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ANNALS

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INSTRUCTIONS TO AUTHORS

1. MATERIAL should be original and not published elsewhere, in whole or in part.

2. LAYOUT should be as follows:

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Number of illustrations (figures, enumerated maps and tables, in this order)
(b) *Abstract* of not more than 200 words, intelligible to the reader without reference to the text
(c) *Table of contents* giving hierarchy of headings and subheadings
(d) *Introduction*
(e) *Subject-matter* of the paper, divided into sections to correspond with those given in table of contents
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Only generic and specific names should be underlined to indicate italics; all other marking up should be left to editor and publisher.

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FISCHER, P.-H., DUVAL, M. & RAFFY, A. 1933. Études sur les échanges respiratoires des littorines. *Archs Zool. exp. gén.* **74**: 627–634.
KOHN, A. J. 1960*a*. Ecological notes on *Conus* (Mollusca: Gastropoda) in the Trincomalee region of Ceylon. *Ann. Mag. nat. Hist.* (13) **2**: 309–320.
KOHN, A. J. 1960*b*. Spawning behaviour, egg masses and larval development in *Conus* from the Indian Ocean. *Bull. Bingham oceanogr. Coll.* **17** (4): 1–51.
THIELE, J. 1910. Mollusca: B. Polyplacophora, Gastropoda marina, Bivalvia. *In:* SCHULTZE, L. *Zoologische und anthropologische Ergebnisse einer Forschungsreise im westlichen und zentralen Süd-Afrika* **4**: 269–270. Jena: Fischer. *Denkschr. med.-naturw. Ges. Jena* **16**: 269–270.

(*continued inside back cover*)

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CRETACEOUS TRIGONIIDAE (MOLLUSCA, BIVALVIA) FROM THE BRENTON FORMATION, KNYSNA

By

MICHAEL R. COOPER

Cape Town Kaapstad

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CRETACEOUS TRIGONIIDAE (MOLLUSCA, BIVALVIA) FROM THE BRENTON FORMATION, KNYSNA

By

MICHAEL R. COOPER

*Department of Geology, University of Oxford**

(With 12 figures)

[*MS. accepted 22 February 1979*]

ABSTRACT

The trigoniid fauna from the Brenton Formation at Knysna is described, and two new species, *Steinmanella kensleyi* and *Pterotrigonia savagei*, are erected. The age of the fauna is discussed and considered to support a late Valanginian age for the Brenton Formation.

CONTENTS

INTRODUCTION

Strata assigned to the Enon Formation of the Uitenhage Group crop out as a small outlier at Knysna, resting unconformably upon sandstones of the Ordovician Table Mountain Group (Fig. 1). Long regarded as Cretaceous, these sediments were recently assigned a Jurassic age (Dingle & Klinger 1972; Klinger *et al.* 1972). More recent information (Beer 1972; Stapleton & Beer 1976; McLachlan *et al.* 1976), however, would seem to confirm the early Cretaceous determination.

Fossils were first recorded from the Enon Formation of the Knysna–Plettenberg area in 1899 when Schwarz listed an *Ammonites* sp., *Trigonia* sp. and *Gervillia* sp., but without mentioning a locality. In 1906, Schwarz recorded a *Trigonia* sp. from Brentford Farm, Knysna, while Kitchin (1908), in his extremely important monograph of the Cretaceous invertebrate faunas of the Uitenhage basin, listed the following species collected by A. W. Rogers in 1905 from Brentford, Knysna: *Trigonia holubi?* sp. nov. (young individual), *Acanthodiscus* sp. and *Belemnites* sp. In 1909, Rogers recorded the following invertebrate fossils from Brentford or, as it is now known, Brenton-on-Lake: *Trigonia rogersi* Kitchin, *Nautilus* sp., *Ptychomya complicata* (Tate) 'or a shell like it', *Perna* sp., *Pentacrinus* sp. and *Cidaris* spines. Schwarz (1915) was the

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Fig. 1. Locality map, with the outcrop of the Brenton Formation hatched and arrowed. 1—Table Mountain Sandstone, 2—Enon conglomerate. After Dingle & Klinger (1972).

first systematically to describe a fauna from these beds when he recorded the new species *Trigonia kitchini* (= *T. rogersi* Rogers *non* Kitchin), *Perna brentonensis* and *P. theseni*.

In his description of some ammonites from the Sundays River Formation, Spath (1930) referred the ammonite recorded by Kitchin (1908) to *Distoloceras* sp. and the belemnite to *Hibolites* sp.

Dingle & Klinger (1972) gave the first detailed description of the Brenton Formation, including measured sections and a review of the older literature, as well as describing an ostracod assemblage to which Dingle assigned a low Upper Jurassic age (with strong Callovian affinities). Klinger *et al.* (1972) redescribed the ammonite recorded by Kitchin (1908) and Spath (1920), assigning it to *Hybonoticeras* aff. *hildebrandti* (Beyrich).

More recently, however, detailed studies of the foraminifera (Beer 1972; Rigassi & Dixon 1972; Stapleton & Beer 1976; McLachlan *et al.* 1976), ostracods (Stapleton & Beer 1976; McLachlan *et al.* 1976), nannofossils (Stapleton & Beer 1976) and palynomorphs (Stapleton & Beer 1976) have all been taken to indicate a Cretaceous, and more specifically, a Neocomian age.

Although not yet recorded from the Brenton Formation, *Megatrigonia* (*Megatrigonia*) cf. *conocardiiformis* (Krauss) occurs in sandstones interbedded in Enon conglomerates at Robberg (Du Toit 1954; Cooper 1974). The latter deposit, recently formally termed the Robberg Formation (Rigassi & Dixon 1972), is related by Cooper (1974) to the same marine transgression that deposited the Brenton Formation.

GEOLOGY

McLachlan *et al.* (1976) gave the following stratigraphic succession through the Brenton Formation, from above downwards:

(iv) Unit I —1–2 m of grey, unfossiliferous silty shale.

(iii) Unit II —0,15–1 m of hard, coarse-grained, conglomeratic sandstone rich in shell debris.

(ii) Unit III—About 15 m of unfossiliferous grey mudstone with sandy to gritty and sometimes pebbly layers.

(i) Unit IV—A highly fossiliferous, soft grey shale yielding fossiliferous calcareous nodules. This unit is at least 6 m thick.

According to McLachlan *et al.* (1976), units III and IV have yielded all the megafossils recorded by previous authors. However, the present collecting has shown *Iotrigonia* cf. *vau* (Sharpe), *Isognomon* sp., *Pterotrigonia savagei* sp. nov. and probably *P. kitchini*, together with cidaroid spines, oysters, reptilian and fossil wood to be present in unit II. Unit IV has yielded abundant *Steinmanella kensleyi* sp. nov., *I. theseni*, *I. brentonensis* and a '*Nautilus*' sp., together with numerous small, undetermined bivalves. The ammonite described by Klinger *et al.* (1972) is preserved in a nodule and almost certainly comes from this unit.

The prefix SAM refers to specimens housed in the collections of the South African Museum, Cape Town, AM to specimens in the Albany Museum, Grahamstown, and RO to specimens in the collections of R. Oosthuizen of Zwartskraal, Prince Albert.

SYSTEMATICS

Family **Trigoniidae** Lamarck, 1819

Subfamily Megatrigoniinae van Hoepen, 1929

Genus *Iotrigonia* van Hoepen, 1929

Type species *Iotrigonia crassitesta* van Hoepen, 1929

Iotrigonia cf. *vau* (Sharpe)

Figs 2–3

Compare

Trigonia vau Sharpe, 1856: 194, pl. 22 (fig. 5). Kitchin, 1908: 110, pl. 6 (figs 1–3).

Material

A single abraded specimen in the South African Museum with recrystallized test preserved, from unit II.

Description

The specimen is a poorly preserved right valve, but shows the chevrons on the flanks so typical of this genus. The anterior limb of the chevron is very narrow and directed obliquely across the flanks, while the posterior limb is

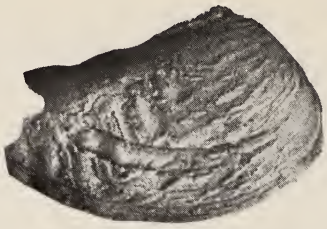

Fig. 2. *Iotrigonia* cf. *vau* (Sharpe).
Right valve. ×1.

broad and thick and directed strongly upwards (dorsally). The umbo is slightly recurved and situated about one-quarter of the shell length posteriorly. The marginal and inner carinae are not developed at the growth stages observed, while the area is ornamented by very faint growth striae.

Discussion

The Brenton example is closest to *I. vau* (Sharpe) (Fig. 3), and may well be conspecific; only the poor preservation of the Brenton specimen prevents the author from uniting them. '*Trigonia*' *dubia* Kitchin (Kitchin 1903) from the Oomia Beds of Kutch, southern India, closely resembles the present form, but differs in having the anterior limbs of the chevrons parallel to the concentric growth lines and not oblique as in *I. vau*.

Iotrigonia stowi (Kitchin) (Fig. 4) from the Sundays River Formation differs from *I. vau* in being more produced both posteriorly and anteriorly, and with a different sculpture pattern on the anterior portion of the flanks.

Other South African species of *Iotrigonia* are *I. crassitesta* van Hoepen (1929: 7, pl. 2 (figs 4–5), pl. 3 (figs 1–2)) (of which *I. inconstans* van Hoepen is a probable synonym) and *I. haughtoni* Rennie (1936: 340, pl. 41 (figs 1–4)), but none is liable to be confused with the present species.

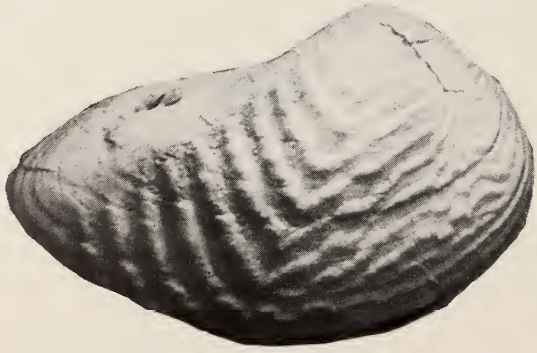

Fig. 3. *Iotrigonia vau* (Sharpe). Right valve of SAM-3976. ×1. This is the original of the specimen figured by Kitchin (1908).

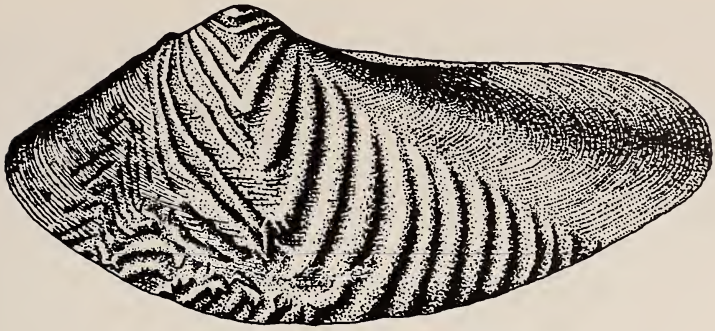

Fig. 4. *Iotrigonia stowi* (Kitchin).
The holotype, after Kitchin (1908). ×1.

Subfamily Pterotrigoniinae van Hoepen, 1929
Genus *Pterotrigonia* van Hoepen, 1929
Type species *Pterotrigonia cristata* van Hoepen, 1929

Discussion

Nakano (1974) considers the subfamily Pterotrigoniinae to include the following taxa: *Pterotrigonia* (*Pterotrigonia*), *P.* (*Rinetrigonia*), *Scabrotrigonia*, *Acanthotrigonia* (*Acanthotrigonia*) and *A.* (*Metacanthotrigonia*). However, within contemporaneous species populations there are intermediates between *Pterotrigonia* and *Rinetrigonia* and between *Acanthotrigonia* and *Scabrotrigonia*. Moreover, it is frequently difficult to place a species within any one of these genera/subgenera, and subsequently the author prefers to follow Cox (1969) in recognizing only *P.* (*Pterotrigonia*) and *P.* (*Scabrotrigonia*), to which may now possibly be added *P.* (*Metacanthotrigonia*).

Pterotrigonia (*Pterotrigonia*) *etheridgei kitchini* (Schwarz)
Fig. 5

Trigonia rogersi Rogers (*non* Kitchin), 1909: 130.
Trigonia kitchini Schwarz, 1915: 120, pl. 4 (figs 2–4). Pringle, 1960: 89.
non *Trigonia kitchini* Stoyanow, 1949: 82, pl. 14 (figs 4–10).

Material

The holotype, AM 3884, and a topotype example, SAM–D3067, are the only known specimens. Both retain recrystallized test and their preservation suggests that they may be from unit II at Brenton.

Description

The holotype shell is strongly inflated anteriorly and rostrate posteriorly. The umbones are strongly incurved and situated very close to the anterior face of the shell.

Fig. 5. *Pterotrigonia* (*Pterotrigonia*) *etheridgei kitchini* (Schwarz). Dorsal, anterior and lateral views of the holotype, AM 3884. ×1.

The flanks are ornamented by prominent ribs which, in the anterior set, are flexuous and curve forwards so as to terminate along the anterior and anteroventral commissure. The posterior set is straight, but there is no clear distinction between the two sets of ribs. Except for a few rather prominent tubercles at the ventral end of the two ribs terminating along the anteroventral margin, discrete tubercles are absent.

The area is bordered dorsally by a distinct inner carina and ventrally by a prominent marginal carina in the early stages, but both these features weaken with maturity. The area is ornamented only by concentric growth striae. The escutcheon is broad, concave, lanceolate, probably extending much of the length

of the dorsal margin of the shell, and is ornamented by irregular, closely spaced, transverse costellae which are finely serrated and more or less normal to the dorsal commissure.

Discussion

'Trigonia' kitchini closely resembles *'Trigonia' etheridgei* Lycett (1875: 127, pl. 27 (figs 1–3)) from the lowermost beds of the Atherfield Clay on the Isle of Wight, and thus of earliest Aptian age. It differs from Lycett's species only in having more transverse costellae on the escutcheon, and in having a few ventral tubercles on only two, not four, ribs. Schwarz's species is also of somewhat older age. However, the differences are so slight that the writer has no hesitation in regarding the two species as conspecific but, until the intraspecific variations in both populations are known, the slight differences are regarded as of subspecific value because of the somewhat different ages and the wide geographic separation of *P. etheridgei* and *P. kitchini*.

This species cannot be confused with any other South African form, but is most closely allied to *P.* (*P.*) *knighti* (Pringle) (1960: 90, pl. 1 (figs 1–3)) from the Sundays River Formation (late Valanginian). It differs in lacking coarse tuberculation along the whole length of the flank ribs.

Pterotrigonia savagei sp. nov. differs from *P. etheridgei kitchini* in being much less inflated anteriorly, more rostrate posteriorly, and with less strongly incurved umbones. There are also distinct, discrete tubercles along the ribs of the anterior set in *P. savagei*, while the transverse costellae ornamenting the escutcheon of *P. savagei* diverge anteriorly.

'Trigonia' kitchini Stoyanow (1949) is preoccupied by Schwarz's name and consequently requires a new name. The Arizonan species appears to be a *Buchotrigonia* closely allied to several other species from the same region and, until population studies are undertaken to determine the range of intraspecific variation amongst these forms, it seems unwise to propose a new specific name.

In view of the vast age difference, *P.* (*P.*) *evansana* (Meek) (Jones 1960: 436, pl. 59 (figs 6–7, 12, 15), pl. 60 (figs 1–11)) from the Coniacian to Lower Campanian of western North America bears a remarkable homoeomorphic resemblance to the present species (compare especially Jones 1960, pl. 60 (figs 6, 9)).

Pterotrigonia* (*Pterotrigonia*) *savagei sp. nov.
Fig. 6

Material

Four fragmentary specimens in the South African Museum, and eight examples in the collection of R. Oosthuizen. All retain recrystallized test.

Holotype

RO 375 (SAM–PCK 5927) is designated as the holotype, the remaining examples are paratypes.

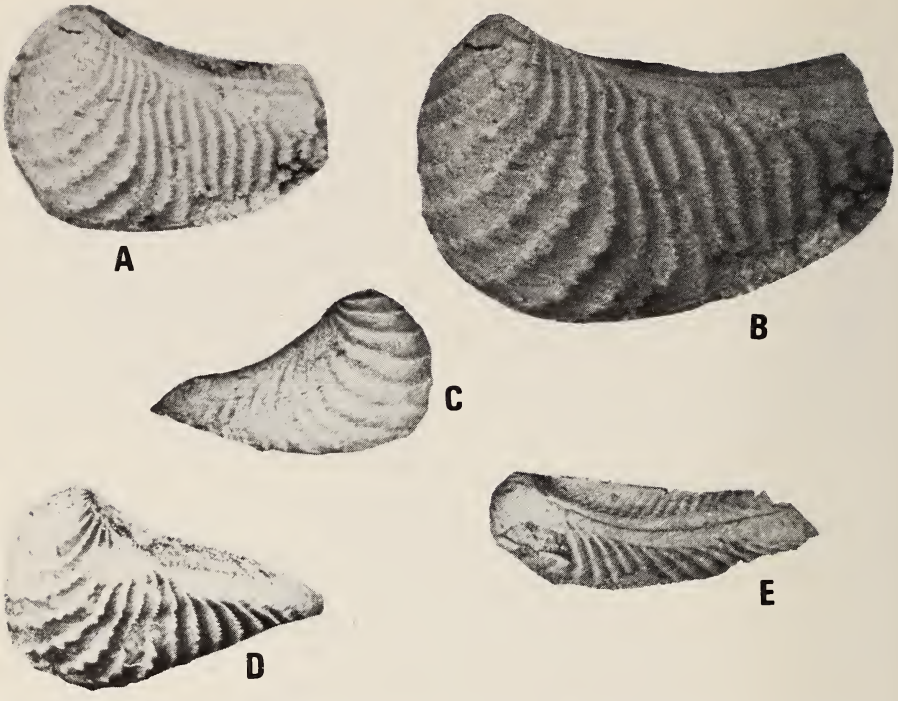

Fig. 6. *Pterotrigonia* (*Pterotrigonia*) *savagei* sp. nov. A. The holotype RO 375 (SAM-PCK 5927). ×1. B. RO 375. ×2. C–E. Paratypes in the collection of R. Oosthuizen. C. RO. 495–A (SAM–PCK 5929). D. RO 495–B (SAM–PCK 5930). E. RO 496 (SAM–PCK 5931). ×1.

Type locality

Brenton-on-Lake, Knysna. Unit II.

Etymology

For Dr N. M. Savage of the University of Oregon, Eugene, whose enthusiasm and keen interest did much to further the author's palaeontological career.

Diagnosis

A species of *Pterotrigonia* characterized by the weak inflation of the valves, the prominent inner carina during the early growth stages, the numerous well-developed flank ribs in which the tuberculate anterior set curves strongly forwards so as to terminate along the anterior and anteroventral margins of the shell. The posterior set of flank ribs are almost straight and finely serrated. Area ornamented only with growth striae and a prominent median longitudinal furrow. Escutcheon with finely serrated, closely spaced costellae which diverge anteriorly.

Description

The shell is weakly inflated anteriorly and strongly produced posteriorly. The umbones are moderately incurved and are situated a short distance posteriorly from the gently convex anterior margin. The nepionic stages are not clearly visible on any of the specimens, although there appear to have been concentric ribs on the flanks at this stage.

The flanks are ornamented with prominent ribs which are clearly divisible into an anterior and posterior set. The anterior set are crowded along the marginal carina (becoming more distantly spaced ventrally), from which they extend almost straight downwards before curving strongly forwards to terminate along the anterior and anteroventral margins. The ribs are initially finely serrated but immediately they start to curve forwards they thicken markedly and develop distinct tubercles. The posterior ribs are finely serrated throughout their length.

The area is ornamented only by transverse growth striae, while a deep, prominent median longitudinal furrow is present at the largest observed size (the holotype). The escutcheon is narrow, lanceolate, extending virtually the whole length of the dorsal margin of the shell. It is ornamented with closely spaced transverse ridges, serrated by the growth lines, which diverge anteriorly from the dorsal commissure.

Discussion

The present species is closest to *P.* (*P.*) *rogersi* (Kitchin) (Fig. 7) from the Lower Cretaceous (late Valanginian) of the Uitenhage basin. It differs, however,

Fig. 7. *Pterotrigonia* (*Pterotrigonia*) *rogersi* (Kitchin). Lateral view of the holotype (SAM–12954) in the South African Museum. ×1.

in being less inflated than *P. rogersi*, with more clearly demarcated anterior and posterior sets of ribs, while the anterior set curves more strongly forwards than in the Uitenhage example, and is more densely ribbed at a comparable growth stage.

Pterotrigonia jubata van Hoepen (1929: 11, pl. 4 (figs 7–10)) bears a superficial resemblance to *P. savagei*, but differs in being more strongly inflated anteriorly, more rostrate posteriorly and much higher, while the costellae ornamenting the escutcheon diverge posteriorly in Van Hoepen's species. Moreover, *P. jubata* is of much younger age (late Albian) and probably does not bear separation from the European *P. aliformis* (Parkinson).

Pterotrigonia savagei also bears a superficial resemblance to *Megatrigonia conocardiiformis* (Krauss) (Kitchin 1908: 119, pl. 7 (figs 2–4)), from which it may be distinguished by its small size, finely tuberculate ribs, prominent inner carina and ornamented escutcheon.

Subfamily Myophorellinae Kobayashi, 1954

Genus *Steinmanella* Crickmay, 1930

Type species *Trigonia holubi* Kitchin, 1908

Discussion

Four subgenera are currently recognized within Crickmay's genus; these are *S.* (*Steinmanella*), *S.* (*Yeharella*), *S.* (*Setotrigonia*) and *S.* (*Litschkovitrigonia*). Cox (1969) diagnosed *Steinmanella s.s.* as follows: 'Oblong to subtrigonal; area with strong irregular transverse ridges invading posteroventral part of the flank in some species; flank costae concentric near umbo, but oblique and tuberculate on most of the surface where they are either all continuous or become broken up and irregular anteriorly and ventrally.'

In *S.* (*Yeharella*) the carinae and transverse ridges are effaced across the area, while in *S.* (*Setotrigonia*) the flank costae extend on to the area, with a tendency for the carinae to become obsolete. In *S.* (*Litschkovitrigonia*) the nepionic growth stages are ornamented with V-shaped ribs which extend on to the area, while the later growth stages are more densely ribbed and with much weaker transverse ridges across the area. According to Cox (1969), *Steinmanella* is a wholly Cretaceous genus, and the Brenton species to be described below clearly belongs to this genus.

Steinmanella* (*Steinmanella*) *kensleyi sp. nov.

Fig. 8

Trigonia holubi? sp. nov. (young individual) Kitchin, 1908: 224.

Material

This species is abundant in the grey clays of unit IV of the Brenton Formation, but is extremely friable, so much so that of scores of fragmentary valves collected, only one complete specimen has been obtained. All the material retains recrystallized test.

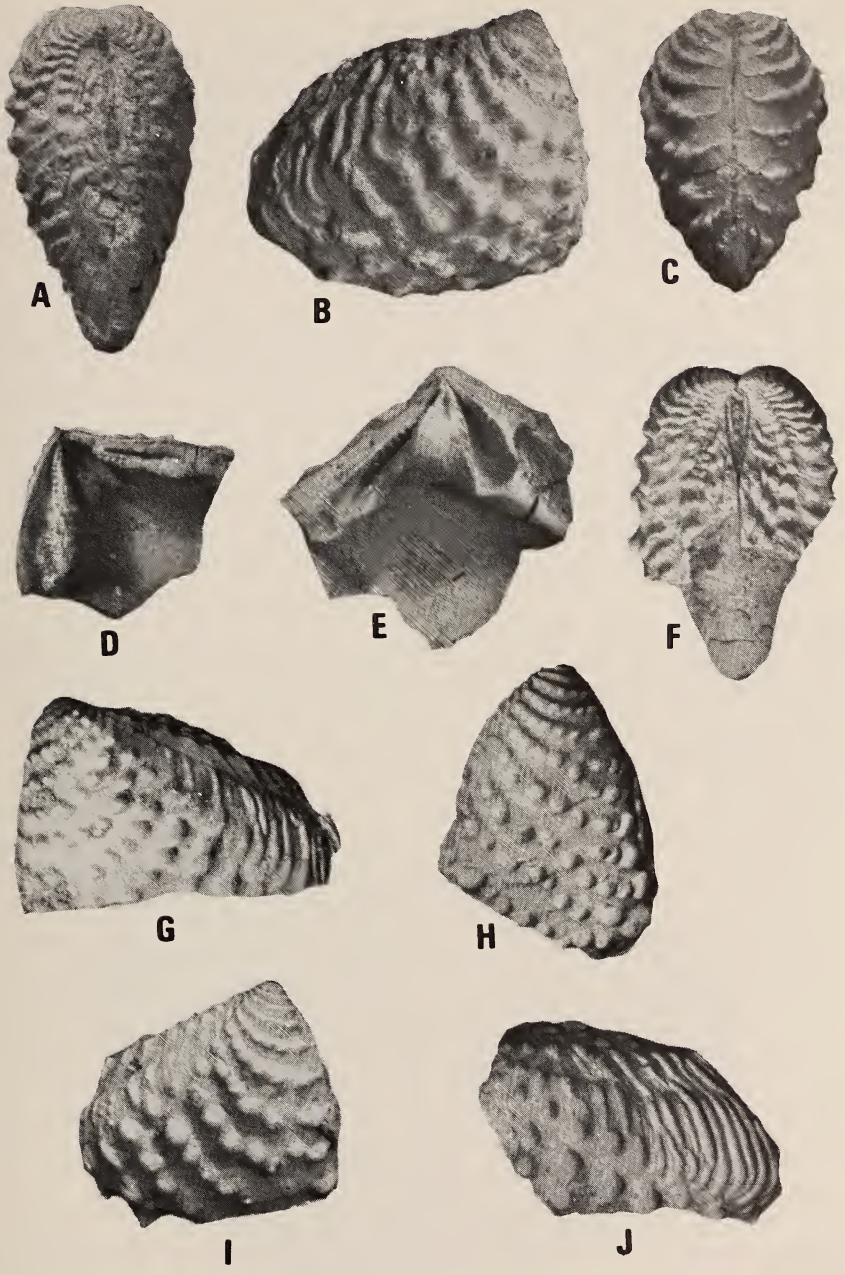

Fig. 8. *Steinmanella* (*Steinmanella*) *kensleyi* sp. nov. A–C. Dorsal, lateral and anterior views of the holotype RO 377 (SAM–PCK 5928). D. Cardinal area of right valve, RO 490. E. Cardinal area of left valve, RO 489. F. Dorsal view of a paratype, RO N24. G. Left valve of SAM–PCK 5922. H. Fragment of right valve, SAM–PCK 5293. I. Fragment of the area of a mature specimen, SAM–PCK 5924. J. Fragmentary right valve. All ×1.

Holotype

The original of the specimen figured in Figure 8A–C, in the R. Oosthuizen Collection, RO 377 (SAM–PCK 5928), is designated as holotype. Paratype and abundant topotype material is housed in the South African Museum (SAM–PCK 5922–5924).

Type locality

Brenton-on-Lake, Knysna. Unit IV.

Etymology

For Dr B. F. Kensley of the Smithsonian Institution, Washington, who assisted in collecting much of the material.

Diagnosis

A moderately small species of *Steinmanella* in which the anterior margin is abruptly truncate, vertical, with terminal umbones, and the posterior broadly rounded. The thick flank costae are ornamented with coarse tubercles and curve forwards so as to terminate mostly along the anterior margin of the valve.

Description

Shell moderately small, longer than high, massive, subtrigonal in outline, with weakly inflated valves. The anterior margin is abrupt, perpendicular, with weakly incurved terminal umbones.

The nepionic stage of the area is ornamented by prominent costae which are continuous with those on the flank, but soon break up to form three rows of tubercles—the ventral row corresponds with the marginal carina, the central row lies just below (ventral) the median longitudinal furrow and delimits the dorsal margin of the area, while the dorsal row corresponds with the inner (escutcheon) carina. Posteriorly, the central and dorsal rows of tubercles elongate to form prominent, irregular, transverse ridges, between which are intercalated additional costae. At large sizes, the median longitudinal furrow is very indistinct and marked only by a slight fold in the ribs crossing the area.

The escutcheon is moderately narrow and long, about two-thirds of the dorsal shell length, and is ornamented with irregular rows of anteroposteriorly elongated tubercles of uneven height. These rows of tubercles diverge at a small angle from the dorsal commissure and posteriorly are seen to be continuous with the transverse ridges across the area. The ligament pit is lanceolate and extends for about one-third of the length of the escutcheon.

In the nepionic stages, the flank ornament comprises well-developed, concentric, nodular costae which weaken considerably on the flattish anterior face of the valves, and are entirely effaced prior to reaching the anterior commissure. With growth, the costae weaken while the tubercles strengthen so as to dominate the ornament. The flank costae tend to be slightly narrower than the interspaces separating them, and most of them curve forwards so as to

terminate along the anterior margin of the shell. The flanks are ornamented with very fine growth striae which cut obliquely across the ribbing.

The teeth are typically trigoniid. The central tooth of the left valve is very prominent and robust, while the anterior tooth is weakly developed, thin, lath-like, and is directed almost vertically downwards. The prominent anterior tooth of the right valve is directed vertically downwards, and is supported on a thickened ledge of shell. The posterior tooth is weakly developed, lath-like, and meets the anterior tooth at an angle of about 60°.

Discussion

This species most closely approaches *Steinmanella mamillata* (Kitchin) (Fig. 9) from the Oomia Group of Kutch, southern India. Kitchin's (1903) species differs from *S. kensleyi*, however, in having a more quadrate outline, while most of the flank ribs terminate along the ventral margin of the shell. This distinction is confirmed by topotype material in the British Museum (Natural History). The differences are not great, but, in view of the greater age of the Indian species (Uppermost Tithonian or Berriasian), they are considered sufficient for specific separation.

The Brenton species is a close homoeomorph of the Aptian '*Trigonia*' *bronni* Agassiz, as is indicated by a specimen in the collections of the South African Museum (D1622) (Fig. 10), from Perte-du-Rhône, France. The French species has, however, a more convex anterior margin, twice as many tubercles in the marginal carina than there are flank ribs (in *S. kensleyi* they are almost equal), a more prominent median longitudinal furrow, and lacks the coarse tuberculation of the escutcheon seen in *S. kensleyi*. Moreover, the transverse

Fig. 9. *Steinmanella* (*Steinmanella*) *mamillata* (Kitchin). The holotype from the uppermost Tithonian or Berriasian of southern India. After Kitchin (1903). ×1.

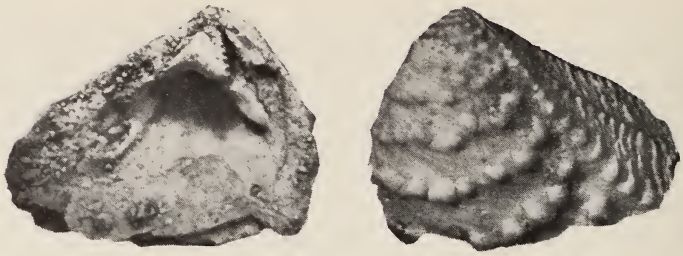

Fig. 10. *Myophorella bronni* (Agassiz). Left valve of SAM–D1622, from the Aptian of Perte-du-Rhône, France. ×1.

ridges across the area of *T. bronni* are far more weakly developed than in the Brenton species.

Steinmanella neuquensis (Burckhardt) (Fig. 11) also bears a close general resemblance to *S. kensleyi*. It differs, however, in lacking the fine concentric ribbing of the nepionic stages seen in the latter species, and in lacking the prominent tuberculation of the escutcheon. Furthermore, this Lower Cretaceous (Berriasian) South American species lacks the rows of tubercles demarcating the marginal and inner carinae, and the median longitudinal furrow of

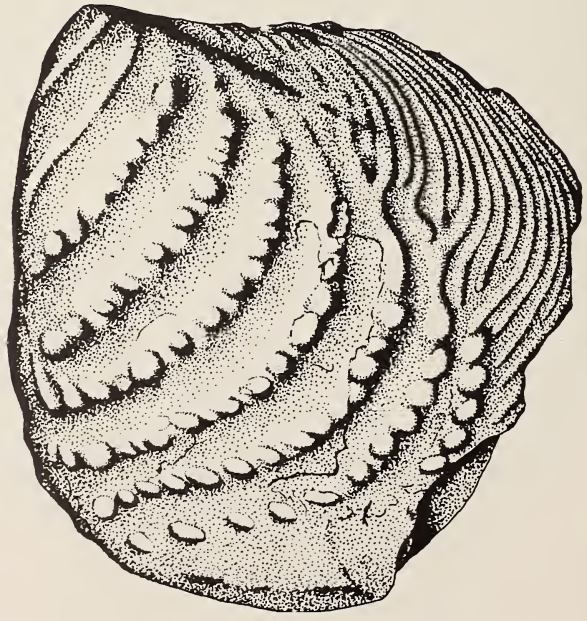

Fig. 11. *Steinmanella neuquensis* (Burckhardt). The holotype from the Berriasian of Argentina. After Burckhardt (1903). ×0,75.

S. kensleyi, while Burckhardt's species also has finer, more prominent transverse ridges across the area, which extend noticeably on to the flanks.

Steinmanella holubi (Kitchin) (Fig. 12) is a lower Cretaceous (late Valanginian) species which closely approaches *S. kensleyi*, but differs in being much larger, with a more quadrate outline, and in having most of the flank costae terminating along the ventral margin of the shell. *Steinmanella herzogi* (Goldfuss), *S. hennigi* (Lange) and *S. transitoria* (Steinmann) are all Neocomian forms which differ so greatly from the present species as not to warrant comparison.

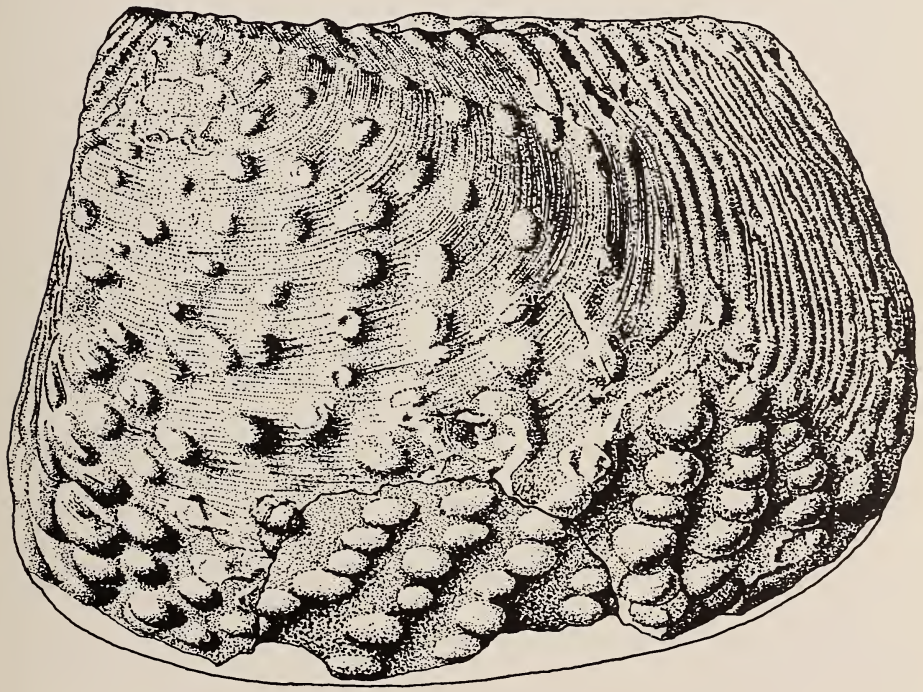

Fig. 12. *Steinmanella* (*Steinmanella*) *holubi* (Kitchin). The holotype from the uppermost Valanginian of south-east Africa. After Kitchin (1908). ×1.

AGE OF THE FAUNA

The marine succession at Brenton-on-Lake, Knysna, is of very limited thickness and unless there is considerable condensation, which has not been detected, it seems most unlikely that more than one stage is involved.

The ostracod fauna recorded by Dingle (*in* Dingle & Klinger 1972) came from unit IV of the Brenton succession and was considered to have strong

Callovian affinities, although the fauna was entirely new and hence such a determination can be regarded only as tentative. However, McLachlan *et al.* (1976) have recently revised the ostracod fauna which, together with the foraminifera, has been shown to have many species in common with the Sundays River Formation and is considered, therefore, to be of uppermost Valanginian age. This determination was supported by the studies of Stapleton & Beer (1976) who, on the basis of 50 species of palynomorphs, 5 species of calcareous nannofossil and 12 species of foraminifera, were led to correlate the Brenton Formation with the upper part of the Sundays River Formation, thereby suggesting a late Valanginian age. In addition to this, the presence of the foraminifera *Lagena hauteriviana hauteriviana* Bartenstein & Brand and *Tristix acutangulus* (Reuss) had led Beer (1972) to suggest an Hauterivian age for the Brenton Formation, whilst the presence of *Marginulina constantia* (Cushman) and *Citharina* cf. *cristellarioides* (Reuss) were used by Rigassi & Dixon (1972) to suggest a Cretaceous age for this unit.

Bate (1975) has recently described a Middle Callovian ostracod fauna from the Mandawa Anticline of Tanzania which supposedly includes two of the Brenton species, viz. *Cytherella knysnaensis* Dingle and *Cytherelloides brentonensis* Dingle. However, the Tanzanian record of *C. brentonensis* is based upon a single specimen which was said to differ from the holotype in lacking marginal dentition and it was perhaps premature, therefore, to assign it, without reservation, to Dingle's species. As regards species of *Cytherella*, Bate (1975) considered the carapace outline to be the most diagnostic feature, yet, in the author's opinion, *C. mandawaensis* Bate (1975, pl. 1 (figs 3–9)) is as close to the holotype of *C. knysnaensis* as is the example of *C. knysnaensis* figured by Bate (1975). Consequently, the writer is inclined to treat the above determinations with some scepticism.

From within a nodule, presumably from unit IV, came the ammonite referred by Kitchin (1908) to the Lower Hauterivian genus *Acanthodiscus* and by Spath (1930) to the Valanginian-Hauterivian genus *Distoloceras*. Klinger *et al.* (1972), however, assigned this specimen to *Hybonoticeras* aff. *hildebrandti* (Beyrich), for which they assigned a late mid-Kimmeridgian age, a determination surely influenced by Dingle's ostracod work.

The trigoniid fauna described herein is a typically Cretaceous assemblage, with neither *Steinmanella* nor *Pterotrigonia* being known prior to the uppermost Tithonian or Berriasian and, in view of the recent microfaunal evidence, provides strong support for a late Valanginian age for the Brenton Formation. This is enhanced by the presence of *Iotrigonia* cf. *vau* (Sharpe), a species known only from the uppermost Valanginian of the Uitenhage basin. Moreover, *Pterotrigonia etheridgei* (Lycett) is known only from the Neocomian to Aptian of southern England and also indicates a Cretaceous age for the Brenton Formation. It is perhaps also significant that the Robberg Formation, the deposition of which was related (Cooper 1974) to the same transgression that deposited the Brenton Formation, has yielded *Megatrigonia* cf. *conocardiiformis*

(Krauss) a species also known from the Sundays River Formation, although in this respect it should be noted that Da Silva (1966) has also recorded this species from the Jurassic of Mozambique and it is, therefore, long-ranging.

At present, the only problem as regards a late Valanginian age for the Brenton Formation and direct correlation with the Sundays River Formation is the determination of the ammonite fragment. This specimen is entirely septate and represents about one-quarter of a whorl which, according to Klinger *et al.* (1972), shows the following features: 'The whorl section is slightly depressed, subpolygonal. Simple primary ribs bear umbilical and large ventrolateral nodes from which ribs bifurcate or trifurcate and cross the venter with a distinct concave-adoral arch. An impression of the venter of the previous whorl is impressed in the dorsum of this fragment and shows a deep, fairly broad siphonal groove bordered by beaded keels.'

A possibly significant feature of this fragment, not mentioned by Klinger *et al.* (1972), is the two subparallel simple ribs at the adoral end of the fragment which have the appearance of the parabolic ribs which border constrictions in many species of ammonite. The genus *Neohoploceras* was introduced by Spath (1939: 105) for: 'rather inflated Neocomitids, with deep constrictions and rib-bundles, starting from umbilical tubercles and bearing lateral tubercles higher up, also single ribs without tubercles between, and specialized ribs, preceding the constrictions, and tuberculate each side of the smooth or grooved siphonal line. The lateral tubercle may disappear on outer whorl. Suture line fairly simple, with asymmetrical first lateral lobe.'

This generic diagnosis covers almost every feature shown by the Brenton ammonite fragment and, in view of the fact that *Neohoploceras* is a characteristic and abundant ammonite in the Upper Valanginian of Madagascar, as well as its occurrence in the Sundays River Formation, viz. *Neohoploceras subanceps* (Tate), together with the microfaunal and trigoniid evidence, the writer considers the determination of Klinger *et al.* (1972) to be incorrect. This fragment is best referred to, therefore, as *Neohoploceras* sp.

It would seem, therefore, that the Brenton and Robberg formations are further deposits whose deposition can be related to the late Valanginian episode of eustatic transgression (Cooper 1974, 1977).

SUMMARY

The trigoniid fauna from the Brenton Formation is described and fully corroborates recent microfaunal evidence for a Cretaceous age for the Brenton Formation. Although the trigoniids cannot be used precisely to date the deposit, the presence of *Iotrigonia* cf. *vau* (Sharpe) in the Brenton Formation and *Megatrigonia* cf. *conocardiiformis* (Krauss) in the Robberg Formation, the deposition of which was considered to be coeval with sedimentation of the Brenton Formation (Cooper 1974), certainly supports the late Valanginian age suggested by microfaunal evidence. The presence of the Kimmeridgian ammonite *Hybonoticeras* is considered to be based upon the misidentification of the late

Valanginian genus *Neohoploceras*. Two new species, *Steinmanella kensleyi* and *Pterotrigonia savagei*, are described, and the macrofaunal list from the Brenton Formation now reads:

Steinmanella (*Steinmanella*) *kensleyi* sp. nov.
Pterotrigonia etheridgei kitchini (Schwarz)
Pterotrigonia savagei sp. nov.
Iotrigonia cf. *vau* (Sharpe)
Isognomon theseni (Schwarz)
Isognomon brentonensis (Schwarz)
Neohoploceras sp.
Hibolites sp.
'*Nautilus*' sp.

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6. SYSTEMATIC papers must conform to the *International code of zoological nomenclature* (particularly Articles 22 and 51).

Names of new taxa, combinations, synonyms, etc., when used for the first time, must be followed by the appropriate Latin (not English) abbreviation, e.g. gen. nov., sp. nov., comb. nov., syn. nov., etc.

An author's name when cited must follow the name of the taxon without intervening punctuation and not be abbreviated; if the year is added, a comma must separate author's name and year. The author's name (and date, if cited) must be placed in parentheses if a species or subspecies is transferred from its original genus. The name of a subsequent user of a scientific name must be separated from the scientific name by a colon.

Synonymy arrangement should be according to chronology of names, i.e. all published scientific names by which the species previously has been designated are listed in chronological order, with all references to that name following in chronological order, e.g.:

Family **Nuculanidae**

Nuculana (*Lembulus*) *bicuspidata* (Gould, 1845)

Figs 14–15A

Nucula (*Leda*) *bicuspidata* Gould, 1845: 37.
Leda plicifera A. Adams, 1856: 50.
Laeda bicuspidata Hanley, 1859: 118, pl. 228 (fig. 73). Sowerby, 1871: pl. 2 (fig. 8a–b).
Nucula largillierti Philippi, 1861: 87.
Leda bicuspidata: Nicklès, 1950: 163, fig. 301; 1955: 110. Barnard, 1964: 234, figs 8–9.

Note punctuation in the above example:
comma separates author's name and year
semicolon separates more than one reference by the same author
full stop separates references by different authors
figures of plates are enclosed in parentheses to distinguish them from text-figures
dash, not comma, separates consecutive numbers

Synonymy arrangement according to chronology of bibliographic references, whereby the year is placed in front of each entry, and the synonym repeated in full for each entry, is not acceptable.

In describing new species, one specimen must be designated as the holotype; other specimens mentioned in the original description are to be designated paratypes; additional material not regarded as paratypes should be listed separately. The complete data (registration number, depository, description of specimen, locality, collector, date) of the holotype and paratypes must be recorded, e.g.:

Holotype
SAM–A13535 in the South African Museum, Cape Town. Adult female from mid-tide region, King's Beach Port Elizabeth (33°51′S 25°39′E), collected by A. Smith, 15 January 1973.

Note standard form of writing South African Museum registration numbers and date.

7. SPECIAL HOUSE RULES

Capital initial letters

(a) The Figures, Maps and Tables of the paper when referred to in the text
e.g. '. . . the Figure depicting *C. namacolus* . . .'; '. . . in *C. namacolus* (Fig. 10) . . .'

(b) The prefixes of prefixed surnames in all languages, when used in the text, if not preceded by initials or full names
e.g. Du Toit but A. L. du Toit; Von Huene but F. von Huene

(c) Scientific names, but not their vernacular derivatives
e.g. Therocephalia, but therocephalian

Punctuation should be loose, omitting all not strictly necessary

Reference to the author should be expressed in the third person

Roman numerals should be converted to arabic, except when forming part of the title of a book or article, such as
'Revision of the Crustacea. Part VIII. The Amphipoda.'

Specific name must not stand alone, but be preceded by the generic name or its abbreviation to initial capital letter, provided the same generic name is used consecutively.

Name of new genus or species is not to be included in the title: it should be included in the abstract, counter to Recommendation 23 of the Code, to meet the requirements of Biological Abstracts.

MICHAEL R. COOPER

CRETACEOUS TRIGONIIDAE (MOLLUSCA, BIVALVIA) FROM THE BRENTON FORMATION, KNYSNA