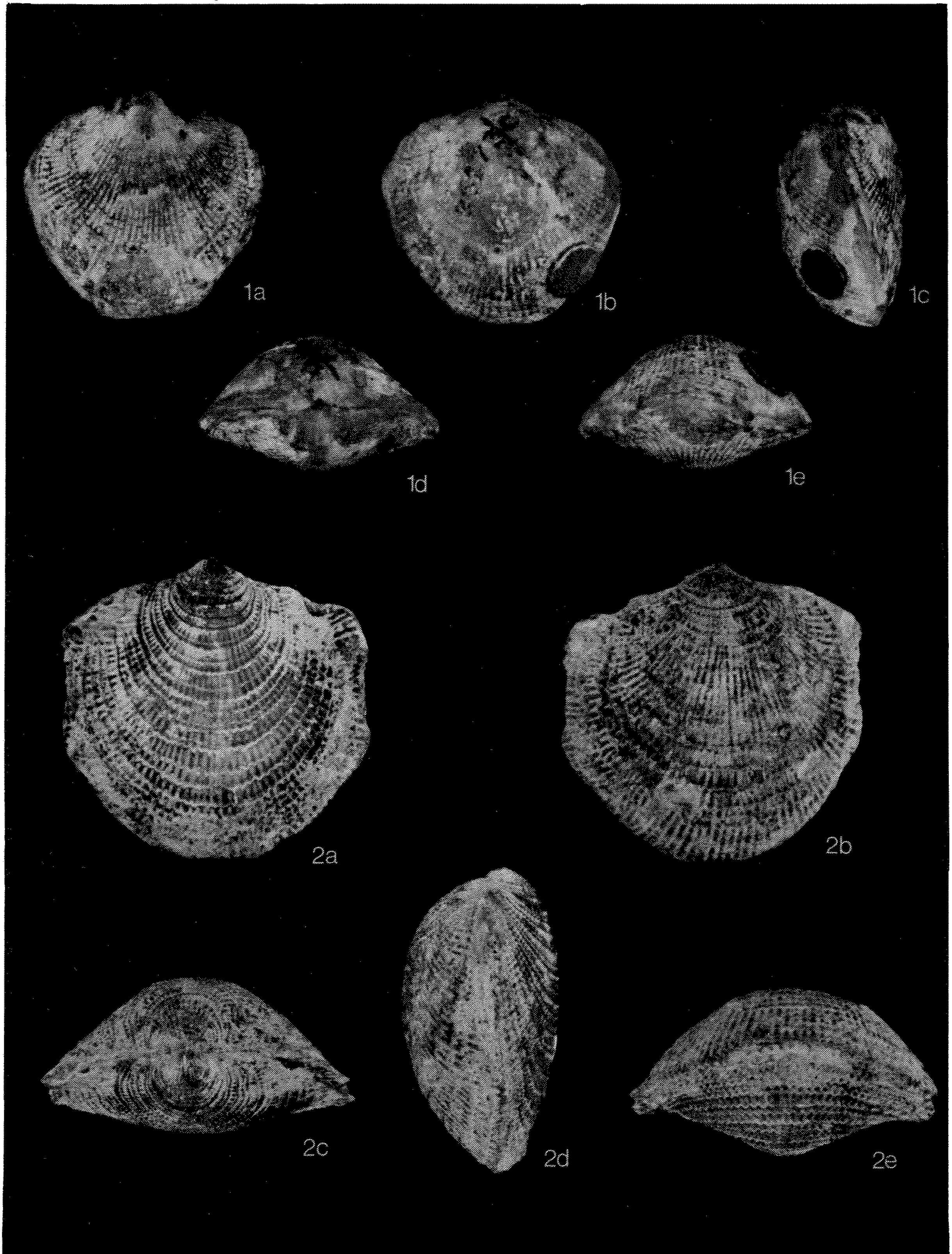


PLATE 1

PLATE II

DESQUAMATIA (SYNATRYPA) KIMBERLEYENSIS (COLEMAN)

page 20

All figures (x2). Geographic data of localities are given in the appendix.

Figure 1 a-e. UWA 26247a a) ventral b) dorsal c) lateral d) posterior e) anterior.T.53, Sadler Limestone Holotype

2 a-e. GSWA F9541 a) ventral b) dorsal c) lateral d) posterior e) anterior.NOB 2, Sadler Limestone

3 a-d. GSWA F9542 a) ventral b) dorsal c) posterior d) anterior.NOB 2, Sadler Limestone

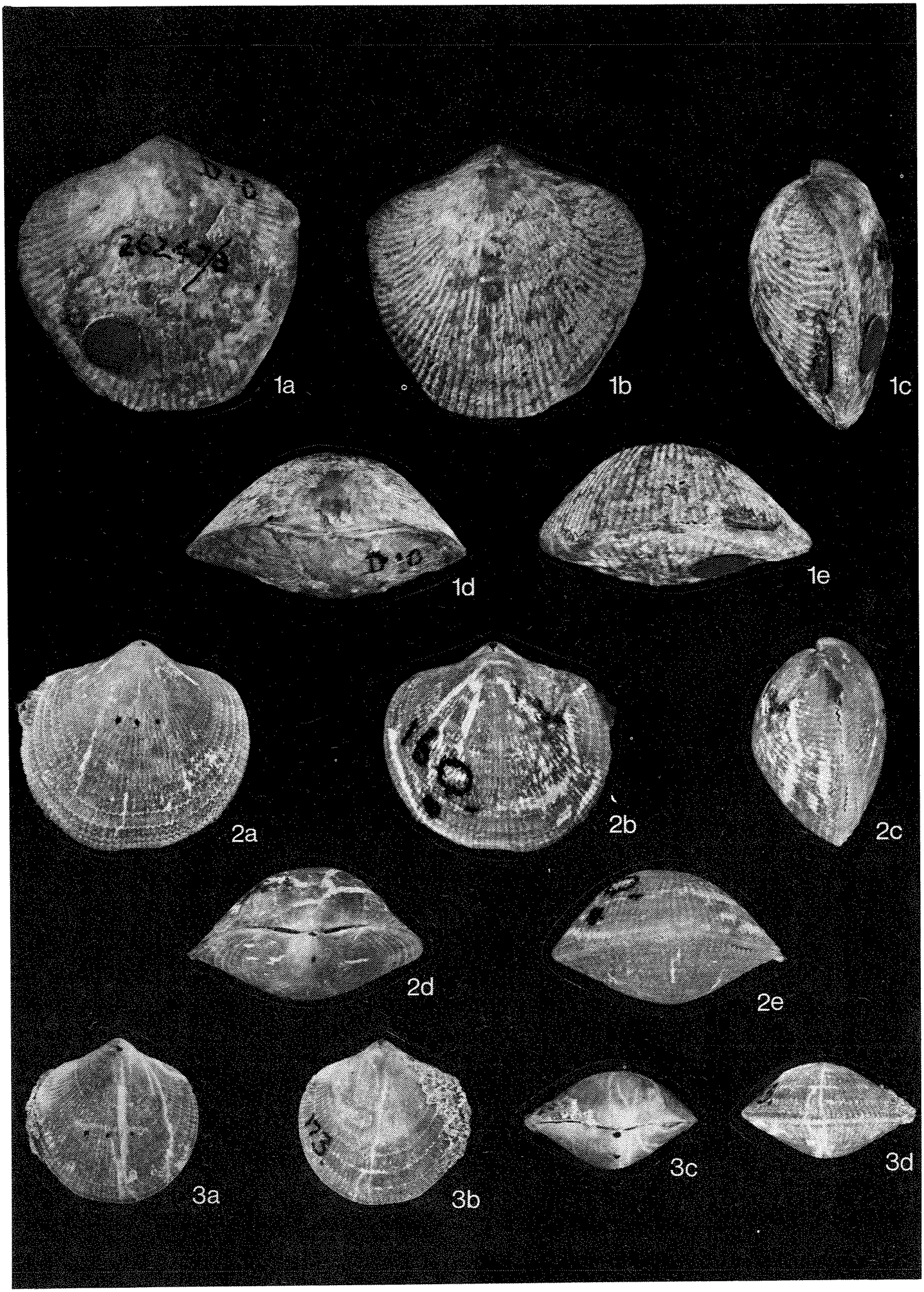

1a
1b
1c
1d
1e
2a
2b
2c
2d
2e
3a
3b
3c
3d

PLATE III

SPINATRYPINA (SPINATRYPINA) PRIDERI PRIDERI (COLEMAN)

page 33

All figures (x2). Geographical data of localities are given in the appendix.

Figure 1. UWA 261261, a) ventral b) dorsal c) lateral d) anterior e) posterior. Menyous Gap. Sadler Limestone, Holotype

2. GSWA F9543 a) ventral b) dorsal c) lateral d) posterior e) anterior.NOB 12, Sadler Limestone

3. GSWA F9544 a) ventral b) dorsal c) posterior d) anterior. NOB 12, Sadler Limestone

4. GSWA F9545 a) ventral b) dorsal c) posterior d) anterior e) lateral.NOB 12, Sadler Limestone

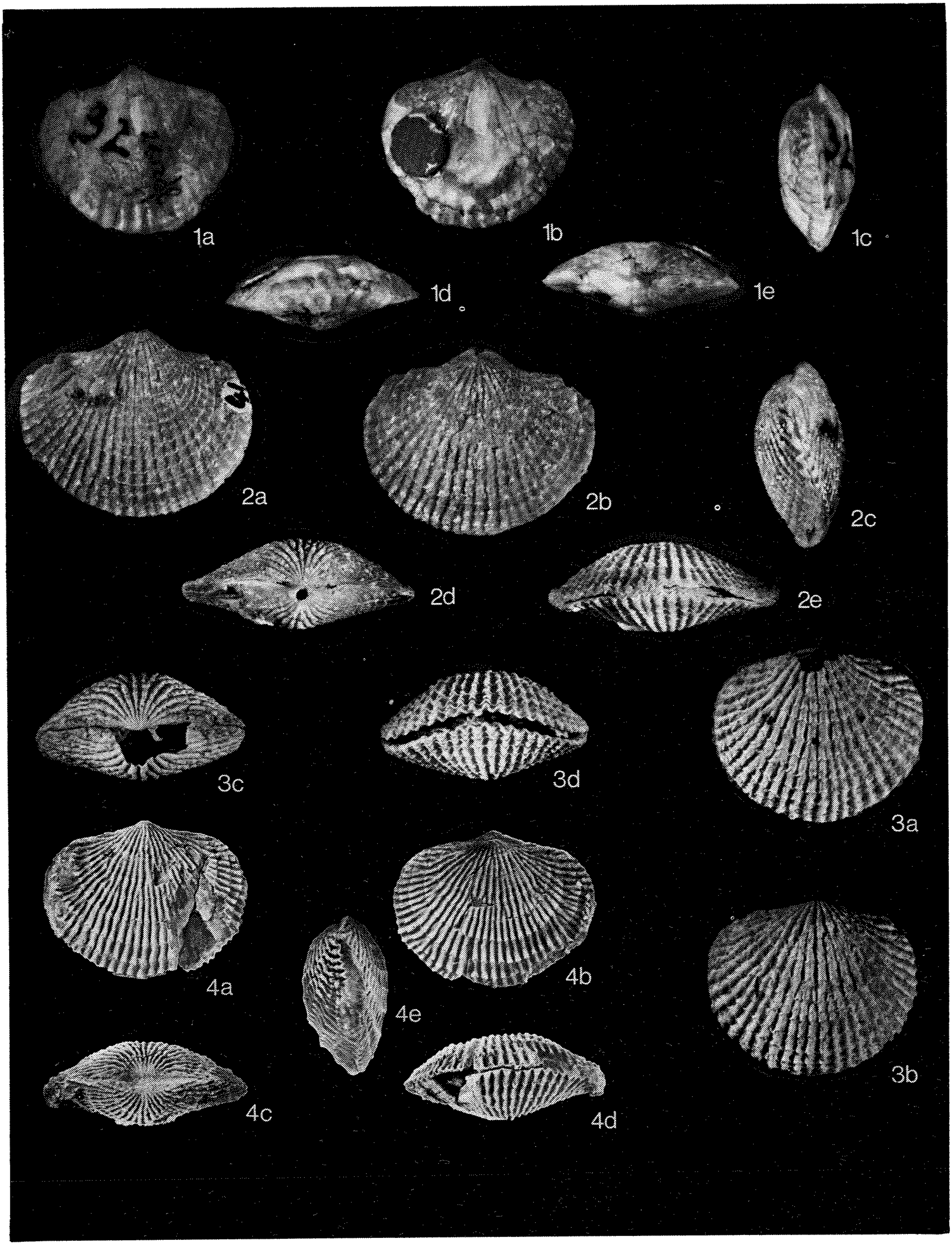

1a
1b
1c
1d
1e
2a
2b
2c
2d
2e
3c
3d
3a
4a
4b
4e
3b
4c
4d

PLATE IV

SPINATRYPINA (SPINATRYPINA) PRIDERI NURUNGUNIA n. subsp.

page 38

All figures (x2). Geographical data of localities are given in the appendix.

Figure 1. GSWA F9440 a) ventral b) dorsal c) lateral d) posterior e) anterior. NOB 12, Sadler Limestone, Holotype

2. GSWA F9446 a) ventral b) dorsal c) anterior d) lateral. NOB 12, Sadler Limestone, Paratype

3. GSWA F9546 a) ventral b) dorsal c) lateral d) posterior e) anterior . NOB 2, Sadler Limestone, Paratype

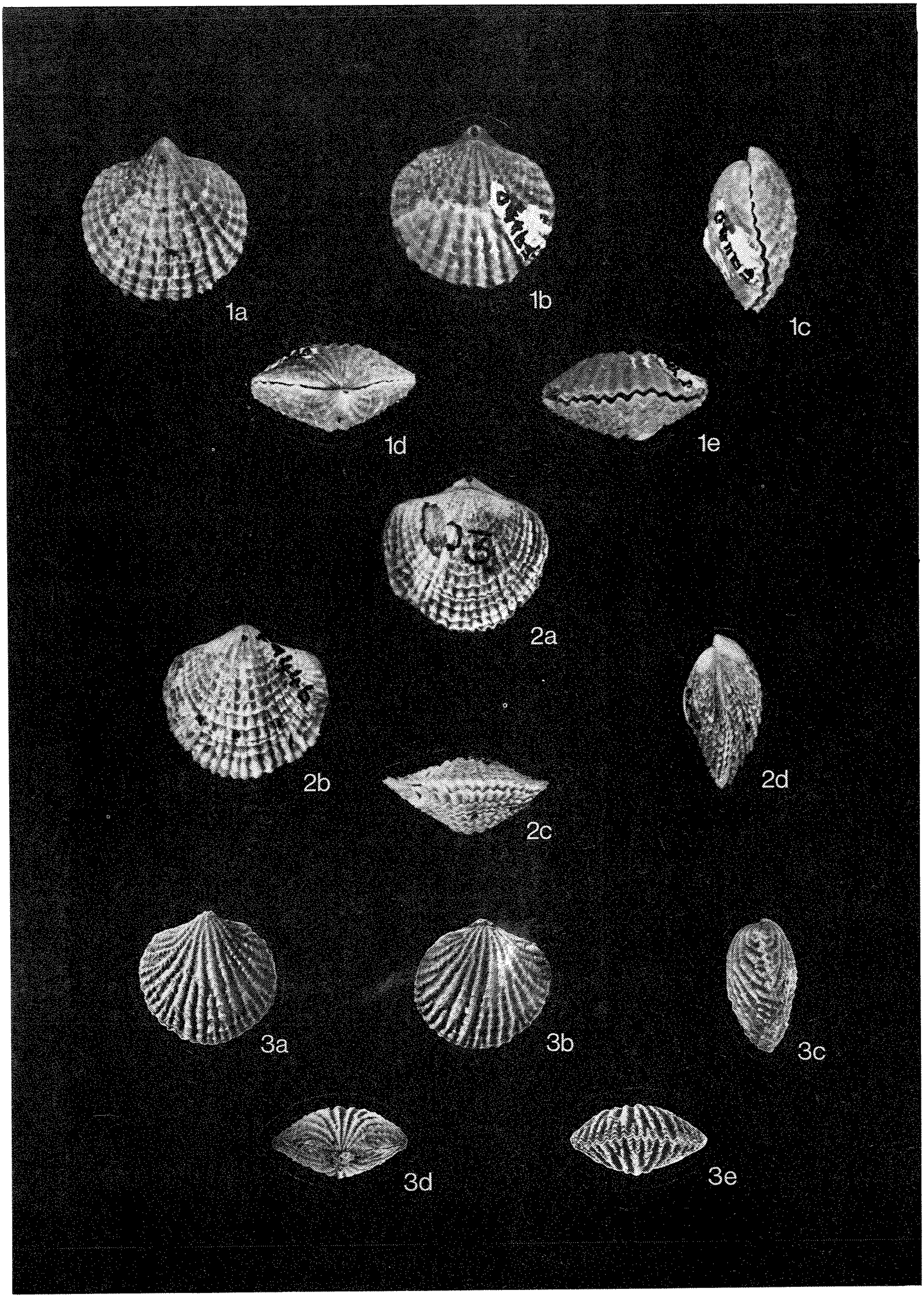

1a
1b
1c
1d
1e
2a
2b
2c
2d
3a
3b
3c
3d
3e

PLATE V

SPINATRYPINA (EXATRYPA) KUNIANDIA (n. sp.)

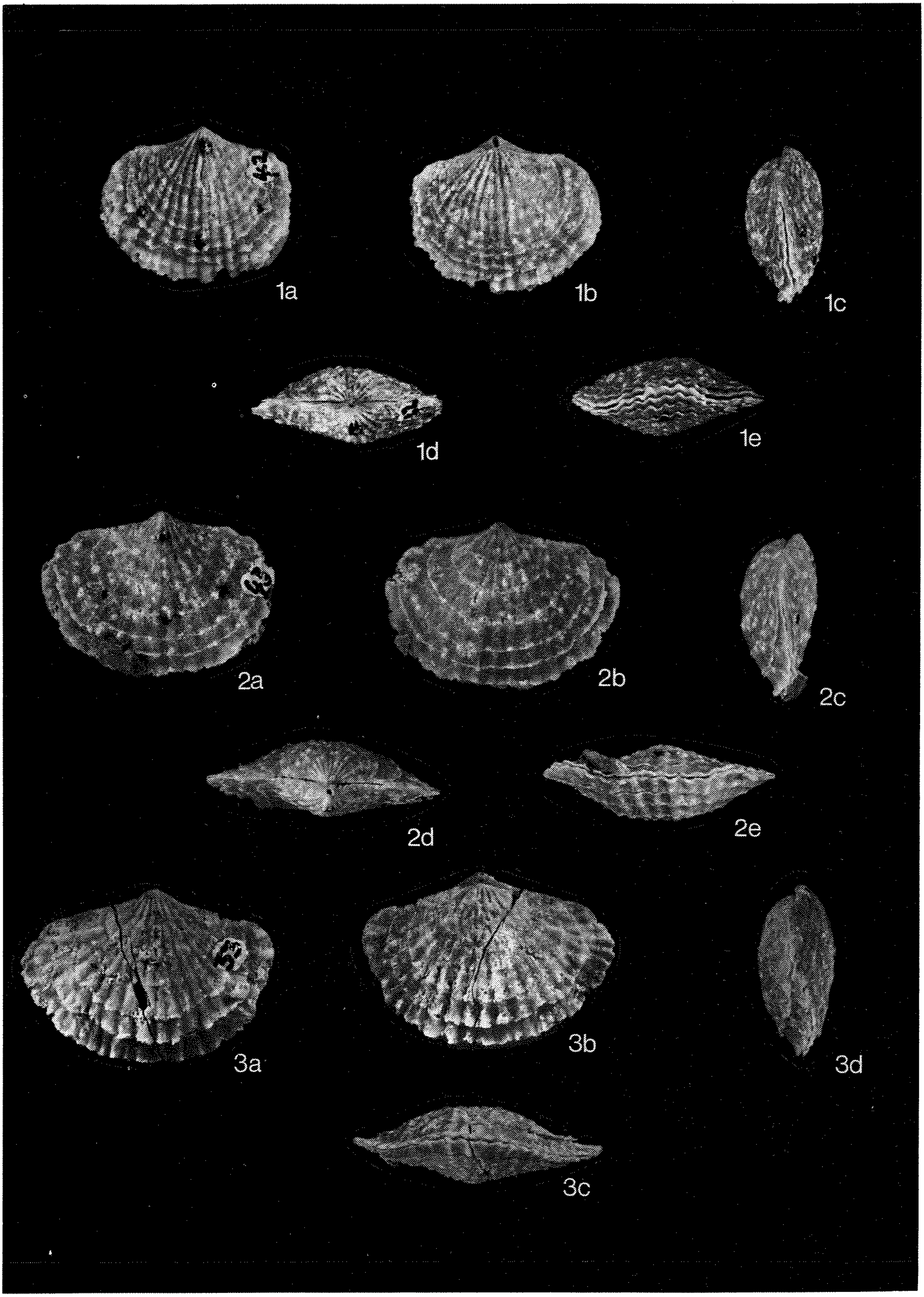
page 45

All figures (x2). Geographical data of localities are given in the appendix.

Figure 1. GSWA F9448 a) ventral b) dorsal c) lateral d) posterior e) anterior. NOB 12, Sadler Limestone (Frasnian) Holotype

2. GSWA F9449 a) ventral d) dorsal c) lateral d) posterior e) anterior. NOB 12, Sadler Limestone Paratype

3. GSWA F9450 a) ventral b) dorsal c) anterior d) lateral. NOB 12, Sadler Limestone, Paratype


1a
1b
1c
1d
1e
2a
2b
2c
2d
2e
3a
3b
3d
3c