

Early Carboniferous (mid-Tournaisian) conodonts from north-eastern Queensland (Ruxton and Teddy Mountain Formations): age-implications and stratigraphic alignments

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ABSTRACT – *Conodonts from an interval with shales and minor carbonates low in the Ruxton Formation of the eastern Clarke River Basin, northeastern Queensland, indicate an age in the Early crenulata Zone. It thus aligns chronologically with the marine transgression into the Burdekin Basin (in the upper Hardwick Formation), with the lower unit of the Teddy Mountain Formation of the Broken River Province and Gray Creek-Stockyard Creek area and, presumably, with the indubitably marine interval within the Venetia Formation in the western Clarke River Basin.*

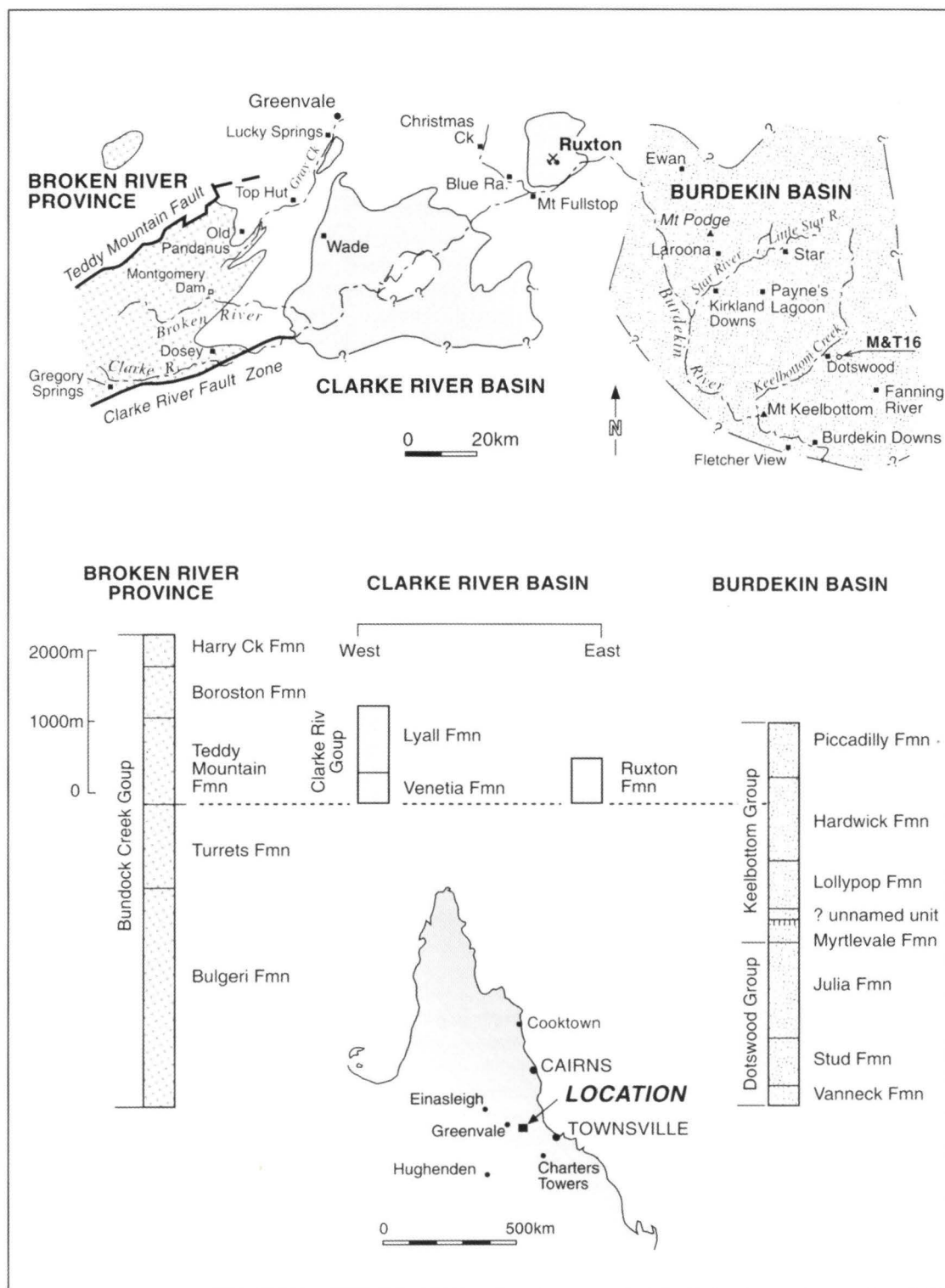
RIASSUNTO – [Conodonti del Carbonifero inferiore (Tournesiano medio) del Queensland nord-orientale (Ruxton e Teddy Mountain Formations): considerazioni cronologiche e correlazioni stratigrafiche] – *La parte inferiore della Ruxton Formation, affiorante nella parte orientale del bacino del fiume Clark (Queensland nord-orientale, Australia) è principalmente costituita da scisti, con alcuni livelli carbonatici. I conodonti estratti da queste rocce hanno consentito di datarle alla Early crenulata Zone (Carbonifero inferiore). Questi sedimenti sono quindi coevi con la trasgressione marina nel Burdekin Basin (nella parte alta della Hardwick Formation), con l'unità inferiore della Teddy Mountain Formation della provincia di Broken River e dell'area di Gray Creek-Stockyard Creek e probabilmente anche con l'intervallo sicuramente marino all'interno della Venetia Formation, nella parte occidentale del bacino del fiume Clark.*

INTRODUCTION

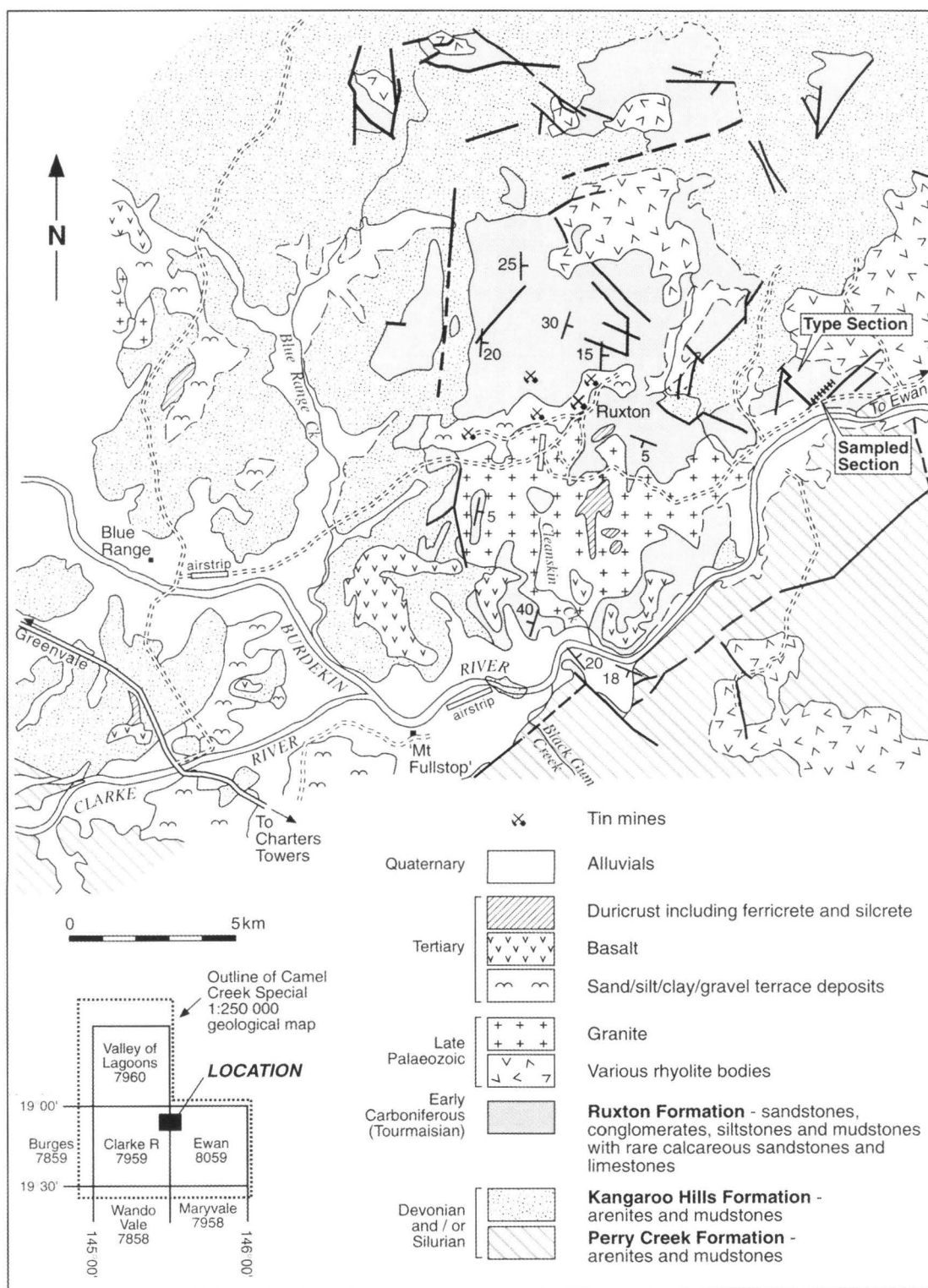
Very little palaeontologic data are available on Late Devonian/Carboniferous sequences of the Broken River Province and Clarke River Basin of northeast Queensland. Palynofloras have been documented from a cliff section forming the north bank of the Clarke River close to its junction with the Broken River and from two bores, Clarke River Nos 3-4R and 5 (Playford, 1986, 1988), a sparse conodont fauna from the Teddy Mountain Formation north of Montgomery Dam (Lang, 1985, 1986), and a report of Tournaisian (probably *sandbergi*-Early *crenulata* Zone) conodonts (Mawson & Talent, 1997) from an isolated tract of Teddy Mountain Formation (shown as Venetia Formation by Withnall & Lang, 1992) in the Stockyard Creek area south of Greenvale. A modicum of palaeontologic identifications of conodonts and macrofauna – brachiopods, solitary rugose corals, euomphalid and other gastropods, and rare trilobites – has been presented in an unpublished thesis on the Ruxton area (Edwards, 1977). Conodonts of “latest Devonian to earliest Carboniferous age” have been reported but not listed from “near the base” of the Ruxton Formation in the south-western part of its area of outcrop, east of ‘Blue Range’ (Fordham *in* Draper *et al.*, 1993, p. 210). Measurements of conodont colour-alteration indices and illite crystallinity from these areas are being presented elsewhere (Brime *et al.*, in prep.).

The palynofloras from the Clarke River Basin provided useful chronologic constraints for the specific cored intervals, but it was not clear when sedimentation was initiated in the Clarke River Basin and how this event may have aligned with transgressive events in the substantial Late Devonian-Early Carboniferous sequences in adjacent regions: the Burdekin Basin to the south and south-east (Draper & Lang, 1994; Mawson & Talent, 1997) and the Broken River Province to the west and northwest (Withnall & Lang, eds., 1993; cf. Text-fig. 1). As a contribution towards improved stratigraphic and chronologic alignments between these areas, conodont data are here presented from limestones in the Shield Creek outcrop-tract of Teddy Mountain Formation in the ‘Pandanus Creek’ area, and from thin carbonate intervals in a previously overlooked shale-siltstone sequence near the base of the Ruxton Formation east of ‘Blue Range’.

These data, considered in conjunction with conodont data from the Teddy Mountain Formation in the Broken River regions, and data presented previously from the Stockyard Creek area of ‘Lucky Springs’, near Greenvale, provide increased precision in stratigraphic alignments between the Devonian-Carboniferous sequences in the four areas. These data help date the downwarping that generated the Clarke River Basin *sensu stricto* in relation to events in the Burdekin Basin to the south-east and Broken River Province to the west. The data also establish the



Text-fig. 1 - Principal areas of Late Devonian-Carboniferous sedimentary sequences in the Townsville hinterland (after Mawson & Talent, 1997) showing suggested alignment of Teddy Mountain, Ruxton and Venetia Formations.



Text-fig. 2 - Geology in the vicinity of the junction of the Clarke and Burdekin Rivers, based on Withnall (1993), showing location of the type section of the Ruxton Formation and the section sampled for conodont data.

transgressive event with which the associated marine incursion might align in Devonian-Carboniferous sequences elsewhere in north-eastern Australia (Mawson & Talent, 1997). Additionally it provides chronologic underpinning for plant petrifications and trilobites presently being documented from this particular section.

Note: The Carboniferous zonal scheme used throughout is based on that proposed by Sandberg *et al.*, (1978). Conodont genera mentioned in the text and on Text-fig. 4 are abbreviated as follows: *Bi.* = *Bispathodus*; *Br.* = *Branmehla*; *P.* = *Polygnathus*; *Pr.* =

Prioniodina; *Ps.* = *Pseudopolygnathus*; *Si.* = *Siphonodella*. Conodonts figured on Plates 1-8 are housed in the collections of the Australian Museum, Sydney. Numbers of specimens, precise horizon, and other locality data for each sample can be obtained from Text-figs. 2-4.

STRATIGRAPHY

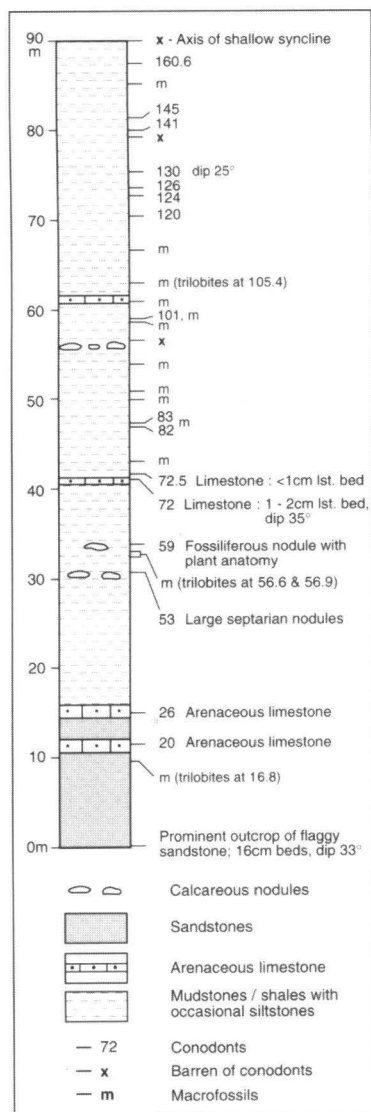
The Ruxton Formation consists of about 750 m of arenites and subordinate siltstones and mudstones resting unconformably on the flyschoid Silurian/Devonian Kangaroo Hills Formation, and non-conformably on an unnamed ?Late Devonian granitic intrusion. The Ruxton Formation is intruded by Late Carboniferous-Permian rhyolite and overlain by Tertiary basalt (Text-fig. 2). The basal sedimentary interval, the 'Unnamed Unit' of Draper *et al.* (1993, p. 203), consists of about 10 m of massive grain-supported pebble to cobble conglomerate with clasts derived from the unconformably underlying, tightly folded Kangaroo Hills Formation. It fines upwards to mudstone, is capped by conglomerate, and is overlain by about 7 m of white coarse to very coarse quartzose sandstone and pebbly sandstone, unit 1 of the Ruxton Formation *sensu stricto*. No fossils have been reported from the 'Unnamed Unit'.

Calcareous nodules and thin lenticular limestones and calcareous arenites are occasionally encountered in the Ruxton Formation, most notably in the shale-siltstone interval (Text-fig. 3) on which this report has focused – the lower half of Unit 2 of Draper *et al.* (1993). It occurs well exposed in a gully tributary to "Eastern Creek" parallel to and adjacent to the Blue Range-Ewan road (Text-figs. 2, 3). As well as yielding a diverse conodont fauna (Text-fig. 4), the limestones contain a rich macrofauna including numerous gastropods, bivalves and brachiopods; a number of trilobites have been recovered from the shale-siltstone horizons. The interval is indicated on the nearby type section of the Ruxton Formation (Draper *et al.*, 1993, fig. 66) as consisting of about 25 m of mudstone with carbonate nodules at its top, followed by about 200 m of section through "recessive topography, [with] minor float mudstone exposed in gullies", with one horizon indicated as having produced brachiopods, plant fragments and gastropods from silty limestone.

IMPLICATIONS OF NEW DATA

AGE OF UNIT 2 OF THE RUXTON FORMATION

The conodont fauna recovered from the RUR section (Text-fig. 4, Plates 1-8) is consistent with an age of Early *crenulata* Zone. Important elements in the fauna include: *Siphonodella crenulata* morph 1, *Si.*



Text-fig. 3 - Stratigraphic column through portion of lower part of the Ruxton Formation exposed in a gully parallel to the Blue Range-Ewan Road showing stratigraphic relationship of horizons sampled in and adjacent to the gully. See Text-fig. 2 for location of sampled section.

		RUR 20	RUR 26	RUR 53	RUR 59	RUR 82	RUR 83	RUR 101	Loose at RUR 120	RUR 124	RUR 126	RUR 130	RUR 141	RUR 145	RUR 160.6
<i>Bispathodus aculeatus aculeatus</i>	Pa		1		6	12	4	1	2	3		2	2	8	2
<i>Bi. spinulicostatus</i>	Pa				11	1			2	2	3		1		
<i>Bi. stabilis</i>	Pa		1		2	29	4	8	21	21	2	27	13	32	9
<i>Brammehla</i> sp.	Pa				8	3	3	1	3	2	3	1		3	3
<i>Pseudopolygnathus dentilineatus</i>	Pa					8		4				3		8	
<i>Ps. n.sp. cf. Ps. dentilineatus</i>	Pa					1			1						
<i>Ps. fusiformis</i>	Pa												1		
<i>Ps. marginatus</i>	Pa						1	2	2	4			2		8
<i>Ps. primus</i>	Pa				2	10		6	2	1		8	2	11	
<i>Pseudopolygnathus</i> sp. A					13	1			2	2	3		2		
<i>Polygnathus communis communis</i>	Pa						6	1						2	
<i>P. formicatus</i>	Pa						3	1	1	1		1		7	1
<i>P. inornatus</i>	Pa	1	1		13	12	15	6	5	1	2	6		20	3
<i>P. inornatus?</i>	Pa						1							1	
<i>P. longiposticus</i>	Pa					2	1	2		2			2	3	7
<i>P. rostratus</i>	Pa					5	1								2
<i>P. symmetricus</i>	Pa						1	3	1					2	2
<i>P. cf. symmetricus</i>	Pa				1										
<i>Polygnathus</i> n. sp. A	Pa					5	6		3		2	3	2	6	2
<i>Siphonodella crenulata</i>	Pa				1		1	4	7	2		10	1	2	1
<i>Si. cf. Si. crenulata</i>	Pa		1		3		1		4						2
<i>Si. isosticha-Si. crenulata</i>	Pa			1		1			1			1			1
<i>Si. lobata</i>	Pa					1		1							
<i>Si. obsoleta</i>	Pa				15	10			1		2				
<i>Si. quadruplicata</i>	Pa							1				1			
<i>Siphonodella</i> sp.	Pa						3	6							
<i>Prioniodina</i> sp.	Pa					1								1	
	Pb					4								2	1
	M					1									1
	Sa					2			2			3		7	3
	Sb					2		1	1			3	2	3	
	Sc	1			1	8	2	3	4	5	2	8	3	23	6
	Sd													1	
Apparatus A	Pa					4									
	Pb					3	1	2	2	1		5	2	4	3
	M					3		1	1	1		1	1	2	2
	Sa													3	
	Sb							1						1	
	Sc					2		1	1	3		1			2
Apparatus B	Pa					2									
	Pb					4	1			1	1			1	
	M											1	1	1	1
Siphonodellid apparatus	Pb					5									
	M					3									
	Sa					5									
	Sb					2									
	Sc					5									
Gen. et. sp. indet.	?													1	
Undetermined elements	Pa				4		4	3	2	1	1	4	1	4	3
	Pb				4	17	9	2	3	4	4	5		19	11
	M		1		3	7	5	1	5	5	2	5	2	14	8
	Sa				1	42	1		1				2	1	
	Sb					3	2	2	2	2	1	5	3	8	10
	Sc	2	2		9	2	27	6	9	14	7	10	23	49	24
Zone		<i>sandbergi</i> or <i>E. crenulata</i>		Early <i>crenulata</i>											

Text-fig. 4 - Distribution of conodont elements in the Ruxton Formation exposed in a gully parallel to the Blue Range-Ewan Road. See Text-fig. 2 for location of sampled section and Text-fig. 3 for location of samples.

obsoleta, *Si. quadruplicata*, *Bispathodus aculeatus aculeatus*, *Bi. stabilis*, *Pseudopolygnathus marginatus*, *P. primus*, *Polygnathus fornicatus*, *P. inornatus*, and *P. longiposticus*. Additionally, other faunal elements occurring in small numbers include: *Si. sp. cf. Si. crenulata*, *Si. lobata*, *Ps. dentilineatus*, *Ps. fusiformis*, *P. communis communis*, *P. rostratus*, *P. symmetricus* and *Prioniodina sp.*

Twenty metres above the base of the RUR section, the first limestone horizon yielded a sparse, non age-diagnostic fauna (Text-fig. 1). Six metres above this, in horizon RUR 26, the siphonodellid, *Si. cf. Si. crenulata* gives the first indication of an age of Early *crenulata* Zone. As *Si. crenulata* morph 1 occurs from RUR 59 to the top of the section, RUR 160.6 (Text-fig. 1), and a number of species occurring throughout the section such as *Bi. aculeatus aculeatus*, *Ps. dentilineatus*, *Ps. primus*, *P. rostratus*, are not usually found in horizons younger than Early *crenulata* Zone, it appears that most of the section was deposited during this time. The first 26 m of section, however, could be older, low in the Early *crenulata* Zone or perhaps late in the *sandbergi* Zone. Lack of age-diagnostic conodonts precludes definite assignment.

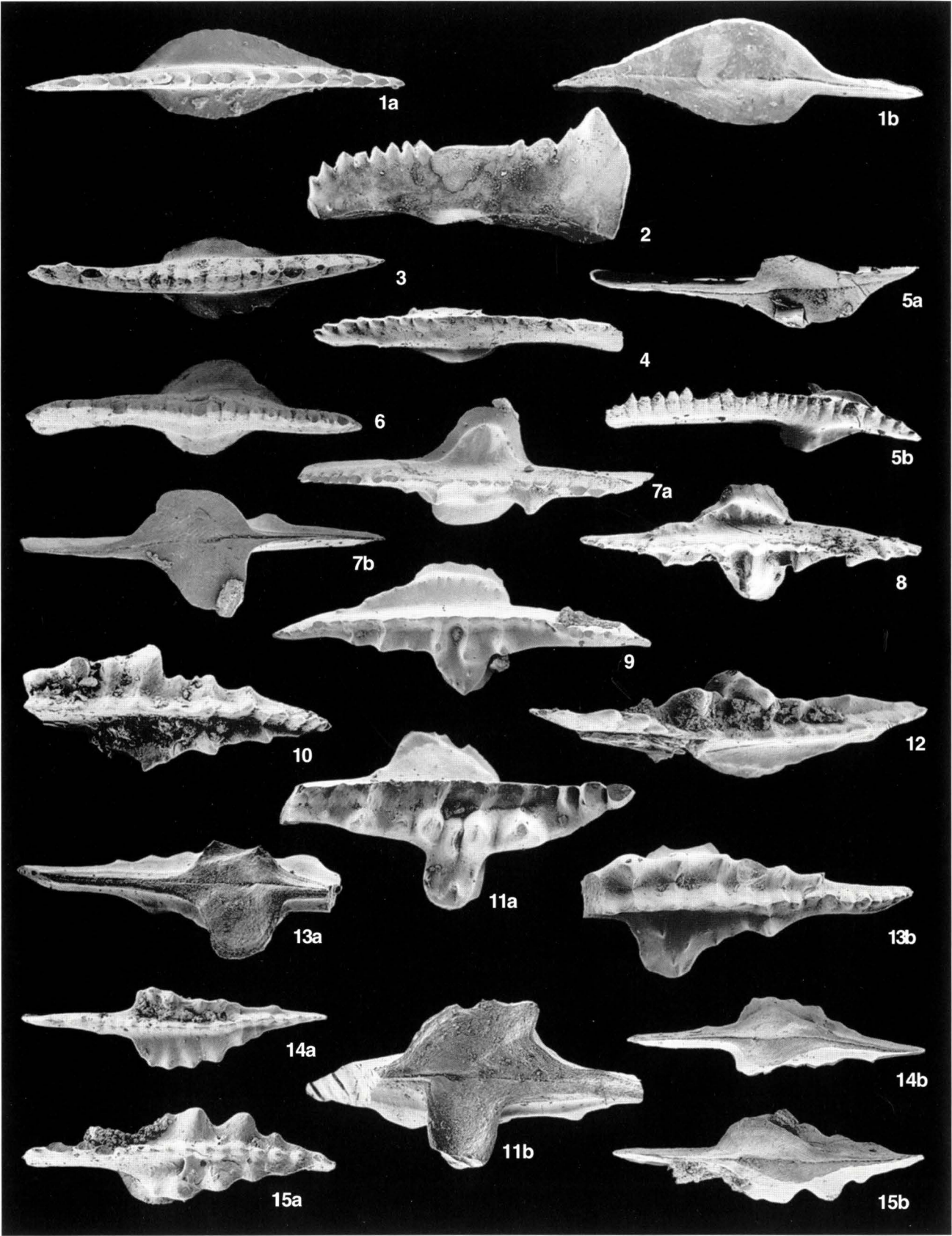
Conodonts from the lower part of the Ruxton Formation are thus broadly consistent with an age not older than Early *crenulata* Zone. The Ruxton Formation thus aligns stratigraphically with the lower part of the Venetia Formation in the Gray Creek area of the western Clarke River Basin, the upper part of the Hardwick Formation of the Burdekin Basin (Mawson & Talent, 1997), and possibly the lower part of the Teddy Mountain Formation of the Broken River Province (Text-fig. 1). Inauguration of the Clarke River Basin by regional subsidence thus appreciably post-dated similar events in the Broken River Province and the Burdekin Basin (cf. Mawson & Talent, 1997).

COMPOSITION OF THE FAUNA AND POSSIBLE DEPOSITIONAL ENVIRONMENT

Of the 626 platform elements in the fauna from the RUR section, 39% are species of *Bispathodus*, 30% are species of *Polygnathus*, 17% are species of *Pseudopolygnathus* and 14% are species of *Siphonodella*. As siphonodellids are normally found in a basin environment (Austin & Barnes, 1973; Austin, 1976; Johnston & Higgins, 1981, Austin & Davies, 1984), and polygnathids and pseudopolygnathids are also considered to inhabit an off-shore environment (Austin, 1976; Austin & Davies, 1984), the high percentage of bispathodids in the fauna appears enigmatic as according to many authors (e.g. Varker & Higgins, 1979; Johnston & Higgins, 1981; Austin & Davies, 1984), these usually occur in near-shore environments. Sandberg (1976) and Sandberg & Gutschick (1984), however, suggest pseudo-polygnathids inhabited the upper and middle foreslopes and that bispathodids may have inhabited near-surface water layers and thus could be recovered in both near-shore and off-shore situations. Austin & Davies (1984) suggested that *Polygnathus inornatus* similarly dwelt in the near-surface water layer. If this is so, this polygnathid (making up 15% of the fauna) and the bispathodids (39% of the fauna) account for more than half (54%) the total fauna suggesting the food-rich, well oxygenated surface waters essential for their success, were, perhaps, more closely allied to a slope environment, rather than a deep basinal situation. High energy events could account for the substantial number of siphonodellids being swept in from deeper waters. Such events would also explain why very few non-platform siphonodellid elements are represented in the fauna as these are more fragile than the Pa elements and therefore more prone to breakage in rough

EXPLANATION OF PLATE 1

- Figs. 1-6 - *Bispathodus stabilis* (Branson & Mehl, 1934).
 1) a: upper view, b: lower view; RUR 83, x 90, AMF 105328;
 2) lateral view; RUR 160.6, x 60, AMF 105329;
 3) upper view; RUR 160.6, x 60, AMF 105330;
 4) upper view; RUR 126, x 75, AMF 105331;
 5) a: lower view, b: upper view; RUR 160.6, x 45, AMF 105332;
 6) upper view; RUR 126, x 60, AMF 105333.
- Figs. 7-8 - *Pseudopolygnathus sp. A*.
 7) a: upper view, b: lower view; RUR 59, x 75, AMF 105334;
 8) upper view; RUR 141, x 45, AMF 105335;
- Fig. 9 - *Pseudopolygnathus n. sp. cf. Ps. dentilineatus* E.R. Branson, 1934. Upper view; RUR 82, x 45, AMF 105336.
- Fig. 10 - *Pseudopolygnathus dentilineatus* E.R. Branson, 1934. Upper view; RUR 141, x 60, AMF 105337.
- Figs. 11 - *Pseudopolygnathus sp. A*. a: upper view, b: lower view; RUR 59, x 60, AMF 105338.
- Fig. 12 - *Pseudopolygnathus n. sp. cf. Ps. dentilineatus* E.R. Branson, 1934. Upper view; RUR 120, x 45, AMF 105339.
- Figs. 13 - *Pseudopolygnathus dentilineatus* E.R. Branson, 1934. a: lower view; b: upper view; RUR 59, x 60, AMF 105340.
- Figs. 14-15 - *Pseudopolygnathus primus* Branson & Mehl, 1934b.
 14) a: upper view; b: lower view; RUR 82, x 45, AMF 105341;
 15) a: upper view; b: lower view; RUR 120, x 45, AMF 105342.



EXPLANATION OF PLATE 2

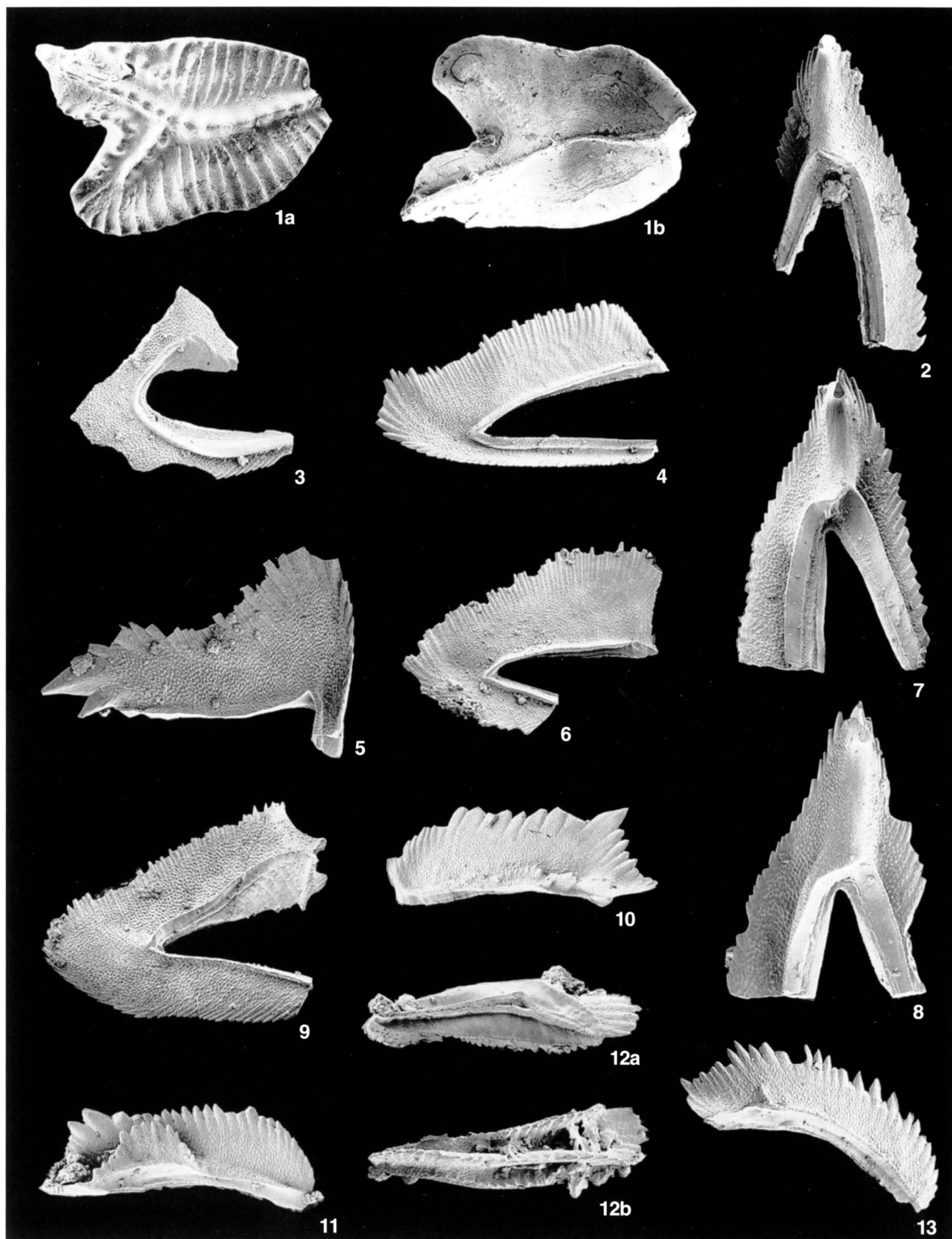
- Figs. 1-2 - *Siphonodella lobata* Branson & Mehl, 1934.
 1) a: upper view of Pa element; b: lower view of Pa element; RUR 101, x 45, AMF 105343;
 2) lateral view of M element; RUR 82, x 45, AMF 105344.
- Figs. 3-13 - *Siphonodellid* apparatus.
 3) lateral view of Sb element; RUR 82, x 30, AMF 105345;
 4) lateral view of Sc element; RUR 82, x 30, AMF 105346;
 5) lateral view of Sb element; RUR 82, x 45, AMF 105347;
 6) lateral view of Sa element; RUR 82, x 30, AMF 105348;
 7) lateral view of Sa element; RUR 82, x 45, AMF 105349;
 8) lateral view of Sa element; RUR 82, x 60, AMF 105350;
 9) lateral view of Sa element; RUR 82, x 45, AMF 105351;
 10) lateral view of Pb element; RUR 82, x 45, AMF 105352;
 11) lateral view of Pb element; RUR 82, x 45, AMF 105353;
 12) a: lower view of Pb element; b: upper view of Pb element; RUR 82, x 45, AMF 105354;
 13) lateral view of Pb element; RUR 82, x 45, AMF 105355.

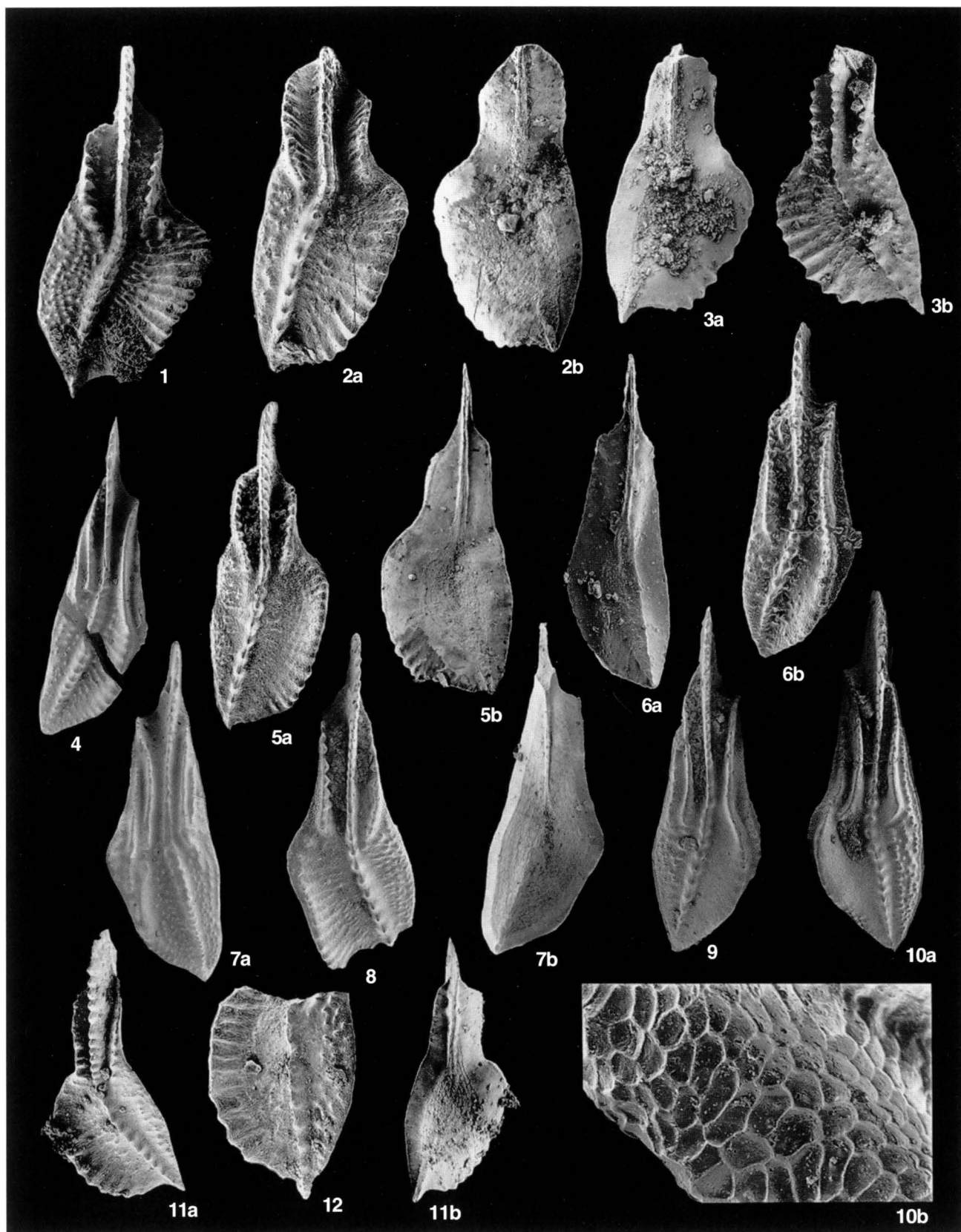
EXPLANATION OF PLATE 3

- Figs. 1-3, 5, 8, 11-12 - *Siphonodella crenulata* (Cooper, 1939) morph 1.
 1) upper view; RUR 83, x 45, AMF 105356;
 2) a: upper view; b: lower view; RUR 130, x 60, AMF 105357;
 3) a: lower view; b: upper view; RUR 160.6, x 45, AMF 105358;
 5) a: upper view; b: lower view; RUR 101, x 60, AMF 105360;
 8) upper view RUR 101, x 60, AMF 105363;
 11) a: upper view; b: lower view; RUR 124, x 45, AMF 105366;
 12) upper view of broken specimen; RUR 124, x 60, AMF 105367.
- Figs. 4, 6-7, 9-10 - *Siphonodella obsoleta* Hass, 1959.
 4) upper view; RUR 59, x 45, AMF 105359.
 6) a: lower view; b: upper view; RUR 82, x 60, AMF 105361;
 7) a: upper view; b: lower view; RUR 59, x 30, AMF 105362;
 9) upper view; RUR 82, x 45, AMF 105364;
 10) a: upper view; RUR 82, x 30; b: enlargement of portion of upper view of AMF 105365; x 720.

EXPLANATION OF PLATE 4

- Figs. 1, 4 - *Siphonodella quadruplicata* (Branson & Mehl, 1934).
 1) upper view; RUR 101, x 30, AMF 105368;
 4) a: upper view; b: lower view; RUR 130, x 30, AMF 105371.
- Figs. 2, 3, 7 - *Siphonodella* sp. cf. *S. crenulata* (Cooper, 1939).
 2) lower view; RUR 160.6, x 60, AMF 105369;
 3) upper view; RUR 160.6, x 60, AMF 105370;
 7) upper view; RUR 26, x 75, AMF 105374.
- Fig. 5 - *Siphonodella obsoleta* Hass, 1959. Upper view; RUR 59, x 60, AMF 105372;
 Fig. 6 - *Siphonodella isosticha* (Cooper, 1939). a: lower view of transitional form; b: upper view of transitional form; RUR 130, x 60, AMF 105373.
- Figs. 8 - *Polygnathus rostratus* Rhodes, Austin & Druce, 1969. a: upper view; b: lower view; RUR 160.6, x 60, AMF 105375.
 Fig. 9 - *Polygnathus* sp. A. Upper view; RUR 120, x 105, AMF 105376.
 Fig. 10 - *Polygnathus longiposticus* Branson & Mehl, 1934. Upper view; RUR 101, x 45, AMF 105377.
 Figs. 11, 13 - *Polygnathus inornatus* E.R. Branson, 1934.
 11) a: lower view; b: upper view; RUR 101, x 30, AMF 105378;
 13) upper view; RUR 124, x 75, AMF 105380.
- Figs. 12, 14 - *Polygnathus inornatus?* E.R. Branson, 1934.
 12) a: lower view; b: upper view; RUR 145, x 60, AMF 105379;
 14) a: upper view; b: lower view; RUR 83, x 90, AMF 105381.







EXPLANATION OF PLATE 5

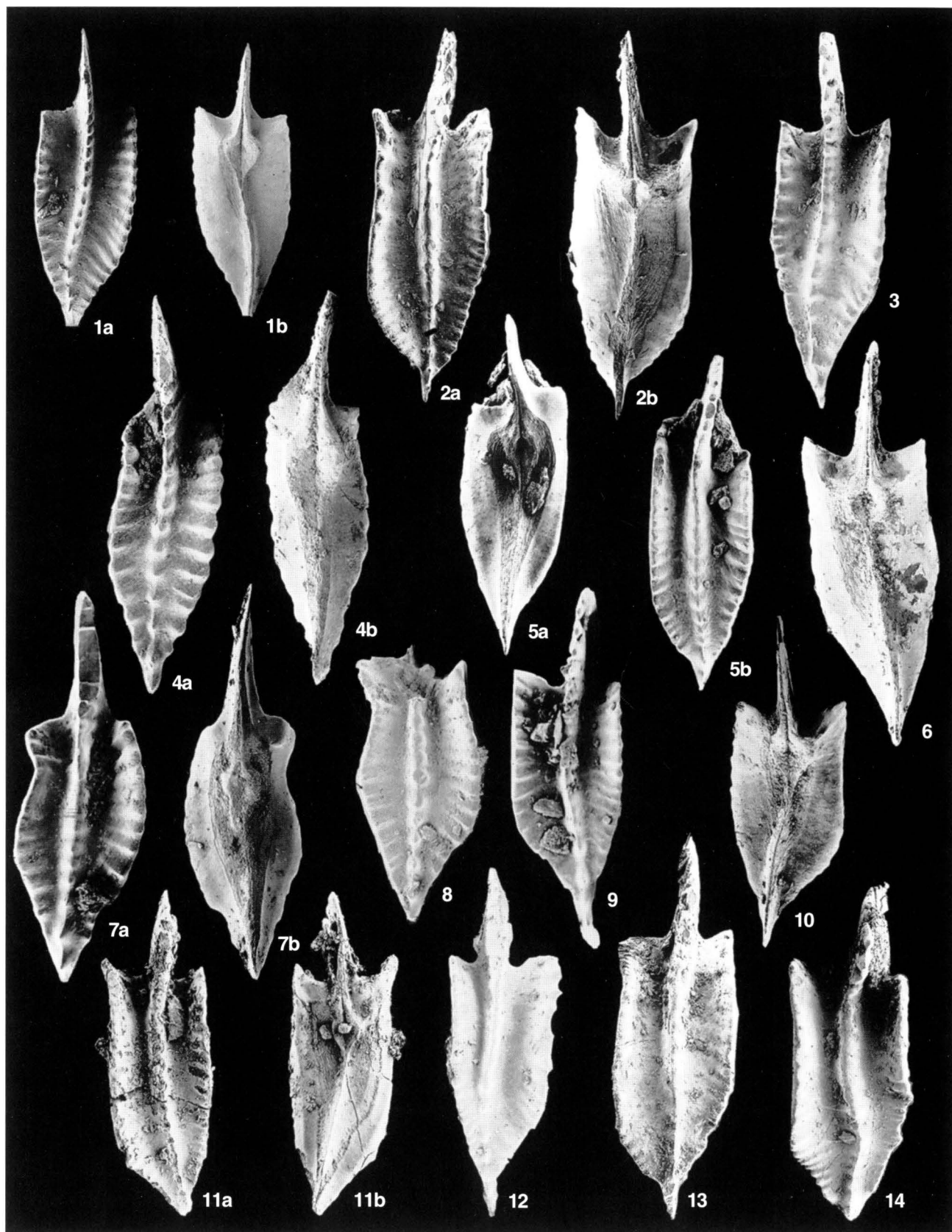
- Figs. 1–2, 7–8, 11, 14 - *Polygnathus inornatus* E.R. Branson, 1934.
 1) a: upper view; b: lower view; RUR 145, x 60, AMF 105382;
 2) a: upper view; b: lower view; RUR 130, x 60, AMF 105383;
 7) a: upper view; b: lower view; RUR 83, x 45, AMF 105388;
 8) upper view; RUR 83, x 45, AMF 105389;
 11) a: upper view; b: lower view; RUR 101, x 45, AMF 105071;
 14) upper view; RUR 83, x 30, AMF 105074.
- Figs. 3, 6, 9–10, 12–13 - *Polygnathus longiposticus* Branson & Mehl, 1934.
 3) upper view; RUR 145, x 60, AMF 105384;
 6) lower view; RUR 145, x 60, AMF 105387;
 9) upper view; RUR 160.6, x 60, AMF 105069;
 10) lower view; RUR 160.6, x 60, AMF 105070;
 12) upper view; RUR 145, x 60, AMF 105072;
 13) upper view; RUR 124, x 60, AMF 105073.
- Figs. 4–5 - *Polygnathus symmetricus* E. R. Branson, 1934.
 4) a: upper view; b: lower view; RUR 83, x 60, AMF 105385;
 5) a: lower view; b: upper view; RUR 101, x 45, AMF 105386.

EXPLANATION OF PLATE 6

- Figs. 1–3, 5, 8 - *Polygnathus fornicatus* Ji, Xiong & Wu, 1985.
 1) upper view; RUR 145, x 75, AMF 105075;
 2) upper view; RUR 145, x 90, AMF 105076;
 3) upper view; RUR 145, x 60, AMF 105077;
 5) upper view; RUR 145, x 90, AMF 105079;
 8) upper view; RUR 83, x 60, AMF 105082.
- Figs. 4, 12, 14 - *Polygnathus longiposticus* Branson & Mehl, 1934.
 4) upper view; RUR 83, x 45, AMF 105078;
 12) a: upper view; b: lower view; RUR 160.6, x 75, AMF 105086.;
 14) a: lower view; b: upper view; RUR 101, x 60, AMF 105088.
- Figs. 6–7, 9 - *Polygnathus inornatus* E.R. Branson, 1934.
 6) upper view; RUR 26, x 60, AMF 105080;
 7) a: upper view; b: lower view; RUR 59, x 105, AMF 105081;
 9) a: lower view; b: upper view; RUR 26, x 75, AMF 105083.
- Figs. 10–11 - *Pseudopolygnathus marginatus* (Branson & Mehl, 1934).
 10) a: lower view; b: upper view; RUR 124, x 90, AMF 105084;
 11) a: upper view; b: lower view; RUR 141, x 75, AMF 105085.
- Fig. 13 - *Polygnathus symmetricus* E. R. Branson, 1934.
 a: lower view; b: upper view; RUR 160.6, x 30, AMF 105087.

EXPLANATION OF PLATE 7

- Figs. 1–2 - *Polygnathus inornatus* E.R. Branson, 1934.
 1) a: lower view; b: upper view; RUR 145, x 75, AMF 105089;
 2) upper view; RUR 145, x 75, AMF 105090.
- Fig. 3 - *Pseudopolygnathus fusiformis* Branson & Mehl, 1934.
 a: lower view; b: upper view; RUR 141, x 75, AMF 105091.
- Figs. 4–5 - *Neopolygnathus communis communis* (Branson & Mehl, 1934).
 4) upper view; RUR 145, x 75, AMF 105092.
 5) upper view; RUR 83, x 90, AMF 105093.
- Figs. 6–11, 15–16 - Apparatus A.
 6) lateral view of M element; RUR 145, x 60, AMF 105094;
 7) lateral view of M element; RUR 145, x 45, AMF 105095;
 8) lateral view of M element; RUR 145, x 60, AMF 105096;
 9) lateral view of M element; RUR 141, x 45, AMF 105097;
 10) lateral view of M element; RUR 145, x 60, AMF 105098;
 11) lateral view of M element; RUR 145, x 60, AMF 105099;
 15) lateral view of Sc element; RUR 82, x 30, AMF 105103;
 16) lateral view of Sc element; RUR 82, x 30, AMF 105104.
- Fig. 12 - Apparatus B. Lateral view of M element; RUR 82, x 30, AMF 105100.
- Figs. 13–14 - Polygnathid non-platform elements.
 13) lateral view of M element; RUR 82, x 30, AMF 105101;
 14) lateral view of M element; RUR 145, x 45, AMF 105102.
- Fig. 17 - Gen. et sp. indet. Upper view; RUR 145, x 75, AMF 105105.







conditions. An upper slope or shelf environment is also suggested by the diversity of the mollusk fauna present in the limestone horizons. On lithologic grounds, Draper *et al.* (1993, p. 210) suggests a muddy shelf environment with storm events occurring spasmodically.

REGIONAL IMPLICATIONS

The conodont biostratigraphy of the Late Devonian-Early Carboniferous units in the Burdekin Basin was the subject of a recent investigation (Mawson & Talent, 1997). Tournaisian conodont faunas of *sandbergi*-Early *crenulata* age were documented from the Venetia Formation in the Big Stockyard Creek area approximately 12 km south of Greenvale, from the Hardwick Formation sampled along "Corner Creek" and from two localities in the vicinity of Star Homestead (= CORN section and localities 20 and 21 respectively of Mawson and Talent, 1997, fig. 2). We suggested (Mawson & Talent, 1997, p. 206, fig. 5) that these faunas were evidence for a transgressive event (T7) initiated late in the *sandbergi* Zone or in Early *crenulata* Zone.

Examination of conodont faunas from the Ruxton Formation and re-appraisal of other Tournaisian faunas in the Clarke River Basin, the Burdekin Basin and the Broken River Province indicate alignment of the Ruxton Formation with the following 4 sampled limestone intervals as well as with other areas in the New England Fold Belt:

i. Gray Creek "Venetia Formation" (= Teddy Mountain Formation)

Conodonts have been obtained from the "Venetia Formation" of the the Gray Creek-Stockyard Creek outcrop-tract of Clarke River Basin south of Greenvale (Withnall & Lang, 1993, p. 245). In that area about 2 dozen conglomeratic limestones occur through a generally poorly outcropping, very shallow marine siltstone-arenite sequence. The conodont data are modest and include *Bi. aculeatus plumulus* and *Ps. primus*. These long-ranging forms are known to co-occur in horizons dated as Early *crenulata* Zone (Mory & Crane, 1982).

ii. Teddy Mountain Formation, in the Broken River Province

A conodont fauna from the Teddy Mountain Formation, NW of Montgomery Dam, documented by Lang (1986) was assigned a Late Devonian age (Middle *expansa* Zone to Middle *praesulcata* Zone). This determination was based on two bispathodid specimens identified as *Bispathodus bispathodus* and the age range suggested by Ziegler & Sandberg (1984). An examination of Lang's illustrations (1986, Pl. 15, figs 1-8) suggests that, allowing for breakage, the two broken specimens are juveniles measuring 0.5 mm and 0.55 mm respectively. Other bispathodids illustrated by Lang average 0.9 mm in length with complete specimens ranging in size from 0.77 mm to 1.1 mm in length. The lateral profile of the specimen illustrated by Lang (Plate 15, Figs 1, 6-8) and the placement of the single right-side denticle above the anterior margin

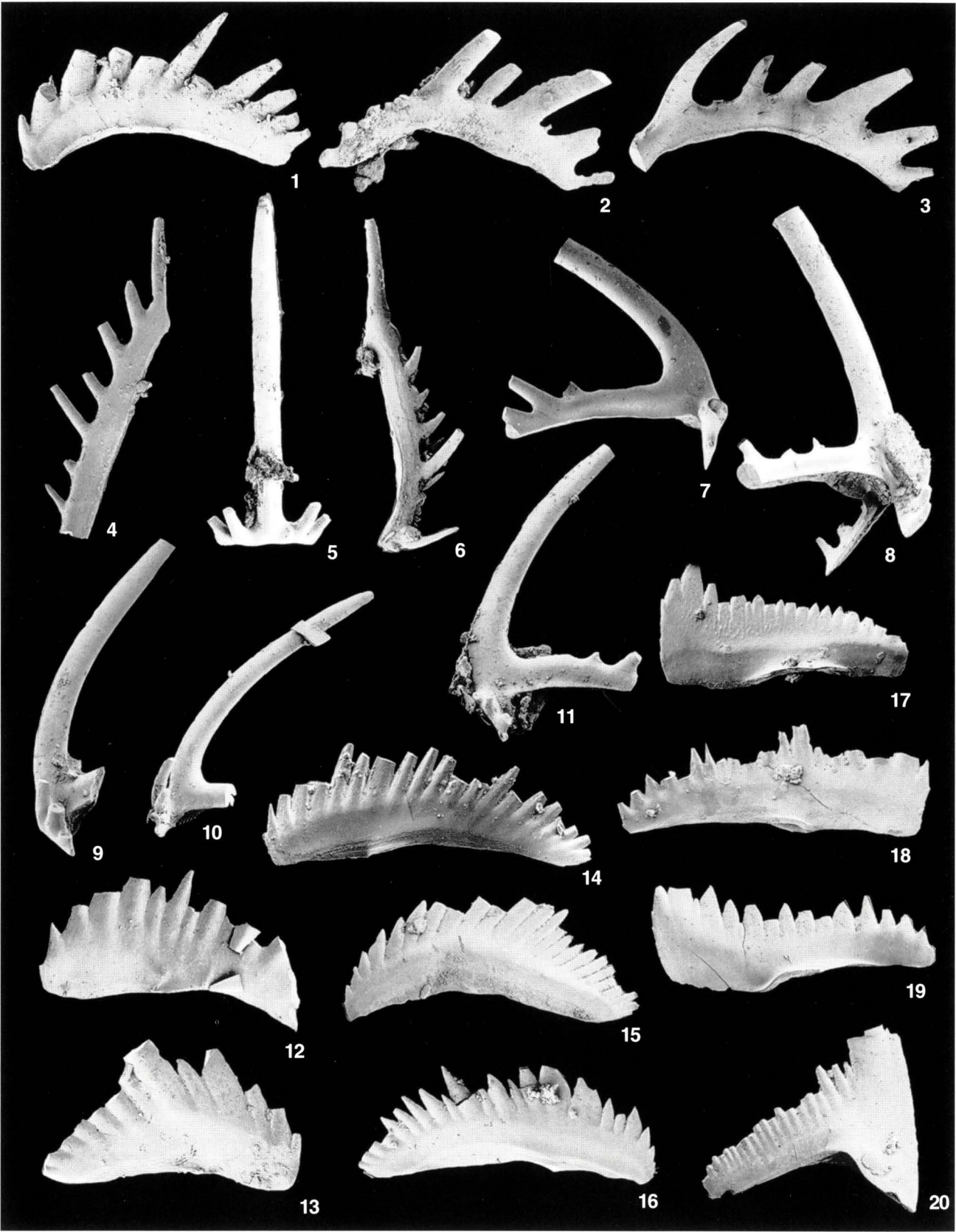
EXPLANATION OF PLATE 8

- Figs. 1-11 - *Prioniodina* sp.
 1) lateral view of Pa element; RUR 145, x 75, AMF 105106;
 2) lateral view of Pb element; RUR 145, x 60, AMF 105107;
 3) lateral view of ?Sc element; RUR 126, x 30, AMF 105108;
 4) lateral view of M element; RUR 145, x 45, AMF 105109;
 5) back view of Sa element; RUR 160.6, x 30, AMF 105110;
 6) lateral view of M element; RUR 82, x 45, AMF 105111;
 7) lateral view of Sc element; RUR 82, x 45, AMF 105112;
 8) lateral view of ?Sd element; RUR 145, x 60, AMF 105113;
 9) lateral view of Sc element; RUR 160.5, x 30, AMF 105114;
 10) lateral view of Sc element; RUR 145, x 45, AMF 105115;
 11) lateral view of Sc element; RUR 145, x 45, AMF 105116.

- Figs. 12-16, 20 - Apparatus B.
 12) lateral view of Pa element; RUR 82, x 45, AMF 105117;
 13) lateral view of Pa element; RUR 82, x 60, AMF 105118;
 14) lateral view of Pb element; RUR 83, x 60, AMF 105119;
 15) lateral view of Pb element; RUR 145, x 30, AMF 105120;
 16) lateral view of Pb element; RUR 82, x 45, AMF 105121;
 20) lateral view of M element; RUR 145, x 60, AMF 105125.

- Figs. 17, 19 - *Bispathodus stabilis* (Branson & Mehl, 1934).
 17) lateral view of Pa element; RUR 145, x 60, AMF 105122;
 19) lateral view of Pa element; RUR 82, x 75, AMF 105124.

- Fig. 18 - *Branmehla* sp. Lateral view of Pa element, RUR 82, x 45, AMF 105123.



of the basal cavity, suggest close affinity with young specimens of *Bi. aculeatus anteposicornis*. This subspecies was reported in a small faunule in the Hardwick Formation (= loc. 22 of Mawson & Talent, 1997) together with species of *sandbergi*–Early *crenulata* age. The development of transverse ridges in the second of Lang's specimens (Pl. 15, figs. 2–5) is reminiscent of juvenile specimen of *Bi. aculeatus aculeatus* or *Bi. a. aculeatus* transitional to *Bi. spinulicostatus* (cf. Ziegler *et al.*, 1974, Pl. 3, figs. 18, 22), especially as regards to the lateral profile and the development of transverse ridges. Until further material is available for study to confirm the presence of *Bi. bispathodus* s.s. in Lang's fauna, the evidence suggests that this fauna should be assigned a *sandbergi*–Early *crenulata* age.

iii. *Reference sections of the Venetia Formation along Gill Creek, etc. in the Clarke River Basin.*

We suggest alignment of the RUR section with the marine interval immediately above the base of the Venetia Formation in the reference section in Gill Creek and in the sequence in Furry Hoop Creek in the Clarke River Basin *sensu stricto* (Draper *et al.*, 1993, p. 205) though there is no conodont data for this. Playford (1988) confirms a Tournaisian age for the Venetia Formation based on his palynological analysis of core samples from two Geological Survey of Queensland boreholes, Clarke River 3–4 and 5.

iv. *Alignment with Pickett's (1981) Hardwick Formation in the Burdekin Basin.*

Within the Hardwick Formation, the unit sampled by Pickett (1981) at Wyatt's locality C414 (= loc. 16 of Mawson & Talent, 1997) on the south flank of Mount Saint Michael yielded *Siphonodella sulcata* and *Si. duplicata*. The co-occurrence of these was taken as indicative of an Early *duplicata* age by Mory and Crane (1982) and, based on suggested age ranges given by Klapper (*in* Ziegler, 1977) and Sweet (1988), Mawson & Talent (1997) suggested a *sandbergi* age for the fauna. According to Ji & Ziegler (1993), however, *Si. sulcata* and *Si. duplicata* became extinct in the Early *crenulata* Zone. It could be, therefore, that at least this interval of the Hardwick Formation aligns with the Ruxton Formation.

v. *Alignment with localities within the New England Fold Belt.*

It has been pointed out by Mory & Crane (1982) that 10 localities within the New England Fold Belt from Rockhampton in central Queensland to Gloucester in the south in northeastern New South Wales, have yielded conodont faunas of Early *crenulata* Zone.

Since Pickett's (1994 – submitted 1991) reassessment of portion of the work carried out by Mory & Crane (1982) in the Wirrabilla area, extended age-ranges have been suggested for several key conodonts

used to date the horizons. For example, Ji & Ziegler (1993) acknowledge *Ps. multistriatus* as being an important element in faunas of Early *crenulata* age. This species is pivotal in dating the Luton Formation and the lower part of the Namoi Formation as being no older than late *isosticha*–Late *crenulata* Zone. Pickett (1994) based the age of the oldest conodont-bearing horizon on the apparent similarity of two specimens of *Pseudopolygnathus* that he considered similar to *Ps. nodomarginatus* and therefore of a comparable age. The illustration (Pickett, 1994, fig. 2.8) of this bispathodid is consistent with closer relationship to *Ps. marginatus* than to *Ps. nodomarginatus*. The illustrated specimen lacks subparallel margins giving it a "shovel-like" appearance rather than a lanceolate outline, and has a greater number of marginal ridges – some of which reach the carina unlike those of the holotype of *Ps. nodomarginatus* that are fewer in number and are restricted to the margins of the platform. *Ps. marginatus* is commonly found in faunas of Early *crenulata* age (e.g. Ji & Ziegler, 1993). An Early *crenulata* age is therefore possible for the Luton Formation as suggested by Mory & Crane (1982).

SUMMARY

The above horizons, previously indicated to be variously "latest Devonian or earliest Carboniferous" (Ruxton Formation), "late Famennian" (Teddy Mountain Formation, Broken River Province), "Tournaisian" (Venetia Formation) and "mid-Tournaisian" (Gray Creek tract, south of Greenvale) are here considered to align with each other (Text-fig. 1), to be all Early *crenulata* Zone and, on the basis of the improved conodont data from the Ruxton Formation, to align chronologically with the well expressed, second youngest transgressive event in the Hardwick Formation of the Burdekin Basin, Mawson & Talent's (1997) transgressive event T7: *sandbergi* Zone–Early *crenulata* Zone. The chronologically less well controlled transgressive event T8 in the Hardwick Formation may be represented by the marine interval, units 3–6, of the upper Ruxton Formation (Draper *et al.*, 1993, fig. 66).

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