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Iron plant (*Astrotricha hamptonii*, Araliaceae): an enigmatic species with a rich history in bioprospecting

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Abstract

Astrotricha hamptonii F.Muell. (Araliaceae) is essentially restricted to the Hamersley Range in the Pilbara region of Western Australia where it grows on cliffs in rock fissures, and on scree slopes. This distinctive plant almost always grows in association with iron ore deposits on banded ironstone formations. Recognisable from the air, this species was used by prospector and pastralist, Lang Hancock's prospecting partner, Ken McCamey, to accurately map the distribution of many of the richest iron ore deposits in the Hamersley Range. This paper provides the first detailed taxonomic description of this species to be published in English. A summary of its use for bioprospecting is provided.

Introduction

Astrotricha hamptonii F.Muell. was named by Ferdinand von Mueller in 1868. Material was sent to Mueller by Charles Harper, a local pastoralist, who collected specimens while looking for favourable grazing land in 1866. However, it remained a rarely collected and poorly known species until made famous in Western Australia in the 1950's. Ken McCamey, an associate of Lang Hancock, identified this species as one of the keys to identifying iron-rich geological formations from the air, providing a simple means for mapping the most prospective areas for further exploration (Moyes 1973).

Astrotricha DC. is endemic to Australia, and appears to be among the earliest diverging lineages in core Araliaceae (Wen *et al.* 2001, Plunkett *et al.* 2004, Li and Wen 2014). Li and Wen (2014), using a combination of plastid and internal transcribed spacer data, arrived at an estimated divergence date for *Astrotricha* of around 90 MYa. Of the 19 formally recognised species of *Astrotricha*, 18 are restricted to eastern Australia, ranging from Victoria to north-east Queensland (Stanley and Ross 1986, Bean 1991, 1995, Makinson 1991, Henwood and Makinson 1992, Henwood *et al.* 1999). A significant number of regional variants in eastern Australia require further taxonomic investigation. Only *A. hamptonii* is known outside of this range, endemic to the Pilbara and Gascoyne regions of Western Australia, a disjunction of almost 2,000 km from all other species. Relatively little data are available on the phylogenetic relationships within *Astrotricha* (Plunkett *et al.* 2004), but based on fruit morphology, *Astrotricha hamptonii* appears to show an affinity with a group of species characterised by fruit with well developed marginal wings (*A. pterocarpa* Benth., *A. cordata* A.R.Bean and *A. intermedia* A.R.Bean) from northern New South Wales and far north Queensland. The Pilbara region, and in particular the Hamersley Range geological block, is known to be an area of ancient endemism with a relatively large number of early-diverging and relictual lineages surviving there (Pepper *et al.* 2008, McKenzie *et al.* 2009).

Bioprospecting and the beginning of the Western Australian iron ore boom

The commercial history of iron ore discovery in Western Australia is as contentious as it is important for the recent history and ongoing economic future of the state. It is generally acknowledged that iron ore in the Pilbara region was first (briefly) reported by Francis Thomas Gregory during his expedition to the Pilbara in 1861 (Gregory and Gregory 1884), and large quantities were documented by State Government geologist Henry Page Woodward in the 1880's (Woodward 1890, 1891, 1894, 1911, Blockley 1975, O'Leary 1993). With a focus on exploration for gold, Maitland (1904, 1905, 1906, 1908) provided further details on the distribution of iron ores in the region. However, these surveys did not emphasise that the iron ore bodies were of commercial-grade, probably largely due to the isolation of the deposits and the preoccupation with locating gold. The first report of a commercial-grade iron ore body, and the subsequent advocacy for mining them, appears to be from a survey of Mount Goldsworthy by K.J. Finucane and R.J. Telford in 1938 (Finucane and Telford 1939).

It was largely the efforts of Lang Hancock and his partners that brought the true extent and potential economic value of the Pilbara's iron ore deposits to light in the 1950's, at a time when exports of iron ore were banned and new tenements could not be pegged (Phillipson 1974, Duffield 1979, Hancock 1979, Marshall 2001). Hancock, a local pastoral lease owner with a significant interest in developing mining operations in the Pilbara, recognised the presence of massive iron ore bodies when flying low over the landscape in a small plane as he was flying south to Perth (Duffield 1979). Mapping the distribution of iron ore bodies by flying over the Hamersley Ranges and observing the outcrops of red, iron-rich rock, Hancock was joined in the search by several geologists and exploration partners in an effort to quantify the value of the deposits and their viability for mining (Moyes 1973).

It was Hancock's prospecting partner, Ken McCamey, who recognised that *Astrotricha hamptonii* grew in a very specific association with iron ore bodies on the cliffs and slopes throughout the landscape (Moyes 1973, Brown 2005). The plants themselves grew on the cliff-lines, with the white stems contrasting strongly against the rusty-red rock. In McCamey's words: "One almost certain sign is what we call the 'iron tree'. It has a white trunk and a green top and grows to about eight feet. Nine times out of ten you find it in iron, and always on the southern side of an ore body. Its roots go down in the leach holes where the silica has leached out" (in Moyes 1973: 42). McCamey also recognised that some other vegetation was associated with the same habitats: "Then there's smaller vegetation to watch for. Poor quality, hungry-looking spinifex, for instance. Or a tree with red curly bark the natives call 'minnarichie'." (quoted in Moyes 1973). Many *Triodia* species ('spinifex') can be found in the same area, with *Triodia* sp. Karijini (S. van Leeuwen 4111) being restricted to outcrops of the Brockman Iron Formation and *T.* sp. Shovelanna Hill (S. van Leeuwen 3835) is often found in similar situations (Western Australian Herbarium 1998–). "Minnarichie" almost certainly refers to a relatively widespread wattle in the Pilbara, *Acacia rhodophloia* Maslin which has curly red bark also known as 'Minni Ritchi' (Maslin *et al.* 2013: 552). This species has a distinctive low-growing form on the ridges of the Hamersley Range (Maslin 2014). While Dixon *et al.* (2006) could not trace the origin of the name 'Minni Ritchi', this reference suggests it may have its origins in *Thalanyji* or a related language from the western Pilbara (Hayes and Hayes 2007). Recognition of these close botanical associations was important for Hancock and McCamey in preparing maps that would subsequently be used to make claims on land for prospecting and mining licences. *Astrotricha hamptonii* is well known locally, but has received scant attention in publications (Mueller 1868, Moyes 1973: photographs pp. 29, 37; Wearne *et al.* 1984).

Today, the geology of the Pilbara has been extensively examined, with iron ore mined in the Pilbara region one of Australia's key exports and a major contributor to the Australian economy (Kay *et al.* 2012). Conversely, the biodiversity of the region is still poorly known and a great deal of additional research is required to understand the unique biological resources of the Pilbara (McKenzie *et al.* 2009).

Habitat specialisation

Habitat preferences in the genus *Astrotricha* vary considerably, but most species occur in generalist habitats in woodland. *Astrotricha pauciflora* A.R.Bean is an exception as it grows in rock fissures, though these are surrounded by woodland rather than being on cliffs (Bean 1997). *Astrotricha hamptonii* has specifically adapted to become cremnophytic, or cliff-dwelling. This habitat specialisation is seen in other Western Australian species, *Boronia cremnophila* R.L.Barrett, M.D.Barrett & Duretto (Barrett *et al.* in press), *Ficus lilliputiana* D.J.Dixon (Dixon 2001), *Kunzea* sp. Keep River (D.Siversten 739) (R.L. Barrett unpubl. data), *Lepidosperma ferricola* R.L.Barrett (Barrett 2007, 2013), *Lindernia cleistandra* W.R.Barker, *L. eremophiloides* W.R.Barker (Barker 1990), *Pityrodia obliqua* W.Fitzg. (R.L. & M.D. Barrett unpubl. data), *Tetratheca paynterae* J.J.Alford subsp. *paynterae* (Alford 1995), *Tetratheca paynterae* subsp. *cremnobata* R.Butcher (Butcher 2007, Butcher *et al.* 2007), *Triodia cremnophila*

R.L.Barrett & M.D.Barrett (Barrett and Barrett 2011) and *T. fissura* R.L.Barrett, G.B.Wells & K.W.Dixon (Barrett *et al*. 2005). Specialisation to growing on cliff faces requires a number of specific physiological adaptations to survive these extreme conditions (Larson *et al*. 2000). Advantages of adapting to these habitats include a relatively stable climate and protection from fire (Larson *et al*. 2000). The ecology of these species is somewhat comparable to those growing on granite rock outcrops (see Hopper *et al*. 1997).

A number of other species in the Pilbara region have adapted to similar habitats, either extending to, or sometimes restricted to, the margins of cliffs, rocky outcrops, and ridge crests. These include *Acacia bromilowiana* Maslin, *A. thoma* Maslin (Maslin and van Leeuwen 2008), *A. rhodophloia* (Maslin 1980), *Corymbia ferriticola* (Brooker & Edgecombe) K.D.Hill & L.A.S.Johnson (Brooker and Edgecombe 1986), *Cryptandra monticola* Rye & Trudgen (Rye and Trudgen 1995), *Dampiera anonyma* Lepschi & Trudgen, *D. metallorum* Lepschi & Trudgen (Lepschi *et al*. 2004), *Eucalyptus aridimontana* D.Nicolle & M.E.French (Nicolle and French 2012), *E. pilbarensis* Brooker & Edgecombe (Brooker and Edgecombe 1986), *Gompholobium oreophilum* C.F.Wilkins & Trudgen (Wilkins and Trudgen 2012), *Grevillea saxicola* S.J.Dillon (Dillon 2014), *Pilbara trudgenii* Lander (Lander 2013), *Pleurocarpaea gracilis* Lander & P.J.H.Hurter (Lander and Hurter 2013) and *Ptilotus subspinescens* R.W.Davis (Davis 2007).

In the Kimberley region, *Eucalyptus ordiana* Dunlop & Done, *Jacquemontia* sp. Keep River (J.L. Egan 5015), *Triodia barbata* R.L.Barrett & M.D.Barrett and *T. fitzgeraldii* N.T.Burb. are known to occur in association with the margins of banded ironstone cliffs, but all of these species also occur in similar habitats on sandstone in the region (Barrett and Barrett 2011). Species specific to banded ironstone formations and related geologies in southern Western Australia have been reviewed by Gibson *et al*. (2007, 2010) who listed 44 taxa as being endemic to ironstone habitats.

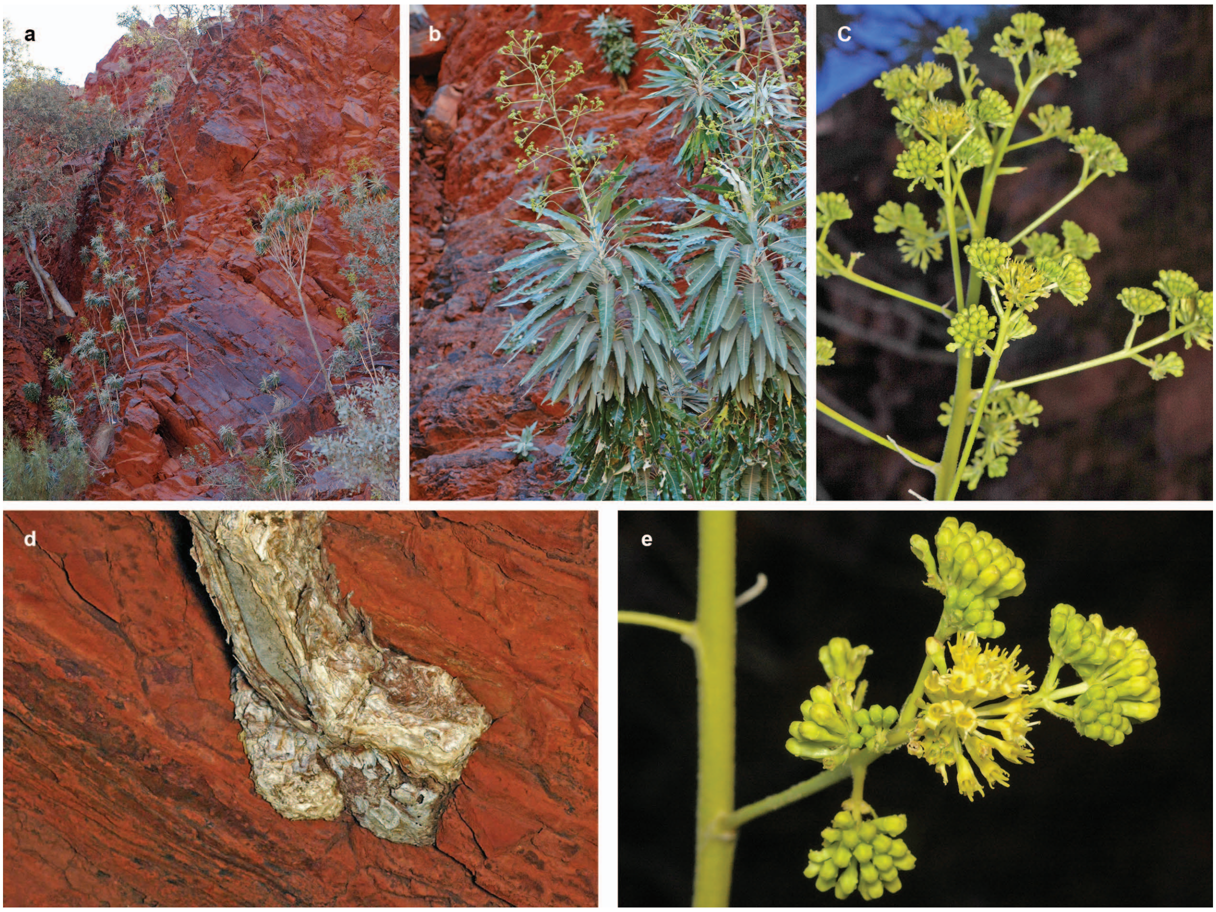

Figure 1. *Astrotricha hamptonii*. **a.** habit and habitat on banded ironstone formation cliff face; **b.** flowering plant; **c.** inflorescence; **d.** swollen stem base in rock fissure; **e.** Flowers and buds. Images from *R. Purdie* 7400. Photographs by M. Fagg, ANBG Collection.

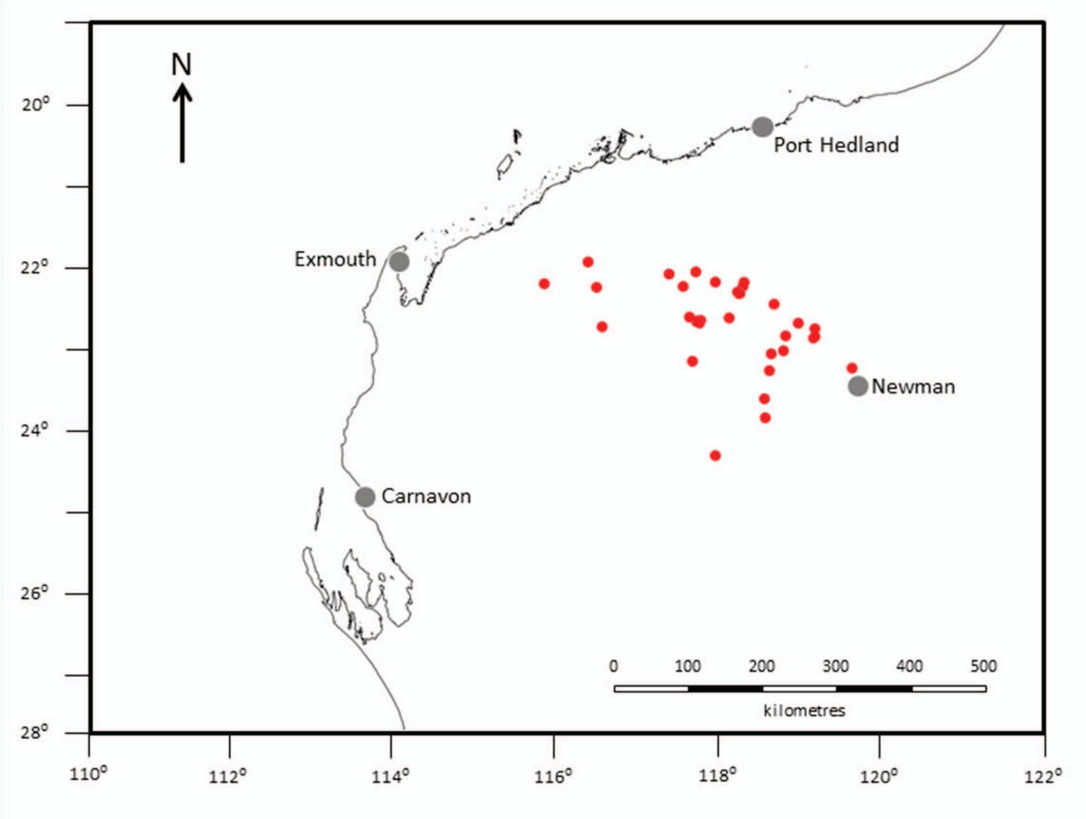

Figure 2. Distribution of *Astrotricha hamptonii* based on data from the *Atlas of Living Australia* (Accessed 7 September 2014). Filled red circles indicate localities of *A. hamptonii* collections.

Methods

The following description is based on dried herbarium specimens, including type material held at CANB, MEL, NSW and PERTH.

Taxonomy

Astrotricha hamptonii F.Muell., *Fragmenta Phytographiae Australiae* 6(45): 125, t. 58 (1868) (as '*A. Hamptoni*').

Holotype: "In hiatibus rupium ad montes Hammersly-Range; *C. Harper*." [In rocky cleft on the mountains of the Hamersley Range, Western Australia, 1866], *C. Harper s.n.* (MEL 119629!).

Shrub to small tree, 1–2(–3) m high, erect, sparsely branched (crown usually 30–60 cm wide), often single-stemmed, young stems indumented, becoming glabrous and fissured (tessellated) with age, usually *c*. 2 cm diam.; base often swollen at point of contact with rock substrate. *Indumentum* on stems, petioles, leaves and bracts stellate-pubescent, with individual hairs 0.20–0.35 mm across (dense on new growth). *Leaves* estipulate, spirally alternate, clustered towards branch tips, narrowly lanceolate to narrowly ovate (occasionally almost linear), 75–170(–250) mm long, 17–30(–60) mm wide; apex acuminate to attenuate; base obtuse; adaxial lamina surface dark green, sparsely stellate hairy or glabrescent, abaxial lamina surface densely covered in a velutinous white to cream indumentum (hairs persisting on old leaves); midrib and lateral veins sunken adaxially, raised abaxially; margins entire; petioles terete, 33–88(–106) mm long, densely covered in a velutinous white to cream indumentum. Inflorescence a thrice-branched terminal panicle, main axis 15–39 cm long, moderately to sparsely stellate-hairy when young, glabrescent when fruiting, green; secondary inflorescence branches similar to main axis, 24–114 mm long, sparsely indumented or glabrous, bearing 1–4 tertiary branches. *Flowers* aggregated into umbels terminating each inflorescence branch, anthesis proceeds sequentially from from main axis to highest order branches. *Umbels* with 8–26 flowers subtended by a triangular involucral bract 3–5.5 mm long; peduncles 2.5–3.8 mm long, glabrous; pedicels slender, pedicels 1.2–2.6 mm long in flower (to 3.2 mm long in fruit). *Flowers* bisexual, protandrous, 2–2.5 mm across; hypanthium glabrous, 3.3–4.3 mm long, turbinate. *Sepals* basipetally fused into a short tube surmounted by 5 lanceolate to ovate lobes, 0.5–0.8 mm long, 0.2–0.3 mm wide, green, glabrous, apex acute or obtuse. *Petals* 5, ovate to deltate, 1.9–2.8 mm long, 1–1.2 mm wide, pale green to yellowish green, recurved, caducous; glabrous, margins with fine papillae; apex acute to obtuse. *Stamens* 5, alternating with the petals; filaments subterete, flattened at base, 1.2–2.3 mm long; anthers cream to white, 1.4–2.1 mm long, versatile, dorsifixed, opening introrsely by longitudinal slits. *Styles* 2, fused at the base, 2.6–4.4 mm long, at first erect, later spreading from base, persistent. *Ovules* 1 per locule. *Fruit* a schizocarp, brown, glabrous, splitting longitudinally at maturity, laterally compressed, 5.5–7 mm long, (2.5–)2.8–3.5 mm wide, 0.9–1.2 mm thick, with very narrow wings developing at the commissural margins at the base of the calyx, to 0.1 mm wide; lacking a free carpophore; mericarps 1-locular. *Seeds c.* 3.6 mm long, *c.* 0.7 mm wide, cream, not readily released from mericarps. **Fig. 1**

Distribution and habitat: Almost entirely restricted to the Hamersley Range (W.A.) where it usually occurs on ironstone cliffs, scree slopes, and outcrops of the Brockman Iron Formation, along ridge tops and on valley walls (Figure 2). Some of these sites are on the highest peaks in Western Australia, at elevations above 1000 m. Most collections are from the otherwise almost bare faces of south-facing cliffs (large and small) and occasionally on east-facing slopes. Plants variously grow in very shallow soil derived from iron-rich parent rock or usually in fissures on the rock face with no soil. There are occasional records from the adjacent Murchison district where it grows in fissures on sandstone, demonstrating that this species is a cliff-face specialist rather than just an ironstone specialist. This species is usually locally common, just highly habitat specific. Recorded growing in association with *Acacia aneura*, *A. bivenosa*, *A. hamersleyensis*, *A. pruinocarpa*, *A. rhodophloia*, *A. spondylophylla*, *Callitris glaucophylla*, *Capparis spinosa*, *Corchorus tectus*, *Corymbia deserticola*, *C. ferriticola*, *C. hamersleyana*, *Cryptandra monticola*, *Eremophila jucunda* subsp. *pulcherrima*, *E. latrobei*, *Eucalyptus ewartiana*, *E. gamophylla*, *E. kingsmillii*, *E. leucophloia*, *E. lucasii*, *E. xerothermica*, *Goodenia stobbsiana*, *Hakea lorea*, *Hibiscus* sp. Gardneri (A.L. Payne PRP 1435), *Indigofera* sp. Fractiflexa (S. van Leeuwen 3773), *Mirbelia viminalis*, *Pimelea forrestiana*, *Plectranthus intraterraneus*, *Pomax rupestris*, *Pterocaulon serrulatum*, *Rhodanthe margarethae*, *Senna ferraria*, *S. glutinosa* subsp. *glutinosa*, *S. glutinosa* subsp. *pruinosa*, *Solanum* sp., *Triumfetta maconochieana*, *Triodia pungens*, *T. wiseana*, *T.* sp. Karijini (S. van Leeuwen 4111), *T.* sp. Shovelanna Hill (S. van Leeuwen 3835) and other *T.* spp.

Conservation status: *Astrotricha hamptonii* is relatively widespread in the Gascoyne IBRA region (IBRA 2012) and the southern part of the Pilbara IBRA region. It is well represented on banded iron stone in the Karijini National Park, and is not currently considered threatened. However, no formal assessment of the total number of plants across the geogrphic range of the species has been undertaken.

Phenology: Flowering and fruiting mostly August to November, but also recorded in December and occasionally from March to May. Flowering is likely to be in response to rainfall events.

Etymology: The epithet honours Doctor John Stephen Hampton, Western Australian Governor (1862–1868), with whom Mueller may have been in contact regarding the medicinal properties of plants collected by Hampton during the Gregory Expedition of 1855–1856 (Sena-Becker 2012).

Notes: Several collectors have noted that this species has a dinstinctive odour, describing it as mustard-, fenugreek- or curry-scented.

First collected by pastoralist Charles Harper in 1866 while exploring inland from Roebourne with Samuel Viveash (Battye 1972), with specimens sent to the Phytologic Museum of Melbourne (now National Herbarium of Victoria) from which the species was named (Mueller 1868). The common names of 'Hancock's Iron Ore Plant' or 'Iron Ore Plant' are applied throughout the Pilbarra (S. van Leeuwen pers. comm.).

Selected material examined: WESTERN AUSTRALIA: Gap in Kunderong Range, Turee Creek Station (southern lease), *c.* 7 km SW of Turee Creek homestead, 26 Oct 2000, *S.J. Black & D.M. Dureau s.n.* (PERTH); SW of Christmas Spring, Lamb Creek, 8 Oct 1966, *J.V. Blockley* 447 (CANB, KPBG); Site 11, South Kunderong Range, 6.9 km ESE of Spring Creek Camp, 28 km SSW of Turee Creek Station Homestead, N Gascoyne, 13 May 2003, *D.J. Edinger & G. Marsh* DJE 3566 (PERTH); near Newman, Dec 2011, *T. Erickson* TEE 797 (PERTH); South side of the Governor on the Governor ridge, 28 Jun 1995 *G. Errington* 466, *P. Cuneo, T. Armstrong & L. Sweedman* (NSW); Mount Amy, Red Hill Station, Nov 1941, *D. Ewing s.n.* (PERTH); Mt Pyrton, Hamersley Range, anno 1878, *J. Forrest s.n.* (MEL); Hamersley Range, near Mount McRae, 24 Aug 1932, *C.A. Gardner* 3157 (PERTH); Yandicoogina, 14 Sep 1980, *K.J. Gibbons* 159 (PERTH); E face of Mesa to W of Hamersley Gorge, 31 Oct 1983, *K.D. Hill* 445 *& L.A.S. Johnson* (CBG, NSW, PERTH, SYD); Wittenoom Gorge, 22 Oct 1963, *F. Lullfitz* 2744 (PERTH); Nicol Bay District, anno 1878, *McRae s.n.* (MEL); 29 km S of Quarry Hill, *c.* 140 km WSW of Tom Price, 3 Aug 1984, *K.R. Newbey* 10661 (PERTH); Silent Gorge, off Great Northern Highway, WNW of Newman, 24 Sep 2009, *R.W. Purdie* 7400 (CANB); Hamersley Ranges, Weano Gorge, 16 May 1992, *I.R. Telford* 11755 (CBG, 2 sheets); 'Manganese' Gully; Marandoo Ridge (the first ridge S of Mount Bruce), Hamersley Range, 27 Sep 1974, *M.E. Trudgen* 1141 (PERTH); Mount Lois, 100 m W of summit, 9.6 km S of High Bluff, 19.3 km NE of Mount Sheila, 12.2 km SE of Camp Anderson, Hamersley Range, 1 Nov 1992, *S. van Leeuwen* 1327 (CANB, PERTH); 16.3 km NNE of Mt Robinson, 31.3 km ENE of Mt Meharry, 40.8 km SE of Mt Windell, 37.7 km W of Weeli Wolli Spring, Hamersley Range, 23 Aug 1995, *S. van Leeuwen* 2020 (PERTH); 59.5 km ENE of Snowy Mountain, 22.3 km WSW of Mt Ella, 22.7 km SSW of West Angela Hill, 24.2 km NNW of Jupidana Well, Hamersley Range, Newman 1:250 000 map sheet, 23 Aug 1995, *S. van Leeuwen* 2030 (PERTH); Mt Samson, 7 km SW of Flagtop, 4.4 km SE of Mt Lionel, 11km NW of Mount Reeder Nichols, Hamersley Range, 10 Sep 1996, S. *van Leeuwen* 2690 (PERTH); 12.2 km S of Caliwinga Spring, 23.9 km NW of Mt McRae, 33.9 km W of Mt Lois, 34.1 km WSW of Hugh Bluff, Hamersley Range, 12 Sep 1996, *S. van Leeuwen* 2805 (PERTH); 24.8 km W of Mt Farquhar, 35.6 km SSE of Mt Rica, 26.6 km NNW of Quarry Hill, 25.1 km E of Urandy Creek Outcamp, Hamersley Range, 14 Oct 1998, *S. van Leeuwen* 4353 (CANB, PERTH); Pilbara, Mt Nameless, *c.* 1 km S from summit, *c.* 5 km SW from Tom Price township, 22 Sep 2006, *N.G. Walsh, D. Halford & D. Mallinson* 6481 (MEL, PERTH); Mount Lois, 11 Sep 1991, *Peter G. Wilson* 1032 *& R. Rowe* (CBG, NSW).

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