COMMONWEALTH OF AUSTRALIA.
DEPARTMENT OF NATIONAL DEVELOPMENT.
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

BULLETIN No. 55.

DEVONIAN AND CARBONIFEROUS BRACHIOPODS FROM NORTH-WESTERN AUSTRALIA

BY

J. J. VEEVERS.

Issued under the Authority of Senator the Hon. W. H. Spooner,
Minister for National Development.
1959.

By Authority:
A. J. ARTHUR, Commonwealth Government Printer, Canberra.
(Printed in Australia.)

7723/58.

COMMONWEALTH OF AUSTRALIA.
DEPARTMENT OF NATIONAL DEVELOPMENT.
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

BULLETIN No. 55.

DEVONIAN AND CARBONIFEROUS BRACHIOPODS FROM NORTH-WESTERN AUSTRALIA

BY

J. J. VEEVERS.

Issued under the Authority of Senator the Hon. W. H. Spooner,
Minister for National Development.
1959.

By Authority:
A. J. ARTHUR, Commonwealth Government Printer, Canberra.
(Printed in Australia.)

7723/58.

COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF NATIONAL DEVELOPMENT.

Minister: SENATOR THE HON. W. H. SPOONER, M.M
Secretary: H. G. RAGGATT, C.B.E.

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

Director: J. M. RAYNER.
Acting Deputy Director: H. TEMPLE WATTS.

This Bulletin was prepared in the Geological Section.

Chief Geologist: N. H. FISHER.

Issued 1*st September*, 1959.

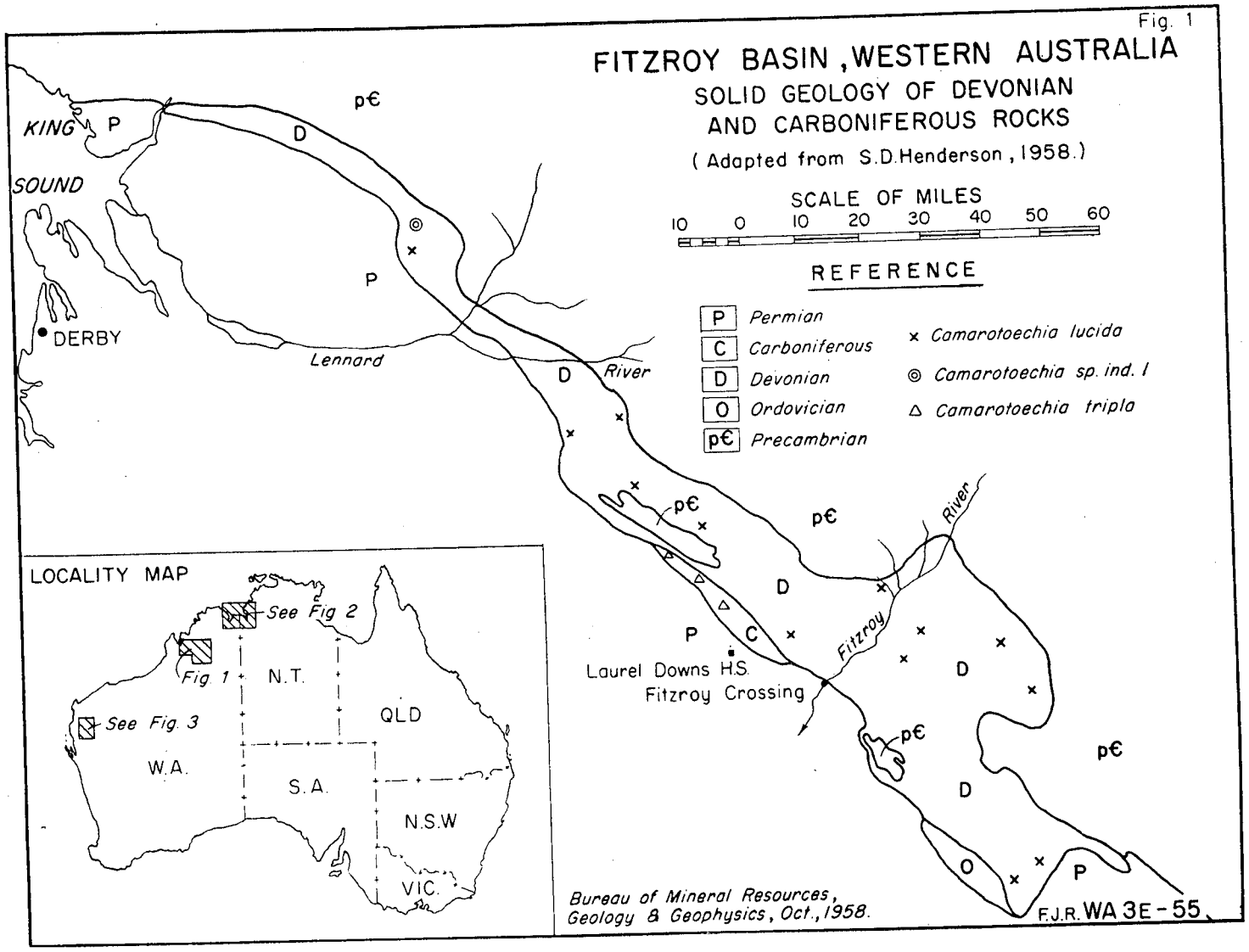
CONTENTS.

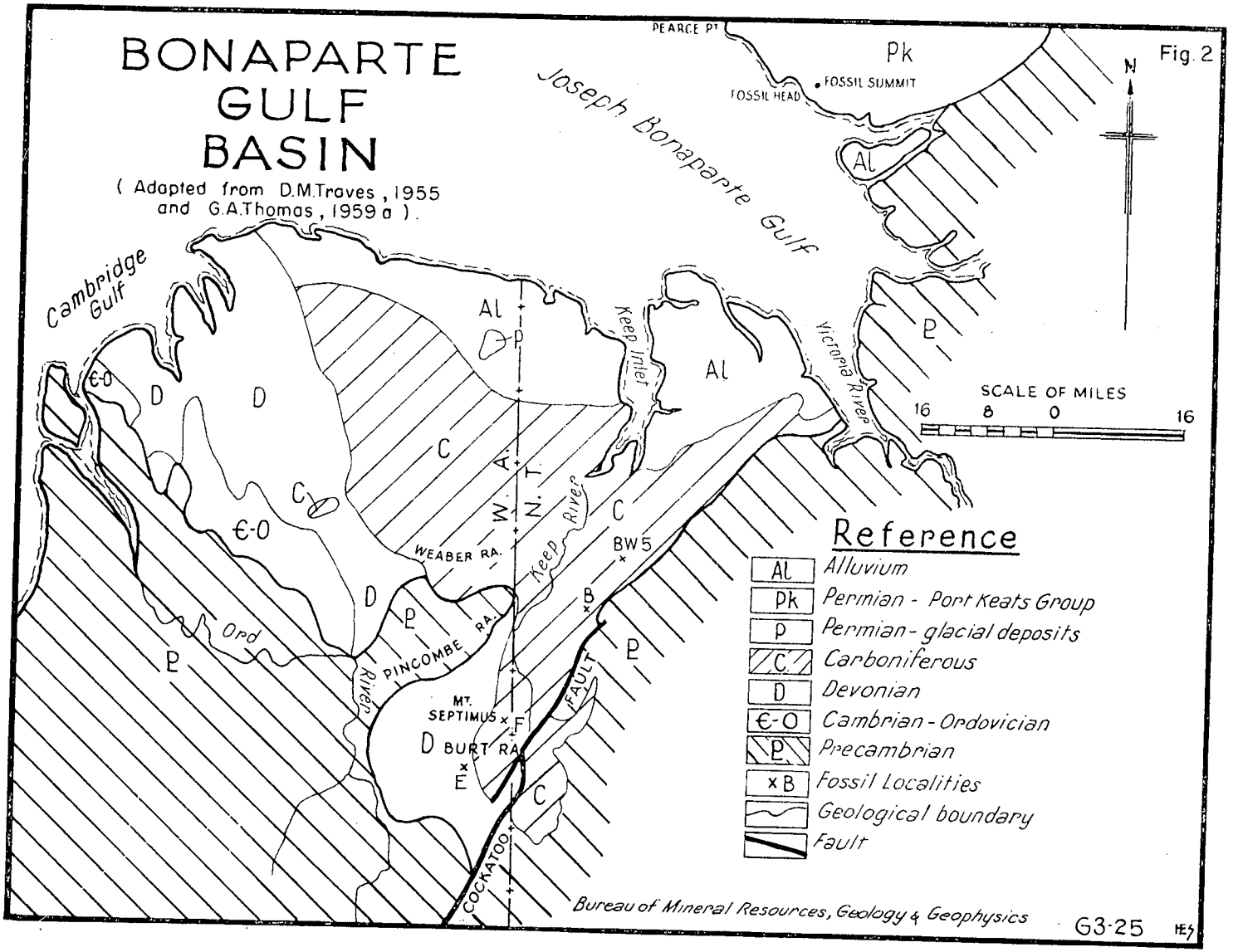
PLATES.

FIGURES.

TABLES.

Fig. 1


FITZROY BASIN, WESTERN AUSTRALIA
SOLID GEOLOGY OF DEVONIAN AND CARBONIFEROUS ROCKS
(Adapted from S.D.Henderson, 1958.)
SCALE OF MILES
10 0 10 20 30 40 50 60
REFERENCE
P Permian
C Carboniferous
D Devonian
O Ordovician
p€ Precambrian
× Camarotoechia lucida
◎ Camarotoechia sp. ind. I
△ Camarotoechia tripla
KING SOUND
DERBY
Lennard River
Fitzroy River
Laurel Downs H.S.
Fitzroy Crossing
LOCALITY MAP
See Fig 2
Fig. 1
See Fig. 3
N.T.
QLD
W.A.
S.A.
N.S.W
VIC.
Bureau of Mineral Resources, Geology & Geophysics, Oct., 1958.
F.J.R. WA 3E-55


BONAPARTE GULF BASIN
(Adapted from D.M.Traves, 1955 and G.A.Thomas, 1959 a).
Fig. 2
PEARCE PT
Pk
FOSSIL HEAD
FOSSIL SUMMIT
Joseph Bonaparte Gulf
N
Al
Cambridge Gulf
Keep Inlet
Victoria River
SCALE OF MILES
16 8 0 16
W.A.-N.T.
Keep River
WEABER RA.
BW5
PINCOMBE RA.
Ord River
MT. SEPTIMUS
BURT RA.
FAULT
COCKATOO
Reference
Alluvium
Permian - Port Keats Group
Permian - glacial deposits
Carboniferous
Devonian
Cambrian - Ordovician
Precambrian
Fossil Localities
Geological boundary
Fault
Bureau of Mineral Resources, Geology & Geophysics
G3-25

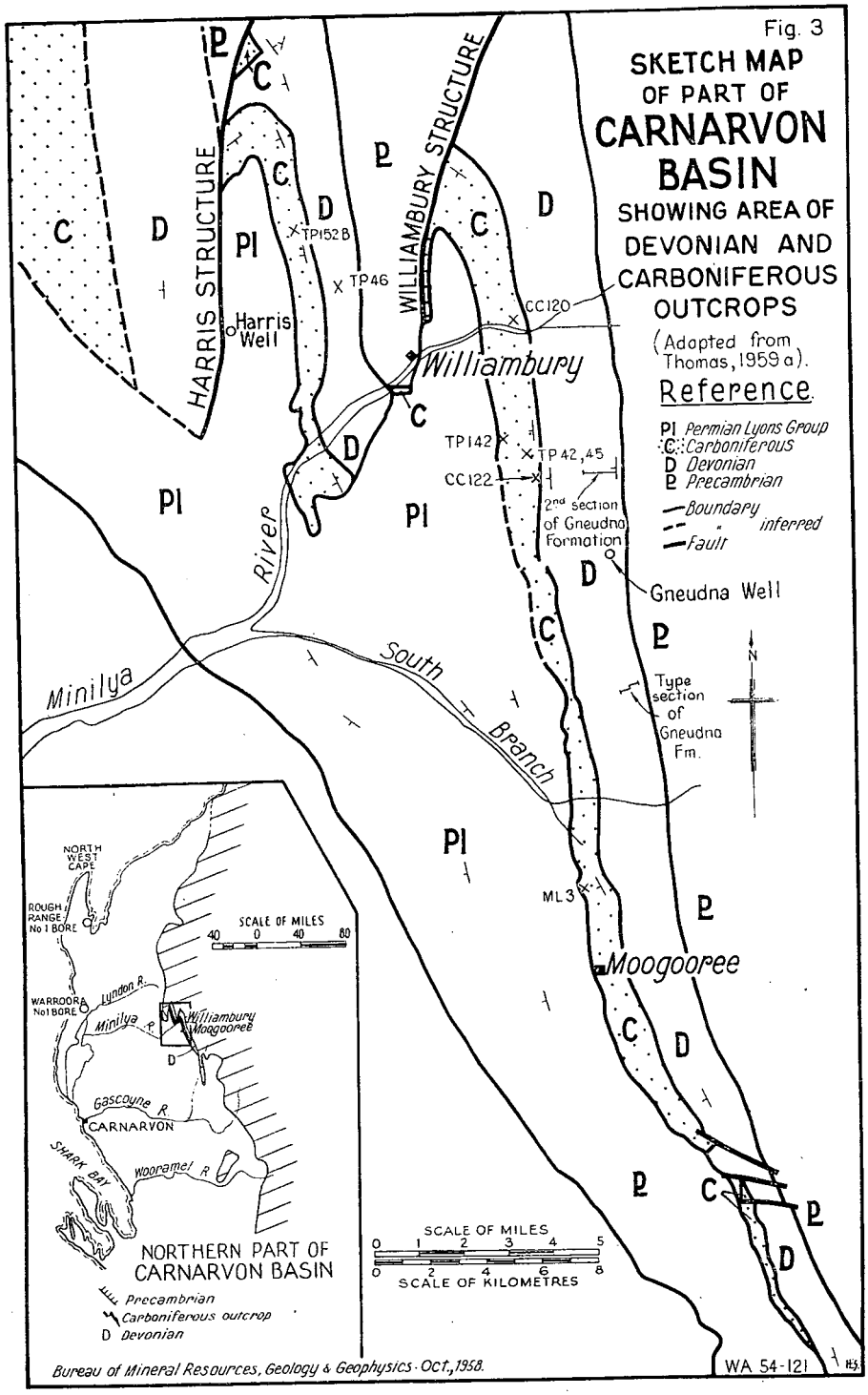


Fig. 3
SKETCH MAP OF PART OF CARNARVON BASIN SHOWING AREA OF DEVONIAN AND CARBONIFEROUS OUTCROPS
(Adapted from Thomas, 1959a).
Reference
Pl Permian Lyons Group
C Carboniferous
D Devonian
P Precambrian
Boundary
inferred
Fault
HARRIS STRUCTURE
WILLIAMBURY STRUCTURE
TP152B
TP46
Harris Well
Williambury
CC120
TP142
TP42,45
CC122
2nd section of Gneudna Formation
Gneudna Well
Type section of Gneudna Fm.
Minilya River
South Branch
ML3
Moogooree
NORTH WEST CAPE
ROUGH RANGE No 1 BORE
WARROORA No1 BORE
Lyndon R.
Minilya R.
Williambury
Moogooree
Gascoyne R.
CARNARVON
SHARK BAY
Wooramel R.
SCALE OF MILES
SCALE OF KILOMETRES
NORTHERN PART OF CARNARVON BASIN
Precambrian
Carboniferous outcrop
D Devonian
Bureau of Mineral Resources, Geology & Geophysics · Oct., 1958.
WA 54-121

CAMAROTOECHIA IN WESTERN AUSTRALIA AND NORTHERN TERRITORY.

SUMMARY.

At least eight forms of the brachiopod genus *Camarotoechia* occur in the Carnarvon, Fitzroy, and Bonaparte Gulf Basins of Western Australia, four in Upper Devonian rocks and four in Carboniferous rocks. One of the Carboniferous species ranges into the Northern Territory. One species, *C. lucida,* is already described, three species are indeterminate, and four, *C. amnica, C. puteana, C. septima,* and *C. eganensis,* are described as new. Each species has been found only in one basin, and the genus cannot therefore be used in correlation between basins; but within each basin, species of *Camarotoechia* are abundant, and prove to be valuable stratigraphical indices, particularly in distinguishing Upper Devonian from Lower Carboniferous rocks.

INTRODUCTION AND STRATIGRAPHY.

Camarotoechia is widely distributed throughout the Devonian and Carboniferous rocks of north-western Australia. The Bureau collections from these rocks contain numerous more or less well-preserved specimens of *Camarotoechia,* among which eight distinct forms are recognizable (Table 1): *C. lucida* Veevers 1959, from the upper Famennian *proteus* zone of the Fitzroy Basin; *C.* cf. *lucida* from the Burt Range Limestone, Bonaparte Gulf Basin; *C.* sp. ind. I from the Frasnian of the Fitzroy Basin; *C.* sp. ind. II from the Carboniferous Yindagindy Formation; *C. puteana* sp. nov. from the Frasnian Gneudna Formation, and *C. amnica* sp. nov. from the Tournaisian Moogooree Limestone, all of the Carnarvon Basin; *C. eganensis* sp. nov. from the Tournaisian Laurel Formation of the Fitzroy Basin; and *C. septima* from the Tournaisian Septimus Limestone and probably from the Tournaisian Spirit Hill Limestone of the Bonaparte Gulf Basin. The ages of the Carboniferous formations are taken from Thomas (1959a).

TABLE 1.—DISTRIBUTION OF CAMAROTOECHIA IN NORTH-WESTERN AUSTRALIA.

European Equivalent.	Carnarvon Basin.	Fitzroy Basin.	Bonaparte Gulf Basin.
Visean(?)..	sp. ind. II. ..	..	..
Tournaisian	*amnica* ..	*tripla* ..	*septima*
upper Famennian	..	*lucida* ..	cf. *lucida*
Frasnian	*puteana* ..	sp. ind. I. ..	..

Since each of these species is restricted to a single sedimentary basin, none is directly useful in correlation between the basins; but within each basin, the abundant, widespread, and easily distinguishable species of *Camarotoechia* are reliable stratigraphical indices, especially useful because they are the only fossils present at many localities.

Details of the distribution of the species, and their relationship to other species of *Camarotoechia,* are given in the descriptions below.

SYSTEMATIC DESCRIPTIONS.

Superfamily RHYNCHONELLACEA.

Family CAMAROTOECHIIDAE.

Subfamily CAMAROTOECHIINAE Schuchert & LeVene 1929.

Genus CAMAROTOECHIA Hall & Clarke 1893.

The characteristic features of *Camarotoechia* are:

(a) a thick, plicated shell;

(b) a ventral valve convex at the umbo, almost flat on the flanks, rest of valve uniformly weakly convex along its length, transversely depressed into a sulcus, which is drawn out dorsally into a tongue; with a small erect beak, a short interarea, and a narrow, open delthyrium;

(c) a dorsal valve evenly convex in profile; median fold broad; umbo broadly convex, tip protruded into delthyrium;

(d) strong teeth supported by short high dental plates;

(e) a broad hinge-plate, split or unsplit, supported by a short median septum; crura short, parallel.

Specific differences in *Camarotoechia* are based on a combination of the following characters:

(a) size of shell;

(b) shape of shell, expressed by the outline: transverse, elongate, circular, or pentagonal;

(c) type of plications: rounded or angular, wide or narrow;

(d) number of plications, particularly number in sulcus;

(e) outline of sinus: rectangular, trapezoidal, or rounded;

(f) size of dorsal fold: high, moderate or low.

These characters are used in distinguishing the eight forms of *Camarotoechia* from north-western Australia (Table 2).

TABLE 2.

DIAGNOSTIC CHARACTERS OF *CAMAROTOECHIA* FROM NORTH-WESTERN AUSTRALIA.

Characters. \ Species.	*puteana* sp. nov.	*lucida* Veevers 1959.	cf. *lucida* (from Burt Ra. Basin).	sp. ind. I. (Veevers 1959).	*eganensis* sp. nov.	*amnica* sp. nov.	*septima* sp. nov.	(?) *C* sp. ind. II. (Carnarvon Basin).
(*a*) Size: maximum width (mm)	30	20	20	15	25	15	15	15
(*b*) Shape: width > length	..	x	x	x	..	x	x	x
width = length	x	..	..	..	x	x	..	x
width < length	x	..	..	..	..	x	..	x
thickness = width	x	..	..	..	x	..	..	..
thickness < width	..	x	x	x	x	x	x	..
transverse, oval	..	x	x	..	..	x	x	..
transverse, pentagonal	..	..	..	x	..	..	..	x
elongate, pentagonal	..	..	..	..	..	x	..	..
elongate, oval	x	..	..	..	..	x	..	..
circular	x	..	..	..	x	..	..	x
(*c*) Type of plications:								
rounded	x	..	..	..	x	x	..	x
broadly angular	..	..	..	..	..	..	x	..
angular	..	x	x	x	..	..	..	..
wide	..	x	x	x	x	..	..	..
moderately wide	..	..	..	..	..	..	x	..
narrow	x	..	..	..	..	x	..	x
(*d*) Number of plications on sulcus	5–7	3 (4, 5)	2	1, 2	2 (3)	2 (3)	3 (2)	3–6
(*e*) Outline of sinus:								
deep, rectangular	..	x	..	..	..	x	x	..
trapezoidal	x	x	x	x	x	x	..	..
shallow, rounded	x	..	..	..	..	..	..	x
(*f*) Size of dorsal fold:								
high	..	x	x	x	x	x	x	..
moderate	..	..	x	..	x	x	..	x
low	x	..	..	..	..	..	..	x

NOTE.—1. Dots linking crosses indicate continuous variation in a single character.

2. In (*d*), the numbers in brackets indicate the number of plications in uncommon specimens only.

CAMAROTOECHIA PUTEANA sp. nov.

See below, page 26.

CAMAROTOECHIA LUCIDA Veevers 1959.

1959 *Camarotoechia lucida* Veevers. Veevers, J. J., *Bur. Min. Resour. Aust. Bull.* 45, p. 88, pl. 10, figs. 1-11, text-figs. 49-54.

CAMAROTOECHIA cf. LUCIDA Veevers 1959.

See below, page 17.

CAMAROTOECHIA sp. ind. I.

1959 *Camarotoechia* sp. ind. Veevers, J. J., *Bur. Min. Resour. Aust. Bull.* 45, p. 94, pl. 10, figs. 12-21, text-fig. 55.

CAMAROTOECHIA EGANENSIS sp. nov.

(Plate 3, figs. 4-7; text-fig. 4.)

1935 *Camarotoechia pleurodon* Phillips var. *tripla, in* Prendergast, K. L., *J. Roy. Soc. W. Aust.*, p. 20, pl. II, figs. 1-6.

Nomenclature: Prendergast designated this form a " variety ", and the figured specimens " morphotypes ", in evident evasion of the International Rules. This inference is inescapable in view of the fact that in the same paper Prendergast describes two

new species, for which either a holotype or a group of syntypes is formally indicated. Section 114 (2) of the *Copenhagen Decisions on Zoological Nomenclature*, viz., that where it is clear that a given name was not intended for use in zoological nomenclature, that name shall possess no status under either the Law of Priority or the Law of Homonymy, is applicable in showing that Prendergast's "*C. pleurodon* var. *tripla*" is invalid.

In my opinion, Prendergast's concept of this form is sound, and it is a new species of *Camarotoechia;* it is named *C. eganensis* from its abundance near Egan's Bore.

Note on Prendergast's specimens: Specimens Nos. 2512, 2513, and 2514 (Prendergast, p. 20) are fair specimens of *C. eganensis*. In correspondence, Dr. B. F. Glenister has told me that specimens 2515, figured by Prendergast on plate II, figs, 1-5, and the specimen figured on plate II, fig. 6 are missing. These are undoubted specimens of *C. eganensis*. Prendergast's specimens come from "12 miles S.W. of Oscar Range Homestead", and, in a broad sense, may be regarded as topotypical.

Diagnosis: Almost spherical *Camarotoechia*, generally with three, rarely four, wide rounded plications on the high dorsal fold.

Material: 341 free calcareous shells, the majority crushed and recrystallized.

Description: Outline trigonal to rounded quadrangular, length, width, and thickness roughly equal, adults nearly spherical. Apical angle 90° or slightly less. Anterior commissure uniplicate, ventral tongue moderately long.

Shell strongly plicated, plications wide, round, number 3, rarely 4, on dorsal fold, and 7 or more on lateral flanks. Fine growth-lines, crowded 3 in 1 mm., visible along anterior commissure.

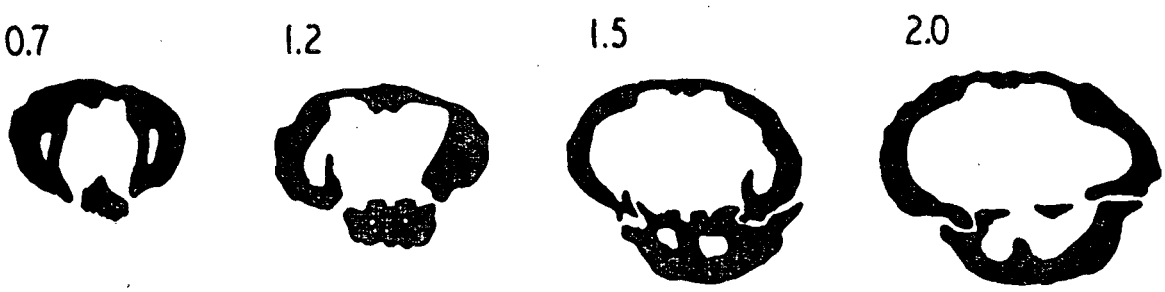


Fig. 4.—*C. eganensis.* **Four serial transverse sections and peels (x 3½) of CPC 3059, from KCH 18.**

Teeth strong, supported by slender dental plates, separated by grooves from denticula. Dorsal median septum short and strong, supports short septalium. Crural bases stand high above ventral surface of united hinge-plate. Sockets deep and broad. Muscle scars well impressed in ventral valve, separated by a broad low medianly grooved ridge.

Measurements (mm.):

—	Length.	Width.	Thickness.
Holotype CPC 3060	14.8	15.7	15.5
Sectioned specimen CPC 3059	14.5	15.4	13.0

Formation and localities: Laurel Formation, south-east of Oscar Range, Fitzroy Basin. The holotype and sectioned specimen come from KCH 18, correlated by G. A. Thomas (pers. comm.) with the upper part of the type section. KC2 is 900 feet and pt. 45 is 1,000 feet above the base of the composite type section (*see* Thomas, 1959b). KCH8, KC14, KCH17, KCH19, pt. 40, and pt. 56 are correlated by Thomas (pers. comm.) with the upper part of the type section, pt. 47 with that part of the type section roughly 800 feet above the base, and pts. 51 and 52 with the middle of the type section, which is estimated to be approximately 1,500 feet thick. KC10 is low in an isolated section about 500 feet thick. *C. eganensis* occurs high in the section of the Laurel Formation penetrated by Borehole B.M.R.2 Laurel Downs (Henderson, 1956), at depths of 250 to 260 feet and 350 to 360 feet.

Discussion: C. eganensis is distinct from *C. pleurodon* (Phillips). The types [B.M. (N.H.) B367 (Phillips, 1836, pt. 2, pl. 12, fig. 27), and B362 (*ibid.*, pl. 12, figs. 29, 30)], from the Carboniferous Limestone of Bolland, Yorkshire, are transverse in outline, and hence the apical angle is nearly straight, whereas it is 90° or less in *eganensis*. Furthermore, the plications in *pleurodon* are sharp, in *eganensis* rounded.

C. eganensis is closest to *C. subglobosa* Weller 1914 (pp. 180-181, pl. 24, figs. 29-33), from the Burlington limestone (Tournaisian equivalent) of the Mississippi Valley. *C. eganensis* differs from *subglobosa* in its more perfectly globose shape and coarser plications, which number only 2 (against the 3 of *subglobosa*) in the sulcus.

C. eganensis resembles also *Camerophoria isorhyncha* (M'Coy) 1844 (*see* Davidson, 1860, pt. V, third portion, pp. 117-118, pl. 25, figs. 1, 2), from the Lower Carboniferous of Ireland, England, and Belgium (*see* de Koninck, 1887, pp. 64, 65, pl. 17, figs. 1-8), which is globose; but, probably added to external differences (*isorhyncha* has 3 plications in the sulcus) are critical internal differences, for, if *isorhyncha* is indeed a *Camerophoria* (*Stenoscisma*), is has a spondylium.

CAMAROTOECHIA AMNICA sp. nov.

(Plate 4, figures 18, 20, 22-31.)

Diagnosis: Camarotoechia with maximum width about 15 mm., outline elongate-oval to pentagonal, plications narrow and rounded, 2, less commonly 3, in proportionately narrow sulcus, sinus rectangular to trapezoidal, fold moderately high.

Material: Over 100 almost entire free calcareous shells, most of them crushed, and 50 free silicified valves.

Description: Outline elongate-oval or pentagonal, less commonly transverse-oval. Profile weakly biconvex to dorsi-biconvex. Anterior commissure generally deeply and narrowly uniplicate, sinus rectangular. Ventral sulcus narrow, continued dorsally as a long narrow tongue. Dorsal profile convex posteriorly, almost flat over anterior half,

medianly arched into a long narrow median fold, set off from sides of valve by vertical flanks. Surface with 14-16 narrow rounded plications, including 2, less commonly 3, in sulcus; growth-lines concentrated 4 in 1 mm. along commissure.

Hinge-plate split (pl. 4, fig. 20) or unsplit (pl. 4, fig. 18). Dorsal median septum extends generally one-third, exceptionally half, length of valve.

Measurements (mm.):

—	Length.	Width.	Thickness.
Holotype CPC 3069	10.2	10.5	8.0
Figured specimen CPC 3071	9.2	10.0	7.6

Variations: The shell outline ranges from transverse to elongate, number of plications in sulcus from 2 (most common) to 3, dorsal fold from high to moderately high, and hinge-plate from split to unsplit.

Formation and localities: Moogooree Limestone. Holotype CPC 3069, figured specimen CPC 3071, and several other calcareous shells, from CC120, northern bank of Minilya River, 5½ miles north-north-west of Gneudna Well; according to G. A. Thomas, equivalent to the interval 478 feet to 488 feet in the type section of the Moogooree Limestone. Figured specimens CPC 3068 and 3070, and several other silicified valves from TP 42, about 440 feet above the base of the Moogooree Limestone near the type section, 3½ miles north-west of Gneudna Well. Also from TP 45 (near TP 42), ML 39 (= CC122), 140 feet above the local base of the Moogooree Limestone, 2 miles north-west of Gneudna Well, and TP 152B, high in an unmeasured section of the Moogooree Limestone, 3 miles north-north-east of Harris Well.

Discussion: The plicated shell, hinge-plate supported by a septalium, and dental plates denote *Camarotoechia.* The literature reveals no species closely related to *amnica,* which seems unique in having such a proportionately narrow sulcus and fold.

Name: L. *amnica,* of a river, referring to its occurrence on the bank of the Minilya River.

Camarotoechia septima sp. nov.

(Plate 4, figs. 1-15, 19, 21.)

Diagnosis: Camarotoechia with maximum width about 15 mm., a transverse-oval outline, 3, less commonly 2, plications in the sulcus, sinus trapezoidal to rectangular, and fold moderately high.

Material: More than one hundred free silicified shells.

Description: Transverse-oval, almost pentagonal in outline, widest slightly posterior to midlength. Profile dorsi-biconvex, dorsal valve strongly convex. Anterior commissure broadly and moderately deeply uniplicate. Deep broad ventral sulcus produced dorsally into a short broad flat tongue. Dorsal profile convex posteriorly, almost straight anteriorly. High broad evenly arched median fold extends forward from midlength, proceeds by sloping flanks to sides of valve. Surface crossed by almost obtusely angular moderately wide plications separated by wide furrows, altogether

18-20 plications, including 3, less commonly 2, in the sulcus. Teeth supported by short high dental plates; sockets shallow, dorsal median septum long, supporting small septalium.

Measurements (mm.):

—	Length.	Width.	Thickness.
Holotype CPC 3063	8.8	11.6	8.0
Figured specimens CPC 3061	7.0	9.1	7.3
CPC 3062	10.0	12.4	8.2

Variations: Notable variations are found in the number of plications in the sulcus (3, less commonly 2), and in the convexity of the dorsal profile (strongly and evenly convex in the holotype, strongly convex posteriorly, almost straight anteriorly in the figured specimens CPC 3061, 3062).

Formations and localities: Locality F (a-c) (Utting, 1957), 350 to 500 feet above the base of the type section (Traves, 1955) of the Septimus Limestone, Mt. Septimus; holotype, and figured specimens CPC 3064, 3065, from the interval 400 to 450 feet above the base (locality F (b)); Locality B (Utting, 1957), an isolated outcrop of limestone (according to Utting, probably Spirit Hill Limestone), 4 miles north-east of Spirit Hill; BW5 (= Loc. 27 of Traves, 1955, pp. 76-77), at the base of an isolated outcrop of limestone and sandstone at the Legune track crossing of Sandy Creek. Traves included this outcrop in the Spirit Hill Limestone, and this is corroborated by the identification of *C. septima* from this locality and from the probable Spirit Hill Limestone at locality B. However, on the grounds that the rest of the brachiopod fauna differs from the typical Spirit Hill assemblage, Thomas (1959a) has suggested that this outcrop is part of the Point Spring Sandstone. Figured specimens CPC 3061 and 3062 come from BW5.

Discussion: C. mitcheldeanensis Vaughan 1905 (pp. 302, 303, text-fig. 6, pl. 26, figs. 7-7b), from the lower Tournaisian rocks of the Bristol area of England, resembles *septima* in all diagnostic characters except plications: more sharply angular in *mitcheldeanensis,* commonly 2, less commonly 3, in the sulcus (the reverse of *septima*). Less importantly, the hinge-plate is probably split in *septima,* unsplit in *mitcheldeanensis.*

C. acutirugata (de Koninck) 1887 (Appendix, p. 141, pl. 16, figs. 1-14) from the Tournaisiam of Belgium can be distinguished from *septima* only by reference to the plications: sharply angular in *acutirugata,* numbering 3 or 4 in the sulcus. Even closer to *septima* is the *Camarotoechia* from the upper Tournaisian of the Moscow Basin identified by Sarycheva & Sokolskaya (1952, pp. 163, 165, pl. 46) as *acutirugata,* for, like *septima,* it differs from *acutirugata s.s.* in having 2 or 3 plications in the sulcus. As its plications are sharply angular, the Moscow Basin form lies intermediate between *acutirugata s.s* and *septima.*

Of the other forms of *Camarotoechia* in Western Australia, *lucida* is closest to *septima:* both have a transverse-oval outline; *C. lucida* has sharper plications, commonly 3, less commonly 4 or 5, plications in the sulcus, compared with commonly 3, less commonly 2, in *septima,* and a higher fold. *C.* cf. *lucida* (see p. 17) from the Burt Range Limestone resembles *septima* in shape, but all specimens so far seen have only 2 plications in the sulcus, and the plications are sharply angular.

(?) CAMAROTOECHIA sp. ind. II.

(Plate 4, figs. 16, 17).

Material: Twenty recrystallized calcareous shells embedded in limestone.

Description: Outline transverse-pentagonal to circular, plications narrow and rounded, numbering 20-25, including 3 to 6 in the broad flat shallow sulcus. Sinus rounded, fold moderately high to low.

Measurements (mm.):

—	Length.	Width.	Thickness.
Figured specimen CPC 3066 (ventral valve)	11.2	12.5	..
Figured specimen CPC 3067 (dorsal valve)	8.5	10.0	..

Formation and localities: Yindagindy Formation, near local base at TP 142, 4 miles north-west of Gneudna Well, and at an isolated locality, ML3, on western bank of creek 1.7 miles north of Moogooree Homestead.

Discussion: The available specimens are unsuitable for sectioning, so whether or not they are *Camarotoechia* remains in doubt.

As far as it is known, (?) *C.* sp. ind. II. agrees closely in external appearance with *C. griasica* Nalivkin (*in* Sarycheva & Sokolskaya, 1952, p. 164, pl. 46) from the middle and upper Famennian rocks of the Moscow Basin. This species has a rounded to transverse-oval outline, an indistinct sulcus and fold, narrow rounded plications, numbering 5 to 7 in the sulcus.

BRACHIOPODS FROM THE BURT RANGE LIMESTONE, BONAPARTE GULF BASIN, WESTERN AUSTRALIA.

SUMMARY.

Two brachiopod forms, cf. *Avonia proteus* Veevers 1959 and *Camarotoechia* cf. *lucida* Veevers 1959, from the uppermost beds of the Burt Range Limestone of the Bonaparte Gulf Basin, resemble brachiopods from the upper Famennian *proteus* zone of the Fitzroy Basin. A third form from this horizon, a productid, is indeterminate.

INTRODUCTION AND STRATIGRAPHY.

A collection of brachiopods from the Burt Range Limestone was made available to the Bureau by Mr. E. P. Utting, Chief Geologist of Westralian Oil Limited. The locality (Loc. E. of Utting, 1957) is situated 5 miles south-west of Mount Septimus, and is 50 feet stratigraphically below the contact of the Burt Range Limestone with the Enga Sandstone (Traves, 1955). Six forms are present in the collection; the productacean and camarotoechiid forms are akin to species described from the Devonian rocks of the Fitzroy Basin (Veevers, 1959a). The others, *Leptaena, Rhipidomella, Athyris,* and a ribbed spiriferacean, which are being studied by G. A. Thomas, do not seem at first glance to resemble described Devonian brachiopods from the Fitzroy Basin though, with the possible exception of the ribbed spirifer, these genera all occur in the *proteus* zone of the Fitzroy Basin.

Thomas (*in* Utting, 1957, p. 6) tentatively dates the assemblage from locality E as uppermost Devonian, and my work supports this conclusion. The camarotoechiid from locality E is closely related to *Camarotoechia lucida* Veevers 1959, which in the Fitzroy Basin is restricted to the *proteus* zone of upper Famennian age. The identification of the *proteus* zone is corroborated by the probable occurrence of the zone index itself at locality E.

SYSTEMATIC DESCRIPTIONS.

Superfamily PRODUCTACEA.

Family PRODUCTIDAE.

Genus AVONIA Thomas 1914, emended Muir-Wood 1928.

cf. AVONIA PROTEUS Veevers 1959.

(Plate 4, figs. 35, 36; text-fig. 5).

1959 *Avonia proteus* Veevers. Veevers, J. J., *Bur. Min. Resour. Aust. Bull.* 45, p. 80, pl. 8, figs. 1-15, text figs. 44, 45.

Material: Three silicified specimens: an almost entire shell, CPC 3073, and two crushed incomplete ventral valves, F 21644a and b.

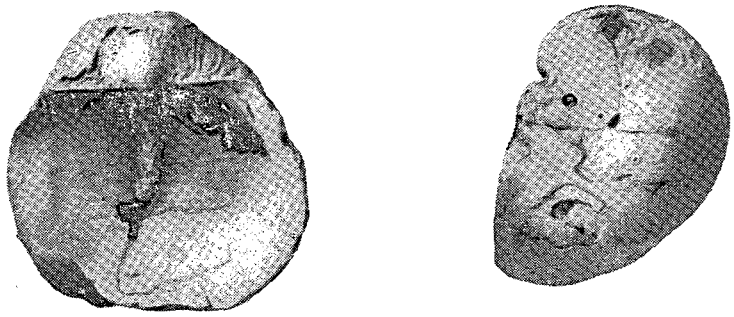


Fig. 5.—cf. *Avonia proteus.* (*a*) **Dorsal, and** (*b*) **lateral views (x 2) of CPC 3073** (*see* **also pl. 4, figs. 35, 36). The limestone which enclosed part of the shell (pl. 4, fig. 36) has been dissolved in acid to reveal the dorsal valve.**

Remarks: Except for a few characters, these specimens resemble the types of *proteus.* CPC 3073 has a long shallow median sulcus, and its spine-bases are only weakly drawn out into pseudocostae. These variations are also found in assemblages of *A. proteus* from the Fitzroy Basin, and by themselves are inadequate to separate the Burt Range specimens from *proteus.* The pseudocostate spine-bases of type *A. proteus* are found in F21644a, and the fine concentric rugae in F21644b. Notwithstanding these similarities, the available material is inadequate for definite determination.

Gen. et sp. ind.

(Plate 4, figs. 32-34).

Material: Two silicified specimens: an almost entire free shell, CPC 3072, and a ventral valve, F21645, the interior of which is filled with rock matrix.

Description: These specimens have a large, strongly convex ventral valve, width slightly greater than hinge width, interarea linear, ears small and poorly defined, umbo moderately large, inturned, venter flat or shallowly concave to form an incipient median sulcus; exterior of ventral valve covered by numerous irregular faint narrow rugae, and few thick erect spines distributed evenly over surface. CPC 3072 has 17 spine-bases, and its rugae are crowded 15 in a space of 5mm. Dorsal valve of CPC 3072 moderately concave, anterior third bent into a trail; ears small and poorly defined, no interarea, surface crossed by faint narrow irregularly concentric rugae.

Measurements (*mm.*):

—	Length.	Width.	Depth of Ventral Valve.
Figured specimen CPC 3072	19.3	18.9	18.0
F21645	20.4	19.7	..

Discussion: Two alternative determinations are possible. On the one hand, these specimens may belong to a genus, such as *Productellina* Reed 1943, or *Leioproductus* Stainbrook 1947, characterized by few spines and numerous concentric rugae. On the other hand, they may belong to *Avonia proteus;* specimen F21645 lies between CPC 3072 and CPC 3073, which is determined above as cf. *A. proteus.* F21645 has weaker concentric rugae and more prominent spine-bases than CPC 3072; the spine-bases, however, are not drawn out as they are incipiently in CPC 3073. Fine concentric rugae are present on both valves of type *A. proteus,* but these are clearly seen on silicified shells only. Therefore, CPC 3072 and F21645 may be aberrant specimens of *A. proteus* differing from typical specimens in having pronounced concentric rugae, and erect, circular (rather than elongate) spine-bases. This determination is favoured by the occurrence of these specimens with cf. *A. proteus* at locality E.

Superfamily RHYNCHONELLACEA.

Family CAMAROTOECHIIDAE.

Genus CAMAROTOECHIA Hall & Clarke 1893.

CAMAROTOECHIA sp. cf. C. LUCIDA Veevers 1959.

1959 *Camarotoechia lucida* Veevers. Veevers, J. J., *Bur. Min. Resour. Aust. Bull.* 45, p. 88, pl. 10, figs. 1-11, text-figs. 49-54.

Remarks: Although all the available fifteen specimens are crushed, their close relationship with *C. lucida* is unmistakable. Both forms have width greater than length, a transverse-oval outline, wide angular plications, and a trapezoidal sinus. The two forms differ in only one significant character, the number of plications in the sulcus: three or more in *lucida,* two in the Burt Range form. This difference cannot be overlooked, for the number of plications in *Camarotoechia* is generally a valid criterion in distinguishing species. Six Burt Range specimens show the number of plications, and all have only two plications in the sulcus, whereas the large collections of *C. lucida* contain only two specimens with two plications, the rest having three or more. Thus an appeal to variation on the basis of available material from the Burt Range is invalid; the specimens are too poorly preserved for separate description; and their close relationship with the Devonian *Camarotoechia* from the Fitzroy Basin is best indicated by the name cf. *C. lucida.*

DEVONIAN BRACHIOPODS FROM THE GNEUDNA FORMATION, CARNARVON BASIN, WESTERN AUSTRALIA.

SUMMARY.

Five brachiopod species from the Gneudna Formation of the Carnarvon Basin are described: *Productella occidua* sp. nov., *Camarotoechia puteana* sp. nov., *Spinatrypa aspera prideri* (Coleman) 1951, cf. *Ladjia saltica* Veevers 1959, and an indeterminate smooth spiriferid. Corals (Hill, 1954) and brachiopods (Glenister, 1956) already described from the Gneudna Formation are listed, and some corrections noted. The brachiopods described below are used in determining the age of the Gneudna Formation as Frasnian, the lower half probably middle Frasnian, the upper probably upper Frasnian.

INTRODUCTION.

The Gneudna Formation (Teichert, 1949; Condon, 1954) is exposed over a narrow strip along the eastern edge of the Carnarvon Basin. Fossils abound in these rocks, and include brachiopods, corals, nautiloids, stromatoporoids, calcispheres, pelecypods, and crinoid stems. Hill (1954) has described four species of corals, Coleman (1951) one species of brachiopod, and Glenister (1956) five species of brachiopods. The remaining brachiopods represent four species, which are described below. Coleman's *Atrypa aspera prideri* is re-described. The calcispheres are being studied at the present by Miss I. Crespin and G. A. Thomas of the Bureau of Mineral Resources, Canberra.

DESCRIBED FOSSILS.

The described fossils from the Gneudna Formation are

CORALS (Hill, 1954)

Hexagonaria gneudnensis Hill 1954, p. 18, pl. 1, figs. 1a, b.
Disphyllum virgatum var. *variabile* Hill 1954, p 20, pl. 1, figs. 2-6.
Thamnopora cf. *polyforata* (Schlotheim), p. 31, pl. 1, figs. 7-9.
Alveolites caudatus Hill 1954, pp. 32, 33, pl. 1, figs. 10-11.

BRACHIOPODS

(a) Coleman (1951)

Atrypa aspera prideri Coleman 1951, pp. 684-685, pl. 102, figs. 11-17.

(b) Glenister (1956)

Austrospirifer variabilis Glenister 1956, pp. 59-60, pl. 2, figs. 1-18, pl. 3, figs. 1-8, text-fig. 1 (1-4).

Cyrtospirifer minilyaensis Glenister 1956, pp. 63-64, pl. 1, figs. 1-3, pl. 3, figs. 9-32, text-fig. 3 (1-5), 5 (1-21)

Cyrtospirifer australis Glenister 1956, pp. 64-65, pl. 1, figs. 4-9, pl. 4, figs. 1-24, pl. 5, figs. 1-5; text-fig. 2 (1-15), text-fig. 3 (7-9), text-fig. 4 (1-14).

Cyrtospirifer gneudnaensis Glenister 1956, pp. 66-67, pl. 5, figs. 6-27, pl. 6, figs. 1-20; text-fig. 1 (5-10), text-fig. 4 (15-18).

Cyrtospirifer brevicardinis Glenister 1956, pp. 67-68, pl. 6, figs. 21-25, text-fig. 3 (6), 6 (1-16).

(c) Described below—

Productella occidua sp. nov.
Camarotoechia puteana sp. nov.
Spinatrypa aspera prideri (Coleman) 1951.
cf. *Ladjia saltica* Veevers 1959.
Spiriferidae gen. et sp. ind.

All these described fossils are based on Bureau material collected in 1949 by M. A. Condon, C. E. Prichard, C. Teichert, and G. A. Thomas from the type section, described by Condon (1954, pp. 13-14 and Condon MS), and from a second measured section, 4¾ miles north of the type section. The distribution of the described fossils in these sections is shown in text-fig. 6.

At this point some corrections to earlier papers are to be noted. Some of the stratigraphical information supplied to Dr. Dorothy Hill was incorrect. The correct details supplied by M. A. Condon from his field notes of the type section (Condon, MS) are given in the passage below, which replaces Hill's *Explanation of Plate* 1, *figs.* 1-11 (1954, pp. 46-47).

GIVETIAN OR LOWER FRASNIAN CORALS FROM THE GNEUDNA FORMATION, CARNARVON BASIN, WESTERN AUSTRALIA.

Fig. 1.—*Hexagonaria gneudnensis* sp. nov. Holotype C.P.C. 766 from 2,574 feet to 2,600 feet in traverse S. of Gneudna Well; i.e. 1,260 to 1,275 feet above base of formation. 1a, transverse, 1b, vertical section.

Fig. 2.—*Disphyllum virgatum* (Hinde) var. *variabile* nov. Holotype, C.P.C. 767, traverse S. of Gneudna Well between 2,936 feet and 2,950 feet; 1,465-1,470 feet above base of formation. Polished section.

Fig. 3.—*Disphyllum virgatum* (Hinde) var. *variabile* nov. C.P.C. 768, traverse N. of Gneudna Well, at 1,035 feet (about 400 feet above the base).

Fig. 4.—*Disphyllum virgatum* (Hinde) var. *variabile* nov. C.P.C. 769, traverse S. of Gneudna Well, at 2,708 feet to 2,721 feet; 1,335-1,345 feet above base of formation.

Fig. 5.—*Disphyllum virgatum* (Hinde) var. *variabile* nov. C.P.C. 770, just below top of formation, about 1 mile N. of Gneudna Well. 5a, 5c, 5e, transverse, and 5b, 5d, vertical sections.

Fig. 6.—*Disphyllum virgatum* (Hinde) var. *variabile* nov. C.P.C. 771, top of formation, about 1 mile N. of Gneudna Well. 6a, transverse, 6b, vertical section.

Fig. 7.—*Thamnopora* cf. *polyforata* (Schlotheim). C.P.C. 772, 2,708 feet to 2,721 feet in traverse S. of Gneudna Well; 1,335-1,345 feet above base of formation.

Fig. 8.—*Thamnopora* cf. *polyforata* (Schlotheim). C.P.C. 773, at 2,936 feet to 2,950 feet in traverse S. of Gneudna Well; 1,465-1,470 feet above base of formation.

Fig. 9.—*Thamnopora* cf. *polyforata* (Schlotheim). C.P.C. 774, top of formation, about 1 mile N. of Gneudna Well. Oblique section.

Fig. 10.—*Alveolites caudatus* sp. nov. Sections from holotype, C.P.C. 765, from near top of Gneudna Formation, 1 mile N. of traverse N. of Gneudna Well.

Fig. 11.—*Alveolites caudatus* sp. nov. Oblique section from C.P.C. 775, at 2,936 feet to 2,950 feet in traverse S. of Gneudna Well; 1,465 feet to 1,470 feet above base of formation.

Necessary corrections should also be made in Hill's text on pages 18, 20, 31 and 32. Additional stratigraphical details are—

p. 18, line 25—*after* " 2,700-2,820 feet along the traverse north of Gneudna Well ", *insert* " 1,370-1,430 feet above the base of the formation " .

p. 31, 7 lines from the bottom: *after* " 2,352-2,370 feet ", *insert* " 1,135-1,145 feet above base ".

p. 31, 5 lines from the bottom: *after* " 3,278 feet in traverse south of Gneudna Well ", *insert* " 1,650-1,660 feet above base ".

The only brachiopods referred to precise localities by Glenister (1956) are the type specimens. Localities of other specimens are not given in the text, nor has Glenister indicated in the collection itself his identification of specimens other than types. Glenister's Table 1, dealing with the ranges of his species, is ambiguous in that localities from the type section and the second measured section are mixed together. Hence the localities of type specimens only of Glenister's species are shown in text-fig. 6.

STRATIGRAPHY AND AGE.

The lowermost 330 feet in the type section, which is 1,696 feet thick (Condon, MS), and the lower 365 feet in the second section are poorly fossiliferous. Brachiopods occur above these levels to 1,380 feet in the type section, and to 1,430 feet in the second section. Corals occur between 1,130 and 1,675 feet in the type section, and from 1,370 feet to near the top of the second section, which is 1,750 feet thick. Hill (1954, p. 46) notes also the occurrence of *Disphyllum virgatum variabile* at 400 feet above the base of the second section. Miss Crespin and Mr. Thomas tell me that the calcispheres occur in the type section between 400 and 500 feet.

The only described fossils which seem useful for zoning the Gneudna Formation are the corals, which, except *D. virgatum variabile*, indicate the uppermost 600 feet of both sections. The ribbed spiriferids might be useful for zoning but the ambiguity concerning their total ranges rules out their present use. Of the other brachiopods, described below, *Camarotoechia puteana* ranges through nearly 1,000 feet in both sections; *Spinatrypa aspera prideri* ranges through a similar interval in the second section and through only 35 feet in the type section; *Productella occidua* has a narrower range, from 1,085 to 1,130 feet in the type section and 1,140 to 1,315 feet in the second section, so that it could be a useful zone fossil; cf. *Ladjia saltica* is represented by three specimens only, which, however, probably come from a single bed, 330 to 335 feet above the base of the type section, and 415 to 420 feet above the base of the second section. The indeterminate smooth spiriferid is represented by one specimen only.

Only one of the brachiopods described below is definitely known outside the Gneudna Formation. This is *Spinatrypa aspera prideri*, which, in the Fitzroy Basin, occurs at Sadler Ridge in the upper Frasnian *torrida* zone, and probably from the upper Famennian *proteus* zone in the Geikie Gap area (*see* Veevers, 1959a). By itself, therefore, *S. aspera prideri* probably indicates upper Frasnian, possibly upper Frasnian to upper Famennian.

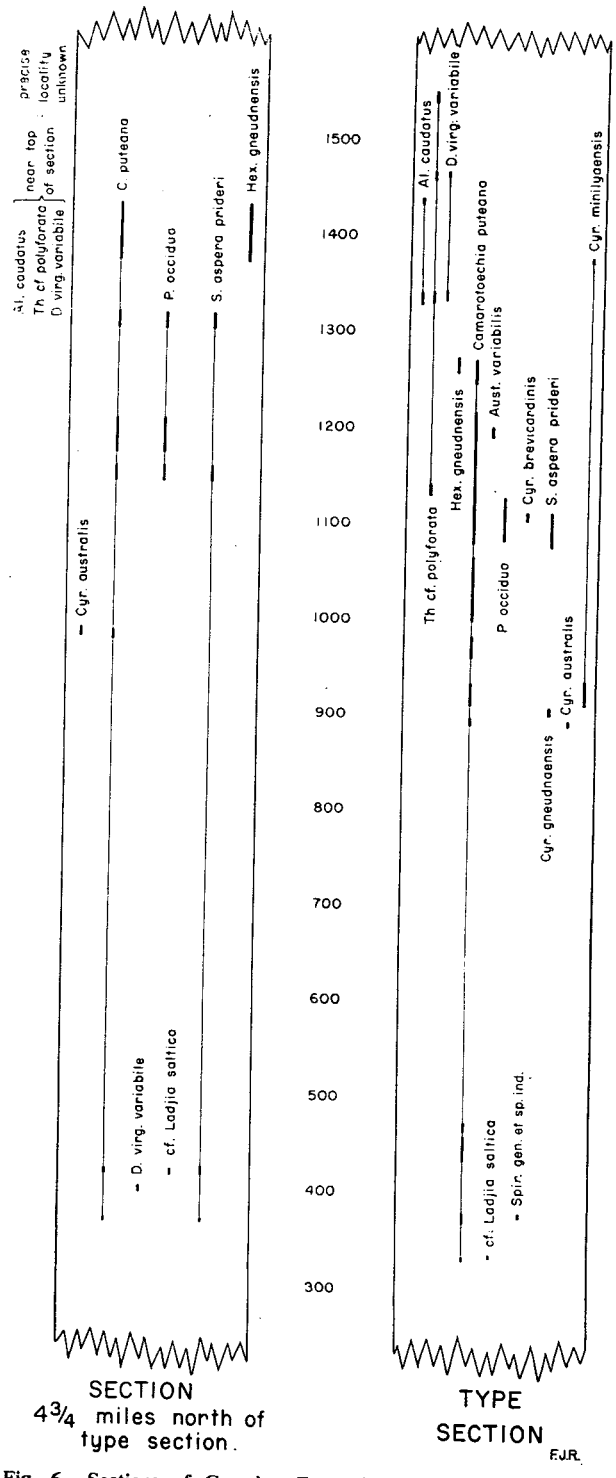


Fig. 6

Fig. 6.—Sections of Gneudna Formation showing distribution of described brachiopods and corals.

NOTES.—1. Heavy lines indicate intervals over which fossils have actually been found.

2. Numbers refer to height in feet above base of section.

3. *Cyrtospirifer* and *Austrospirifer:* Glenister (1956) indicates precise localities of type specimens only.

Ladjia saltica Veevers 1959 is almost certainly present in the Gneudna Formation, but more material is necessary to confirm this identification. In the Fitzroy Basin, *L. saltica* is the index fossil of a zone of middle Frasnian age. As noted above, cf. *L. saltica* occurs in the Gneudna Formation at the lowest richly fossiliferous bed in the type section (at 330 to 335 feet), and at 415 to 420 feet in the second section. *S. aspera prideri* and cf. *L. saltica* occur side by side at this level in the second section, and the overlap of their ranges probably indicates that this bed lies at the boundary between the middle and upper Frasnian, or, in other words, between the *saltica* and *torrida* zones.

The new species of *Camarotoechia* and *Productella* corroborate this estimate. *C. puteana* is closely related to *C. congregata,* which in New York State ranges through the Givetian Hamilton group to the Gilboa sandstone, which, as a Tully formation equivalent, is uppermost Givetian or lowermost Frasnian (*see* Cooper et al., 1942). *P. occidua* is closely related to *P. subaculeata,* which is restricted to the upper half (Ferquien) of the Frasnian. Moreover, *P. occidua* is probably represented, though by a single specimen only, in the upper Frasnian *torrida* zone at Sadler Ridge in the Fitzroy Basin. As noted above, *P. occidua* occurs in the intervals 1,085-1,130 feet in the type section, and 1,140-1,315 feet in the second section, which therefore are probably upper Frasnian in age.

Among the corals, *Thamnopora* cf. *polyforata* resembles the species from the upper Givetian and lower Frasnian of Belgium, and *Disphyllum virgatum variabile* resembles *D. goldfussi* var. *hsianghsiensis* Yoh 1937 from the upper Middle Devonian of southern China. *Hexagonaria gneudnensis* is closely related to the Fitzroy Basin species, *H. brevilamellata* (Hill) 1936, from the *ramosa* zone of uppermost Givetian age, and a similar form to *D. virgatum variabile* was found in the Fitzroy Basin, " north of Pillara Range. Doubtfully from Pillara Limestone " (Hill, 1954, p. 48). In this area, the Pillara Formation ranges in age from uppermost Givetian to the lower half of the Frasnian.

In discussing the Gneudna corals, Hill (1954, p. 5) concludes that " the genera to which they belong are those dominant and characteristic in the Pillara Limestone of the West Kimberleys, and in upper Givetian and early Frasnian faunas elsewhere, so that the Gneudna Formation is probably of this age ".

Glenister (1956, p. 46) believes that " new species of *Cyrtospirifer* fix the age of this fossiliferous horizon [the interval 600 to 1,470 feet of the type section] as late Frasnian ". This estimate is based on the belief that the genus *Cyrtospirifer* is restricted to the Frasnian, for, except for saying (p. 64) that " Like all the other species of *Cyrtospirifer* to be described later, *C. minilyaensis* is closely comparable though not identical with some of the species described by Grabau (1931) and Tien (1938) from the Upper Devonian of southern China ", Glenister omits comparisons of the Gneudna *Cyrtospiriferae* with species outside this formation. G. A. Thomas, who is studying ribbed spirifers from the Upper Palaeozoic of Western Australia, has pointed out in conversation that *Cyrtospirifer* ranges into the Famennian of the Fitzroy Basin. Doubtless the species of *Cyrtospirifer* from the Gneudna Formation are valuable as stratigraphical indices, but their value will not be realized until the species themselves are compared with other members of the genus.

In summary, the age of the Gneudna Formation, estimated on the basis of described fossils, is Frasnian, the lower half probably middle Frasnian, the upper probably upper Frasnian. The lower limit is marked by the occurrence of *Ladjia* cf. *saltica*, of probably middle Frasnian age, the upper limit by the occurrence of *P. occidua*, of probable upper Frasnian age. The lowermost 300 feet of the type section and the lowermost 400 feet of the second section are poorly fossiliferous, but as both sections are continuous sequences, the lower part of the formation is also probably middle Frasnian.

SYSTEMATIC DESCRIPTIONS.

Superfamily PRODUCTACEA.

Family PRODUCTIDAE.

Subfamily PRODUCTELLINAE Schuchert & LeVene.

Genus PRODUCTELLA Hall 1867.

PRODUCTELLA OCCIDUA sp. nov.

(Plate 1, figures 6-13; text-figures 7, 8.)

Diagnosis: Like the type species, *P. subaculeata*, but with reclining spines.

Material: Seventy incomplete calcareous shells.

Description—Exterior: Outline circular to transversely elliptical, profile strongly concavo-convex, concavity of dorsal valve corresponding closely with convexity of ventral valve. Hinge-line wide, shell widest at midlength.

Ventral valve strongly convex, posterior outline with evenly arched venter and lateral flanks. Convexity of profile increases towards posterior. Umbo broad and low, tip weakly inturned, cicatrix of attachment not seen. Ears poorly defined, small and flat. Interarea extends across entire hinge-line, short, anacline. Delthyrium moderately broad, anterior part filled by cardinal process, posterior half covered by an indistinct flat pseudodeltidium.

Dorsal valve moderately to deeply concave, with raised ears. Umbo tiny, a mere conical rise. Interarea well developed along entire hinge-line, length equal to half that of ventral interarea, hypercline. Posterior face of bilobed cardinal process raised slightly above level of interarea. Exterior crossed by broad concentric rugae interrupted by fairly large circular depressions. Entire surface finely pitted. Ventral exterior covered by low indistinct rugae, and by an estimated 100 broad reclining hollow spines, which were probably long when intact.

Interior: Tiny bilobed teeth project from delthyrial angles (text-fig. 7, 8, section 1.45), and engage in rudimentary sockets formed by base of cardinal process and wall of dorsal valve; sockets continue slightly anteriorly as cavities in wall of dorsal

valve (text-fig. 7, 8, 1.65). Sulcus between cardinal process lobes short, dorsal side of process deeply furrowed. Interior of dorsal valve marked by two low broad parallel ridges (text-fig. 7, 1.65 and 1.95), which give way near midlength to a low narrow median septum (4.8). Adductor scars in ventral valve deeply impressed on ventral side of umbonal region (text-fig. 7, 0.7, 1.0).

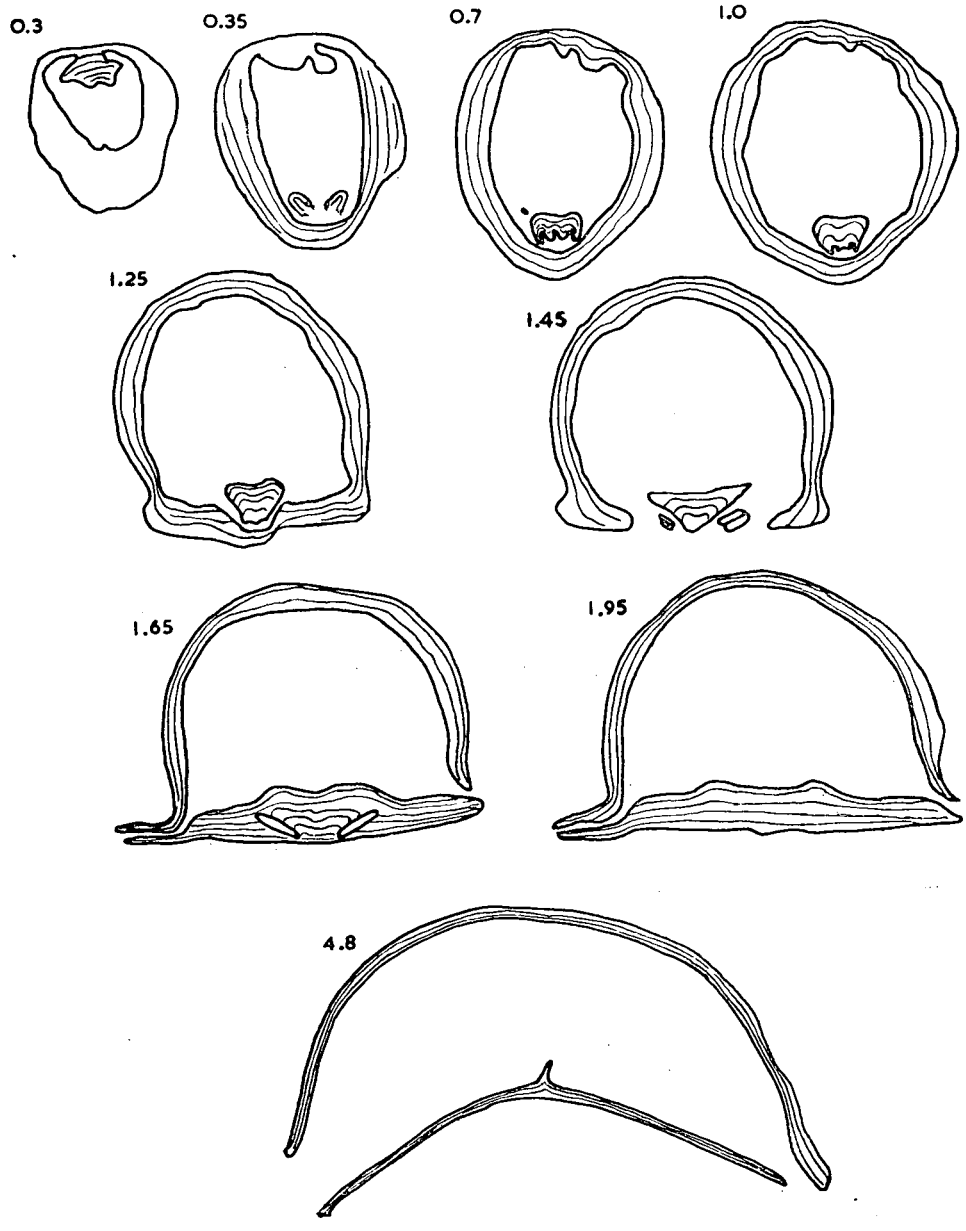


Fig. 7.—*P. occidua* sp. nov. Nine serial transverse sections and peels (x 7) of CPC 3049, from TP30.

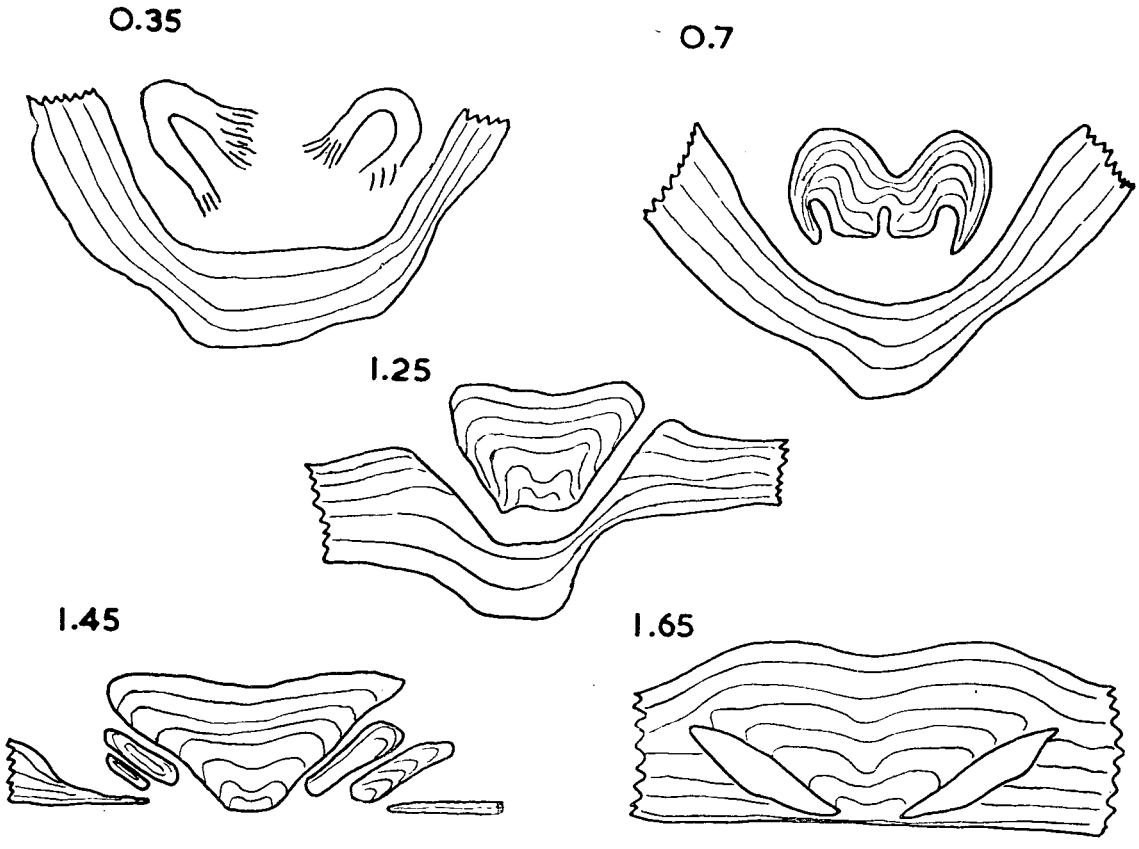


Fig. 8. *P. occidua* **sp. nov. Enlargements (x 20) of parts of five sections shown in text-figure 7.**

Shell structure: Individual growth laminae are very thin. At the tip of the cardinal process they are drawn out dorsally into narrow ridges, which afforded a greater area of attachment for the diductors. The shell is barely pseudopunctate; only few taleolae appear in serial sections. In this respect, *P. occidua* shows further resemblance to *P. subaculeata,* which is also practically devoid of taleolae (*see* Veevers, 1959b).

Estimated measurements (mm.):

—	Length.	Width.	Depth of Ventral Valve.
Holotype CPC 3047	15	15	8
Figured specimen CPC 3048	13	14	6
Sectioned specimen CPC 3049	12.8	15	7

Localities: Gneudna Formation, 1,085-1,130 feet (TP 193-196) above base of type section; 1,140-1,155 feet (TP 20), 1,170-1,205 feet (TP 30), and 1,300-1,315 feet (TP 29) above the base of the measured section, north of Gneudna Well. The holotype, CPC 3047, and figured specimen CPC 3048 come from TP 30.

Discussion: *P. occidua* and *P. subaculeata* (Murchison) 1840, the type species of *Productella,* are closely related. Internal features in both species are similar, with the trivial exception that the teeth of *occidua* are bilobed whereas those of the type are simple (*see* Veevers, 1959b). All other characters are identical with one important exception: whereas the spines in *subaculeata* are erect, those in *occidua* are reclining. On this basis, alone, however, *occidua* is clearly distinguishable from the type.

cf. *Productella* sp., represented by a single specimen from the Sadler Formation, Fitzroy Basin, Western Australia (Veevers, 1959a, p. 80, pl. 8, figs. 24, 25), is probably *occidua.* Shell shape and other external features (as far as they are known) are similar, but further specimens from the Fitzroy Basin must be collected before a sound comparison can be made.

Superfamily RHYNCHONELLACEA.

Family CAMAROTOECHIIDAE.

Subfamily CAMAROTOECHIINAE.

Genus CAMAROTOECHIA Hall & Clarke 1893.

CAMAROTOECHIA PUTEANA sp. nov.

(Plate 2, figs. 13-22, pl. 3, figs. 1-3; text-figs. 9, 10.)

Diagnosis: *Camarotoechia* with maximum width of 30 mm., outline elongate-oval or circular, plications narrow and rounded, 5 to 7 on shallow trapezoidal to rounded sulcus, fold low.

Differential diagnosis: Like the type species, *C. congregata,* but with a considerably shallower and broader sulcus in the ventral valve.

Material: Over one hundred free, partly recrystallized, calcareous shells.

Description: Elongate-oval or circular in outline, widest at midlength. Profile circular to dorsi-biconvex, dorsal valve of large specimens strongly and evenly convex. Anterior commissure broadly and moderately deeply uniplicate. Ventral valve sulcus produced dorsally into a short flat tongue. Dorsal valve evenly convex in profile; median fold developed anterior to midlength, flat-topped, proceeding by steep, nearly vertical flanks to the weakly convex sides of valve. Entire surface of both valves covered by rounded plications separated by narrow furrows, altogether 20 to 25 including 5 to 7 on the sulcus. Mature specimens have 2 or 3 growth-lines in 1 mm. along commissure.

Delthyrial cavity deep and broad, walled by short high vertical dental plates. Teeth flat, short, broad, longitudinally grooved. Sockets bounded on inner side by vertical walls of hinge-plate, laterally by low ridges. Median septum long and broad, supporting posterior part of septalium-like structure which differs from typical septalia in being bridged over medianly by part of hinge-plate to form a short median cavity (text-fig. 9, sections 1.6 and 1.8, text-fig. 10, 0.8 and 1.3); hinge-plate perforated

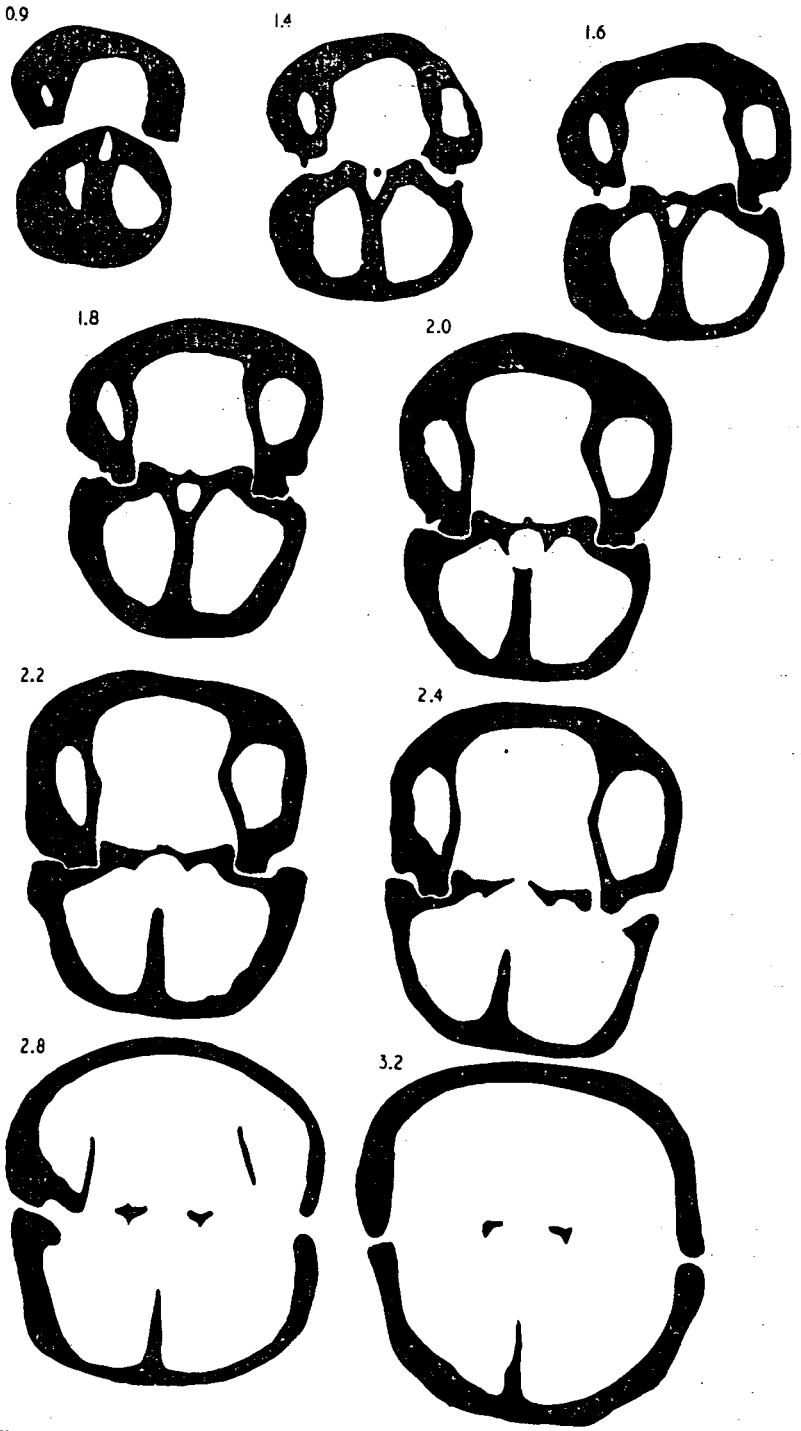


Fig. 9.—*C. puteana* sp. nov. Nine serial transverse sections (x 4) of F17393b, from TP 197.

(text-fig. 9, 1.4) or imperforate (text-fig. 10, sections 0.8 to 2.2), supported by septalium over its posterior half only, continues anteriorly without support. Dorsal adductors probably attached to narrow median ridge on ventral side of hinge-plate. Crura short and parallel, lie in plane of commissure.

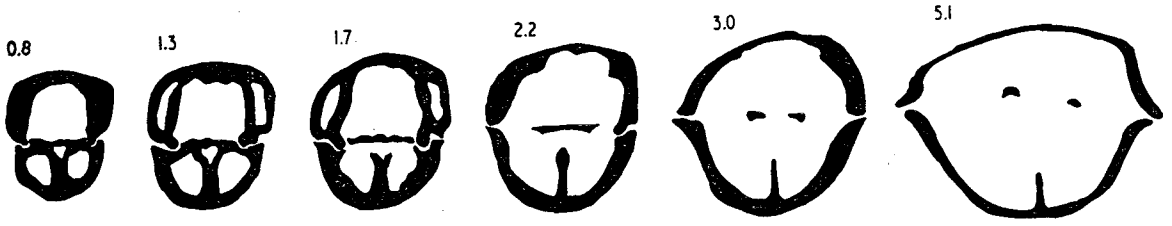


Fig. 10.—*C. puteana* **sp. nov. Six serial transverse sections and peels (x 1½) of CPC 3058, from TP 177.**

Types: Holotype CPC 3055 from locality TP 22, figured specimens CPC 3056 from T 8 and CPC 3057 from T 12.

Measurements (mm.):

—	Length.	Width.	Thickness.
Holotype CPC 3055	21.6	20.7	16.4
Figured specimen CPC 3056	13.2	15.0	11.6
CPC 3057	28.0	24.9	26.0
Sectioned specimen F17393b	20.7	20.7	16.2
CPC 3058	23	25	17

Variations: Small adult specimens like CPC 3056 (pl. 3, figs. 1-3) are almost quadrangular in outline and the plications are proportionately narrower and the grooves proportionately broader than those of larger specimens. Large adults like CPC 3057 differ from the holotype in their greater thickness, more conspicuous dorsal fold, and deeper sulcus.

Localities: Gneudna Formation, type section—

Locality.	Feet above base.
TP 159	330– 335
TP 160–161	370– 380
TP 164–166	435– 460
TP 168	465– 475
TP 177	890– 895
TP 178–181	910– 935
TP 184–185	960– 985
TP 187	1,020–1,025
TP 188–190	1,000–1,070
TP 192–202	1,080–1,220
TP 203–204	1,250–1,275

Measured section, north of Gneudna Well—

Locality.	Feet above base.
TP 8	365
TP 11	415– 420
TP 17	975– 985
TP 20	1,140–1,155
TP 30	1,170–1,205
TP 22, 29	1,300–1,315
TP 31	1,370–1,430

Also from TP 46, an isolated outcrop 2 miles north-west of Williambury Homestead; TP 151, lower half of type section; T 8, T 8a, low in type section; T 11, T 12, in upper third of type section.

Discussion: C. puteana is closely related to the type species, *C. congregata:* shell shape and ribbing are similar, but whereas the sulcus is moderately deep and narrow in *congregata,* in *puteana* it is considerably shallower and broader. A further difference may be provided by the unsplit condition of the hinge-plate in *puteana.* Published illustrations of the dorsal interior of *congregata* show a split hinge-plate. Topotypical specimens of *congregata* from the Hamilton group of eastern New York State (B.M. (N.H.) B 9564, B 96425, B 96427, B 96428, B 96510) have a split hinge-plate; B 96426 has an unsplit hinge-plate. This kind of intraspecific variation is quite common in *Camarotoechia* and is referred to by Cooper (1944, p. 311) in his diagnosis:

> ". . . dorsal interior with divided hinge plates; no cardinal process, and segments of hinge plate attached to median septum by supporting plates making a short, small cruralium often covered with growth of inner hinge plates."

Each of the three sectioned specimens of *C. puteana* is provided with an unsplit hinge-plate, which, rather than being rare as it is in the type species, is probably normal in the new species.

Serial transverse sections of the Couvinian *C. hexatoma hexatoma* (Schnur) (*in* Schmidt, 1941, pl. 5, figs 4a-i) compare closely with those of *C. puteana* (text-fig. 9), and perhaps *hexatoma;* like *puteana,* is also characterized by an unsplit hinge-plate. The similarities between these forms vanish when exteriors are compared, for *hexatoma* has a broad and deep sulcus, a prominent fold, and broad plications.

In an environment favouring specimens with strong muscles, an initially split hinge-plate, the ventral surface of which serves as the attachment area of the diductor muscles, would probably be bridged over by callus deposits secreted by expanded muscle-bases. Cellulose peels of etched transverse sections give no evidence that callus was deposited on the hinge-plate. On the contrary, growth laminae of the hinge-plate are entirely concordant with one another and are of roughly the same thickness, features characteristic of normal uninterrupted shell growth. At least for *puteana* therefore the unsplit hinge-plate is probably a specific character.

Other similar species are *C. peetzi* Tolmachoff 1931 (p. 549, pl. 6, figs. 21-25), from the Lower Carboniferous limestones of the Kuznetz Basin, Russia, which has a more prominent fold and sinus, and *C. mutata* (Hall) 1856, as illustrated by Weller (1914, pl. 24, figs. 41-60) from the Salem limestone of Indiana and Illinois (Lower Carboniferous), which is almost identical with juvenile specimens of *C. puteana* (pl. 3, figs. 1-3), but differs from adult *puteana* in its transverse outline, proportionately deeper sulcus, and proportionately narrower plications and broader grooves.

Superfamily ATRYPACEA.

Family ATRYPIDAE.

Genus SPINATRYPA Stainbrook 1951.

SPINATRYPA ASPERA PRIDERI (Coleman) 1951.

(Plate 2, figs. 1-10; text-fig. 11.)

1951 *Atrypa aspera prideri* Coleman. Coleman, P. J., *J. Paleont.*, 25, 684-685, pl. 102, figs. 1-17.

1959 *Spinatrypa aspera prideri* (Coleman). Veevers, J. J., *Bur. Min. Resour. Aust. Bull.* 45, p. 121, text-figs. 74, 75.

Remarks: Coleman originally described *prideri* from the Frasnian of the Fitzroy Basin; at the same time he noted its occurrence in the Devonian of the Carnarvon Basin and figured a suite of these specimens (Coleman, 1951, pl. 102, figs. 11-17).

The range of variation is shown by the three shells, juvenile, mature, and senile, figured on plate 2. The juvenile shell (pl. 2, figs. 9, 10) is weakly biconvex, but the type of radial costae and concentric growth-lines characteristic of adults is already present. The senile specimen (pl. 2, figs. 5-8) has its anterior third crossed by closely crowded growth-lines.

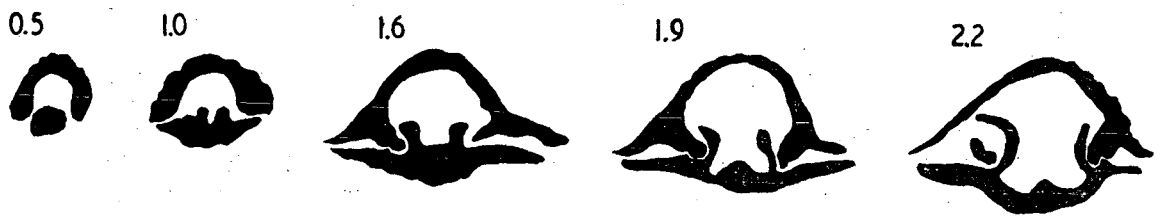


Fig. 11.—*S. aspera prideri* **(Coleman) 1951. Five serial transverse sections and peels (x 3) of CPC 3053, from TP 192; its measurements are L = 17.5 mm., W = 18 (est.), and T = 10.2.**

The shell interior is the same as that in the *prideri* from the Fitzroy Basin (cf. text-fig. 11 with Veevers, 1959a, text-fig. 74).

Localities: Gneudna Formation, 1,080 to 1,115 feet above the base of the type section (TP 192-195), and at 365 (TP 8), 1,140 to 1,155 (TP 20), and 1,300 to 1,315 (TP 22, 29) feet above the base of the measured section, north of Gneudna Well.

Superfamily SPIRIFERACEA.

Family SPIRIFERIDAE.

Subfamily AMBOCOELIINAE George 1931.

Genus LADJIA Veevers 1959.

cf. LADJIA SALTICA Veevers 1959.

(Plate 1, figs. 1-5; text-fig. 12.)

1959 *Ladjia saltica* Veevers. Veevers, J. J., *Bur. Min. Resour. Aust. Bull.* 45, p. 126, pl. 12, figs. 1-29, text-figs. 76-78.

Material: Three calcareous shells, one, C.P.C. 3045, entire except for a worn external surface. One specimen was serially sectioned.

Description: The salient features of these three shells are the biconvex, submegathyrid shape, high apsacline ventral interarea, low anacline dorsal interarea, a broad shallow ventral median sulcus, a broad low dorsal median fold, and a surface marked by numerous faint radial costellae, seen best on F17143b. Ventral valve has prominent pedicle plate (text-fig. 12, sections 0.6, 0.8 and 1.3), short high dental plates (1.3, 1.8), and large hinge teeth (1.8, 2.1). Dorsal valve has large sockets (sections 0.6, 0.8), and a large cruralium supported by a low median septum.

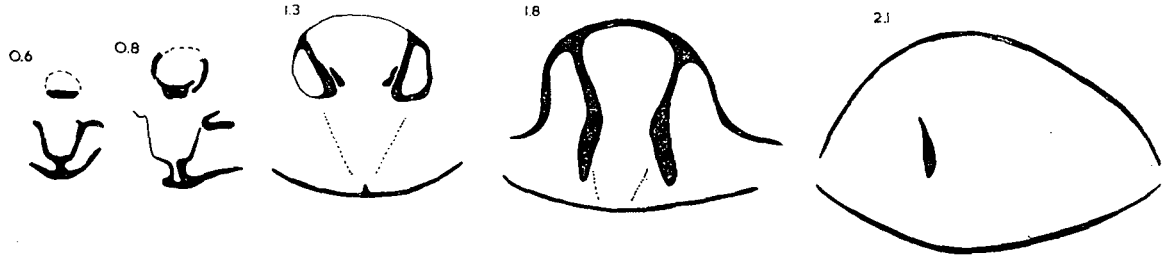


Fig. 12.—cf. *L. saltica* Veevers 1959. Five serial transverse sections (x 5) of CPC 3046, from TP 159.

Measurements (mm.):

	Length.	Width.	Thickness.
Figured specimen CPC 3045	6.9	8.1	4.6
Sectioned specimen CPC 3046	8.3	11.3	6.0
F17143b	10.3	11.5	7.6

Localities: C.P.C. 3045 and F17143b from locality 11, section north of Gneudna Well, 415 feet to 420 feet above base; C.P.C. 3046 from locality 159, type section, 330 to 335 feet above base.

Discussion: Only one doubt remains concerning the identification of these specimens as *L. saltica*. The sectioned Gneudna specimen has dental plates, and a cruralium: topotypical *L. saltica* rarely have dental plates (only 3 out of 100 specimens have them) and a cruralium (1 in 100)*. This doubt is almost overcome by a comparison of other characters, which are identical.

In the Fitzroy Basin, *L. saltica* indicates a zone of middle Frasnian age.

Family SPIRIFERIDAE.

Gen et sp. ind.

(Plate 2, figs. 11a, b, 12a, b.)

The observable features of this single specimen (C.P.C. 3054 from locality 161, type section of Gneudna Formation, 375 to 380 feet above base) are pentagonal outline and brachythyrid hinge-line; long, gently curved ventral interarea, well-developed deltidial plates inclined at right-angles to interarea, and thick pedicle collar; a finely reticulate pattern of radial striae and concentric growth-lines (3 or 4 striae in 1 mm. at anterior margin); laterally directed spiralia (seen on worn side of shell).

The measurements of C.P.C. 3054 are length 19.2 mm., width 20.4 mm., and thickness 12.2 mm.

C.P.C. 3054 is similar in shape to specimens of *Ladjia saltica* Veevers 1959 such as C.P.C. 2993 (Veevers, 1959a, pl. 12, figs. 11-15). External differences are the fewer radial striae and much smaller size of *L. saltica*.

* If the dental plates and the cruralium of the sectioned specimen are invariable characters of this form, it is probably a *Rhynchospirier*. See Veevers (1959a, p. 125. footnote).

TABLE 3.—AIR-PHOTOGRAPH CO-ORDINATES OF LOCALITIES.

Locality.	4-mile Map Area.	Run No.	Photo No.	Quadrant.	Co-ordinates.		
					x	y	diagonal.
		Camarotoechia amnica.					
TP42	Minilya	13A	5037	C	1.23	0.80	1.47
TP45	Minilya	13A	5037	C	1.35	0.50	1.45
TP152B	Minilya	13	5013	C	0.75	0.22	0.77
CC120	Minilya	13A	5037	D	2.64	0.11	2.65
CC122=ML39 ..	Minilya	13A	5037	C	2.64	0.96	2.80
		Camarotoechia septima.					
Locality B .. .. (Utting, 1957)	Auvergne	9	5039	D	4.18	3.66	5.55
BW5 .. .. = Locality 27 of Traves, 1955	Auvergne	7	5075	B	1.73	1.94	2.48
Locality F	Auvergne (actually in Cambridge Gulf 4-mile area)	11	5127	C	2.30	1.32	2.65
		Camarotoechia eganensis.					
KC2	Lennard River ..	15	5150	A	1.65	1.27	2.18
KC10=T11 ..	Lennard River ..	14	5104	D	0.28	0.90	0.96
KC14=KCH18=T17	Lennard River ..	15A	5068	C	2.43	3.79	4.50
KCH8=Pt. 8 ..	Lennard River ..	15A	5067	C	2.59	0.41	2.63
KCH17=T7 ..	Lennard River ..	15A	5068	B	1.89	0.10	1.90
KCH19=Pt. 83 ..	Noonkanbah ..	1A	D5064	D	0.98	0.60	1.17
Pt. 40	Lennard River ..	15A	5067	C	2.67	0.64	2.75
Pt. 45	Lennard River ..	15A	5068	D	0.87	0.27	0.90
Pt. 47	Lennard River ..	15A	5068	D	0.95	0.55	1.10
Pt. 51	Lennard River ..	15A	5068	D	1.54	0.36	1.59
Pt. 52	Lennard River ..	15A	5068	D	1.45	0.32	1.47
Pt. 56	Noonkanbah ..	1A	D5066	D	3.08	1.55	3.44
		Camarotoechia sp. ind. II.					
TP142	Minilya	13A	5037	A	0.36	0.16	0.40
ML3	Kennedy Range ..	1	5009	C	0.14	1.18	1.20
		Gneudna Formation.					
Type section: base	Minilya	15	5011	C	0.57	2.18	2.27
Transferred along strike: from	Minilya	15	5011	C	0.60	1.90	2.00
to	Minilya	15	5011	C	0.87	1.95	2.14
top	Minilya	15	5011	C	0.91	1.70	1.94
Section north of Gneudna Well: base	Minilya	13A	5037	C	1.38	3.30	3.65
top	Minilya	13A	5037	C	2.60	1.60	3.04
		Bonaparte Gulf Basin.					
Locality E .. .. (Utting, 1957)	Auvergne (actually in Cambridge Gulf 4-mile area)	12	5131	D	0.10	0.39	0.391

ACKNOWLEDGMENTS.

Part of this work was carried out in the Geology Department of Imperial College, London, and in the Department of Geology of the British Museum (Natural History), London, during the period January-June, 1956, while I was on leave from the Bureau.

I gratefully acknowledge the kindness of Professor H. H. Read and Dr. E. I. White for extending to me the facilities provided by their departments. During this time I held a Beit Scientific Research Fellowship.

Dr. B. F. Glenister kindly lent me specimens from the University of Western Australia Collections.

The photographs are the work of Mr. G. T. Reid and Mr. C. Zawartko.

REFERENCES.

COLEMAN, P. J., 1951.—*Atrypa* in Western Australia. *J. Paleont.*, 25, 677-690, pls. 100-102, text-figs. 1-3; addendum, *Ibid.*, 26 (5), 861 (1952).

CONDON, M. A., 1954.—Progress report on the stratigraphy and structure of the Carnarvon Basin, Western Australia. *Bur. Min. Resour. Aust. Rep.* 15.

COOPER, G. A., 1944.—Phylum Brachiopoda, *in* "Index Fossils of North America", by H. W. Shimer & R. S. Shrock. Technology Press, pp. 277-365, pls. 105-143.

COOPER, G. A., et al., 1942.—Correlation of the Devonian sedimentary formations of North America. *Bull. geol. Soc. Amer.*, 53, 1729-1794.

DAVIDSON, T., 1860.—A monograph of the British Brachiopoda. V(3). The Carboniferous Brachiopoda. *Palaeontogr. Soc. Monogr.*, 12, 81-120, pls. 17-26.

GLENISTER, B. F., 1956.—Devonian and Carboniferous spiriferids from the North-West Basin, Western Australia. *J. Roy. Soc. W. Aust.*, 39, 46-71, 8 pls., 7 text-figs.

HEMMING, F., Editor, 1953.—Copenhagen Decisions on Zoological Nomenclature. *Int. Trust Zool. Nomenclature,* London.

HILL, DOROTHY, 1954.—Coral faunas from the Silurian of New South Wales and the Devonian of Western Australia. *Bur. Min. Resour. Aust. Bull.* 23, 51pp., 4 pls.

de KONINCK, L.-G., 1887.—Faune du calcaire carbonifère de la Belgique. 6ième partie: Brachiopodes. *Ann. Mus. Hist. nat. Belg.*, 14.

PHILLIPS, J., 1836.—The Geology of Yorkshire. Pt. 2. London, Murray.

PRENDERGAST, KATHLEEN L., 1935.—Some Western Australian Upper Palaeozoic fossils. *J. Roy. Soc. W. Aust.*, 21, 9-35, pls. 2-4, 6 text-figs.

SARYCHEVA, T. G., & SOKOLSKAYA, A. N., 1952.—Key to the Palaeozoic Brachiopoda of the Moscow Basin. *Trans. paleont. Inst. Mosc.*, 38, 307 pp., 71 pls., 231 text-figs. (in Russian).

SCHMIDT, HERTA, 1941.—Die mitteldevonischen Rhynchonelliden der Eifel. *Abh. senck. natur. Ges.*, 459, 79 pp., 7 pls., 1 text-fig.

TEICHERT, C., 1949.—Discovery of Devonian and Carboniferous rocks in the North-West Basin, Western Australia. *Aust. J. Sci.*, 12 (2), 62-65.

THOMAS, G. A., 1959a.—Carboniferous stratigraphy of Western and Northern Australia. *C. R. Congr. strat. carbonifère,* Heerlen, 1958 (in press).

THOMAS, G. A., 1959b.—Lower Carboniferous Laurel Formation of the Fitzroy Basin. In *Bur. Min. Resour. Aust. Rep.* 38.

TOLMACHOFF, I. P., 1931.—Faune du calcaire carbonifère du bassin houiller de Kousnetzk. Pt. 2. *Geol. Publ. principal geol.-prosp. Dept.*, Moscow, Leningrad. "Fin de l'ouvrage publié dans les 'Materiaux pour la géologie générale et appliquée', livr. 25, 1924. Comité Géologique."

TRAVES, D. M., 1955.—The geology of the Ord-Victoria region, Northern Territory. *Bur. Min. Resour. Aust. Bull.* 27, 133 pp., 3 pls.

UTTING, E. P., 1957.—Report on exploration and geology within Permit No. 3, Northern Territory during 1956. *Rep. to Westralian Oil Limited* (unpubl.).

VAUGHAN, A., 1905.—The palaeontological sequence in the Carboniferous Limestone of the Bristol area. *Quart. J. geol. Soc. Lond.*, 61, 181-307, pls. 22-29.

VEEVERS, J. J., 1959a.—Devonian brachiopods from the Fitzroy Basin, Western Australia. *Bur. Min. Resour. Aust. Bull.* 45, 220 pp., 18 pls.

VEEVERS, J. J., 1959b.—The type species of *Productella, Emanuella, Crurithyris* and *Ambocoelia* (Brachiopoda). *J. Paleont,* 33 (in press).

WELLER, S., 1914.—The Mississippian Brachiopoda of the Mississippi Valley Basin. *Ill. geol. Surv. Monogr.* 1, 508 pp., 83 pls.

Page 35 is blank.

PLATE 1.

cf. *Ladjia saltica* Veevers 1959. .. .. .. Page 30

Figs. 1-5.—Dorsal, ventral, anterior, posterior and lateral views (x 4) of CPC 3045.
Gneudna Formation, Carnarvon Basin.

Productella occidua sp. nov. .. .. .. Page 23

Figs. 6-13, x 4.
Figs. 6-9.—Dorsal, ventral, posterior and lateral views of the holotype, CPC 3047.
Figs. 10-13.—Dorsal, ventral, posterior and lateral views of CPC 3048.
Gneudna Formation, Carnarvon Basin.

1

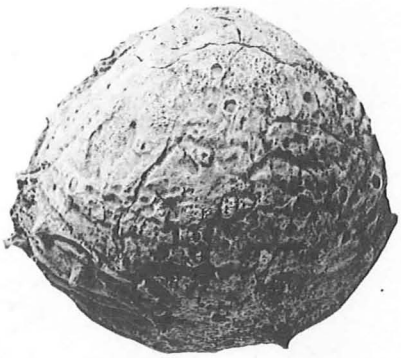
2

3

4

6

5

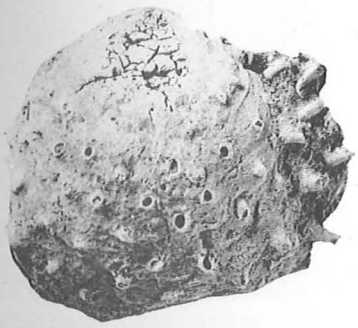


7

8

10

9



11

12

13

PLATE 2.

Spinatrypa aspera prideri (Coleman) 1951. .. .. Page 30

Figs. 1-10, all x 1 except 9 and 10, x 4.
Figs. 1-4.—Dorsal, ventral, lateral and anterior views (x 1) of a mature shell, CPC 3050
Figs. 5-8.—Dorsal, ventral, lateral and anterior views (x 1) of a senile shell, CPC 3051.
Figs. 9, 10.—Dorsal and lateral views (x 4) of a juvenile shell, CPC 3052.

Gneudna Formation, Carnarvon Basin.

Spiriferidae gen. et sp. ind. .. .. .. Page 31

Figs. 11a and 12a (x 1), 11b and 12b (x 3).
Figs. 11a, b.—Dorsal views (x 1, x 3) of CPC 3054.
Figs. 12a, b.—Lateral views (x 1, x 3) of CPC 3054.

Gneudna Formation, Carnarvon Basin.

Camarotoechia puteana sp. nov. .. .. .. Page 26

Figs. 13-22, all x 1.
Figs. 13-17.—Dorsal, ventral, lateral, anterior and posterior views of a gibbous shell, CPC 3057.
Figs. 18-22.—Dorsal, ventral, lateral, anterior and posterior views of the holotype, CPC 3055.

Gneudna Formation, Carnarvon Basin.

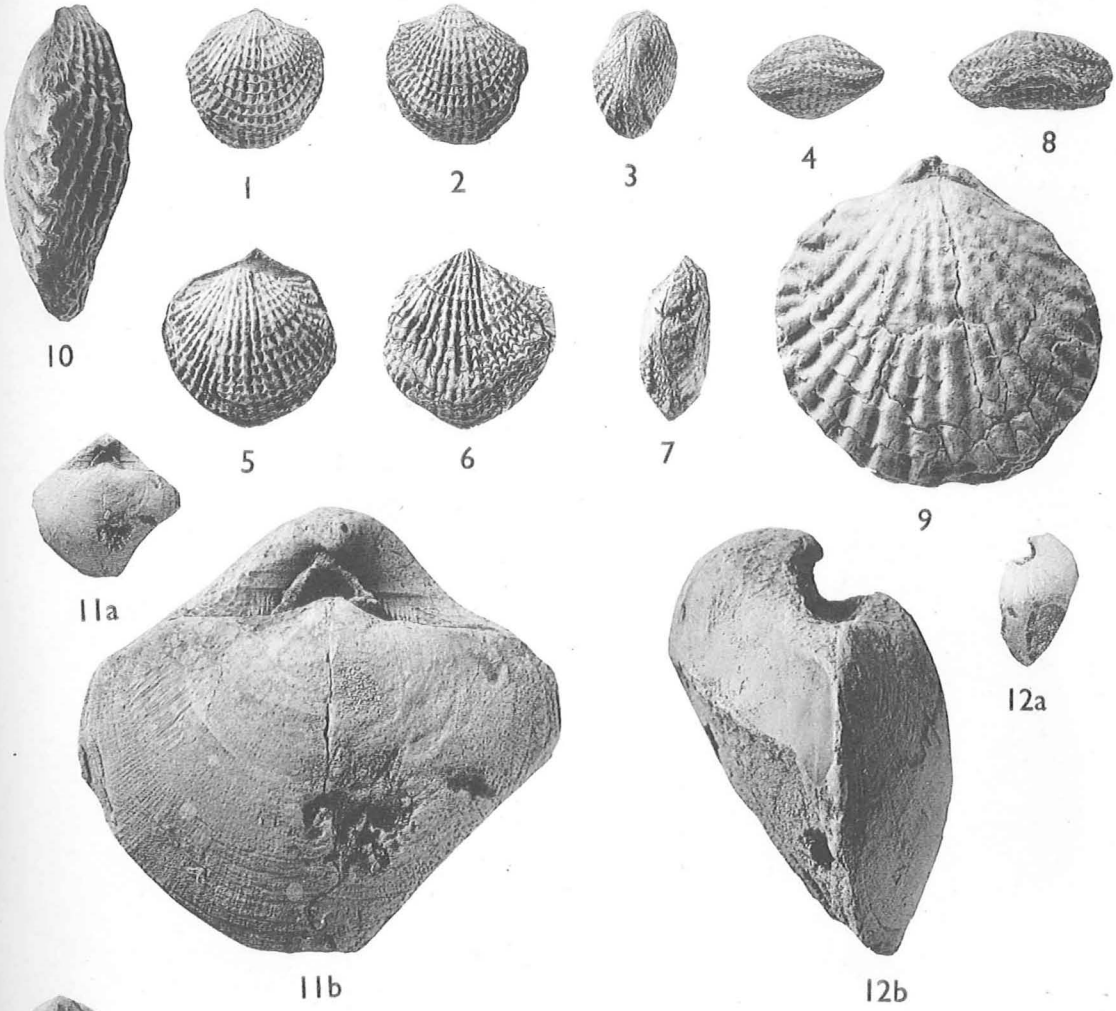
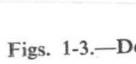

10
1
2
3
4
8
5
6
7
9
11a
11b
12a
12b
13
14
15
16
17
18
19
20
21
22

PLATE 3.

Camarotoechia puteana sp. nov. .. .. .. Page 26



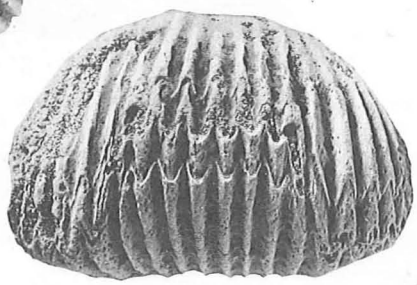
Figs. 1-3.—Dorsal, lateral and anterior views (x 4) of a juvenile shell, CPC 3056.
Gneudna Formation, Carnarvon Basin.

Camarotoechia eganensis sp. nov. .. .. .. Page 9

Figs. 4-7.—Dorsal, ventral, lateral and anterior views (x 4) of the holotype, CPC 3059.
Laurel Formation, Fitzroy Basin.

1

2



3

4

5

6

7

PLATE 4.

Camarotoechia septima sp. nov. .. .. .. Page 12

Figs. 1-15, 19, 21, all x 2.
Figs. 1-5.—Dorsal, ventral, lateral, anterior and posterior views of a silicified shell, CPC 3061.
Figs. 6-10.—Dorsal, ventral, lateral, anterior and posterior views of a larger silicified shell, CPC 3062.

(?) Spirit Hill Limestone, Sandy Creek, N.T.

Figs. 11-15.—Dorsal, ventral, lateral, anterior and posterior views of a silicified shell, CPC 3063.
Fig. 19.—Internal view of a silicified ventral valve, CPC 3065.
Fig. 21.—Internal view of a silicified dorsal valve, CPC 3064, showing the split hinge-plate.

Septimus Limestone, Mt. Septimus.

Camarotoechia sp. ind. II. .. .. .. Page 14

Figs. 16, 17, x 2.
Fig. 16.—External view of ventral valve, CPC 3066.
Fig. 17.—External view of dorsal valve, CPC 3067.

Camarotoechia amnica sp. nov. .. .. .. Page 11

Figs. 18, 20, 22-31, all x 2.
Fig. 18.—Internal view of a silicified dorsal valve, CPC 3070, showing the unsplit hinge-plate.
Fig. 20.—Internal view of a silicified dorsal valve, showing the split hinge-plate.
Figs. 22-26.—Dorsal, ventral, lateral, anterior and posterior views of a calcareous shell, CPC 3069.
Figs. 27-31.—Dorsal, ventral, lateral, anterior and posterior views of another calcareous shell, CPC 3071.

Moogooree Limestone, Williambury-Moogooree area, Carnarvon Basin.

Productidae gen. et. sp. ind. .. .. .. Page 16

Figs. 32-34.—Dorsal, ventral and lateral views (x 1) of CPC 3072.

cf. *Avonia proteus* Veevers 1959. .. .. .. Page 15

Figs. 35, 36.—Ventral and posterior views (x 1) of CPC 3073.

Burt Range Limestone, Bonaparte Gulf Basin.


1


2


3


4


5


6


7


8


9


10


11


12


13


14


15


16


17


18


19


20


21


22


23


24


25


26


27


28


29


30


31


32


33


34


35


36