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Abstract
The New Zealand asaphid trilobite Ogygites collingwoodensis is redescribed on the basis of the type material and new collections, and its assignment to Basiliella is confirmed. The species occurs with the trinucleid trilobite Incaia bishopi and graptolites indicative of the Nemagraptus gracilis zone (early Late Ordovician, early Sandbian/Gisbornian), mostly as disarticulated material in intensely bioturbated siltstone of the Douglas Formation. Comparison with coeval faunas is limited due to the low diversity of this fauna, but B. collingwoodensis shows some limited similarity to contemporaneous eastern Australian faunas, whereas Incaia also occurs in South America and South China.

Keywords
Trilobita, Asaphidae, Late Ordovician, New Zealand, Basiliella, Incaia, GeoQUEST

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The asaphid trilobite *Ogygites collingwoodensis* Reed, 1926 from the Late Ordovician of New Zealand

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The New Zealand asaphid trilobite *Ogygites collingwoodensis* is redescribed on the basis of the type material and new collections, and its assignment to *Basatiella* is confirmed. The species occurs with the trinucleid trilobite *Incaia bishopi* and graptolites indicative of the *Nemagraptus gracilis* zone (early Late Ordovician, early Sandbian/Gisbornian), mostly as disarticulated material in intensely bioturbated siltstone of the Douglas Formation. Comparison with coeval faunas is limited due to the low diversity of this fauna, but *B. collingwoodensis* shows some limited similarity to contemporaneous eastern Australian faunas, whereas *Incaia* also occurs in South America and South China.

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Keywords: Trilobita, Asaphidae, Late Ordovician, New Zealand, *Basatiella*, *Incaia*.

REED (1926) described two new Ordovician trilobite species, *Dionide hectori* and *Ogygites collingwoodensis*, from two separate regions of the province of Nelson in the South Island of New Zealand, based on material collected by members of the New Zealand Geological Survey. Bishop (1965) reported the discovery of *in situ* material of the *B. collingwoodensis* fauna on the Paturau River in the Collingwood area.

*Ogygites collingwoodensis* Reed, 1926 is redescribed here on the basis of type and new material collected from Bishop’s locality; the trinucleid trilobite occurring with *B. collingwoodensis* was described as *Incaia bishopi* by Hughes & Wright (1970). Reed (1926, p. 312) inferred for this occurrence an Early Ordovician age, rather than the Late Ordovician age that has been established on the basis of the associated graptolite fauna (Hughes & Wright 1970, Cooper 1979).

*Dionide hectori* Reed, 1926 is a member of a diverse fauna from the Patriarch Formation in the Wangapeka River area and was redescribed by Wright (1979) as *Ruapyge hectori*, and by Wright et al. (1994) as *Hysterolemus hectori*. The species is now known to have a latest Cambrian or earliest Ordovician age rather than the generalised Ordovician age suggested by Reed (1926). Abundant material of the *H. hectori* and associated faunas collected from the Mount Patriarch area mainly in the 1960s and 1970s was described by Wright et al. (1994).

**STRATIGRAPHIC SETTING**

*Incaia bishopi* and *B. collingwoodensis* have been found in outcrops and in scree slopes along the Paturau River (see Hughes & Wright 1970, fig. 1) in northwest Nelson Province in the South Island of New Zealand, in the Douglas Formation (Bishop 1971), where the strata contain a early Sandbian/Gisbornian (early Late Ordovician; see Bergström et al. 2009) graptolite fauna including *Nemagraptus gracilis* (see Cooper 1979). A geological map of the area is given by Zhen et al. (this volume, fig. 1). The trilobite locality in the Douglas Formation lies within the Buller Terrane (see Zhen et al. this volume, fig. 1). The fossiliferous beds are mostly highly bioturbated, deepwater siltstones, with subordinate sandstone and mudstone. Most of the trilobites at the main locality on the Paturau River are disarticulated and tectonically deformed, and occur as internal and external moulds. No significant macrofauna other than the trilobites and graptolites occurs in these beds.

**BIOGEOGRAPHY**

As previously observed (Hughes & Wright 1970, Webby & Edgecombe 2001), the presence of *Incaia* in the Paturau River fauna suggests
South American affinities. Webby & Edgecombe (2001) noted that the other two known Ordovician species of Incaia are from Peru and Bolivia (I. nordenskioldi Bulman, 1931: late Darriwilian) and Argentina (I. deormacaei Baldis & Pothé de Baldis, 1995: Gisbornian) and that faunal exchange between the Precordilleran region and the Gondwana margins would explain this (limited) faunal relationship during the Darriwilian-Caradoc interval. The record of Incaia from the Arenig of South China (Turvey & Zhou 2002; Turvey 2005, 2007) is interesting, not only because the palaeobathymetric setting for Incaia in South China is shown by Turvey (2005, text-fig. 8) at the outer edge of the intermediate shelf, but because the Chinese occurrence is older than the other (L.lanvin-Caradoc) occurrences of the genus and indicates a wider geographic extent for the genus.

The asaphid re-described here almost certainly belongs to Basiliella, a much more cosmopolitan genus than Incaia. There are some morphological features indicating that B. collingwoodensis is close to B. fortis (Webby, 1973) from central New South Wales, further supporting biogeographic ties between eastern Australia and New Zealand in the Ordovician.

SYSTEMATIC PALAEOONTOLOGY

Material studied is held at the Institute of Geological and Nuclear Sciences, Lower Hutt (AR), and the School of Earth Sciences, Victoria University of Wellington (Va): both New Zealand.

Basiliella Kobayashi, 1934

Type species. Asaphus barrandi Hall, 1851; Black River Group, Wisconsin, Caradoc: by original designation.

Remarks. Many contributions have greatly clarified the nature of this genus (especially Zhou & Fortey 1986, see this reference for full listing of species up to that time; Lee & Choi 1992, 1999; Edgecombe & Webby 2007; Edgecombe et al. 2004). Turvey (2007) summarised recent ideas confirming the close relationship between Ogygites de Tromelin & Lebesconte, 1876 and genera such as Opsimaspaphis Kielen, 1960; this grouping discussed by Turvey (2007) clearly excludes the New Zealand species.

Basiliella collingwoodensis (Reed, 1926) (Figs 1A-K, 2A-J)

1926 Ogygites collingwoodensis: Reed, p. 310-312, pl. 16, figs 1a-b.
1980 Ogygites; Stevens, p. 187, fig. 11.5.
1981 Ogygites collingwoodensis; Speden & Keyes, fig. 3E.
1986 Basiliella collingwoodensis Reed; Zhou & Fortey, p. 179.

Material. The lectotype here selected is AR 664 (Reed 1926, fig. 1b), a rather complete internal mould (Fig. 1A) lacking free cheeks; the other specimen, the paralectotype (AR 663; Reed 1926, fig. 2A) is an internal pygidial mould. Additional specimens on which this analysis is based are AR 2271–2297 and Va 369-371. Reed’s two type specimens, held at the Institute of Geological and Nuclear Sciences, bear the locality number GS 9505; both are incomplete and the cephalon of the lectotype in particular is poorly preserved and has been damaged at some time during preparation.

Type locality. Reed’s material was collected by field officers of the New Zealand Geological Survey from boulders in the Paturau River in northwest Nelson, South Island, New Zealand. This locality was designated (Bishop 1965) as GS 9504 (S3/526). Subsequent collections have been made mainly from the single, mainly scree locality on the W side of the Paturau River, and rarely from outcrop (Bishop 1965, 1971; Hughes & Wright 1970). Graptolites from the same locality were assigned to the Nemagraptus gracilis zone by Cooper (1979) indicating a late Ordovician (early Sandbian/Gisbornian; Bergström et al. 2009) age.

Diagnosis. A species of Basiliella with a moderately concave librigenal field inside a narrow convex border, and long genal spine. Eight to nine pygidial axial rings, pleural furrows marked, interpleural furrows absent.

Description. Cephalon transversely oval, with broad flat preglabellar field. Glabella slightly

Fig. 1. Basiliella collingwoodensis (Reed, 1926). A-B, plaster cast of lectotype AR 664. A, x 1.4; B, cranium, x 2.9. C, latex cast of cranium, AR 2273, x 1.6. D, partial cranium AR 2279, showing posterolateral limb and eye ridge, x 2.7. E, juvenile cranium AR 2272, x 3.6. F, librigena AR 2278 showing long genal spine, x 1.9. G, librigena AR 2288, x 1.6. H, librigena AR 2282, x 1.3. I, latex cast of incomplete hypostome AR 2276, showing probable scaly sculpture. x 2.6. J-K, hypostome AR 2277, x 3.7. J, latex cast, K, internal mould. Scale bars 5 mm. All material from Douglas Formation, Paturau River area, Nelson Province, New Zealand; Gisbornian (Nemagraptus gracilis zone).
expanding forwards, reaching about 33% of cranial width and 80% of cephalic length; axial furrows diverging forward only slightly, no preglabellar furrow. Axial furrows weak, poorly defined posteriorly; almost straight. Frontal half of glabella elevated and rounded, anteriorly being semi-ovate rather than semicircular in outline. S1 poorly defined, but running postero-medially from in front of eyes, creating pear-shaped glabella. Other glabellar furrows unclear. Eyes located well posterior of glabellar mid-length, with strong palpebral ridge and shallow furrow inside. Facial sutures diverge in front of palpebral lobes at just less than 90°; each suture line then bends to run intramarginally to meet anteriorly at about 135°. Bacculae well defined in small specimens, extending as low ridges from posterior border furrow to level with posterior limit of eye. Median node on occipital ring; occipital furrow weak. Postero-lateral limb short (Figs 1C, E) and triangular. Free cheek moderately concave at mid-length, frontal area and posterior portion gently concave, median suture not seen; narrow convex border; doublure wide, reaching outer edge of eye. Gential spine long, apparently rounded in cross section.

Hyposomes poorly preserved, but show stubby posterior wings, rounded anterior border, circular or slightly transversely ovate median body and elongate (sag.) ovate to subcircular maculae. faint suggestion of short triangular medial anterior continuation of pre-glabellar field at junction of sutures (see also Webby 1973, pl. 53, figs 11-12). One hyposome (Fig. 11) retains a suggestion of scaley sculpture. Thorax with 8 segments; tips of segments deflected posteriorly; pleural furrows marked, deep and angular.

Pygidium transverse with rounded anterolateral corners; in transverse profile there is a wide smooth horizontal margin outside of and narrower than the convex pleural field; no border furrow. Eight well defined pleural ribs, all slightly curved posteriorly; posterior edges of pleuracae steep, anterior edges gently sloping. Axis about 20% of pygidial width anteriorly, with 8 (possibly 9) axial rings. Axial furrows straight to gently mutually convex, tapering slightly towards the posterior; some suggestion (maybe enhanced by deformation) of a slightly swollen terminal piece which is smooth; furrows between rings weak. Pleural furrows not developed. Doublure reaches at least halfway across pleural field, reaching well inside posterior end of axis. Terrace lines meet lateral margins at a slight angle, also making slight angle with inner edge of doublure (Fig. 2J); outer terrace lines may make a slight angle with inner set of terrace lines (Fig. 2J), and anterolaterally swing laterally to become parallel to transverse terrace lines on articulating facet (Fig. 2G). Terrace lines curve around posterior end of axis (Fig. 2H).

Dimensions. As can be seen from the illustrations, most specimens are asymmetrical due to tectonic deformation, but probably are not too greatly stretched. Measurements taken from the relatively complete lectotype (Fig 1A) are: the whole specimen is 53.6 mm long; the cranium (Fig. 1B, C) is 22.8 mm long (sag.) and estimated at 34 mm wide (tr.); and the pygidium (Fig. 1A) is 13 mm long (sag.) and 38.6 mm wide (tr.). The large free cheek (Fig. 1F) is 46.3 mm long (sag.).

Remarks. In view of the accumulated knowledge of Basillletta, there seems little doubt that this is the correct generic assignment for the New Zealand species as previously indicated by Zhou & Fortey (1986). The original assignment to Oxygites can be refuted in the light of comments on that genus (see Turvey 2007) and other discussions of Basillletta (see above).

All material lacks any original exoskeleton, so surface sculpture is mostly not preserved, except on one incomplete hyposome which shows fine sculpture (Fig. 11). Determination of original dimensions and some morphological features, especially details of glabellar furrows, are largely obscured by tectonic deformation. The terrace lines on the pygidium anterolaterally (Fig. 2J) swing to meet the essentially transverse terrace lines of the articulating facet (see Henningmoen 1964, pl. 2, fig. 3; Salter 1866, pl. 22, fig. 9), and do not appear to be an artefact of compression.

*Basillletta collarwoodensis* differs from the following east Australian *Basillletta* in having a pronounced genal spine: *B. choli* Edgecombe, Banks & Banks, 2004; B. cf. *B. choli* of Edgecombe, Banks & Banks, 2004: B.

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**Fig. 2. Basillletta collarwoodensis** (Reed, 1926). A. plaster cast of paralectotype AR 663, x 1.4. B. latex cast of thorax and pygidium, x 1.8. C. juvenile pygidium AR 2289, x 2.1. D. internal mould of juvenile pygidium AR 2295, x 3.6. E. latex cast of pygidium AR 2286, x 2.0; note cranium of Linnaea bishopi Hughes & Wright, 1970 at lower left. F. latex cast of pygidium AR 2287, x 1.5. G. internal mould of pygidium AR 2292, x 1.6. H. internal mould of pygidium AR 2294, x 4.6, showing imprint of doublure. I. internal mould of pygidium AR 2290, showing detail of terrace lines, x 1.4. J. internal mould of pygidium showing detail of terrace lines, AR 2292, x 2.5. Scale bars all 5 mm. All material from Douglas Formation, Pataua River area, Nelson Province, New Zealand, Gisbornian (Neugrapthus gracilis zone).
karnbergensis Edgecombe & Webby, 2007; and B. lewisi Kobayashi, 1940. Basilicus (Basilica) illarensis (Etheridge, 1893) (see Laurie 2006) from central Australia also has a blunt genal angle.

The Late Ordovician Basilica forstii (Webby, 1973) (see also Edgecombe & Webby 2007) is similar in having a strong genal spine, but differs in having at least 12 pygidial axial rings. In the context of the above remark about genal spines, Forrey (1980, figs 9-10) drew attention to the relative reduction in genal spine length in larger specimens of B. tyrannus (Murchison, 1839), and the implications for comparisons of larger and smaller specimens; there are large cheek fragments (e.g., AR 2284) of B. collingwoodensis in the Patarau River material, but the genal angle is poorly preserved. Material of the B. forstii group illustrated by Edgecombe & Webby (2007) also shows a more obtuse angle formed by the frontal sutures anteriorly, and a much wider cranium in front of the eye.

The Gisbornian (Late Ordovician) B. choi Edgecombe, Banks & Banks, 2004, has a similar cranium but a blunt genal angle. Ogygiella australis Harrington & Leanza, 1957 was illustrated by Benedetto (2003, p. 313, pl. 17, figs 1-5) as a member of Basilicus (Basilica) and differs markedly from B. collingwoodensis in having weak pleural ribs on the pygidium, as well as very prominent bacculae. Zhou & Forrey (1986) described from China the new species Basilicus (Basilica) asper, which differs, along with B. jialuni Zhou & Forrey, 1986 (see Edgecombe & Webby 2007, p. 272) from B. collingwoodensis in the smooth or faintly segmented pygidium and the pear-shaped, swollen frontal glabellar lobe.

Basilica satunensis Kobayashi & Hamada, 1964, from the Middle Ordovician of Thailand, is a species with a long genal spine, but differs from B. collingwoodensis principally in having fewer pygidial axial rings, a better defined and longer posterior border furrow and an upturned cephalic margin anteriorly.

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