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Author(s): Ian R. H. Telford, Patrizia Sebastian, Jeremy J. Bruhl, and Susanne S. Renner
Source: Systematic Botany, 36(2):376-389. 2011.
Published By: The American Society of Plant Taxonomists
URL: http://www.bioone.org/doi/full/10.1600/036364411X569561

Systematic Botany (2011), 36(2): pp. 376–389

DOI 10.1600/036364411X569561

Cucumis (Cucurbitaceae) in Australia and Eastern Malesia, Including Newly Recognized Species and the Sister Species to *C. melo*

Ian R. H. Telford,[1,3] Patrizia Sebastian,[2] Jeremy J. Bruhl,[1] and Susanne S. Renner[2]

[1]Botany & N. C. W. Beadle Herbarium, School of Environmental and Rural Science, University of New England, Armidale, Australia
[2]Systematic Botany and Mycology, University of Munich, Menzinger Str. 67, 80638 Munich, Germany
[3]Author for correspondence (itelford@une.edu.au)

Communicating Editor: Mark P. Simmons

Abstract*—**Molecular phylogenetic analyses based on numerous plant accessions have shown that *Cucumis* comprises 25 species in Asia, the Malesian region, and Australia, rather than just two as traditionally thought. Among the 25 species several are new, and here we describe four from tropical Australia. The new species ***C. costatus, C. queenslandicus, C. umbellatus, and ***C. variabilis*** are illustrated, their distributions are mapped based on 7–50 collections per species, and information is provided on habitats and conservation status. We also validate ***C. althaeoides*** comb. nov. and ***C. argenteus*** comb. nov., update the description of *C. picrocarpus*, and provide a key to the 11 native and naturalized species of *Cucumis* occurring in Australia and eastern Malesia. The Australasian species diversity of *Cucumis*, a genus that until recently was held to be essentially African, is of interest also because Australia harbours the sister species to the commercially important melon, *C. melo*.

Keywords*—Cucumis picrocarpus*, melon, morphological characters, phylogenetics, sequencing herbarium specimens, taxonomy.

Phylogenetic reconstructions for the Cucurbitaceae have revealed unexpected relationships for Australian species and genera (Kocyan et al. 2007). Of particular interest is the discovery that *Cucumis* as traditionally conceived (Kirkbride 1993) is paraphyletic and that it comprises 25, rather than two, Asian, Malesian, and Australian species (Renner et al. 2007; Renner and Schaefer 2008; Sebastian et al. 2010). A particularly poorly understood African/Asian/Australian genus found embedded in *Cucumis* is *Mukia* Arn. In the last comprehensive treatment of the Australian Cucurbitaceae (Telford 1982), *Mukia* was presented as containing six species in Australia: the putatively widespread and polymorphic *M. maderaspatana* (L.) M. Roem. (now *Cucumis maderaspatanus* L.), *M. micrantha* (F. Muell.) F. Muell. (now *Austrobryonia micrantha* (F. Muell.) I. Telford), and five species not validly published but assigned code names. Based on molecular data, three of these unnamed species, together with *M. micrantha*, form a distinct clade, described as *Austrobryonia* H. Schaef., a genus of the tribe Bryonieae, an early branch in the Cucurbitaceae (Schaefer et al. 2008). Several other new combinations required by the molecular findings, but not concerning Australian species, have already been made (Ghebretinsae et al. 2007a; Schaefer 2007).

Molecular data obtained since 2007 for an increasingly comprehensive sampling of Asian and Australian specimens (over 100 accessions, mostly from herbarium collections) have revealed that the *Cucumis* species treated as *Mukia* sp. A and *M.* sp. B in the *Flora of Australia* (Telford 1982), and a third more recently discovered species, are close relatives, in line with their morphological similarity. These three species are sister to *C. javanicus* (Miq.) Ghebret. & Thulin (Fig. 1). Molecular data generated for the present study also show that *Melothria argentea* is a genetically distinct species of *Cucumis* (Fig. 1). Likewise, a species originally described as *Bryonia althaeoides* by Seringe (1828) and later regarded as a species of *Mukia* (Roemer, 1846) or *Melothria* (Nakai, 1938) turns out to be the sister species to *C. variabilis*, another new Australian species (Fig. 1). Lastly, the native Australian species *C. picrocarpus*, which had long been regarded as a synonym of *C. melo* (Kirkbride 1993), instead is the sister species to melon, *C. melo* (Fig. 1). The geographic origin of *C. melo* itself and its likely domestication in the Eastern Himalayas region are dealt with in a related paper (Sebastian et al. 2010). Because of the great interest of melon breeders in *C. picrocarpus*, we here provide an updated description of this species based on new observations in the herbarium and field. Lastly, we provide a key to the 11 native and naturalized species of *Cucumis* now known from Australia and adjacent eastern Malesia.

Materials and Methods

***Herbarium Work, Field Observations, Morphological Data*—**Specimens in BRI, CANB, DNA, MEL, NE, PERTH and QRS (now in CNS) were examined, and we also obtained scans of types from B, E, G-DC, and PR. Floral measurements were taken on rehydrated dried specimens. Fieldwork by the first two authors greatly improved understanding of the ecological niches of the native Australian species of *Cucumis*.

***Molecular Phylogenetics*—**The DNA sequence matrix for this paper is modified from the one used in Sebastian et al. (2010). That study included 113 accessions of *Cucumis* and its sister group, *Muellerargia* Cogn., sequenced for six chloroplast regions (the *trnL* intron, the intergenic spacers *trnL-F*, *rpl20-rps12*, and *trnS-G*; and the genes *rbcL* and *matK*) plus the nrDNA ITS1 and ITS2, and the intervening 5.8 S gene segment. The dataset comprised 6,202 aligned positions, and for the present study, we added sequences for two accessions from Timor (*C. althaeoides* Zippel 107 (L): *rpl20 - rps12* intergenic spacer (HQ439182); *Cucumis* sp. nov. collector ignotus 1305 (L): *rpl20 - rps12* and *trnS - trnG* intergenic spacers (HQ439180, HQ439181) to resolve the application of the name *C. althaeoides*. In the phylogeny shown here (Fig. 1) we excluded most African *Cucumis* and several undescribed species from mainland Asia and from Africa. The phylogeny in Sebastian et al. (2010: Fig. 2) and the one included here (Fig. 1) are not identical in their taxon sampling. Sequencing approaches and phylogenetic methods are as described in Sebastian et al. (2010). Maximum likelihood (ML) analyses (Felsenstein 1973) and ML bootstrap searches (Felsenstein 1985) were performed using RAxML (Stamatakis et al. 2008).

Voucher information and GenBank accession numbers are listed in Table S1 of Sebastian et al. (2010). The alignment used for the present study has been deposited in TreeBASE (study number S10944).

Results and Discussion

Based on the combined nuclear and plastid sequence data and geographic provenence of the samples (Fig. 1), there are

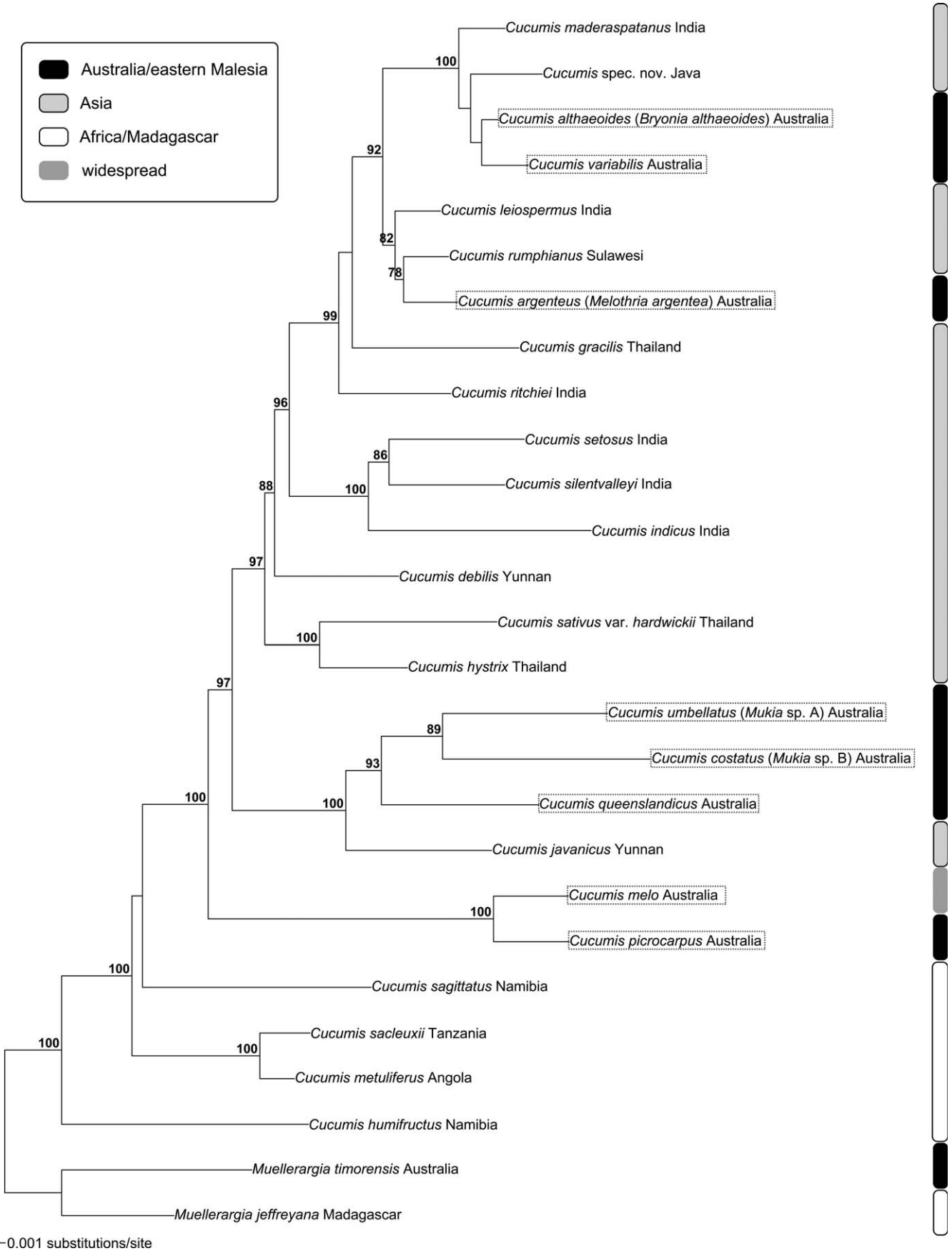

FIG. 1. Maximum likelihood tree for 27 species of *Cucumis* based on combined chloroplast and nuclear sequences; numbers at nodes are bootstrap values ≥ 75%. The tree is rooted on *Muellerargia*, the sister group of *Cucumis*. Geographic occurrence of species is color-coded (inset), and the geographic origin of each accession follows the species name. Species discussed in the text are marked by boxes.

eight indigenous species of *Cucumis* in Australia, of which one also occurs in Timor and southern New Guinea. *Cucumis maderaspatanus* does not occur in Australia (Sebastian et al. 2010; our Fig. 1), and previous citations of that species for Australia were based on misidentifications. Resolving the circumscription of all biological species hiding under the name *C. maderaspatanus*, however, requires an analysis of specimens from throughout the range of this putatively Asian/African species (De Wilde and Duyfjes 2006). In the present study, we begin this task by comparing relevant Australian specimens and names (Telford 1982), excluding those already transferred to *Austrobryonia* H. Schaef. (Schaefer et al. 2008).

Besides the eight native species of *Cucumis*, three African species have become widely naturalized in Australia, viz. *C. myriocarpus* Naudin, *C. zeyheri* Sond. in Harv. & Sond., and *C. metuliferus* E. Mey. ex Naudin, and there are also sporadically naturalized populations of cultivated melon, *C. melo*, a species that likely evolved in the eastern Himalayan region (Sebastian et al. 2010; contra Ghebretinsae et al. 2007b). Because of the potential interest for *Cucumis* breeders, we include a key to the 11 native and naturalized Australian species, following the taxonomic treatment of the four new species, two new combinations, and an emended description of *C. picrocarpus*.

Species of *Cucumis* native to Australia are descended from five ancestral lineages that arrived from southeast Asia several million years ago (Sebastian et al. 2010 for molecular clock estimates of divergence times in *Cucumis*). One of the five entries into Australia gave rise to *C. costatus, C. queenslandicus,* and *C. umbellatus*, while *C. picrocarpus*, *C. melo*, and *C. argenteus* represent independent arrivals to the continent (Fig. 1). The genetically distinct Australian endemic *C. picrocarpus* diverged from *C. melo* about 3 Ma ago (Sebastian et al. 2010), while Australian populations of *C. melo* all represent naturalized cultivated forms. The early dates of collection and their distribution suggest Australian *C. melo* to be indigenous, perhaps dispersed in preEuropean times by the aboriginal people as it is a wild food.

The last two Australian species, *C. variabilis* and *C. althaeoides,* represent another small 'radiation.' This limited diversification resembles the situation in other Cucurbitaceae colonizations of Australia (Schaefer et al. 2008, 2009). A recent review of vertebrate, invertebrate, and plant distribution ranges across the Australian monsoon tropics implicates the formation of the Carpentarian Gap, separating the Kimberley region and Arnhem Land from the Cape York Peninsula in the interruption of gene flow in numerous species (Bowman et al. 2009), and this event may also explain the *C. costatus* - *C. umbellatus* divergence (Fig. 1), which dates to the early Quaternary (Sebastian et al. 2010).

Cucumis queenslandicus, C. costatus and *C. althaeoides* inhabit savannah communities adapted to seasonal heavy rain and fire. They are perennials with thickened rootstocks allowing dormancy in the dry season and rapid growth in the wet. *Cucumis umbellatus* is an annual species occurring on the Kimberley – Arnhem Land sandstone plateau escarpments that are less fire-prone than savannah. *Cucumis variabilis* and *C. argenteus* inhabit some of the most arid parts of Australia and exhibit convergence vegetatively, both sometimes have leaves covered with dense, white, villous hairs (see the color photos of these species provided with their descriptions). *Cucumis picrocarpus* and the possible indigenous variant of *C. melo* grow on clay flats, such as alluvium on flood plains, but are recorded from a variety of habitats. More details about the vegetation types in which the Australian species occur are provided following the species descriptions.

Taxonomic Treatment

Key to Species of *Cucumis* in Australia and Eastern Malesia

Identification of Australian *Cucumis* specimens requires flowers, fruits, and seeds; vegetative material could be identified by sequencing the ITS region and then BLASTing sequences against the complete *Cucumis* species sample in GenBank. The key below is applicable only to Australian material and includes both native and naturalized species, with the introduced African species marked by an asterisk.

1. Female flowers in fascicles, sometimes coaxillary with several males 2
   2. Female flowers mostly 3–7 per axil; central Western Australia ..... *C. variabilis*
   2. Female flowers mostly 1 or 2, rarely 3 or 4 per axil; northern and inland Australia 3
      3. Seeds verrucose; mostly coastal E Malesia, northern Australia ..... *C. althaeoides*
      3. Seeds smooth; mostly inland Australia ..... *C. argenteus*
1. Female flowers solitary 4
   4. Seeds pitted or verrucose 5
      5. Fruit globose or subglobose 6
         6. Fruit 1–3 seeded; fruiting pedicel > 5 cm long; male inflorescence umbellate ..... *C. umbellatus*
         6. Fruit 6–25-seeded; fruiting pedicel <1 cm long; male inflorescences fasciculate ..... *C. althaeoides*
      5. Fruit ellipsoidal, fusiform or ovoid-fusiform 7
         7. Male inflorescence racemose; fruit strongly ribbed, the ribs scabrid ..... *C. costatus*
         7. Male inflorescence fasciculate, rarely racemose; fruit weakly ribbed, the ribs hispid ..... *C. queenslandicus*
   4. Seeds smooth 8
      8. Fruit aculeate; aculei scattered or dense, soft or rigid 9
         9. Fruit globose; aculei soft, scattered ..... **C. myriocarpus*
         9. Fruit ellipsoidal 10
            10. Aculei dense, soft ..... **C. zeyheri*
            10. Aculei scattered, rigidly pointed ..... **C. metuliferus*
      8. Fruit smooth or longitudinally ribbed, variously hairy, sometimes glabrescent 11
         11. Leaves unlobed or shallowly 3- or 5-lobed; lobes<one third of lamina width; fruit with short antrorse hairs; native or naturalized ..... *C. melo*
         11. Leaves deeply 5-lobed; lobes > one third of lamina width; fruit sparsely pilose with spreading hairs, glabrescent ..... *C. picrocarpus*

Cucumis picrocarpus F. Muell., descr. emend.

Cucumis picrocarpus F. Muell., Trans. Philos. Inst. Victoria 3: 46. 1859 as 'picrocarpa.'

Cucumis picrocarpus requires lectotypification because no specimens were cited in the protologue, only the distributional statement: "In many parts of tropical Australia" (von Mueller 1859). We carry out this lectotypification, together with another typification of a Mueller name, in an accompanying paper (I. Telford, et al. in prep.).

Cucumis trigonus auct. non Roxb.: Bentham, Fl. Austral. 3: 317. 1863; F. M. Bailey, Queensland Fl. 696. 1900.

Cucumis melo auct. non L.: I. R. H. Telford, Fl. Australia 8: 189. 1982 p.p.; J. H. Kirkbride, Biosystematic monograph of the genus *Cucumis* (Cucurbitaceae), p. 79. 1993 p. p.

Trailing or climbing annual herb, monoecious, hispid on most vegetative parts; stems to 1.5 m long, ribbed. Tendrils simple, to 8 cm long. Leaves: petiole 30–123 mm long; lamina broadly ovate in outline, 28–140 × 26–130 mm, mucronate, deeply palmately 5-lobed, the lobes lobulate, denticulate. Inflorescences unisexual. Male flowers in (1–)3–8 flowered fascicles or racemes; peduncles to 4 mm long; pedicels 3.5–12(–35) mm long; hypanthium narrowly campanulate, 3.8–4.3 mm long, hispid with spreading hairs; calyx lobes linear to narrowly triangular, 1.8–2 mm long, hispid; corolla lobes elliptic or ovate, 18–22 × 10–12 mm, mucronate, sparsely hispid outside, particularly apically, glabrous inside, yellow; stamens inserted towards the base of the hypanthium tube; anthers one 1-thecous, two 2-thecous, sigmoid, ca. 2 mm long; connective appendage ca. 1 mm long, lobed, papillose; disc depressed globose, ca. 0.6 mm diam. Female flowers solitary; pedicels 2–25 mm long; ovary ellipsoidal, 4–6.5 mm long, 3–3.8 mm diam, pilose with spreading hairs; hypanthium above constriction 2–3.2 mm long; perianth similar to male; disc annular, ca. 1 mm diam, lobed; style 0.6–1 mm long; stigmatic branches 1.5–1.7 mm long. Fruits subglobose to ellipsoidal, 28–55 mm long, 25–40 mm diam, sparsely pilose with simple, multicellular hairs, glabrescent, pale green with darker longitudinal markings; fruiting pedicel to 56 mm long. Seeds many, elliptic, 4–5.6 × 2.2–3 mm, ± compressed with the faces slightly convex, the remnant of the funicle often remaining attached, appearing wing-like, smooth, buff.

Representative Specimens Examined—AUSTRALIA. Western Australia: 3.5 km WSW of Barowana Hill, Hamersley Ranges, *Trudgen 18824* (PERTH); E side of old crossing at Fitzroy Crossing, *Mitchell 3070* (CANB, PERTH); Block 68, Sugar cane experimental area, Dept of Agriculture, Kununurra, *Aplin 6279* (K, PERTH); 100 m N of Lissadell Homestead main airstrip, 5 km NE of homestead, *Mitchell 3076* (CANB, PERTH). Northern Territory: Victoria Highway, ca. 19 km W from Victoria River crossing, *Purdie 3261* (CANB, NA); Sturts Creek North, Birrinbubu Station, *Maconochie 1753* (CANB, NT); Top Springs, *Telford 11659* (CANB, DNA, M, NE, NSW, US); Stuart Swamp, 5 km NNE of Daly Waters, *Latz 13729* (CANB, DNA); Rockhampton Downs, Government Paddock 7, *Wilson N402* (CANB, K, NT). Queensland: Camooweal Caves National Park, Nowranie Waterhole, *McDonald & Dennis 8916* (BRI, NE); Mount Eliza, 8.5 km along O'Briens Creek Road from Mount Surprise township, *Telford & Sebastian 13314* (M, NE), our Fig. 2A, B. New South Wales: Kirramingly Nature Reserve, ca. 30 km WSW of Moree, *Nano & M. Gardner NE96519* (NE); 'Burrenda', near Burren Junction, *Carrington CANB 310499* (CANB).

Distribution—Endemic to northern Australia from the Hamersley Ranges, Western Australia eastwards to Rockhampton, Queensland, and southwards in the Murray – Darling Basin to Burren Junction, New South Wales (Fig. 3).

Habitat—*Cucumis picrocarpus* grows in a variety of habitats, particularly on clay flats, such as alluvium on flood plains, but recorded also from rocky loam on hillsides. Vegetation communities include *Astrebla* grassland, grassy open woodland with *Eucalyptus*, *Bauhinia*, *Terminalia* and riverine woodland dominated by *Eucalyptus camaldulensis* Dehnh. and *E. microtheca* F. Muell.

Phenology—Flowers and fruits February–May.

Conservation Status—The species is widespread and common and is not considered at risk.

Notes—Von Mueller (1859) in the protologue described the fruits as extremely bitter. Several specimens in CANB and MEL were annotated "*Cucumis melo* subsp. nov." by Charles Jeffrey in 1986. *Cucumis picrocarpus* is sympatric with *C. melo* over much of its range (Fig. 3) but no intergrading or hybridization has been observed.

Cucumis melo L., Sp. Pl. ed. 1, 1011. 1753.—TYPE: SWEDEN: Plant cultivated at Uppsala (lectotype: LINN, sheet number 1152.8, photograph!); see discussion in A. D. J. Meeuse (1962).

Cucumis jucundus F. Muell., Trans. Philos. Inst. Victoria 3: 46. 1859 as 'jucunda'.—TYPE: AUSTRALIA. Northern Territory: Victoria River, *Mueller s. n.* (neotype K, photograph!; isoneotype: K, photograph!), fide Kirkbride (1993).

Cucumis pubescens T. Mitch., J. Exped. Tropical Australia 110. 1848 nom. nud., non Willd. 1805.—TYPE: AUSTRALIA. 31 March 1848, latitude of camp, 28°38′47″S, *Mitchell s. n.* (holotype: K).

Trailing or climbing annual herb, hispid on most parts, monoecious; stems to 3 m long, 2.6 mm diam, ribbed. Tendrils simple, to 9 cm long. Leaves: petiole 15–80 mm long; lamina ovate in outline, 3–78 × 2.6–74 mm, unlobed or palmately shallowly 3- or 5-lobed, mucronate, denticulate. Inflorescences unisexual. Male flowers in (1–)3–5-flowered fascicles; pedicels 3–13 mm long; hypanthium narrowly campanulate, 3.5–4.3 mm long, pilose with spreading hairs; calyx lobes linear to narrowly triangular, 2–4 mm long; corolla lobes ovate to elliptic, 8–12 × 4–6 mm, mucronate, glabrous or sparsely hispid outside, glabrous inside, yellow; stamens inserted towards the base of the hypanthium tube; anthers one 1-thecous, two 2-thecous, sigmoid, ca. 2 mm long; connective appendage 1–2.2 mm long, lobed, papillose; disc depressed subglobose, ca. 0.8 mm diam. Female flowers solitary; pedicels 2.8–13 mm long; ovary ellipsoidal, 5–8 mm long, 2–3.4 mm diam, pilose with antrorse or spreading hairs; hypanthium above constriction 2.4–3 mm long; perianth similar to male; disc shortly cylindrical, ca. 1.3 mm diam, lobed; style 1–1.4 mm long; stigmatic branches 1.3–1.8 mm long. Fruit ellipsoidal, 20–36 mm long and 14–24 mm in diam, with short antrorse hairs, fruiting pedicel to 14 mm long. Seeds elliptic, 4.2–5 × 2–2.7 mm, ± compressed with the faces slightly convex, smooth, buff.

Representative Specimens Examined—AUSTRALIA. Western Australia: ca. 10 km W of Mount Vernon Station Homestead near Meekatharra, *Mitchell 4713* (CANB, PERTH); Hamersley Ranges National Park, on flats E of Mount Bruce, *Trudgen 2578* (PERTH), Fig. 2C shows an image of this specimen; Harding River bridge, Roebourne, *Olsson 57* (PERTH); ca. 100 km S of Dampier on Hamersley Iron Railway line road, *Mitchell PRP231* (CANB, PERTH); De Grey River, *Burbidge 948* (PERTH). Northern Territory: Jasper Gorge, Victoria Downs road crossing of Jasper Creek, *Telford 11655* (BRI, CANB, DNA, NE, US). South Australia: Oodnadatta, *Knight 242* (AD); Lake Eyre basin, Scrubby Camp Waterhole, *Thorpe 85* (AD). Queensland: 47.9 km by road SW from Burke – Gulf Development

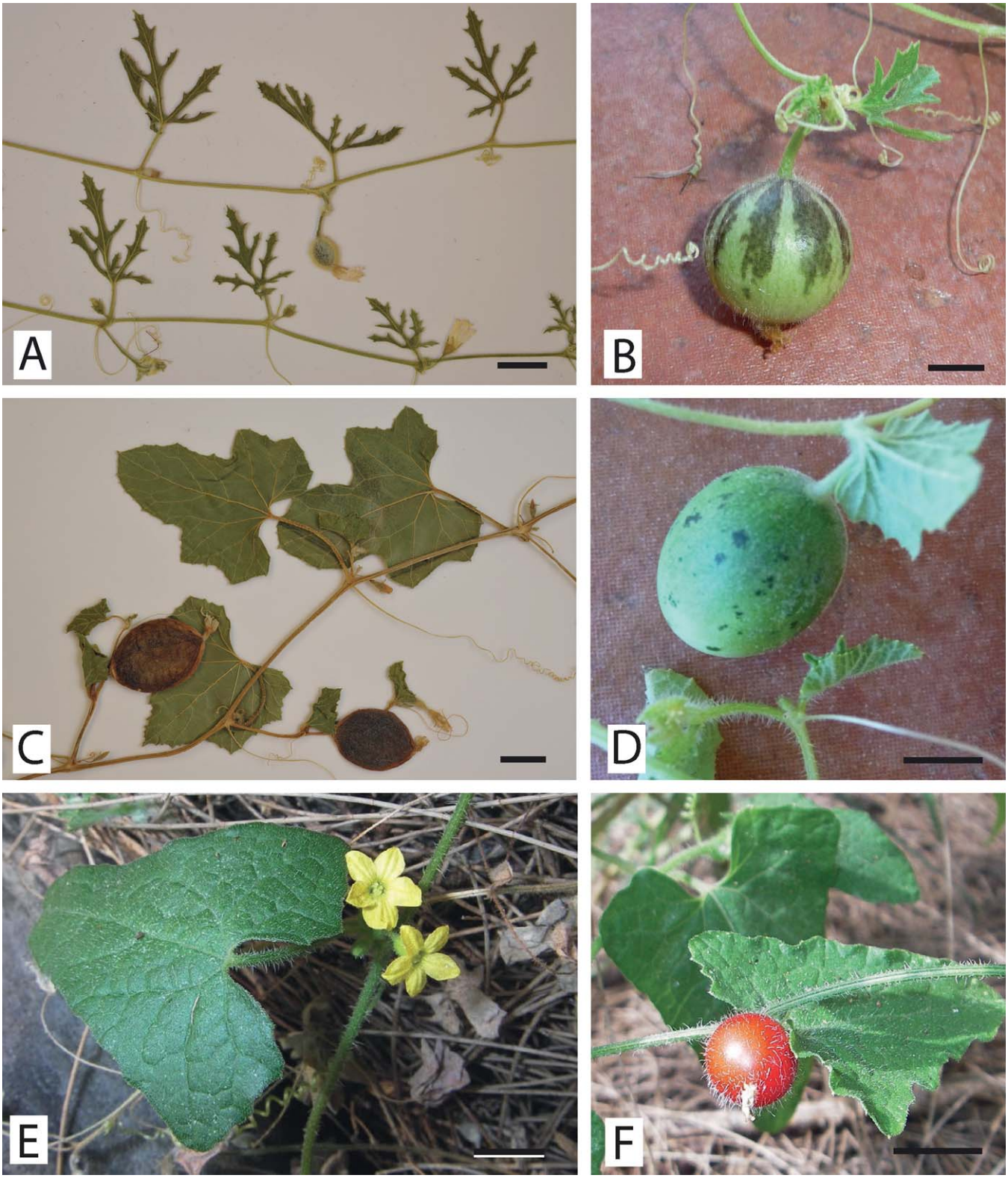

Fig. 2. Morphological traits of Australian *Cucumis* species. A, B. *Cucumis picrocarpus*. A. Flowering stems. B. Developing fruit (both from *Telford & Sebastian 13314*). C, D. *C. melo*. C. Flowering and fruiting stems (from *Trudgen 2578*); D. fruit (from *Telford & Sebastian 13313*). E, F. *C. althaeoides*. E. Male inflorescence. F. Fruiting stem. (both from *Copeland & Bell 4220*). Scale bars = 1 cm. Images A, C by J. J. Bruhl; B, D by P. Sebastian; E, F by L. M. Copeland.

Road junction near Normanton, *McDonald & Dennis 8872* (BRI, NE); Mount Eliza, 8.5 km along O'Briens Creek Road from Mount Surprise township, *Telford & Sebastian 13313* (M, NE), Fig. 2D shows an image of this collection; Long Hole, Winton Water Supply, *Forster & Booth 22315* (BRI, DNA, MEL, NE).

Distribution—Widespread in Australia across the tropics and subtropics from near Meekatharra, Western Australia to Rockhampton, Queensland, south to Lake Eyre South, South Australia, and near Wilcannia, New South Wales (Fig. 3).

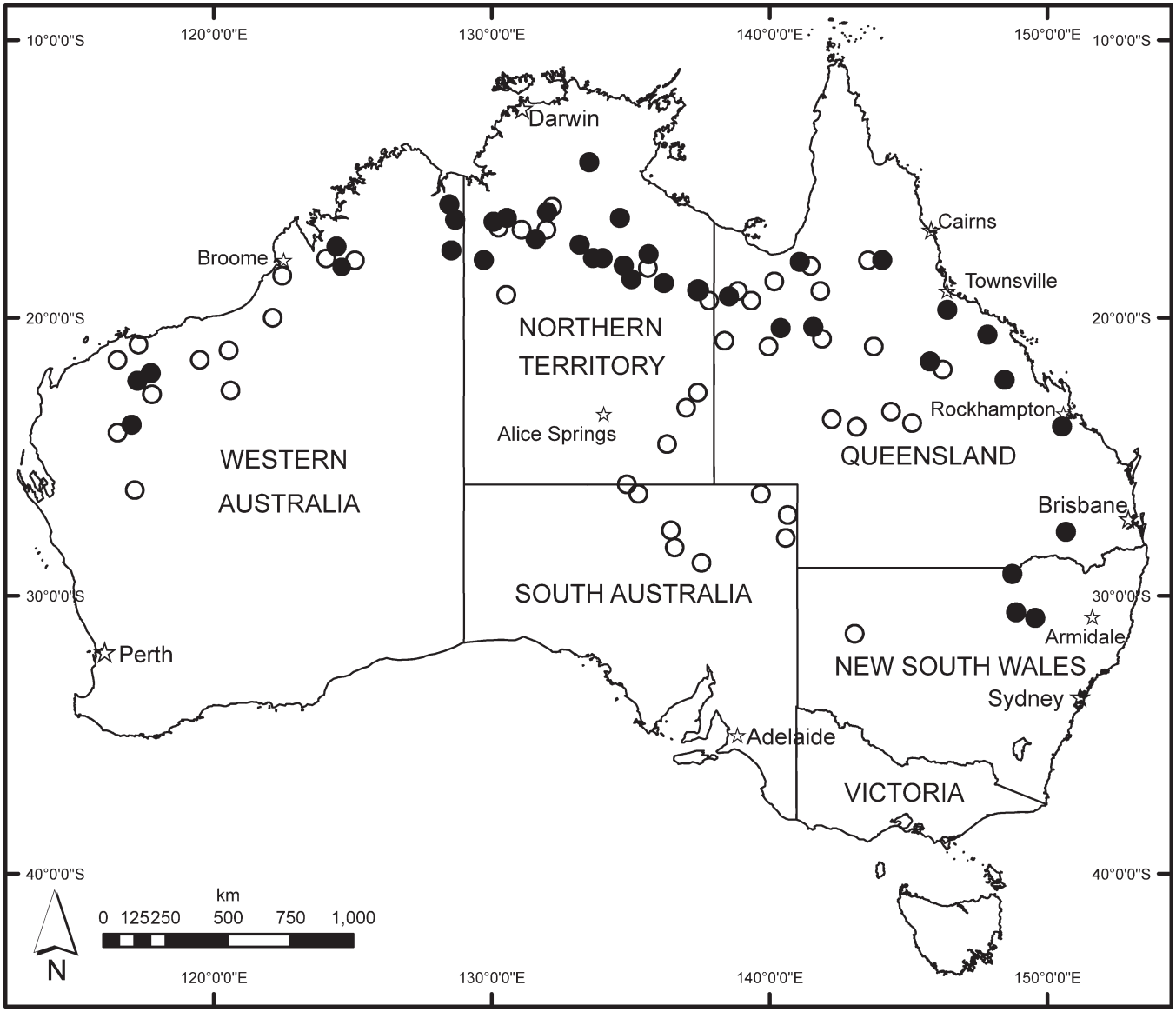

FIG. 3. Distributions of *Cucumis picrocarpus* (solid circle); *C. melo* (hollow circle).

Habitat—*Cucumis melo* grows in a variety of habitats including grasslands on cracking clays, *Eucalyptus*, *Corymbia*, *Acacia*, or *Grevillea* grassy woodlands on clay flats, less commonly on rocky slopes.

Phenology—Flowers and fruits January–May.

Conservation Status—The species is widespread and common and is not considered at risk. In Western Australia, the species is recorded as "common all along the Ashburton floodplain" (label data from *Mitchell PRP231*).

Notes—The description above is based on Australian material. This taxon was treated by Kirkbride (1993) as *Cucumis melo* L. subsp. *agrestis* (Naudin) Pangalo, a subspecies thought to occur throughout Africa, Asia, and Australia. The Australian populations appear to be indigenous as early European explorers already found *C. melo* in inland Australia before the establishment of Western settlements and gardens there. Because the fruits are wild food of aboriginal people, there is the possibility of anthropogenic range expansion, but resolving whether humans account for the species' arrival in Australia will require a detailed phylogeographic study of *C. melo*.

The aboriginal people in the Pilbara eat the fruits as a wild food (label data from *Burbidge 948*); the local aboriginal name is "Yindjibarndi" (label data from *Olsson 57*). In the Lake Eyre region, South Australia, "eaten by the Aborigines when falls off vine, rubbed in sand first"; local name "Ilcarta" (label data from *Knight 242*).

Plants of domestic cultivars are occasionally found as weeds around picnic areas (e.g. New South Wales: Namoi River, Warrabah National Park, *Hosking 941*) but they do not appear to persist.

Cucumis costatus I. Telford sp. nov.—TYPE: AUSTRALIA. Queensland: Cook District: Mt Scatterbrain, Butchers Hill Station, near Lakeland, 15°52′ S 144°53′ E, 25 Jan. 1992, *Forster 9514* (holotype: BRI!; isotypes: CNS!, M!, MEL!, NE!).

Mukia sp. B, I. R. H. Telford, Fl. Australia 8: 186. 1982.

Mukia racemosa I. Telford, J. D. Briggs & J. Leigh, Rare or Threatened Australian Plants ed. 2: 44. 1995 nom. nud.

Mukia sp. (Little Annan R., *B. Gray 101*), R. J. F. Henderson (ed.), Names & Distributions of Queensland Plants 53. 2002; P. Bostock & A. E. Holland, Census of the Queensland Flora 54. 2007.

Ab affini *Cucumi javanico* differt floribus masculis in racemo digestis, fructu costato seminibusque turgidis.

Trailing or climbing herb, monoecious, hispid on most vegetative parts; stems to ca. 1.5 m long, ca. 1 mm diam, ribbed, sparsely hispid, annually sprouting from a thickened perennating rootstock. Tendrils simple, to 40 mm long. Leaves: petioles 10–33 mm long; lamina triangular to ovate, 25–35 × 18–28 mm, cordate, scarcely lobed or shallowly 3- or 5-lobed, dentate, the lobes obtuse, mucronate, hispid on both surfaces with hairs to 0.7 mm long. Inflorescences unisexual. Male flowers in 4–11-flowered racemes 25–37 mm long; peduncles 3–30 mm long; pedicels 3–12 mm long; hypanthium narrowly campanulate, 2.6–5.3 mm long, hispid; calyx lobes 5, narrow-triangular, 0.6–2 mm long; corolla lobes 5, rotate, ovate, 2.8–5.2 × 1–2.2 mm, apex rounded, glabrous or sparsely hispid outside, glabrous inside, yellow; stamens inserted about the middle of the hypanthium tube; anthers one 1-thecous, two 2-thecous, straight, ca. 2.2 mm long; connective appendage minute; disc depressed subglobose, ca. 1.3 mm diam. Female flowers solitary; peduncles 10–14 mm long, elongating in fruit; ovary narrowly fusiform, attenuate, 6–9.5 mm long ca. 2 mm diam, hispid with retrorse multicellular hairs; hypanthium above constriction ca. 3 mm long; perianth similar to male; staminodes absent; disc annular, ca. 1 mm diam; style ca. 1.8 mm long; stigma 3-branched, the branches ca. 1 mm long, each bifid for about half their length. Fruit fusiform or ellipsoidal, 16–32 mm long, 10–12 mm diam, longitudinally 9- or 10-ribbed, sparsely hispid, scabrid on ribs with retrorse tubercle-based hairs, green, 15–30-seeded; pericarp thin, showing seeds when dry; fruiting peduncle up to 40 mm long. Seeds ovate, 3.4–4 × 2.6–3 mm, pale brown, the faces convex, pitted, the margin narrow.

Representative Specimens Examined—AUSTRALIA. Queensland: McIvor River area, 0.5 km N of Tribulation Creek, 45 km NW of Cooktown, *Wannan & Addicot 3845* (BRI); McIvor River, 5 km SW of Mt Ray, *Wannan & Lyon 3931* (BRI, CNS, NE, NSW), our Fig. 4A and B; Endeavour River, *Persieh 169* (MEL); Little Annan River crossing on the Cooktown road, *Gray 101* (CNS); 0.9 km E of the West Normanby River on the Lakeland Downs to Cooktown road, *Clarkson* &. *MacDonald 6747* (BRI, CANB, CNS); northern ridge off Mount Sampson, Annan River catchment, *McDonald et al. 2086* (BRI).

Distribution—Endemic to North-Eastern Queensland on the eastern fall of the Great Dividing Range in southern Cape York Peninsula, the species is recorded from the drainage basins of the McIvor, Endeavour, Annan, and Normanby Rivers (Fig. 5).

Habitat—*Cucumis costatus* grows in gallery forest or eucalypt woodland and depauperate deciduous vine thicket on low rocky hills, on basalt or metamorphics, to 300 m altitude. Associated species recorded include *Eucalyptus platyphylla* F. Muell., *E. leptophleba* F. Muell. and *Erythrophleum chlorostachys* (F. Muell.) Baillon.

Phenology—Flowers and fruits January–April.

Conservation Status—The species was allocated category 2K in Briggs and Leigh (1995), meaning it is a poorly known taxon with a geographic range of less than 100 km. At the type locality, it is recorded as "very common." Additional recent collections indicate that *C. costatus* is more widespread than previously thought, and we therefore do not consider it at risk.

Etymology—From Latin costatus (ribbed), in reference to the pronounced longitudinal ribbing of the fruit.

Notes—*Cucumis costatus* was the first Australian *Cucumis* species sequenced for nuclear and chloroplast regions and is included in the phylogeny of Renner et al. (2007) as *Cucumis* sp. HS414. It differs from the morphologically similar *C. javanicus* in the male flowers being borne in racemes and costate fruits.

Cucumis queenslandicus I. Telford sp. nov.—TYPE: AUSTRALIA. Queensland: Cook District: 5 km SE of Chillagoe, beside Burke Development Road, 18 Apr. 2006, *Wannan & Beasley 4266* (holotype: BRI!; isotypes: CANB!, CNS!, M!, NE!).

Ab affini *Cucumi costato* differt foliis non profunde vel profunde lobatis, floribus masculis fasciculatis vel racemosis et fructu leviter costato.

Trailing or climbing perennial herb, monoecious, hispid on most vegetative parts; stems to 70 cm long, ribbed, annually sprouting from a thickened, perennating, ± cylindrical rootstock. Tendrils simple, to 60 mm long. Leaves: petioles (6–)14–40 mm long; lamina subtriangular to broadly ovate in outline, 9.5–44 × 11.5–42 mm, cordate, shallowly or deeply 3- or 5-lobed, when deeply lobed the lobes sinuately lobed, dentate, obtuse, mucronate, hispid on both surfaces with hairs to 0.2 mm long. Inflorescences unisexual. Male flowers in 2–5-flowered fascicles or racemes with peduncles to 12 mm long; pedicels 1.3–13 mm long; hypanthium narrowly campanulate, 2.8–4.2 mm long; calyx lobes 5, linear, 0.8–1.3 mm long; corolla lobes 5, obovate, 3.4–4.2 × 2–2.5 mm, rounded, glabrous or sparsely hispid outside, glabrous inside, yellow; stamens 3, inserted about the middle of the hypanthium tube; anthers one 1-thecous, two 2-thecous, straight, ca. 2 mm long; connective appendages minute; disc depressed globose, ca. 1.2 mm diam. Female flowers solitary; peduncle 5–18 mm long, scarcely elongating in fruit; ovary narrowly fusiform, ca. 5.5 mm long, ca. 1.2 mm diam, attenuate, densely hispid with retrorse, multicellular hairs; hypanthium above constriction ca. 6 mm long; perianth similar to male; disc annular, undulate, ca. 0.5 mm diam; style ca. 1.3 mm long; stigma capitate, ca. 2.5 mm long; staminodes absent. Fruit ovoid–fusiform, 15–23 mm long, 9–10 mm diam, slightly 10-ribbed, hispid, 10–20-seeded; pericarp thin, showing seeds when dry; fruiting pedicel 7–16 mm long. Seeds ovate, 4.5–5 × 3.8–4.2 mm, pale brown, the faces convex, pitted, the margin narrow. Figure 4C shows an image of the type collection.

Representative Specimens Examined—AUSTRALIA: Queensland: Cook District: Metal Hills section, Chillagoe – Mungana Caves National Park, *McDonald 8814* (BRI, NE), Fig. 4D shows an image of this collection; Mt Eliza, 8 km NW of Mt Surprise, *Forster & Bean 12812* (BRI); Mt Eliza, 8.5 km along O'Briens Creek Road from Mount Surprise township, *Telford & Sebastian 13316* (BRI, CNS, M, NE); Undara National Park, Quartz Blow Lookout, *McDonald 3662* (BRI); Newcastle Range, eastern flank, W of Mount Surprise, *McDonald* 3393 (BRI); near Copperfield River Dam, Kidston, *Bean & Forster 7443* (BRI).

Distribution—*Cucumis queenslandicus* is endemic to North-Eastern Queensland on the western fall of the Great Dividing Range where it is known from near Chillagoe and from Undara Volcanic National Park to the Newcastle Range and south to the Copperfield River (Fig. 5).

Habitat—The species grows in *Eucalyptus* woodland on granite (Undara Volcanic National Park), the granite/limestone contact zone (Chillagoe), and deciduous vine thickets on granite hills (Mount Eliza and Undara Volcanic National Park) at 400–550 m altitude. Associated species recorded

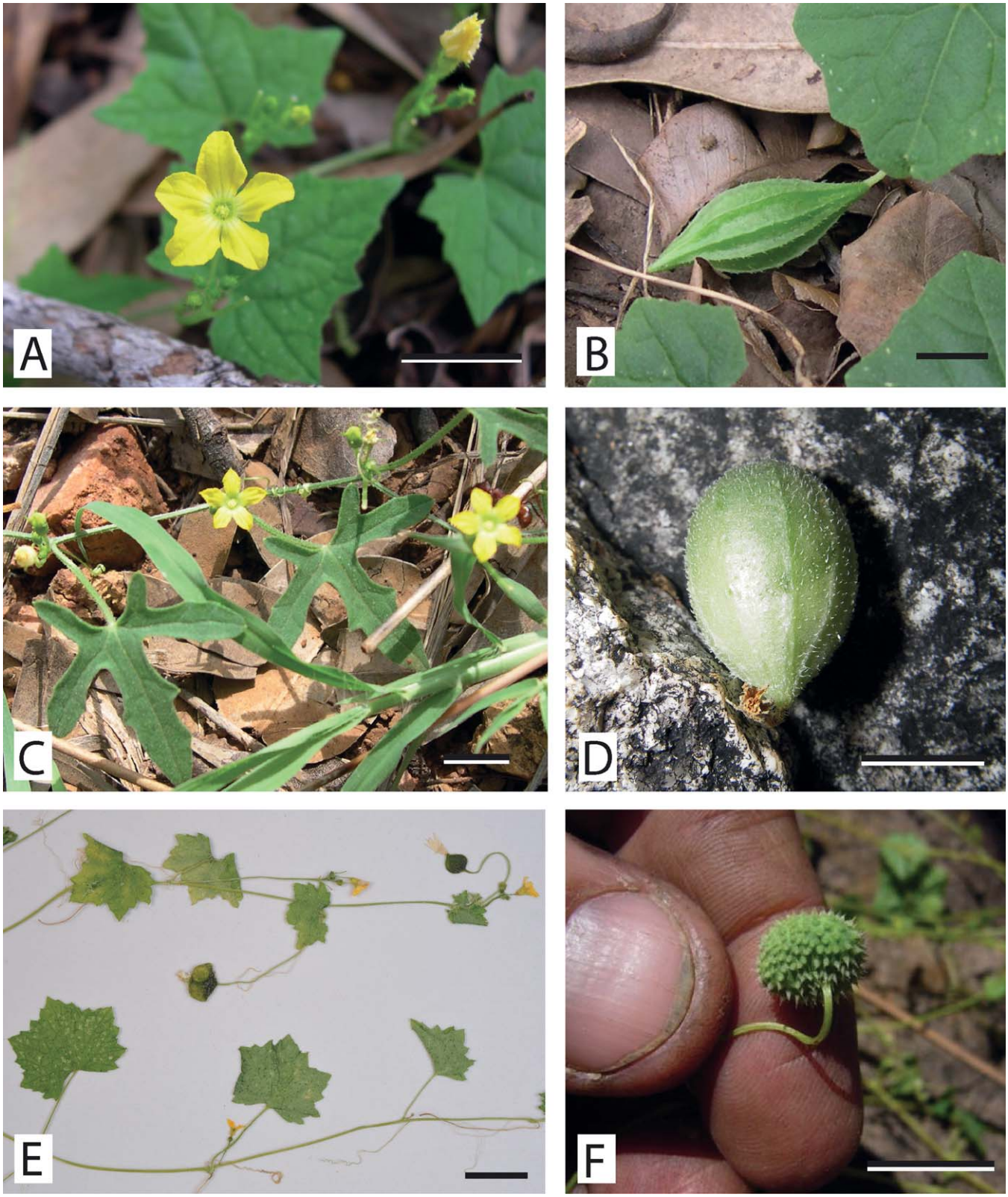

Fig. 4. Morphological traits of Australian *Cucumis* species. A, B. *Cucumis costatus*. A. Male inflorescences. B. Fruit (both from *Wannan & Lyon 3931*). C, D. *C. queenslandicus*. C. Male inflorescences (from *Wannan & Beasley 4266*). D. Fruit (from *McDonald 8814*). E, F. *C. umbellatus*. E. Flowering stems with developing fruit (from *Sebastian 14*). F. Fruit (from *Wannan, Wardrop & Lane 5728*). Scale bars = 1 cm. Images A–C, F by B. S. Wannan; D by K. R. McDonald; E by J. J. Bruhl.

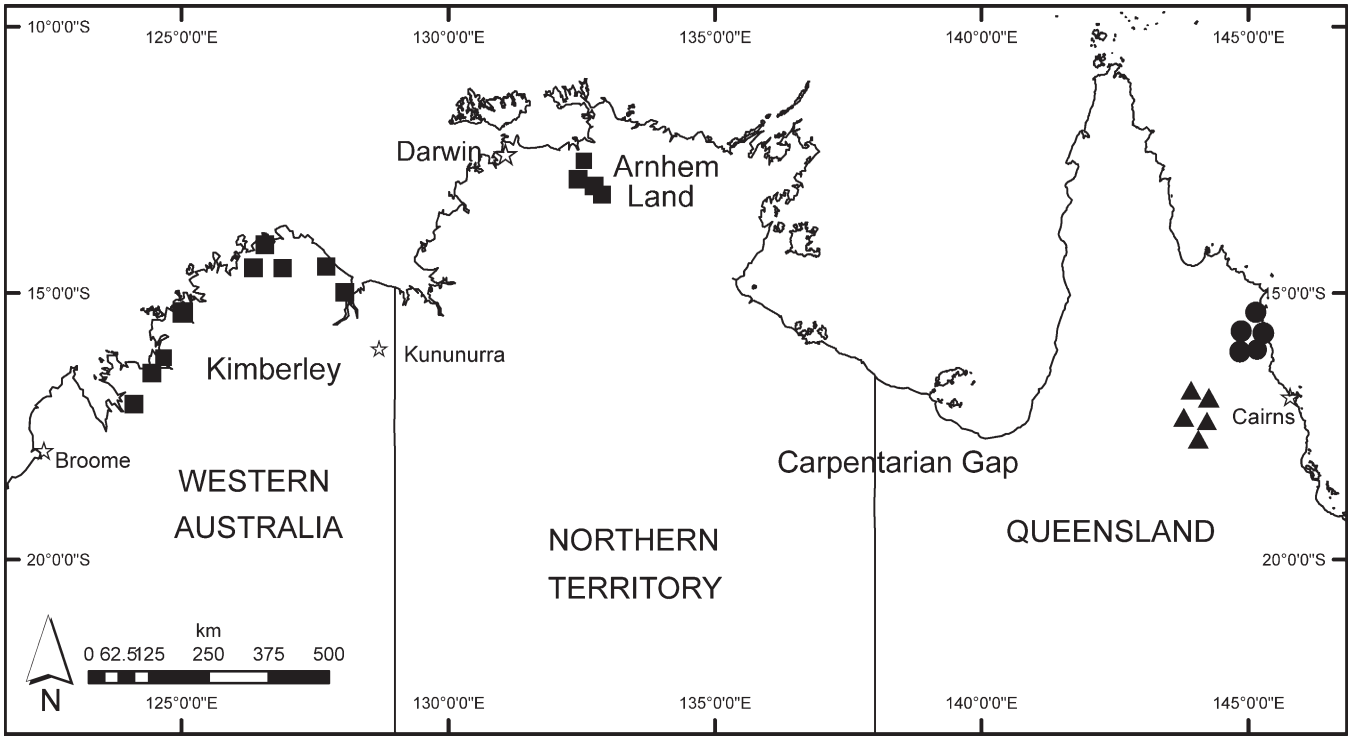

FIG. 5. Distributions of *Cucumis costatus* (circle); *C. queenslandicus* (triangle) *C. umbellatus* (square).

include *Eucalyptus cullenii* Cambage, *E. miniata* Schauer, *Erythrophloeum chlorostachys*, *Brachychiton chillagoensis* Guymer and *B. albidus* Guymer.

Phenology—Flowers and fruits January–June, mainly March–April.

Conservation Status—*Cucumis queenslandicus* is widespread with several recent collections in the Newcastle Range and Mount Surprise areas and is not considered at risk. It is conserved in Chillagoe – Mungana Caves and Undara Volcanic National Parks.

Etymology—Named for the state which includes the area of endemism of the species in north-eastern Queensland.

Notes—Molecular data (Fig. 1) corroborate an affinity to *C. costatus* and *C. umbellatus*. *Cucumis costatus* differs in having male flowers in more elongate racemes and strongly-ribbed fruit, *C. umbellatus* in umbellate male inflorescences and small unribbed fruit.

Cucumis umbellatus I. Telford sp. nov.—TYPE: AUSTRALIA. Northern Territory: Darwin and Gulf: Kakadu National Park, Ubirr, Apr. 2009, *Sebastian 14* (holotype: CANB!; isotypes, DNA!, K!, M!, MO!, NE!, PERTH!).

Cucumis sp. Gunlom (*J. L. McKean 864b*), Council of Heads of Australian Herbaria, Australian Plant Census. 2008 (http://www.chah.gov.au/apc/index.html)

Mukia sp. A, I. R. H. Telford, Fl. Australia 8: 184. 1982; J. R. Wheeler, Fl. Kimberley Region 252. 1992.

Ab affini *Cucumi costatus* differt floribus masculis umbellatis, fructibus longissime pedicellatis subglobosis vel ellipsoidalibus et seminibus paucioribus.

Trailing or climbing annual herb, monoecious, most vegetative parts sparsely hispid; stems to 2 m long, to 1 mm diam, ribbed. Tendrils simple, to 2 cm long. Leaves: petiole 8–35 mm long; lamina broadly ovate in outline, 10–40 × 14–45 mm, cordate, shallowly 3- or 5-lobed, dentate, the lobes obtuse, mucronate, sparsely hispid on both surfaces with hairs to 1.8 mm long. Inflorescences unisexual. Male flowers in 12–20-flowered umbels; peduncles 10–55 mm long; pedicels 3–13 mm long; hypanthium campanulate, 1.6–2.2 mm long, sparsely hispidulous; calyx lobes linear, 0.5–0.8 mm long, sparsely hispidulous; corolla lobes ovate, 2.6–4 × 1.6–2 mm, obtuse, mucronate, glabrous or sparsely hispidulous outside, glabrous inside, yellow; stamens inserted about the middle of the hypanthium tube; anthers one 1-thecous, two 2-thecous, straight, ca. 1.2 mm long; connective appendages minute; disc depressed subglobose, ca 0.7 mm diam. Female flowers solitary, rarely paired in axils; peduncle 5–25 mm long, greatly elongating in fruit; ovary subglobose to fusiform, ca. 0.8–1.2 mm diam, hispid with retrorse hairs; hypanthium above the constriction narrowly campanulate, 1.4–1.8 mm long; perianth similar to male; disc annular, ca. 0.6 mm diam; style ca. 0.8 mm long; stigmatic branches 0.8–1 mm long. Fruit subglobose, 4–7 mm diam, hispid with tubercle-based hairs, ripening bright orange, with 1 or 2, rarely 3 seeds; fruiting peduncle 50–115 mm long. Seeds ovate, 4.5–5 × 2.8–3.4 mm, buff, the faces convex, deeply pitted, the margin narrow. Figure 4E shows an image of the type specimen.

Representative Specimens Examined—AUSTRALIA. Western Australia: 15 km N of Mount Disaster, *Keighery 10601* (PERTH); Prince Regent River, *Wannan et al. 5728* (BRI, PERTH), Fig. 4F shows an image of this collection; island inside Yule Entrance, Walcott Inlet, *Mitchell 3531* (CANB, NE, PERTH); Boongarree Is., 18.3 km NE of Mount Knight, *Keighery 10695* (CANB, PERTH); mouth of Glenelg River, 20.5 km NW of Mount French, *Keighery 10689* (PERTH); tributary of Camp Creek, ca. 12 km SW of CRA Mining Camp, Mitchell Plateau, *Kenneally 7909* (PERTH); Carson Escarpment, 2.5 km N of Face Point, *Keighery 10667* (PERTH); Cambridge Gulf, 1887, *Wright* (MEL). Northern Territory: Obiri [Ubirr] Rock track, 4 km NW of Cahills Crossing, East Alligator River, *Telford & Wrigley 7631* (CANB, DNA, K, NE, PERTH);1 mile SW of Cannon Hill, *Martenz & Schodde AE 647* (BRI, CANB, DNA, NT); Kakadu National Park, Gubarra, *Sebastian 15* (BRI, CANB, DNA, L, M, NE, US); Baroalba

Creek, ca. 1 km E of gorge entrance, *Cunliffe s. n.* (CANB, DNA, NSW, OSS, UNSW); Little Nourlangie Rock, *Telford & Wrigley 7814* (BISH, CANB); headwaters of Liverpool River, *Craven & Wightman 8363* (CANB).

Distribution—*Cucumis umbellatus* is endemic to northern Australia, occurring in the western and northern Kimberley region and disjunctly in the Northern Territory along the northwestern escarpment of Arnhem Land (Fig. 5).

Habitat—The species grows in sandy soils on sandstone, usually on rock outcrops or talus slopes or in rocky watercourses. The species occurs in vine thickets together with *Allosyncarpia ternata* S. T. Blake forest, in low open woodland with *Xanthostemon paradoxus* F. Muell. and *Terminalia hadleyana* W. Fitzg., and in open shrubland with *Triodia* species.

Phenology—Flowering and fruiting February–May.

Conservation status—*Cucumis umbellatus* is widespread in the Kimberley region, where it is conserved in Drysdale River National Park, and it is also common in Kakadu National Park. The species is therefore not considered at risk.

Etymology—From the Latin umbella (parasol), in reference to the inflorescences of the male flowers.

Notes—The peduncle of the female flower elongates up to 115 mm as the fruit develops. This elongation may push the ripening fruit into the protection of crevices in the rocky slopes of its habitat. In the African *Cucumis humifructus*, the fruits are geocarpic; buried by the elongating pedicel (Meeuse, 1962). Although separated by a disjunction of some 500 km, no morphological differences between Kimberley and Top End populations are apparent.

Cucumis argenteus (Domin) P. Sebastian & I. Telford, comb. nov. *Melothria argentea* Domin, Biblioth. Bot. 89: 635, Fig. 196. 1929.—TYPE: AUSTRALIA. Queensland: Flinders River near the town Hughenden, Feb. 1910, K. *Domin 8716* (holotype: PR, photograph!)

Melothria celebica var. *villosior* Cogn., Bull. Acad. Roy. Sci. Belgique ser. 3, 14: 357. 1887.—TYPE: AUSTRALIA. Gulf of Carpentaria, *Mueller s. n.* (holotype: BR photograph!; isotype: MEL!).

Mukia maderaspatana auct. non (L.) M. Roem.: I. R. H. Telford, Fl. Australia 8: 183, 185 Fig. 40E, G. 1982.

Trailing or climbing herb, monoecious, most vegetative parts pilose or densely hispid; stems to 3 m long, to 2 mm diam, ribbed. Tendrils simple, to 9 cm long. Leaves: subsessile or petiole to 28 mm long; lamina triangular, lanceolate or broadly ovate in outline, 24–93 × 14–87 mm, cordate, acute or obtuse, mucronate, shallowly 3- or 5- lobed, denticulate, densely scabrid or villous with hairs to 1.2 mm long on both surfaces. Inflorescences unisexual. Male flowers in 2–5-flowered fascicles; pedicels to 7 mm long; hypanthium campanulate, 3–3.5 mm long, pilose or hispid; calyx lobes linear, ca. 1 mm long, pilose or hispid; corolla lobes ovate, 3.4–3.6 × 2.5–2.7 mm, rounded, sparsely pilose or puberulous outside, the hairs denser apically, puberulous inside, pale yellow; stamens inserted about the middle of the hypanthium tube; anthers one 1-thecous, two 2-thecous, straight, ca. 2 mm long; connective appendages minute; disc depressed subglobose, 0.7–1.3 mm diam. Female flowers 1 or 2 per axil, sometimes coaxillary with several males; subsessile or pedicels to 2 mm long; ovary subglobose, ca. 1.5 mm diam, white pilose with antrorse hairs; hypanthium above the constriction narrowly campanulate, 2.4–3 mm long; perianth similar to male; disc annular, 1–1.5 mm diam; style ca. 1.8 mm long; stigmatic branches ca. 1.8 mm long. Fruits globose, 6.4–8 mm diam, pale green with darker longitudinal markings, at maturity sparsely or densely pilose, red, with 5 seeds; fruiting pedicel to 2.5 mm long. Seeds ellipsoidal, 4.5–4.8 × 2.8–3.3 mm, the faces convex, smooth, lacking a thickened margin, grey-black or pale brown.

Representative Specimens Examined—AUSTRALIA. Western Australia: 246 km from Broome along Great Northern Highway towards Port Hedland, *Telford & Butler 6028* (BISH, CANB, K, MO, PERTH); Wolf Creek Crater, *George 15338* (NT, PERTH). Northern Territory: Petermann Ranges, Lasseters Cave, *Henshall 3450* (AD, DNA, NT); Kings Canyon National Park, *Bruhl & Quinn 2162* (L, NE); Ilparpa Road, Alice Springs, *Albrecht 10202* (CANB, NT), Fig. 6B shows an image of this specimen; West Island, Sir Edward Pellew Group, *Braithwaite 3290* (CANB). South Australia: Lake Eyre region, Peake Creek, *Conrick 724* (AD, CANB). Queensland: Riversleigh archaeological site D, Australian Geographic information area, *Barnsley 1656* (BRI, CANB, NE), Fig. 6A shows an image of this specimen; 20.2 km by road S of Musselbrook Mining Camp on road to Camooweal, *Thomas & Johnson s. n.* (A, AD, BRI, DNA, K, NE); 3 km from Mount Isa, *Ollerenshaw & Kratzing 1161* (BRI, CANB, L).

Distribution—Endemic to Australia, *Cucumis argenteus* occurs widely from Ninety Mile Beach, Western Australia, southwards to the Flinders Ranges, South Australia, eastwards to Winton, Queensland (Fig. 7).

Habitat—*Cucumis argenteus* grows in a range of habitats from sand plains, loamy flats, rocky hillsides and limestone ridges to tussock grassland, *Triodia* hummock grassland, open shrublands and eucalypt or *Acacia* woodland.

Phenology—Flowers and fruits throughout the year, possibly in response to rainfall, but mostly between April and August in tropical areas.

Notes—Three collections by K. Domin of *Melothria argentea* from the Flinders River near Hughenden, Queensland, are held in PR, numbered *Domin 8715, 1816*, and *8717*. Although no collector's number is given in the protologue, the image is of *K. Domin 1816,* with the caption "*Melothria argentea* Dom. nach dem Originalexemplare von Flinders River frequenter." The species differs from *C. rumphianus* in its smaller fruit and seeds. Being widely distributed, the species is accordingly variable in leaf size and indumentum length and density. Collections from the Barkly Tableland and its northern slopes, Queensland, are densely white hairy; plants further inland are scabrid. Specimens with the dense, whitish indumentum only on the lower leaf surface have been collected (*Braithwaite 3290*, *Ollerenshaw & Kratzing 1161*). Further study may lead to the recognition of two subspecies.

Cucumis althaeoides (Ser.) P. Sebastian & I. Telford, comb. nov. *Bryonia althaeoides* Ser. in DC. Prodr. 3: 306. 1828; *Mukia althaeoides* (Ser.) M. Roem. Syn. Monogr. 2: 47. 1846; *Melothria althaeoides* (Ser.) Nakai, J. Jap. Bot. 14: 127 1938 (as "*altaeoides*").—TYPE: TIMOR. *leg. ign*. (holotype: G-DC, photograph!).

Mukia maderaspatana auct. non (L.) M. Roem.: I. R. H. Telford, Fl. Australia 8: 183, 185 Fig. 40F. 1982; W. J. J. O. de Wilde & B. E. E. Duyfjes, Thai For. Bull. (Bot.) 34: 43.2006 p. p.

Trailing or climbing perennial herb, monoecious, most vegetative parts hispid, sometimes pilose; stems to 3 m long, to 1.6 mm diam, ribbed, annually sprouting from a perennating rootstock. Tendrils simple, to 15 cm long. Leaves: subsessile or petiole to 38 mm long; lamina ovate or broadly lanceolate in outline, sometimes hastate, 24–75 × 18–70 mm, cordate, unlobed or shallowly 3-lobed, rarely 5-lobed, obtuse or acute, mucronate. Inflorescences unisexual. Male flowers in 3–10(–15)-flowered fascicles, sometimes in racemes with peduncles to 3 mm long; pedicels to 7 mm long; hypanthium narrowly campanulate, 3–3.4 mm long, hispid or pilose

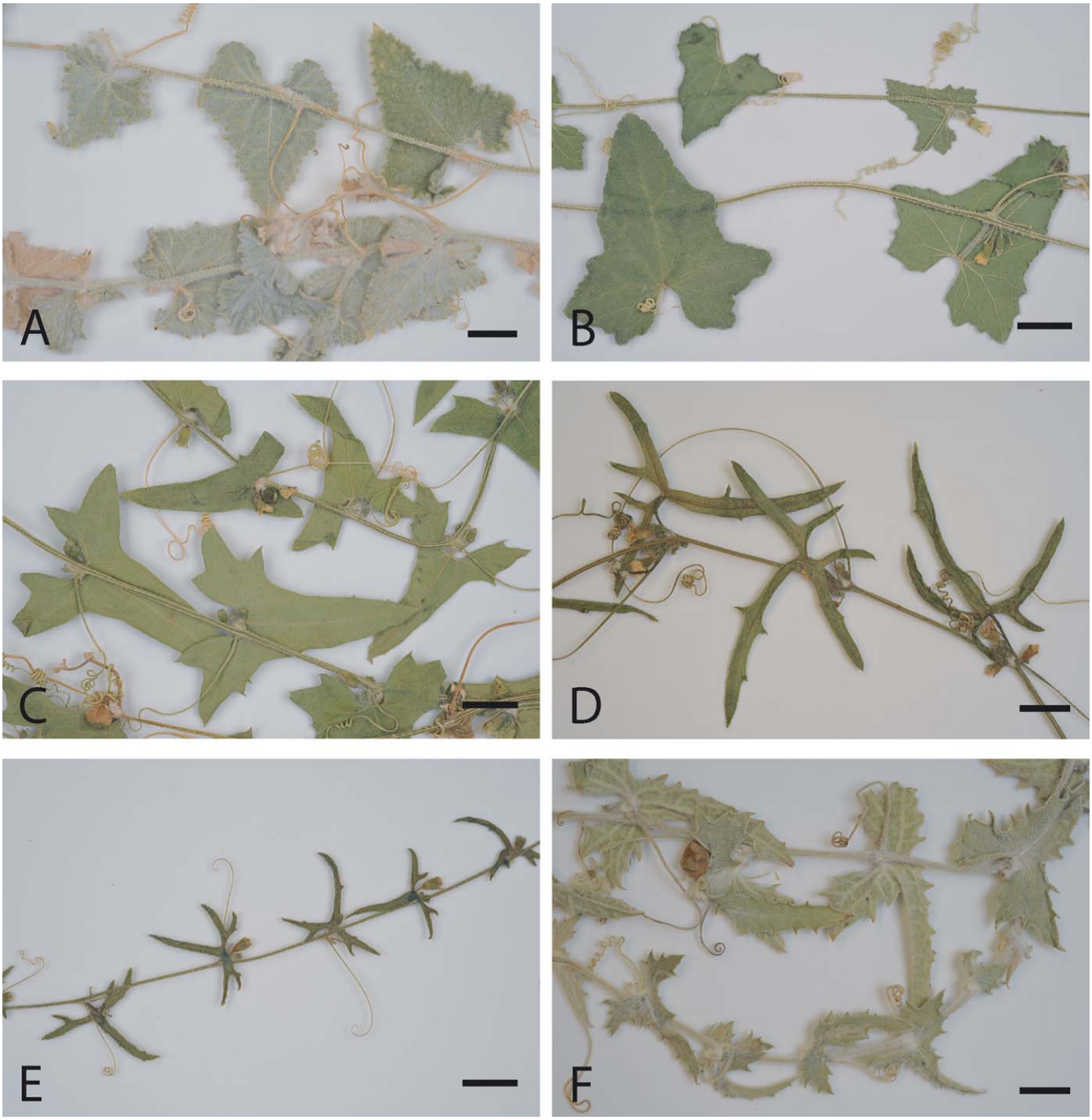

Fig. 6. Morphological traits of Australian *Cucumis* species. A, B. *Cucumis argenteus*. A. Typical specimen from Barkly Tableland, Queensland (*Barnsley 1656*). B. Typical specimen from Central Australia (*Albrecht 10202*). C–F. *C. variabilis*. C. Typical specimen from southern Pilbara, Western Australia (from *Byrne 2809*). D. Variant from North West Cape, Western Australia (from *Wajon 473*). E. Variant from Barrow Island, Western Australia (from *White 87*). F. Pilbara variant (from *Payne PRP 1864*). Scale bars = 1 cm. Images by J. J. Bruhl.

outside; calyx lobes linear, 0.8–1.4 mm long, hispid or pilose; corolla lobes ovate, 3.8–4.2 × 2.6–2.8 mm, rounded, mucronate, sparsely hispid outside, the hairs denser apically, glabrous or hispid along the veins inside, hispid around the mouth of the hypanthium tube, bright yellow; stamens inserted about the middle of the hypanthium tube; filaments ca. 0.4 mm long; anthers one 1-thecous, two 2-thecous, straight, 1.5–2 mm long; connective appendages minute; disc depressed globose, 0.8–1.4 mm diam. Female flowers 1 or 2, rarely 3 or 4 per axil; pedicels to 2 mm long; ovary ellipsoidal, ca. 3 mm long, pilose with antrorse hairs; hypanthium above the constriction narrowly campanulate, ca. 3 mm long; perianth similar to male; disc annular, 1–1.2 mm diam; style ca.1.5 mm long; stigmatic lobes 3, ca. 1.3 mm long. Fruit globose, 8–18 mm diam, pale green with darker longitudinal markings, at maturity sparsely pilose, red, with 9–20(–25) seeds; fruiting pedicel to 6 mm long. Seeds ovate, 3.8–4.5 × 2.3–2.8 mm, buff, the faces convex, verrucose, the margin thickened, raised.

Representative Specimens Examined—INDONESIA: Timor, *Zippel 107* (L). PAPUA NEW GUINEA: near Matapaili village, *Darbyshire 696*

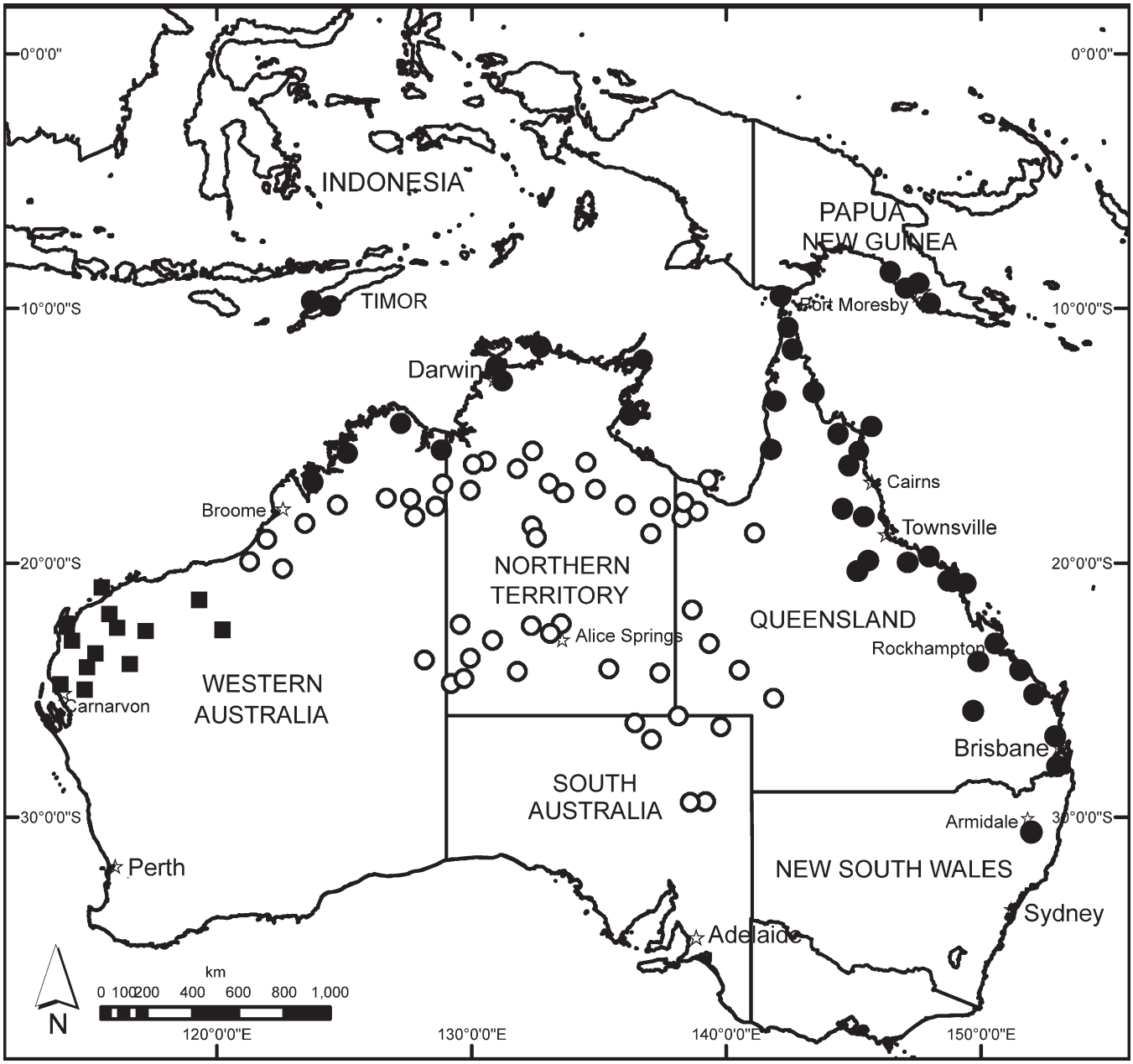

FIG. 7. Distributions of *Cucumis althaeoides* (solid circle); *C. argenteus* (hollow circle); *C. variabilis* (square).

(A, CANB, L, LAE); S coast near Hood Bay, *Paijmans 775* (CANB); SE side of Little Mount Lawes, ca. 16 miles N of Port Moresby, *Pullen 6804* (A, BRI, CANB, L, LAE, K, TNS). AUSTRALIA: Western Australia: Glycosmis Bay, *Mitchell 7726* (PERTH). Northern Territory: Humpty Doo, *McKee 8320* (DNA); 13 km SW of Cape Arnhem, *Brennan 2576* (DNA). Queensland: Lizard Island, Mangrove Beach, *Batianoff & Tarte 12083* (A, BRI, DNA, K, LE); McIvor River, "Mount Ray", 1.5 km NW of Mount Ray, *Telford & Sebastian 13308* (BRI, CNS, L, M, NE); Bucasia Beach, 13 km N of Mackay, *Clarke NE 81288* (CANB, M, NE); Tannum Sands, 15 km SE of Gladstone, *Telford 5499* (CANB). New South Wales: Oxley Wild Rivers National Park, Aspley River, 300 m downstream from Rusdens Creek, *Copeland & Bell 4220* (CANB, M, NE, NSW), our Fig. 2E and F.

Distribution—*Cucumis althaeoides* occurs in coastal and subcoastal Timor, southern New Guinea and northern Australia, from the Kimberley region in Western Australia eastwards through the Northern Territory, Queensland and south to near Walcha, New South Wales (Fig. 7).

Nakai (1938) cites collections from the Ryukyu Islands and Taiwan, and states that the species also occurs on the Philippines, Borneo, New Guinea, and Timor (besides Australia). As yet, we have not studied specimens from north of Timor.

Habitat—The species grows on coastal sands or riverine alluvium in herbfields and *Casuarina* or *Eucalyptus* woodland. On coralline beach sands of eastern Queensland, the species is recorded as growing under *Casuarina equisetifolia* L. and *Pandanus tectorius* Parkinson ex J. P. du Roi.

Phenology—Flowers and fruits April–August.

Conservation Status—Widespread and common, the species is not considered at risk.

Notes—*Cucumis althaeoides* differs from other Australian species in its verrucose seeds with thickened margins. Why Nakai (1938) treated the species under *Melothria* is unclear to us. The species shows considerable variation in leaf morphology over its range, notably in petiole length and degree of lobing of the lamina. In southern Papua New Guinea and northeastern Queensland, plants bearing larger,

many-seeded fruits (up to 1.8 mm diam long, with 16–20 seeds) occur and perhaps warrant formal recognition at the rank of subspecies.

Besides *C. althaeoides*, a second species [*A. R. Insani SAN 10* (L), collector ignotus 1305 (L), *H. Raap 499* (L), the latter in our Fig. 1] occurs on Timor and westwards to at least Java. Based on the molecular data, this still unnamed species is sister to *C. althaeoides* and *C. variabilis*.

Cucumis variabilis P. Sebastian & I. Telford sp. nov.—TYPE: AUSTRALIA. Western Australia: 46.5 km along North West Coastal Highway from Ashburton River bridge towards Carnarvon, 25 Apr. 1992, *Telford 11578* (holo: PERTH!; iso: BRI!, CANB!, K!).

Mukia maderaspatana auct. non (L.) M. Roem.: I. R. H. Telford, Fl. Australia 8: 183. 1982.

Ab affini *Cucumi althaeoidi* differt foliis non profunde vel profunde lobatis, lobis plerumque angustissimis, seminibusque laevibus margine carentibus.

Trailing or climbing herb, monoecious, most vegetative parts hispid or pilose; stems to 2 m long, to 1.8 mm diam, ribbed. Tendrils simple, to 13 cm long. Leaves: petiole 2.4–18 mm long; lamina triangular, lanceolate or ovate in outline, often hastate or sagittate, 16–102 × 14–55 mm, cordate, acuminate, mucronate, shallowly to deeply 3- or 5-lobed, usually sparsely serrate, on deeply lobed leaves, the lobes usually narrow, linear. Inflorescences mostly unisexual. Male flowers in 5–14-flowered fascicles, sometimes in racemes on peduncles to 4 mm long; pedicels 3–7.5(–12) mm long, at first pilose; hypanthium campanulate, 3.5–4.2 mm long; calyx lobes linear, 1–1.3 mm long, hispidulous outside; corolla lobes ovate, 4.6–5 × 3–3.4 mm, obtuse, mucronate, hispidulous outside, glabrous inside, yellow; stamens inserted about the middle of the hypanthium tube; filaments 0.6–1.2 mm long; anthers one 1-thecous, two 2-thecous, straight, 2.2–2.6 mm long; connective narrow; appendages minute; disc depressed subglobose, ca. 1.2 mm diam. Female flowers in 3–7-flowered fascicles; subsessile or pedicels to 8 mm long; ovary subglobose, ca. 1.8 diam, hispidulous with antrorse hairs; hypanthium above the constriction narrowly campanulate, ca. 4 mm long; perianth similar to male; disc annular, ca. 1.4 mm diam, style ca. 2 mm long; stigmatic branches 0.8–1.2 mm long. Fruit globose, 5–8 mm diam, at maturity glabrescent, ripening orange-red, with 10–15 seeds; fruiting peduncle to 8.5 mm long. Seeds ovate, 5.6–6.5 × 3–3.4 mm, the faces convex, smooth, minutely verrucose in two lines around the nonprojecting margin, grey or pale brown.

Representative Specimens Examined—AUSTRALIA. Western Australia: Barrow Island, 75 m E of turnoff to R33, *White 87* (PERTH), Fig. 6E shows an image of this specimen; Yardie Creek Road, Cape Range National Park, near Exmouth, *Wajon 473* (PERTH), Fig. 6D shows an image of this specimen; 3 miles N of Exmouth, *Allan 469* (CANB, MEL, PERTH); Carawine Pool, ca. 140 km SE of Shay Gap, *Newbey 10312* (PERTH); Cape Range, road to nos 3 and 4 wells, *George 2470* (PERTH); ca. 25 km N of Marble Bar on small track W of Shay Gap road, *Mitchell PRP905* (CANB, PERTH); Shellborough, 40 km NNW of Goldsworthy, *Telford & Butler 6476* (CANB, PERTH); coast NW of Ilgarene Well, De Gray Station, *Payne PRP1864* (PERTH), Fig. 6F shows an image of this specimen; ca. 23.4 km WNW of De Grey Homestead, adjacent to Freshwater Bore, *Mitchell PRP868* (CANB, PERTH); Roy Hill, *Byrne 2809* (PERTH), Fig. 6C shows an image of this specimen; Barrabiddy Creek, *Ashby 2944* (PERTH); 45 km E of Carnarvon, *Wilson 8389* (CANB, L, PERTH); 10 km ENE of West Angela Hill, Hamersley Ranges, *Trudgen 15877* (PERTH); 11.6 km WSW of Mount Sabine, Millstream-Chichester National Park, Hamersley Ranges, *Weston 20385* (PERTH).

Distribution—*Cucumis variabilis* is endemic to Western Australia, where it ranges from NE of Onslow to the Cape Range and Barrow Island, southwards to Carnarvon and the Ashburton River and eastwards to NE of Nullagine (Fig. 7).

Habitat—The species grows on calcareous or siliceous sand and on rocky ridges and slopes in *Eucalyptus* low open woodland, *Acacia* shrubland and *Triodia* hummock grassland.

Phenology—Flowers and fruits May–October.

Conservation Status—*Cucumis variabilis* is widespread and not considered at risk. It is conserved in Cape Range, Hamersley Ranges, and Millstream-Chichester National Parks.

Etymology—Latin variabilis (varying), in reference to the vegetative variability of the species.

Notes—*Cucumis variabilis* has been illustrated in Telford (1982: Figs. 40G, 40E), both times as *Mukia maderaspatana*, showing the extremes of leaf variability. The species shows two lines of variation: leaf morphology and indumentum. More southerly populations inland from Carnarvon bear larger leaves with a scattered, scabrid indumentum. Populations from North West Cape have a similar indumentum but narrower leaf segments with extreme reduction shown in the Barrow Island population. This island population has been listed as a putative new species, "*Cucumis* sp. Barrow Island" (*D. W. Goodall 1264*), in the Western Australian "FloraBase" (http://florabase.calm.wa.gov.au/). In the Pilbara, plants bear thicker leaves with a dense, white, villous indumentum similar to Barkly Tableland populations of *C. argenteus*. These variants may eventually deserve formal taxonomic recognition as subspecies.

Acknowledgments. We thank the Associate Editor Mark Simmons and two extremely helpful reviewers for numerous corrections; the directors at BRI, CANB, DNA, MEL, PERTH and QRS (now CNS) for the loan of material, with special thanks to Donna Lewis (DNA) and Darren Crayn (CNS) for assistance with field work; directors at E, B, G-DC, MEL and PR for images of specimens; Australian National Parks and Wildlife Service for permission to collect in Kakadu National Park; Keith McDonald and Bruce Wannan (Department of Environment and Resource Management, Queensland) for additional collections and images of plants in their natural habitats. Werner Greuter, Palermo, provided the Latin diagnoses. Cate McGregor and Kirsten Knox helped with map graphics. The School of Environmental and Rural Science (UNE) provided funding for IRT.

Literature Cited

Bowman, D. M. J. S., G. K. Brown, M. F. Braby, J. R. Brown, L. G. Cook, M. D. Crisp, F. Ford, S. Haberle, J. Hughes, Y. Isagi, L. Joseph, J. McBride, G. Nelson, and P. Y. Ladiges. 2009. Biogeography of the Australian monsoon tropics. *Journal of Biogeography* 37: 201–216.

Briggs, J. D. and J. H. Leigh. 1995. Rare or threatened Australian plants. Melbourne: CSIRO Publishing.

De Wilde, W. J. J. O. and B. E. E. Duyfjes. 2006. *Mukia* Arn. (Cucurbitaceae) in Asia, in particular in Thailand. *Thai Forest Bulletin (Botany)* 34: 38–52.

Felsenstein, J. 1973. Maximum likelihood and minimum-steps methods for estimating evolutionary trees from data on discrete characters. *Systematic Zoology* 22: 240–249.

Felsenstein, J. 1985. Confidence limits on phylogenies: an approach using the bootstrap. *Evolution* 39: 783–791.

Ghebretinsae, A. G., M. Thulin, and J. C. Barber. 2007a. Nomenclatural changes in *Cucumis* (Cucurbitaceae). *Novon* 17: 176–178.

Ghebretinsae, A. G., M. Thulin, and J. C. Barber. 2007b. Relationships of cucumbers and melons unraveled: Molecular phylogenetics of *Cucumis* and related genera (Benincaseae, Cucurbitaceae). *American Journal of Botany* 94: 1256–1266.

Kirkbride, J. H. 1993. Biosystematic monograph of the genus *Cucumis* (Cucurbitaceae). Boone, North Carolina: Parkway Publishers.

Kocyan, A., L.-B. Zhang, H. Schaefer, and S. S. Renner. 2007. A multi-locus chloroplast phylogeny of the Cucurbitaceae and its implications for character evolution and classification. *Molecular Phylogenetics and Evolution* 44: 553–577.

Meeuse, A. D. J. 1962. The Cucurbitaceae of Southern Africa. *Bothalia* 8: 1–111.

von Mueller, F. 1859. Some hitherto unknown Australian Plants. *Transactions of the Philosophical Institute of Victoria* 3: 46.

Nakai, T. 1938. On the Japanese species of *Melothria*. *Journal of Japanese Botany* 14: 122–131.

Renner, S. S. and H. Schaefer. 2008. Phylogenetics of *Cucumis* (Cucurbitaceae) as understood in 2008. Pp. 53–58 in *Cucurbitaceae 2008, Proceedings of the IXth EUCARPIA meeting on genetics and breeding of Cucurbitaceae Avignon, France 21–24 May, 2008*, ed. M. Pitrat. Avignon: INRA.

Renner, S. S., H. Schaefer, and A. Kocyan. 2007. Phylogenetic relationships among *Cucumis* (Cucurbitaceae): Cucumber (*C. sativus*) belongs in an Asian/Australian clade far from melon (*C. melo*). *BMC Evolutionary Biology* 7: 58.

Roemer, M. 1846. Familiarum Naturalium Regni Vegetabilis Synopses Monographicae seu Enumeratio Omnium Plantarum hucusque Detectarum Secundum Ordines Naturales, Genera et Species Digestarum, Additas Diagnosibus, Synonymis, Novarumque vel Minus Cognitarum Descriptionibus Curante M. J. Roemer. Vol. 2. Weimar: Landes Industrie Comptoir.

Schaefer, H. 2007. *Cucumis* (Cucurbitaceae) must include *Cucumella, Dicoelospermum, Mukia, Myrmecosicyos* and *Oreosyce*: a recircumscription based on nuclear and plastid DNA data. *Blumea* 52: 165–177.

Schaefer, H., I. R. H. Telford, and S. S. Renner. 2008. *Austrobryonia* (Cucurbitaceae), a new Australian endemic genus, is the closest living relative to the Eurasian and Mediterranean *Bryonia* and *Ecballium*. *Systematic Botany* 33: 125–132.

Schaefer, H., C. Heibl, and S. S. Renner. 2009. Gourds afloat: a dated phylogeny reveals an Asian origin of the gourd family (Cucurbitaceae) and numerous oversea dispersal events. *Proceedings. Biological Sciences* 276: 843–851.

Sebastian, P., H. Schaefer, I. R. H. Telford, and S. S. Renner. 2010. Cucumber (*Cucumis sativus*) and melon (*C. melo*) have numerous wild relatives in Asia and Australia, and the sister species of melon is from Australia. *Proceedings of the National Academy of Sciences USA* 107: 14269–14273.

Seringe, N. C. 1828. Cucurbitaceae. In A. P. De Candolle, ed., Systematis Naturalis Regni Vegetabilis 3: 297–320.

Stamatakis, A., P. Hoover, and J. Rougemont. 2008. A rapid bootstrap algorithm for the RAxML web-servers. *Systematic Biology* 75: 758–771.

Telford, I. R. H. 1982. Cucurbitaceae. Pp. 158–198 in *Flora of Australia*, ed. A. S. George, Canberra: A. S. Australian Government Publishing Service.