THE SIGNIFICANCE OF A NEW LOCALITY FOR *MONOGRAPTUS THOMASI* (EARLY DEVONIAN) SOUTHWEST OF BEACONSFIELD, TASMANIA, AND OF THE CORN HILL FORMATION

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(with one plate, three text-figures and one appendix)

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Monograptus thomasi, Early Devonian, occurs west of Cabbage Tree Hill, Beaconsfield, Tasmania, in rocks previously mapped as Cambrian. The occurrence constrains the location of a basal thrust considered to be a conduit for Late Devonian gold mineralisation. The Corn Hill Formation, which contains the graptolite, is significant in regional stratigraphic, palaeogeographic, structural and tectonic models.
Key Words: ***Monograptus*, Devonian stratigraphic relationships, Tasmania, thrust fault, gold mineralisation.**

INTRODUCTION

The discovery in December 2000 of Early Devonian graptolites in Blyth Creek, 2 km southwest of Beaconsfield (146°48'E, 41°13'S) and some 5 km NNW of an earlier discovery of the same species by Banks & Rickards (1989) (fig. 1) is significant at both a local and regional scale. The discovery confirms the recent reassignment of the rocks containing the fossils, previously considered Cambrian in age (Green 1959, Gee & Legge 1971, 1979), to the Devonian. In so doing, it constrains the location of a basal thrust considered to be a conduit for later Devonian gold-bearing mineralising fluids, which gave rise to the Tasmania Reef deposit at Beaconsfield. In a regional sense, the graptolites provide further solid evidence for incorporation of the fossiliferous rocks into the framework of the geology of northeastern Tasmania, which is currently being revisited.

The material collected and described in this paper was dug from bedrock exposed in two outcrops 5 m apart in the bed of Blyth Creek. The creek has cut through thin Tertiary regolith into bedrock over a length of about 500 m.The incision reveals rocks similar to those which crop out on Leviathan Hill immediately to the northeast. Sampling conditions could best be described as adverse, as Blyth Creek drains a significant spring discharging in the order of 5–6 Ml/day and the sampling site is constantly beneath a metre of fast-flowing water. Although no outcrop occurs in the area of the spring, it is reasonably assumed that the water flows from a sinkhole in the Flowery Gully Limestone, as travertine-like deposits occur around the edges of the spring. The limestone, of Early Ordovician age (Kennedy 1971), crops out at several localities in the district and occurs stratigraphically above the Denison Group siliciclastics which crop out on Peaked Hill immediately west of the spring and generally dip east.

STRATIGRAPHY

Hills (1982) defined the Corn Hill beds, hereafter (Appendix) redefined as the Corn Hill Formation, of Devonian age in the vicinity of Bulls Road, east of Flowery Gully, and interpreted them as a series of turbidite deposits having affinities with the Mathinna Group of northeastern Tasmania. At Flowery Gully, the Corn Hill Formation disconformably overlies fine-grained, in places flaser-bedded, quartz siltstones, the Johnston Creek Siltstone (Hills 1982) of Late Ordovician or Early Silurian age (Kennedy 1971, Hills 1982, Kennedy & Hills 1989: 212–213). The Corn Hill Formation, over an approximate thickness of 600 m, consists largely of foliated micaceous shaley siltstones with lesser quartzwacke sandstones interbedded with graded quartzwacke sandstone-siltstone-shale units of turbiditic style, particularly along Bulls Road, southwest of Beaconsfield. At this type locality, the Corn Hill Formation shows characteristic alternation of shale and sub-greywacke over intervals of a metre (Hills 1982) and exhibits flute casts (pl. 1A), cross-lamination, slump folds and load cast features similar to those illustrated by Powell *et al.* (1993: fig. 12c) from the Scamander Slate and Quartzite (Scamander Formation) of Walker (1957) at Upper Scamander. Hills (1982) measured 28 of these features to derive a palaeocurrent direction towards the ENE, consistent with the common mean direction of 059° derived by Powell *et al.* (1993) for the Mathinna Supergroup in the Bridport–Bellingham area (fig. 2). The top of the Corn Hill Formation is truncated by Devonian thrusting. A Pragian age was assigned to the formation by Hills (1982) on the basis of a diverse fauna including the pelecypods *Actinopteria meridionalis* and *Praecardium* sp., the dacryoconarid *Styliolina minuta* and various cephalopods, trilobites and plant fragments. Banks & Rickards (1989) recorded *Monograptus thomasi* at the same location on Bulls Road and confirmed the Pragian age for the formation. A plant, cf. *Baragwanathia*, is associated with *M. thomasi* at that locality (Baillie *et al.* 1989: 236).

Mapping in recent years by geologists from the Beaconsfield Gold Mine, in particular MacDonald (1999), suggested that the Corn Hill Formation was extensive along strike. The formation was considered to encompass the rocks at Leviathan Hill which Green (1959) defined as the Ilfracombe Slate and considered as of Cambrian age on lithological grounds. This conclusion was not challenged when Gee & Legge (1971, 1979) invoked a model of

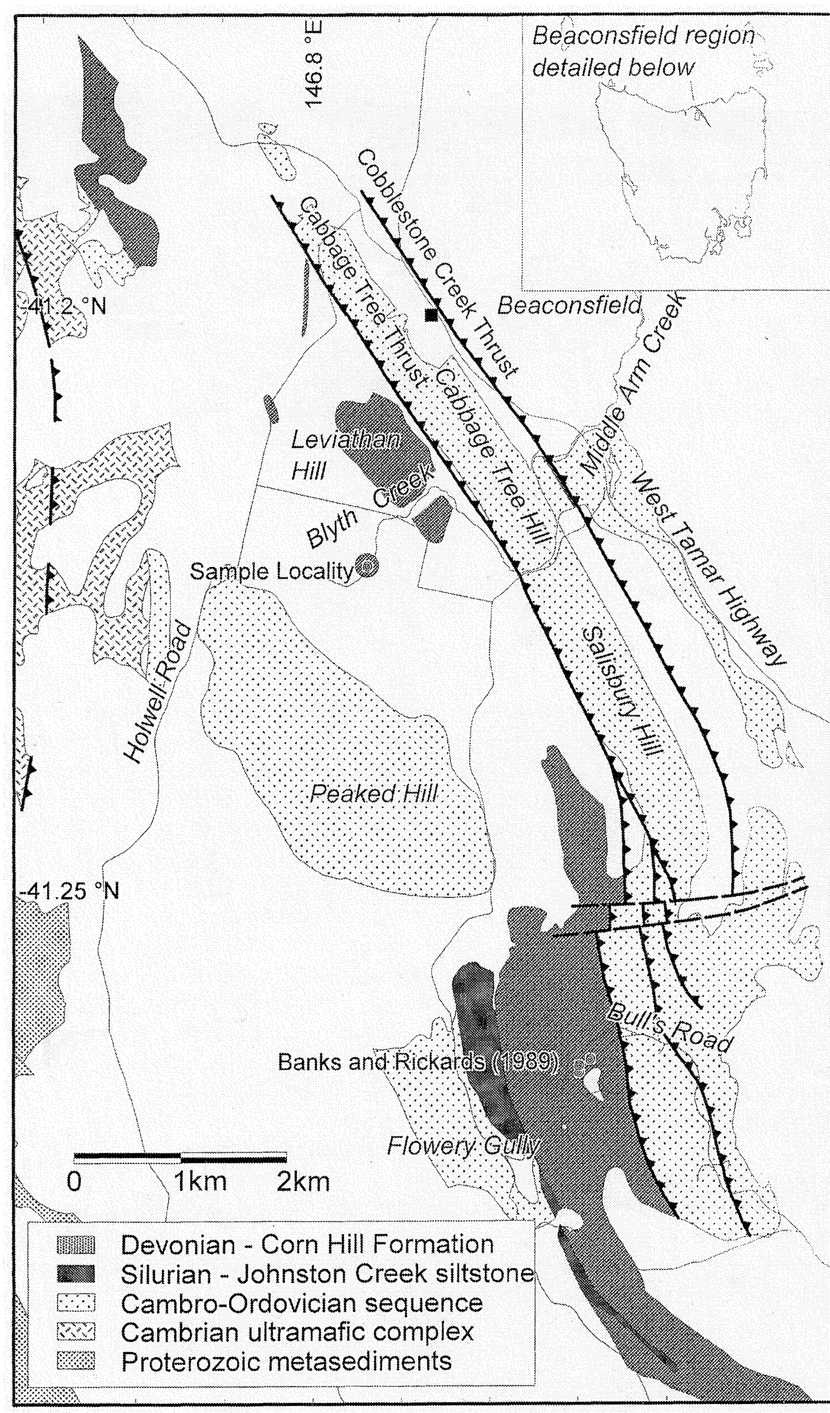

FIG. 1 — Map of the Beaconsfield area, Tasmania, showing the fossil locality, the distribution of the Corn Hill Formation and the postulated positions of relevant thrusts.

southwest-verging imbricate thrusting to explain the repeating strike ridges of Palaeozoic strata in the Beaconsfield district. The discovery of *M. thomasi* described herein has, however, confirmed the recent suggestion. A specimen from Leviathan Hill contains rare, poorly preserved bodies which resemble the stems of vascular plants found in the Panama Group elsewhere in northeastern Tasmania, and one may be dichotomously branched. Partial Bouma sequences have been recently recognised in the Formation on Leviathan Hill (pl. 1B). Although it is clear that the term "Ilfracombe Slate" has priority over "Corn Hill Formation" as a stratigraphic name, strict application of the priority principle would introduce ambiguity and potential confusion. Therefore the later name is preferred (Staines 1985: 91).

Green (1959) mapped a black graphitic shale in poor (and now covered) outcrop, overlying the Flowery Gully Limestone within the township of Beaconsfield, which he named the Grubb Beds and compared with the Mathinna Group of northeastern Tasmania. Recent drilling and underground development at the Beaconsfield Gold Mine has allowed detailed examination of this unit *in situ* and in drill core. Lithologically the rocks are somewhat similar to the Corn Hill Formation, and correlation between the two units has been made (Kennedy 1971, Hills 1998, MacDonald *et al.* 2001). To date, a single cephalopod fragment (UTGD 127752) is the only fossil recovered in Beaconsfield. Similar rocks also crop out along strike 2 km southeast of Beaconsfield and they too were mapped as the Grubb Beds by Green (1959). The reported occurrence of

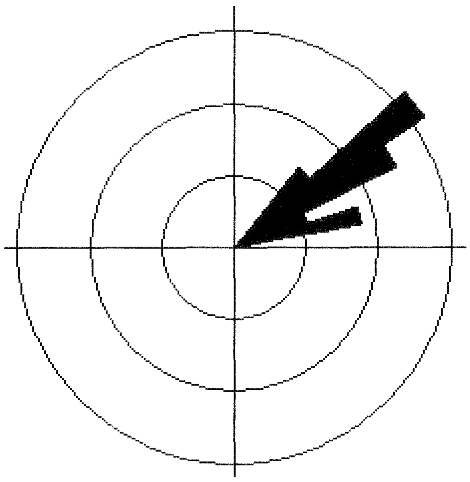

FIG. 2 — Current direction rose, Corn Hill Formation, Bulls Road.

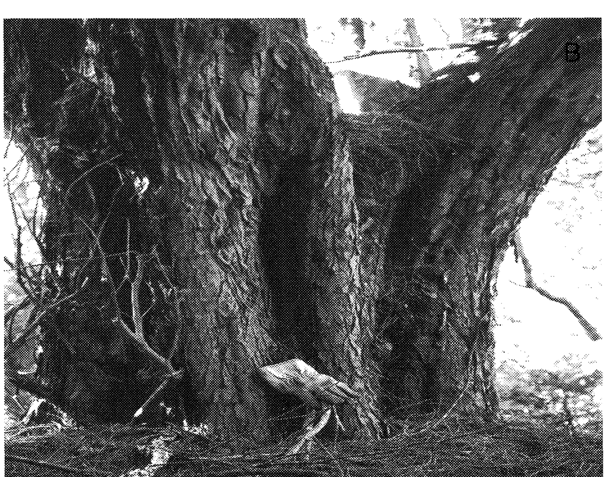

PLATE 1
(A) Flute cast in the Corn Hill Formation, Bulls Road. (B) Bouma units D and E with some C; convolute bedding, pillow structure and flames, Corn Hill Formation, Leviathan Hill; x1.

a high-spired gastropod and a possible biserial graptolite from this location (Öpik in litt. 1962, Banks *et al.* 1989) makes correlation with the Corn Hill Formation improbable, and correlation with the Johnston Creek Siltstone, as suggested by Hills (1982), may be more appropriate. The formation is approximately 50 m thick in the vicinity of the Beaconsfield Gold Mine and is truncated above by the Cobblestone Creek Thrust. The Corn Hill Formation is now considered to be absent at this locality.

SYSTEMATIC PALAEONTOLOGY

Genus *Monograptus* Geinitz, 1852
Monograptus thomasi Jaeger, 1966
Figure 3

1906 *Monograptus dubius* Suess; T.S. Hall, 267, 69–71, ?268, fig. 3.

?1907 *Monograptus* spp.; T.S. Hall, 140–141.

?1907 *Monograptus* cf. *crenulatus* (Tornquist); T.S. Hall, 140–141.

?1907 *Monograptus* sp. (*colonus* group); T.S. Hall, 140–141.

1925 *Monograptus dubius* Suess; Baragwanath, 21, 22.

1933 *Monograptus riccartonensis* Lapworth; Keble, 293, plate.

1935 *Monograptus uncinatus* var. *orbatus* Wood, *M. uncinatus* var. *microspora* (sic) (Jaekel), *M. chimaera* Barrande; Elles (in Lang & Cookson 1935), 422, pl. 32, figs 51–53.

1935 *Monograptus galaensis* Lapworth ex *Monograptus* cf. *galaensis* Lapworth; Thomas (in Lang & Cookson 1935), 422.

1937 *Monograptus uncinatus* var. *orbatus* Wood, *?M. uncinatus* var. *micropoma* (Jaekel); Harris & Thomas, 69, 73–74, pl. 2, figs 23–25, 27–28, ?26, ?30, (non 29).

1960 *Monograptus uncinatus* var. *orbatus* Wood, *M. uncinatus* var. *micropoma* (Jaekel); Thomas, pl. 13, figs 187–188.

1964 *Monograptus* sp. nov. (of the *hercynicus* type) forma A and B; Berry, 9–13, pls 1–2; fig. 1a.

1966 *Monograptus thomasi* sp. nov.; Jaeger, 403–411, pl. 41, figs 3–5; pl. 42, figs 2–7; pl. 43, figs 1 a–c, o.

1970 *Monograptus thomasi* Jaeger; Jaeger, 175–180.

1971a *Monograptus thomasi* Jaeger; Lenz & Jackson, 13–14, pl. 2, figs 1–4, text-figs 3A, B, H, I.

?1971b *Monograptus* cf. *thomasi*; Lenz & Jackson, 131.

1973 *Monograptus thomasi* Jaeger; Jaeger, 104, fig. 1n.

1975 *Monograptus thomasi*, Jaeger; Mu & Ni Yu-nan, 22–24; pl. 7, figs 1–4, 8–11; pl. 8, figs 8 b, 30 d.

1977 *Monograptus thomasi*; Wang Xiao-feng, 196, table 1.

1978 *Monograptus thomasi* Jaeger; Jackson, Lenz & Pedder, pl. 4, fig. 5.

1979 *Monograptus thomasi*; Koren', 99–100, fig. 5:4.

1980 *Monograptus thomasi*; Wang Xiao-feng, chart 2, fig. 2.

1983 *Monograptus thomasi alexandraensis* n. subsp; Jaeger, 252–253, pl.1, fig.13.

1983 *Monograptus thomasi helmckei* n. subsp.; Jaeger, 251–252, pl. 1, figs 6–12, text-figs 5 a–e.

1984 *Monograptus thomasi* Jaeger; Porebska, 117, fig. 7.

1984 *Monograptus thomasi* Jaeger; Garratt & Rickards, fig. 8E.

1985 *Monograptus thomasi* Jaeger; Ni Yu-nan, 7; pl. 3, fig. 6; pl. 4, figs 3, 6, 8.
1987 *Monograptus thomasi* Jaeger; Garratt & Rickards, fig. 2i.
1988 *Monograptus thomasi alexandraensis* Jaeger; Jaeger, 434, fig. 2P.
1988 *Monograptus thomasi thomasi* Jaeger; Jaeger, 434–436, figs 1, 2Q.
1988 *Monograptus thomasi helmckei* Jaeger; Jaeger, 435, fig. 2R.
1989 *Monograptus thomasi* Jaeger; Banks & Rickards 112–116, figs 2, 3, Pl. 1.

Material

About 30 specimens in a deeply weathered pale shale, hemipelagic in origin, with two, poorly developed, foliaceous cleavages (fissilities). There is little noticeable effect of the two cleavages on the dimensions of the diagenetically flattened graptolites — there are no noticeably broad nor noticeably narrow views. Most specimens show little of the thecal details, certainly not through any length of rhabdosome, but in some the typical proximal rhabdosomal curvature is visible, and others have a few proximal or distal thecae preserved. It is almost certain that the two assemblages collected are monotypical and all specimens are referable to *M. thomasi*. Specimen numbers: UTGD 127750 (fig. 3), UTGD 127751 (counterpart).

Details of the locality and stratigraphy are given above.

Diagnosis

Rhabdosomes medium-sized, up to 30 mm long, either straight distally or with slight ventral curvature, and proximally with a characteristic dorsal curvature embracing th 3–10; thecal hoods decrease in size distally where the ventral apertural rim is seen in some cases; the first few thecae have a very slight tendency to metathecal isolation; sicula conspicuously placed dorsally, with pronounced dorsal tongue; dorsoventral width at level of hood of th1 is about 1 mm; more distally is 1.80–1.90 mm; thecal spacing 10–12 over first few mm, 8–10 in 10 mm distally; Σ = 1.20–1.30; thecal overlap about one half; sicula 1.50–1.70 mm, reaching to midway between th1 and th2.

Description

It is possible that the complex deformation of the rock has a cancelling- out effect in terms of spatial deformation on the bedding plane, because the rhabdosomes, reaching 30 mm in length, appear not to be deformed. However, they were diagenetically flattened before deformaton of the rock.

The dorsoventral width reaches 1.90 mm, some being a little more slender distally; the most distal parts of the stipes sometimes show the ventral apertural margin where the hood has receded or been broken off on the counterpart. Thecal overlap shows well only on the specimen illustrated; the interthecal septum curves towards the dorsal side of the rhabdosome about halfway between successive thecal apertures, so that thecal overlap is about half. In one instance, the dorsal thecal foramen, leading to the next theca, is visible (th7, fig. 3).

In the proximal thecae the dorsal thecal hood is always conspicuous and the aperture beneath it, roughly horizontal in disposition, faces proximally. The "hook" occupies about one-third of the rhabdosomal dorsoventral width, perhaps a little more than that on proximal thecae. The sicula is conspicuous and imparts a dorsal deflection to the extreme proximal end. No sicular details are visible save a dorsal hood and short virgella on some specimens. The most distal parts of each colony are either straight or with very gentle ventral curvature.

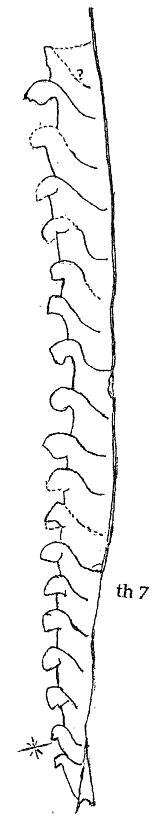

FIG. 3 — Monograptus thomasi *Jaeger, 1966 (UTGD 127 750), x 5; compression direction indicated; Blyth Creek, Univ. Grid Ref. 55G DQ 483750.5436480; BEACONSFIELD 4843, Geological Atlas 1: 25 000 Series. Tasmanian Geological Survey.*

Remarks

This material is clearly less deformed than that described by Banks & Rickards (1989) from near Flowery Gully about 5 km to the SSE, where stretched and broadened specimens were common. The present material is very close to Jaeger's (1966) types in dimensions, although the latter were deformed, and allowances need to be made. We have provided a full synonymy because this species seems, interestingly, to be quite widely recorded: Tasmania, Victoria, New South Wales, Canada, China and Russia (see synonomy).

Jaeger (1966) and Banks & Rickards (1989) give a detailed comparison with other and related species, which we shall not repeat here. *M. thomasi alexandraensis* Jaeger (1988) differs from the type subspecies in having a more robust proximal end and *M. thomasi helmeckei* has a distinctive and large th1.

CORRELATION

Reed (2001 b) introduced the term "Mathinna Supergroup" to reflect the diverse tectonic history of the Mathinna Group. Within that Supergroup, he defined the Tippogoree

Group as including the Stony Head Sandstone and the Turquoise Bluff Slate of Powell *et al.* (1993), and the Panama Group as including the Bellingham Formation and the Sidling sandstone of Powell *et al.* (1993). The Ordovician to Devonian succession in western Tasmania is rather different and is known as the Wurawina Supergroup, consisting of a Late Cambrian and Early Ordovician Denison Group, a later Ordovician Gordon Group, and two Silurian and Early Devonian Groups, the Eldon and the Tiger Range.

Correlation of the Corn Hill Formation with the Mathinna Supergroup of northeastern Tasmania has already been mentioned. Indeed, the occurrence of Mathinna Supergroup correlates in the Beaconsfield district is not a new concept, early comparisons having been drawn by Green (1959) and Kennedy (1971) without conclusive evidence. However, only recently has an adequate basis for that correlation been suggested by Hills (1982), Baillie *et al.* (1989), Banks & Rickards (1989), MacDonald *et al.*(2001) and Reed (2001a, b). The lithological and sedimentological characters of the Corn Hill Formation are similar to those of the Sidling sandstone of Powell *et al.* (1993) and of the Scamander Formation of Walker (1957), the latter cropping out near the eastern limit of the known Mathinna Supergroup. Baillie (pers. comm.) has recently recognised typical Bouma divisions A, C & D/E of the turbiditic facies in the Corn Hill Formation on Leviathan Hill. This contrasts with the findings of Powell *et al.* (1993:191).

Vascular land plants have been reported from the Corn Hill Formation (Hills 1982, Banks & Rickards 1989), from the Sidling sandstone (Powell *et al.* 1993) and the Scamander Formation (Walker 1957, Rickards & Banks 1979), as well as in several other places in northeastern Tasmania (Cookson 1937) from probably equivalent horizons. The Corn Hill Formation contains pelecypods, an unusual orthoconic cephalopod with tubular walls, an abundance of dacryoconarids and graptolites, as well as other invertebrate fossils. The Scamander Formation contains an orthoconic cephalopod generically, possibly even specifically, the same as that in the Corn Hill Formation, many dacryoconarids, generically and specifically the same as those in the Corn Hill Formation, and a *Monograptus* close in age to but specifically different from that in the Corn Hill Formation (Rickards & Banks 1979).

Depositional and palaeoecological features link the Corn Hill Formation to the Sidling sandstone and more strongly to the Scamander Formation. The Corn Hill Formation and the similar units within the Panama Group further east in Tasmania show close lithological, sedimentological and palaeontological links with the approximately contemporaneous Wilson Creek Shale in the eastern part (Mount Easton Province) of the Melbourne Zone in Victoria, as noted by Banks & Rickards (1989) and earlier authors. The graptolite–land plant association for which the Wilson Creek Shale is "famous" (VandenBerg *et al.* 2000: 151) is also present in the Corn Hill Formation, as noted by Banks & Rickards (1989); there are genera and probably species of bivalves and dacryoconarids in common, and the orthoconic cephalopod with tubular walls was first noted in Australia as *Orthoceras striatopunctatum* by M'Coy (1879) from the Mount Easton Province.

In contrast, the Corn Hill Formation and equivalent units in the Panama Group are somewhat to very different sedimentologically and palaeontologically from the slightly older Bell Shale (Eldon Group) and the approximately contemporaneous Point Hibbs Limestone in western Tasmania. Baillie & Williams (1975: 7) concluded that the Bell Shale was deposited in shallow water, at times from waning currents, and gave no evidence of turbidity currents. Vascular land plants have been reported from the equivalent of the Bell Shale on the Gordon River but are rare to very rare; graptolites have not been reported from Devonian units in the Eldon or Tiger Range Groups. Bivalves have been reported from the Bell Shale but are yet to be properly studied; cephalopods are rare. Dacryoconarids are present but far from abundant. The palaeoecology of the Bell Shale and McLeod Creek Formation, respectively in the Eldon and Tiger Range Groups, and slightly older than the Corn Hill Formation (Talent *et al.* 2000: 254, Correlation Chart), and of the approximately contemporaneous coralline Point Hibbs Limestone (Talent *et al.* 2000: 254), all in westen Tasmania, seems to be quite different from the palaeo-ecology of the Corn Hill Formation.

IMPLICATIONS

The thrust model used by Gee & Legge (1971, 1979) to explain the structural setting of the Palaeozoic rocks of the Beaconsfield district has stood the test of time (Elliott *et al.* 1993, MacDonald *et al.* 2001, Reed *et al.* 2001) and is not reiterated here. Gee & Legge (1971), in assigning a Cambrian age to the strata on Leviathan Hill, interpreted the Cabbage Tree Thrust as occurring midway between Peaked Hill to the southwest and Cabbage Tree Hill to the northeast. However, recognition of the Corn Hill Formation in the Blyth Creek/Leviathan Hill area has tightly constrained the Cabbage Tree Thrust, at the base of the Cabbage Tree slice of Palaeozoic strata, to a position between Leviathan Hill and Cabbage Tree Hill, as stated by MacDonald *et al.* (2001) (fig. 1). The thrust is one of several in the Beaconsfield district of early Middle Devonian (late-stage Tabberabberan) age, which, as illustrated by Powell & Baillie (1992: 203), facilitated southwest directed crustal shortening. Various models, such as proposed by Powell (1991), Keele *et al.* (1994) and Taheri & Bottrill (1994), suggest that basal thrusts provided a conduit for fluid transport across northeastern Tasmania. As a result of the constraint placed upon the position of the Cabbage Tree Thrust, the latter is now considered to be the primary conduit for the gold-bearing fluids which gave rise to the shear-hosted Tasmania Reef in Cambro-Ordovician sedimentary rocks immediately to the northeast (Hills *et al.* 2001). The Tasmania Reef is the largest gold deposit of its type in Tasmania and it is currently being exploited by the Beaconsfield Gold Mine.

The Corn Hill Formation also has regional stratigraphic and tectonic significance which requires some background explanation. The idea of a terrane boundary of some sort between northeastern and western Tasmania has been argued for a number of years. Leaman *et al.* (1973: 2, 3) suggested that the Tamar Valley separated two structural regimes, and referred to a major lineament along the Tamar line and to the lithological and structural asymmetry across that line up to Middle Palaeozoic times. This idea was taken up and expanded by Williams (1976: 23) who referred to the feature as the "Tamar Fracture System". This Fracture System was seen as separating the Western Tasmania Terrane (Wurawina Supergroup) from the Eastern

Tasmania Terrane (the Mathinna Supergroup). Baillie (1985) referred to it as a "suture" and Williams (1989: 486–491) gave a summary of the elements of the asymmetry. Several of the authors in the Geophysics chapter (13) of Burrett & Martin (1989) referred to the Fracture System, e.g. Leaman (p. 452), Parkinson and Richardson (p. 458), Wellman (pp. 459–461) and Richardson (p.466), and some problems were noted. The existence of the Fracture System (Leaman 1994) and its position, i.e. the boundary between the Eastern and the Western Terrane, have been debated (Elliott *et al.* 1993, Leaman 1994, Hills 1998, Reed 2001b). The present conundrum is the recognition of the Corn Hill Formation, correlated with the Mathinna Supergroup, part of the Eastern Tasmania Terrane, lying not only west of the Tamar River, but also west of outcrops of Wurawina Supergroup rocks, Denison and Gordon Groups, characteristic of the Western Tasmania Terrane.

The germ of one solution to the anomaly of the position of the Corn Hill Formation emerged first in 1973 (before the Formation had been recognised), when a geophysical anomaly in the Dazzler Range west of Beaconsfield was attributed to thrusting (Leaman *et al.* 1973). A little later, Gee & Legge (1979: 29, fig. 9) depicted southwesterly directed thrusting to explain the relationships of Palaeozoic rocks near Beaconsfield. The idea of such thrusting was further developed and applied on a broader scale in northern Tasmania by Powell & Baillie (1992). However, their sections do not explain the occurrence of the Corn Hill Formation (of Eastern Tasmanian Terrane affinity) west of Denison Group rocks (of Western Tasmania Terrane affinity) at Beaconsfield.

A further step in the solution of this anomaly began to emerge when Banks & Smith (1968) suggested the possibility of recumbent folds in the slate at Turquoise Bluff. Subsequently, Gee & Legge (1979: 40) inferred the presence of a recumbent syncline between Beechford and Stony Head. Later, Powell & Baillie (1992) showed that the two formations of the Tippogoree Group were folded into a large recumbent, east-facing syncline. Reed (2001b) suggested that rocks affected by this fold had one more cleavage than the younger Panama Group close by and quoted Cocker (1982), who suggested an age of 423 ± 22 Ma for the low-grade regional metamorphism of the Turquoise Bluff Slate based on Rb/Sr ratios. This suggested to Cocker (1982: 154) a likely age of Middle Silurian, but with an age within the span from Late Ordovician to Early Devonian. He tentatively suggested (Cocker 1982: 155) a correlation with the Benambran Orogeny. This correlation was developed by Reed (2001b). As has been shown earlier, sedimentological and palaeontological characters link the Corn Hill Formation to the Panama Group, more specifically the Sidling sandstone.

Reed (2001b: 792, fig. 6) went further to propose north-easterly directed thrusting in the Benambran Orogeny, followed by deposition of the Panama Group, with later southwesterly directed thrusting in the Devonian as part of the late Tabberabberan movements in order to provide a possible explanation of the current juxtaposition of the Mathinna and Wurawina Supergroups near Beaconsfield. The boundary between the two supergroups may have been in about the same place from Early Ordovician to Early Devonian time or may have varied in position. In neither case has any original boundary been recognised. Any boundary or boundaries may well be hidden below cover rocks in the Tamar Valley region or thrust out in the Benambran and/or Tabberabberan Orogenies, as suggested in principle by Powell *et al.* (1998, fig. 15), who showed the Western and Eastern Terranes separated by a gap of about 70 km in the Emsian.

The recognition of Benambran deformation in the Mathinna Supergroup is a key difference between the models of Reed (2001b) and Powell & Baillie (1992). As some earlier authors, Powell & Baillie (1992) correlated the Mathinna Supergroup with the Melbourne Zone in Victoria, a zone in which Benambran deformation is not observed. Reed (2001b) maintained that the deformation of the Tippogoree Group associated with the Benambran Orogeny demonstrated tectonic affiliation of northeastern Tasmania with the Tabberabbera Zone, immediately east of the Melbourne Zone in Victoria, presumably in Late Ordovician and Early Silurian time.

Powell & Baillie (1992: 207) noted the similarity in the type of cleavage developed between the Stony Head Sandstone and rocks on the south coast of NSW, the Adaminaby Group, several areas of Lower Ordovician rocks in the Benambra Terrane and a cleavage approaching stripy cleavage in the "Lower Ordovician part of the the Melbourne zone" (i.e. in the western part of that zone). Thus, Moore *et al.* (1998: 108, fig. 1) showed an Adaminaby Group equivalent in the Tabberabbera Zone (Pinnak Sandstone, with which Reed (2001b) correlated the Stony Head Sandstone) and in the Bendigo Zone (Castlemaine Supergroup) extending for a time into the Melbourne Zone. The Bendigo Zone, like the Tabberabbera Zone, exhibits Benambran deformation. Therefore correlation of the Stony Head Sandstone with the Castlemaine Group is not inconsistent with the observations made by Powell & Baillie (1992) and accommodates the key element of Benambran deformation recognised by Reed (2001b).

The graptolite *Loganograptus* cf. *logani* from the Early Ordovician Turquoise Bluff Slate (Banks & Smith 1968) suggests a relationship with the Bendigo Zone or the western part of the Melbourne Zone of Victoria as a distinct possibility. Elsewhere in the Mathinna Supergroup, late Ludlow graptolites occur at Golden Ridge northwest of Scamander (Rickards *et al.* 1993); these suggest affinity with the Humevale Formation in the Darraweit Guim Province in the north-central part of the Melbourne Zone. In even younger (Pragian) parts of the Mathinna Supergroup, the Scamander Formation and the Corn Hill Formation, faunal and sedimentological relationships are with the Wilson Creek Shale in the Mount Easton Province of the Melbourne Zone. *Monograptus thomasi* (Banks & Rickards 1989 and herein) has been recorded from the Wilson Creek Shale but not from units in the Tabberabbera Zone; although this may be the result of ecological differences, the benthonic faunal elements as well as the planktonic graptolites are similarly restricted.

Thus, sedimentological, faunal and structural characters of the Mathinna Supergroup are consistent with affinity of these northeastern Tasmania rocks with rocks in the Bendigo Zone in pre-Benambran time and show a strong affinity with those in the Melbourne Zone after that Orogeny.

Reed (2001b) also recognised a parallel between the lack of evidence of Benambran deformation in the Late Cambrian and Ordovician Denison and Gordon Groups, i.e. pre-Benambran rocks, in western Tasmania generally and particularly in those rocks in the Beaconsfield area (overlain disconformably by the Corn Hill Formation), and a similar lack in the correlative rocks in the Melbourne

Zone in Victoria. He suggested that the Wurawina Supergroup was shielded from the effects of the Benambran deformation by underlying continental basement, in much the same way that Cayley *et al.* (1999) rationalised the lack of Benambran deformation of pre-Benambran Palaeozoic rocks in the Melbourne Zone as being due to shielding by underlying continental basement. VandenBerg *et al.* (2000: 357, 358, fig. 5.2) showed the basement beneath central Victoria as the Selwyn Block, which they argue represents a continuation of the Proterozoic to Cambrian crust beneath Tasmania deformed in the Cambrian Tyennan Orogeny. This correlation is strongly supported by the continuity of aeromagnetic data across Bass Strait (VandenBerg *et al.* 2000: 358, fig. 5.2).

Remnants of the Selwyn Block have been mapped in isolated locations in southern Victoria, notably Waratah Bay. Indeed, Cayley *et al.* (2002: 233) mapped the upper contact of the Selwyn Block, the Tyennan Unconformity, at Waratah Bay, and correlate the strata above the unconformity directly with the Wurawina Supergroup in Tasmania. VandenBerg *et al.* (2000:159) and Cayley *et al.* (2002: 228, 234, fig. 2) considered that the Selwyn Block at Waratah Bay and extending to the north beneath the Melbourne Zone was a topographic high, the Waratah Bay Platform, for much of the Early and Middle Palaeozoic. The Wurawina Supergroup correlates of the Waratah Bay Platform at Waratah Bay are thin, and the sequence is incomplete in comparison to those in Tasmania. The Waratah Fault transposes the Devonian Liptrap Formation, which VandenBerg *et al.* (2000: 148, fig 2.106) correlated with the Eildon Sandstone of the Mount Easton Province of the Melbourne Zone, immediately underlying the Wilson Creek Shale. This relationship between Wurawina Supergroup correlates and the Melbourne Zone at Waratah Bay in Victoria, has strong parallels with that between the Wurawina Supergroup and the Corn Hill Formation at Beaconsfield in Tasmania and warrants further study.

SUMMARY AND CONCLUSIONS

Recent discovery of a Pragian (Early Devonian) graptolite (*Monograptus thomasi*) west of Beaconsfield has allowed recognition of a northerly extension of the previously known outcrop of the Corn Hill Formation and requires that the Cabbage Tree Fault lies east of its earlier postulated position, thus closer to Beaconsfield. This fault is thought to have been a feeder channel to the gold deposit at Beaconsfield.

The sedimentological characters and fauna of the Corn Hill Formation strongly suggest connection with the Scamander Formation of the Panama Group of the Mathinna Supergroup in northeastern Tasmania and with rocks in the Melbourne Zone in Victoria. This affinity seems to be consistent with older but post-Benambran connections. Pre-Benambran connections of the Supergroup seem most likely to have been with the Bendigo Zone.

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APPENDIX

Corn Hill Formation — Definition and Comments by P.B. Hills

The Corn Hill Formation is defined as that succession of cleaved micaceous shaley siltstone with lesser quartzwacke sandstone, siltstone and shale units, of generally turbiditic character cropping out east of Flowery Gully and extending northwest over a strike length of approximately 12 km to the vicinity of Leonardsburg in the Beaconsfield district in northern Tasmania (fig. 1). The type locality of the formation is at 146°50'E, 41°16'S on Bulls Road, where it was first mapped in substantial road cuttings as the Corn Hill beds by Hills (1982) and where Banks & Rickards (1989) reported the first occurrence in Tasmania of *Monograptus thomasi*.

The Corn Hill Formation exhibits alternation from shale to quartzwacke sandstone over intervals of approximately a metre, many forming Bouma sequences. Sedimentary structures such as slumping, flute casting (e.g. pl. 1A), cross bedding, and small scale erosional cut-offs are common (specimens in the collection of the School of Earth Sciences, University of Tasmania, include numbers 61 846–50 and 63 909–17). Readings on flute casting and cross bedding, in particular, indicate current movement from the WSW (fig. 2). Fossils occurring at the type locality include, in addition to *M. thomasi*, pelecypods, e.g. *Actinopteria meridionalis*, *Praecardium* sp. and several others not yet identified, the dacryoconarid *Styliolina minuta*, numerous cephalopods, a trilobite and plant fragments (specimens in the collection of the School of Earth Sciences, University of Tasmania, include numbers 121 286–305 and 123 5834–628 and others). Many of the invertebrate fossils are fragmentary and show signs of transport prior to burial. The recently discovered occurrence of *M. thomasi* in Blyth Creek, 5 km to the NNW of the type locality, is the only other known fossil locality in the formation. The Corn Hill Formation is considered to have been deposited in a moderate energy, deep water, outer shelf environment.

The stratigraphic and structural setting of the Corn Hill Formation was recently revised by MacDonald *et al.* (2001). The unit disconformably overlies the Johnston Creek Siltstone of Late Ordovician or Early Silurian age. The latter unit may be a correlate of the Arndell Sandstone (including the Westfield Beds) at the top of the Gordon Group of southern-central Tasmania or of the Eldon Group of western Tasmania and represents the uppermost strata of the Wurawina Supergroup in the Beaconsfield district. The Corn Hill Formation may be up to 600 m thick, although the actual thickness is difficult to determine, due to poor outcrop in a region of some structural complexity. There is evidence of folding, perhaps of recumbent folding, within the unit at Flowery Gully. Specifically, the Corn Hill Formation is apparently confined to the Peaked Hill slice of Palaeozoic strata, as defined by Gee & Legge (1979), is truncated by the Cabbage Tree Thrust, and is not mapped in the overlying Cabbage Tree slice or the Cobblestone Creek slice.

The Corn Hill Formation is correlated with the Sidling sandstone, the upper formation of the Mathinna Supergroup of northeastern Tasmania, and with the Scamander Slate and Quartzite, on lithological, sedimentological and palaeontological grounds. Thus, it is considered, as part of the Mathinna Supergoup, to be a unit within the Lachlan Fold Belt. It is also correlated palaeontologically with the Wilson Creek Shale in the Melbourne Zone of the Lachlan Fold Belt in Victoria.

The Corn Hill Formation was first recognised as a Pragian correlative of the Mathinna Supergroup by Hills (1982). Previously, Kennedy (1971) had noted similarity between the rocks east of Flowery Gully and the Mathinna Supergroup, without further detail. He recalled an earlier suggestion by Green (1959) that rocks then exposed in Beaconsfield (the Grubb Beds) were also similar to rocks in the Mathinna Supergroup, but the Grubb Beds have subsequently been correlated with the Johnston Creek Siltstone and the Eldon Group of western Tasmania. The Mathinna Supergroup correlation was recognised by Elliott *et al.* (1993), a correlation discounted by Powell *et al.* (1993), but the sedimentological correlation has now been accepted after further examination in the field by Baillie (pers. comm.). The unit was further discussed by MacDonald *et al.* (2001) and Reed (2001b).