A NEW TRINUCLEID TRILOBITE FROM THE UPPER ORDOVICIAN OF NEW SOUTH WALES

by K. S. W. CAMPBELL *and* GWENDA J. DURHAM

ABSTRACT. The new genus and species of trinucleid trilobite *Parkesolithus gradyi* described herein is the first member of the family to be described from Australia though there have been occasional records of occurrences. It is found in Upper Ordovician siltstones near Parkes, New South Wales.

IN 1967 Dr. A. E. Grady discovered numerous specimens of a trinucleid trilobite in poorly outcropping black siltstones on the property of Mr. S. K. Mill, 'New Durran', approximately 15 miles W. of Parkes, New South Wales (grid reference 598899 Forbes 1:250 000 Topographical Sheet). Parkes is situated approximately 170 miles WNW. of Sydney. Ordovician rocks have been suspected to occur in the area for more than half a century (Andrews 1910). Recently an extensive Late Ordovician fauna of brachiopods, trilobites, ostracods, and conodonts has been discovered in the vicinity of the trilobite locality (Packham 1967). These have been recovered from an unnamed limestone that lies an unknown distance stratigraphically below the trinucleid-bearing siltstone. Packham has suggested that the limestone fauna is of late Wilderness age in terms of the American sequence, or Gisbornian in terms of the Australian graptolite sequence.

Associated with the trinucleids are a few poorly preserved brachiopods and numerous specimens of the graptolites *Orthograptus truncatus socialis* (Lapworth), *O. truncatus intermedius* Elles and Wood and *Climacograptus* cf. *scharenbergi* Lapworth. These indicate an Eastonian (Caradocian) age which is consistent with Packham's determination of the age of the under-lying limestone.

No trinucleids have been described previously from Australia. There are, however, various records of the group, for example 'a cryptolithid close to *Eirelithus*' from probable Middle Ordovician siltstones in Tasmania (Banks 1962), 'fragmentary trinucleids' in the limestone mentioned above from Parkes (Packham 1967), and *Trinucleus* from the Upper Ordovician Cliefden Caves Limestone and Malongulli Formation of central New South Wales (Packham *et al.* 1969, pp. 80–1).

The text-figure and the plate are the work of Mrs. J. A. Davis and Mr. L. Seeuwen respectively.

SYSTEMATIC DESCRIPTION

Family TRINUCLEIDAE Hawle and Corda 1847
Subfamily CRYPTOLITHINAE Angelin 1854
Genus PARKESOLITHUS gen. nov.

Type species. Parkesolithus gradyi sp. nov. from an unnamed formation in the Upper Ordovician, west of Parkes, N.S.W.

Diagnosis. Cephalon similar in shape to that of *Cryptolithus*; small eye tubercles present just medial to the highest point of the cheek and opposite the anterior edge of furrow 2p;

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glabella with furrow 1p formed of a double pit, and 2p and 3p almost imperceptible externally but forming distinct, strongly arcuate muscle areas internally; occipital ring sharply crested but not produced into a spine; glabella and cheeks unornamented; upper lamella with pit rows E_1, E_2, I_1, and I_4 (and usually I_2) continuous around the entire structure, and I_3 present laterally; regularity of pit rows lost on postero-lateral parts of fringe; a strong continuous list present between E_1 and E_2; lower lamella with very weak girder. Thorax with 6 segments. Pygidium subtriangular in outline; 8+ weak axial rings; 7+ pleural ribs weak but distinct; posterior border prominent and steep.

Remarks. We accept the subfamilial divisions of the Trinucleidae proposed by Whittington (1941) with the addition of the Hangchungolithinae of Lu. The shape of the glabella, the deep but small glabellar furrows 1p that are in close juxtaposition to the occipital furrow, the very weak furrows 2p, the virtual absence of the furrows 3p, the flat to gently concave dorsal fringe, and the absence of radial sulci on the fringe, all indicate that *Parkesolithus* is more closely related to the Cryptolithinae than any of the other subfamilies. Eye tubercles are not normal in members of this subfamily as it is at present constituted (Whittington *in* Moore 1959). We are not inclined to place much weight on this feature, however, since eye tubercles do occur in such genera as *Eirelithus* Lamont.

If, as most workers believe, the number of E rows of pits on the fringe is of fundamental taxonomic importance, *Parkesolithus* is closely related to *Broeggerolithus* Bancroft. However, there are considerable differences. The preglabellar fringe of *Broeggerolithus* has E_{1-2} and I_{1-2} complete; I_3 is introduced laterally and usually forms the innermost row, though I_4 is occasionally present inside it. In *Parkesolithus*, on the other hand, E_{1-2}, I_{1-2}, and I_4 are continuous in front of the glabella and I_3 is introduced between I_2 and I_4 antero-laterally (see discussion under the specific description for the identification of I_{3-4}). The two genera also differ in the following: the pronounced list between E_1 and E_2 on the upper lamella of *Parkesolithus* does not occur in *Broeggerolithus*; 2 p in *Parkesolithus* is deeper than in *Broeggerolithus*; the girder is much stronger in *Broeggerolithus*; the postero-lateral margin of the cephalon is turned back to form a large triangular genal angle in *Parkesolithus*, but is almost transverse in *Broeggerolithus*; the genal spines are directed obliquely outwards in *Broeggerolithus* but almost directly backwards in *Parkesolithus*. In our opinion these differences outweigh the similarity of the two E rows.

In the shape of the cephalon, glabella, genal spines, glabellar furrows, muscle scars, and pygidium *Parkesolithus* is closely comparable to *Cryptolithus*, but there are many differences in the fringe and girder structure. Typical species of *Cryptolithus* have a single E row, fewer complete I rows, new I rows introduced against the cheek rather than between existing rows, and a pronounced girder on the lower lamella. There are, however, species doubtfully assigned to *Cryptolithus* that have some features in common with *Parkesolithus*, the best known being *C.*? *bedinanensis* Dean (1967) from the Caradocian Bedinan Formation of Turkey. On the upper lamella of the fringe this species has a distinct list inside the outermost row of pits, and many specimens have four continuous rows of pits in front of glabella whereas most species of *Cryptolithus s.s.* have three. *Parkesolithus* has five. Furthermore, the insertion of new rows takes place antero-laterally between existing rows rather than against the cheek (Dean, pl. 4, figs.

4, 5, 6, 8). However, examination of the material convinces us that Dean was correct in interpreting the position of the girder as inside the outermost row of pits as is normal for *Cryptolithus*. His plate 3, fig. 7 tends to emphasize unduly the pseudogirders inside the girder proper. We are not inclined, therefore, to place *C.*? *bedinanensis* in *Parkesolithus* despite the above-mentioned similarities.

Parkesolithus gradyi sp. nov.

Plate III, figs. 1–15

Material. Holotype 21293; paratypes 21288–9, 21295a–b, 21301, 21304, 21306, 21308–10, 21315a–b, 21318a–b, 21321a–b, 21327a–c, 21328, 21331–4, 21337a–b. Geology Department, Australian National University Collection.

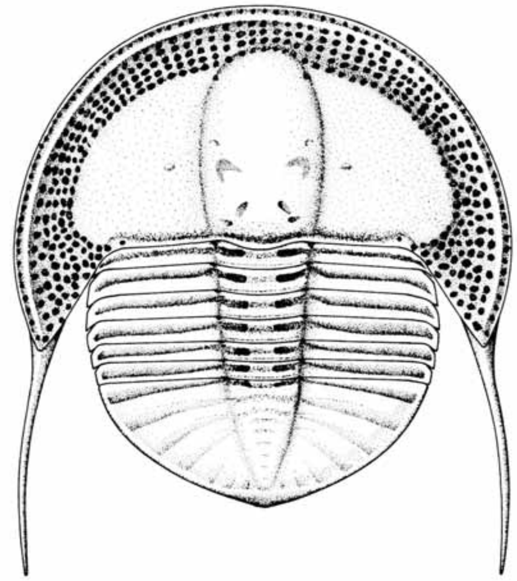
Description

Cephalon. Outline semicircular, approximately twice as wide as long (sag.); no accurate estimate of height available because of distortion; lateral margins at genal angle parallel and extend into genal spines which are faintly convex outwards and extend almost straight backwards; genal spines posterior to fringe approximately equal to median length of cephalon, unornamented and almost square in cross-section with a faint furrow along the ventral surface and an even fainter one along the dorsal surface; precise termination of spine not observed but spine tapers very gradually over its anterior three quarters and then more rapidly.

Ratio of length to width of glabella is approximately 3:2 (variation cannot be determined owing to crushing); outline expands slightly to 1p and then more rapidly, giving a mildly pyriform outline; greatest width and height located about two-thirds of the length of the glabella from the occipital furrow; anterior margin gently rounded and only slightly deflecting the continuous rows of pits on the fringe.

Occipital ring narrow and convex in posterior profile, sharply crested on the posterior half in sagittal profile; no occipital spine; axial furrow broad and shallow, deepening laterally into small occipital pits which are located inside the axial furrow; occiput considerably lower than the anterior portion of the glabella and about one-tenth of the length of the glabella. Glabellar furrow 1p of two pits lying in the same shallow depression on the lateral slope of the glabella; the more posterior pit moderately deep and circular medially but with a shallow antero-lateral extension, and situated immediately in front of the tiny occipital pit; the more anterior one is two or three times larger, shallower and oval in outline with the long axis directed antero-medially well up on the flanks of the glabella, the deeper posterior portion almost in contact with the posterior depression. 2p situated on the lateral slope of the glabella directly anterior to the oval depression of 1p, scarcely visible externally, but internally forming a shallow horseshoe-shaped ridge open posteriorly, the posterior extremities being slightly more prominent than the remainder. 3p a very faint comma-shaped depression on the slope of the glabella slightly more than midway along its length, the deeper part of the depression being higher on the slope of the glabella and the long axis pointing medially. All three pairs of depressions lie inside the axial furrow.

Axial furrows parallel, broad, shallow, and straight except for a slight curvature at the widest point of the glabella; anterior pits small and separated from the fringe by a low ridge. No ornament on the glabella and no median tubercle.



TEXT-FIG. 1. Reconstruction of *Parkesolithus gradyi* gen. et sp. nov.

Cheeks slightly convex with the highest point near the postero-lateral corner; cheeks distinctly lower than the glabella and slope away gently medially to the axial furrow and more steeply to the fringe; posterior border furrow moderately deep; a shallow extension of the posterior border furrow present a short distance along the posterior border beyond the fulcrum; most specimens with a tiny pit (separate from the fringe pits but probably one of them) in the triangular space between the posterior border, the posterior border furrow and the inner edge of the fringe (see Pl. 111, figs. 14–15).

EXPLANATION OF PLATE 111

Parkesolithus gradyi gen. et sp. nov.

Fig. 1. Latex cast of the first two thoracic segments; ×2; 21304 ANU.
Fig. 2. Latex cast of ventral surface showing the pleural tips and the broken apodemes; ×1·4; 21318a ANU.
Figs. 3 and 4. Latex cast of ventral surface showing complete apodemes; ×2 and ×4; 21301 ANU.
Fig. 5. Latex cast of dorsal surface; ×2; 21308 ANU.
Fig. 6. Latex cast of exterior of pygidium; ×3·5; 21332 ANU.
Figs. 7 and 8. Latex casts of dorsal surfaces of two cephala; 7 is a juvenile holaspid; ×5 and ×1·4; 21310 and 21334 ANU.
Fig. 9. Latex cast of dorsal surface cephalon; ×2; 21327a ANU.
Fig. 10. Mould of internal surface of thorax, pygidium and lower lamella; ×1·5; 21315a ANU.
Fig. 11. Latex cast of dorsal surface of thorax and pygidium, and ventral surface of lower lamella; ×1·5; 21315b ANU.
Fig. 12. Latex cast of dorsal surface of pygidium; ×1·9; 21289b ANU.
Fig. 13. Latex cast of ventral surface of cephalon showing lower lamella; ×1·6; 21309 ANU.
Figs. 14 and 15. Internal moulds of two cephala; ×1·5, ×2; 21295a and 21293 ANU.

Pair of small circular eye tubercles opposite the anterior edge of furrow 2p, on the inner slope of the cheeks *c.* one-quarter of the distance from the axial furrow to the fringe; no ornamentation on cheeks but extremely faint eye ridges extend from the eye tubercles anteromedially to the axial furrow opposite the 3p muscle scar on some specimens.

Posterior border short, highest along the sharp posterior edge and sloping gently forwards into the symmetrical posterior border furrow; border longer (exsag.) behind the first few pits on the fringe and then gradually fades away laterally; posterior border of fringe almost straight and inclined at an angle of 45° to posterior border of cheeks; articulatory furrow along posterior border very shallow, if present at all. Doublure on the occipital ring very short and with a slightly thickened edge.

Upper lamella of fringe. Anteriorly and antero-laterally fringe slopes gently down for half its width then turns up slightly, resulting in a gently concave fringe with the inner and outer margins being on the same level. Laterally and postero-laterally fringe less concave, especially its inner part which actually becomes convex and very steep near the posterior border, and is on a much higher level than the still slightly concave outer part; a prominent concentric ridge developed inside E_1 around the entire circumference except in the most posterior part of the genal angle where it fades out abruptly; fringe narrowest in front of the glabella; on all specimens E_1, E_2, I_1, and I_4 complete in front of glabella; on most specimens I_2 also complete; I_3 never complete and most anterior pits of this row inserted near the line of the axial furrow, i.e. about R_{4-7}; I_4 bent distinctly forwards in front of the glabella on all specimens, but I_2 only slightly distorted if at all. Anteriorly and antero-laterally pits radially arranged; three or four innermost rows usually arranged radially as far back as a line joining the eyes; in this region radial arrangement of pits sometimes gives a false impression of weak sulci; anterior radial rows straight, antero-lateral ones slightly arcuate. Laterally and postero-laterally, pits mostly irregularly arranged with many additional ones inserted. Normally ten pits present along the posterior border of the fringe. All pits approximately the same size but outermost row and innermost row smaller on some specimens.

Pit count (half-fringe)

Row	*No. of pits*	*Mean*	*No. of specimens*
E_2 (outermost row)	38–44	42	9
E_1 (first row inside ridge)	30–6	32	7
I_1—I_2	30–6	31	7

Other rows too irregular to count.

Lower lamella of fringe. Girder at very weak angulation, only slightly stronger than the weak pseudogirders on either side; girder continued down along genal spine as the inner ventral carina on some specimens (Pl. 111, fig. 13) but not on others (Pl. 111, fig. 11); outer ventral carina of the spine is a continuation of the outer fringe margin; no sign of any prominent ridge or furrow between E_1 and E_2 corresponding to the ridge on the upper lamella.

Thorax. Six segments in the thorax; axis tapers slightly towards the pygidium; axial furrow shallow, deeper at the back than the front of each segment giving a regular notched appearance; axial ring short (sag. and exsag.), axially one-third of the total length of the segment; ring rises steeply from the articulating furrow to a crest, immediately behind which is a shallow furrow that extends the full width of the ring.

Deep transverse slit-like apodemal pits set well in from the axial furrow with a slight depression on their outer and a much deeper one on their inner margin; apodemes set about mid-length on the segment; articulating furrow symmetrical with a uniform slope anterior and posterior and a well-rounded base; articulating half-ring on all segments short, on the anterior segment its anterior margin being almost transverse but on subsequent segments gently convex forwards; articulatory processes relatively short.

Pleurae of third and fourth segments *c.* 1·75 times as wide as the axis; anterior and posterior pairs slightly shorter than the middle pair; anterior pleurae shorter so as to fit against the posterior border of the cheeks and fringe of the cephalon. Anterior edges of the first pleural segment on opposite sides of fulcrum set at an angle of 45°; posterior edge also bends slightly posteriorly at fulcrum; pleural tip moderately sharp. On more posterior segments angulation of pleural tip progressively less pronounced; last segment with a blunt almost square pleural tip, a virtually straight posterior edge and an anterior edge with only a slight angulation close to the pleural tip. Fulcrum moves progressively outwards on more posterior segments and on the last one is almost at the extremity; pleural furrow on anterior segment of uniform length (exsag.) throughout, deepest at the axial furrow, shallowing laterally and then deepening again towards the pleural tip; furrow transverse between the axial furrow and the fulcrum, then curving posteriorly to terminate almost on the posterior edge of the pleural tip; furrows progressively broader and shallower on more posterior segments (and have progressively more rounded lateral terminations) until on the last segment the furrow occupies most of the segment surface. Posterior band on anterior segment lanceolate and flat-topped; on second segment of uniform length (exsag.) and sharp crested; on third segment unusually high and sharp crested and diminishing in size distally to fulcrum; and on segments four, five, and six, triangular in outline, rounded on top, and progressively shorter (exsag.).

Tips of pleurae downturned to form an almost vertical lateral doublure; no inflected ventral doublure present. Apodemes on all segments strong; all transverse and with a distinct swelling and ventral projection at their median end; some also with a much smaller lateral swelling.

Pygidium. Two to three times as wide as long depending on size (the larger are relatively wider) with subtriangular axis extending to the posterior margin; eight definite rings visible on the dorsal surface, and possibly one or two more on exceptionally well-preserved specimens, the more posterior ones being very faint; rings deflected forwards medially, the amount of deflection decreasing posteriorly; anterior ring furrows deepest laterally but longest sagittally, the most anterior one almost bisecting the anterior ring; on more posterior segments ring furrows visible only on the medial part of the axis; articulating half ring short but with a pronounced arcuate anterior outline. Axial furrow broad, shallow, and only slightly deepened opposite the ends of the more anterior ring furrows.

Anterior margin of the pleural regions of the pygidium straight and sharp; inner half of pleural region smooth and gently concave except on the most anterior segment where it is almost flat; outer half gently concave and rising to a sharp ridge on the posterior border; outside this ridge doublure widest and gently convex on either side of the axis, but more steeply sloping and progressively narrower postero-laterally and laterally, becoming vertical at the anterior end of the pygidium; line of border ridge arcuate but actual posterior margin of pygidium sub-triangular; axis meets border ridge posteriorly producing a gently rounded crest on the ridge; very fine terrace lines on the posterior doublure fading medially behind the axis.

Seven 'pleural ribs' readily distinguished; ribs clearly marked only in the outer half of the pleural field, straight to slightly curved in outline and symmetrically sloping front and back; ribs meet border ridge at their distal extremities but do not interrupt crest of ridge; extremely delicate interpleural furrows occasionally seen and cut obliquely across these 'pleural ribs' which are thus seen to be composed of the posterior band of a given segment adaxially and the anterior band of the next succeeding segment distally (see text-fig. 1).

Pair of deep apodemal pits in the first ring furrow set well in from the axial furrow; on each side of second ring furrow a pair of ovate, subequal, slightly raised muscle scars reach two-thirds of the distance to the median line from the axial furrow; on subsequent ring furrows outer scar of pair tends to maintain its size whereas the inner one gradually diminishes, but on most posterior furrows outer scar also diminishes rapidly; paired arrangement probably maintained right to posterior extremity; eleven pairs of scars (in addition to the apodemes) present on largest and most complete specimen.

Remarks. The material is all crushed to some extent so that it is difficult to determine the exact proportions of the various structures, or in many specimens such details as the pit arrangement on parts of the fringe. With regard to the latter character, however, enough specimens are known for us to be confident of the interpretation given above. We may have been unconventional in the way that we have interpreted the interruption of I_3 and the continuity of I_4 in front of the glabella. Some authors may prefer to interpret I_3 as continuous and I_4 as interrupted. In our opinion this would be unjustified since it is possible to consider the I_4 pits as forming a continuous, but gently flexed row in front of the glabella in all specimens, whereas continuity cannot be considered for I_3 without an angular change in direction of the row. But even more important is the fact that on some specimens, particularly 21321a–b, the pits of the I_3 row diminish in size towards the line of the axial furrow and the row wedges out between I_2 and I_4, the pits of which retain their normal size. It is also worth noting that on one specimen, 21328C, I_2 fails immediately in front of the glabella, but on nine others it appears to be complete.

The girder is variably developed but is always weak and virtually indistinguishable from the ridges on either side. It has been recognized by its continuity with the carina on the venter of the genal spine and/or by the slight change in slope of the lamella on its inner side. In most specimens there is no doubt about its recognition. Take, for example, the specimen figured on Plate 111, fig. 11. The carina on the genal spine does not continue strongly into any one of the ridges, though it could continue into the outermost ridge only by a distinct flexure. On the other hand, on the antero-lateral and anterior parts of the specimen the second ridge in from the margin marks a change in slope of the inner and outer parts of the lamella. The normal situation is shown on Pl. 111, fig. 13. In our opinion it is not possible to interpret any ridge other than the one inside the second row of pits as the girder on any of our specimens.

The radial arrangement of the pits which occurs on the anterior and antero-lateral parts of the fringe often does not extend across the E_1–E_2 ridge to row E_2, and on several specimens the pits of this latter row are definitely offset. The regularity of all rows tends to break down postero-laterally. Sometimes it is not possible to recognise even E_1, and occasionally there is an odd pit on the ridge between E_1 and E_2.

There may possibly be some doubt about our interpretation of the glabellar furrows and muscle scars. We have chosen to use the terminology 1p to 3p for these structures despite the fact that the anterior ones can scarcely be described as furrows. The occipital apodeme is very small and shallow and could easily be overlooked. The double structure in front of it that we have labelled 1p, is clearly the homologue of 1p together with the posterior muscle scar of Whittington's (1968) interpretation of *Cryptolithus*. Since in all other trinucleids on which the glabellar furrows are clearly defined they are three in number, and since the two pits in question lie more or less in the one depression, it seems unlikely that they represent separate glabellar furrows.

Finally, we have chosen to refer to the downturned edge of the pygidium and the corresponding parts of the pleural tips as the doublure rather than the border as is the usual practice. These parts carry terrace lines as is normal on the doublure; there is no completely inflected exoskeleton such as might be expected if the parts in question are really the border; and the sharp crest around the extremities of the pygidium corresponds with the border of other trilobites. It seems clear to us therefore that the doublure has been modified in shape to serve some special function in the trinucleoids.

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K. S. W. CAMPBELL
GWENDA J. DURHAM
Geology Department
Australian National University
Canberra, A.C.T.
Australia

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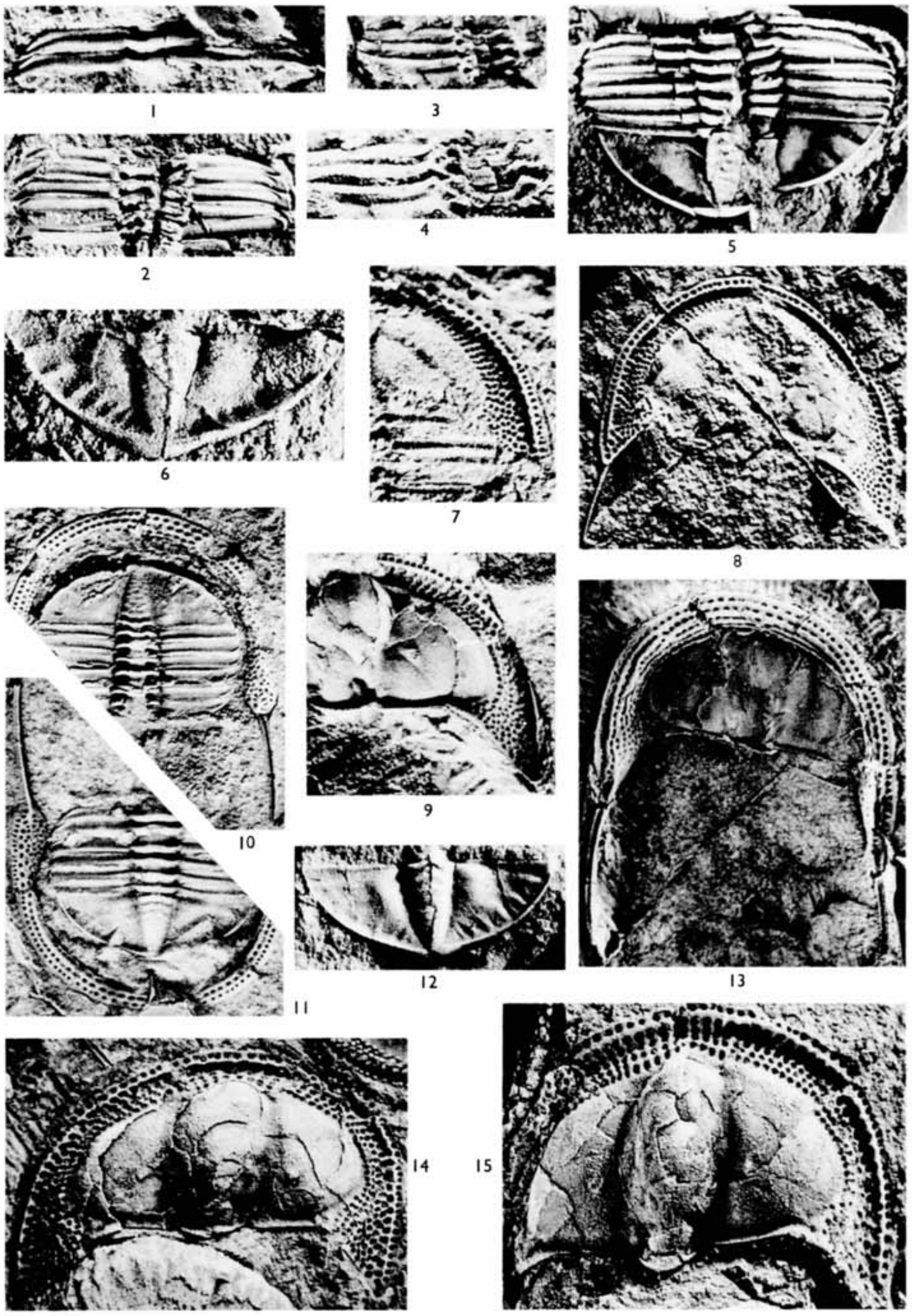

CAMPBELL and DURHAM, *Parkesolithus gradyi* gen. et sp. nov.