

## *Ocimum* L. (Lamiaceae) in Australia and Papua New Guinea

Barry J. Conn

National Herbarium of New South Wales, Mrs Macquaries Road, Sydney NSW 2000, Australia  
[barry.conn@rbgsyd.nsw.gov.au](mailto:barry.conn@rbgsyd.nsw.gov.au)

### Abstract

A review of the genus *Ocimum* (Lamiaceae) in Papua New Guinea and Australia reveals the presence of five species and the natural hybrid, *Ocimum* × *africanum*. *Ocimum caryophyllum* F.Muell. is reinstated for most of the Australian plants previously included in the widespread *O. tenuiflorum* L. The other species recognized for Papua New Guinea and Australia are *O. americanum*, *O. basilicum* and *O. gratissimum*. An identification key, brief descriptions and distribution maps are provided for these taxa. An enumeration of collections examined is included.

### Introduction

The genus *Ocimum* (Lamiaceae subfamily Nepetoideae tribe Ocimeae) consists of up to about 70 species (based on The Plant List 2013) with most native to Central and South America, Africa and Asia (Hayley et al. 2004). Several species are cultivated as horticultural plants (Cervenkova and Haban 2004; Darrah 1974), for medicinal properties (Grosvenor et al. 1995; Gupta et al. 2009; Prakash and Gupta 2005) and/or as ritualistic plants (Subrahmanya and Raveendran 2010). Several studies have clarified the genetic diversity of the Ocimeae (Paton et al. 2004; Suddee et al. 2004; Suddee et al. 2005) and the genus *Ocimum* (Grayer et al. 1996; Paton et al. 2004; Singh et al. 2004; Vieira 2003). There have been many studies of taxonomic complexities within species (Carović-Stanko et al. 2010; Grayer et al. 1996; Khosla 1993; Paton 1992; Paton et al. 2004). Typification problems within the genus have been resolved by Paton (1992) and Paton and Putievsky (1996).

Taxonomic accounts of the genus in this and neighbouring regions are relatively few (Backer and Bakhuizen van den Brink 1965; Conn 1992; Keng 1978; Mabberley and Kok 2004; Peekel 1984). The overall morphological similarities and distinguishing features of the taxa in the respective regions are dealt with differently by these authors. Backer and Bakhuizen van den Brink (1965) recognised several forma to account for the different morphological variants in the species of *Ocimum* occurring in Java (Indonesia). The variants that they recognised were characterised by the type of indumentum, calyx and corolla colour, and aroma of crushed leaves. Keng (1978) and Peekel (1984) both provided less detail about the morphological variation within the species of Malesia and the Bismarck Archipelago (Papua New Guinea), with Peekel (1984) briefly mentioning colour variants. *Ocimum basilicum* and *O. tenuiflorum* were recognised as occurring in the Kimberley region of Western Australia (Conn 1992), but the variation within *O. tenuiflorum* (s. lat.) (here treated as *O. caryophyllum*) was not discussed because of the relatively small amount of morphological variation within the plants of that region. Prior to this paper, the natural hybrid *O.* × *africanum* was not formally recognised as occurring in Papua New Guinea or Australia.

This paper briefly discusses the taxonomic distinctness and variability of the *Ocimum* taxa occurring in Papua New Guinea and Australia, with the distribution of each taxon summarised according to subregions of Papua New Guinea (Womersley 1978), and those of Australia according to the regions of Western Australia (Beard 1980), the Northern Territory (Chippendale 1972) and Queensland (Anonymous 1975). The relative paucity of herbarium collections for most of these taxa and the lack of distinguishing morphological features results in the uncertainty of the identity of several. Therefore, the distributional information provided for each taxon is very incomplete. Unfortunately, limited material of *Ocimum* from Indonesian Papua was available during this study, resulting in the lack of distributional information for species in the western part of New Guinea.

## Taxonomy

Distinguishing species and infraspecific taxa are frequently problematic because of the large amount of morphological variability, at least sometimes assumed to be a result of hybridization. Since the distinctness of species may be often difficult to recognise, several characters may need to be considered when identifying species. The following key is provided as a guide to the identification of *Ocimum* in the Papua New Guinea-Australian region. Species descriptions and other notes are arranged in alphabetical order. Refer to Paton (1992) and Suddee et al. (2005) for more details on nomenclature and typification.

### Key to species of *Ocimum* in Papua New Guinea and Australia

- 1 Throat of calyx closed in fruit, with abaxial median lobes pressed up against adaxial lip, with lateral lobes held level with or lower than the abaxial median lobes; calyx tube with inner surface hairy underneath the adaxial lip, otherwise glabrous; mericarps sub-spherical ..... **5. *Ocimum gratissimum***
1. Throat of calyx open in fruit, with adaxial and abaxial lips far apart and lateral lobes held between the adaxial and abaxial lips; calyx tube with inner surface glabrous or with a dense ring of hairs at throat; mericarps ovoid to obloid ..... 2
- 2 Fruiting calyx initially held somewhat distant and transverse to infructescence axis (becoming more downward pointing when mericarp mature) ..... 3
2. Fruiting calyx usually sub-appressed to infructescence axis, hence mouth and lobes always downward pointed..... 5
- 3 Calyx throat with a dense ring of hairs; corolla tube funnel-shaped; adaxial staminal filaments with a distinct hairy appendage near base; mericarps dark brown to black, copiously mucilaginous when wet; corolla at least 4 mm long ..... **3. *Ocimum basilicum***
3. Calyx throat glabrous or hairs very short (<0.2 mm long), sparse, glandular; corolla tube parallel-sided to very slightly funnel-shaped; adaxial staminal filaments with a minute indistinct appendage near base; mericarps brown, usually not or only very slightly mucilaginous when wet; corolla 3.5–6 mm long ... 4
- 4 Petioles 4–10(–12) mm long; leaf lamina ± glaucous, not thin nor membranous (veins often indistinct), usually narrowly ovate, (6–)10–35 mm long, 4–10(–12) mm wide, with base obtuse to very shortly attenuate, margin usually ± bluntly serrate to serrulate, sometimes with only one or a few teeth, rarely entire; floral bracts with apex shortly acuminate (acumen up to 0.5 mm long); calyx 2–2.5 mm long, with inner surface usually sparsely to moderately hairy on lower third ..... **4. *Ocimum caryophyllum***
4. Petioles 9–20(–30) mm long; leaf lamina green, ± thin and membranous (veins usually distinct), ± ovate to elliptic, (17–)20–50 mm long, 8–25 mm wide, with base shortly attenuate, margin bluntly serrate or with teeth sub-apiculate; floral bracts with apex distinctly acuminate (acumen 0.5–1 mm long); calyx 1.5–2 mm long, with inner surface glabrous or abaxially sparsely and minutely hairy ..... **6. *Ocimum tenuiflorum***
- 5 Fruiting calyx 5–6 mm long; adaxial staminal filaments with appendage 0.7–1 mm long, distinctly hairy, and anthers 0.8–c. 1 mm across (on dried material); leaves frequently lemon-scented (when crushed) ..... **1. *Ocimum × africanum***
5. Fruiting calyx 4–5 mm long; adaxial staminal filaments with appendage indistinct to distinct (short, 0.1 < 0.5 mm long), flattened, usually glabrous or almost so, and anthers 0.3–0.5 mm across (on dried material); variously aromatic ..... **2. *Ocimum americanum***

**1. *Ocimum* × *africanum*** Lour. *Flora cochinchinensis* 2: 370 (1790).

Neotype (Suddee et al. 2005): Cochinchine, *Talmy* 76 (K; isoneotype: P).

*Ocimum citratum* Rumphius *Herbarium Amboinense* 5: 266, t. 93 f. 1 (1747).

*Ocimum pilosum* Willd. *Enumeratio Plantarum Horti Regii Botanici Berlinensis* 2: 629 (1809).

*Ocimum basilicum* L. var. *pilosum* (Willd.) Benth. in Wall. *Plantae Asiaticae Rariores* 2: 13 (1830).

*Ocimum americanum* L. var. *pilosum* (Willd.) A.J.Paton *Kew Bulletin* 47: 426 (1992).

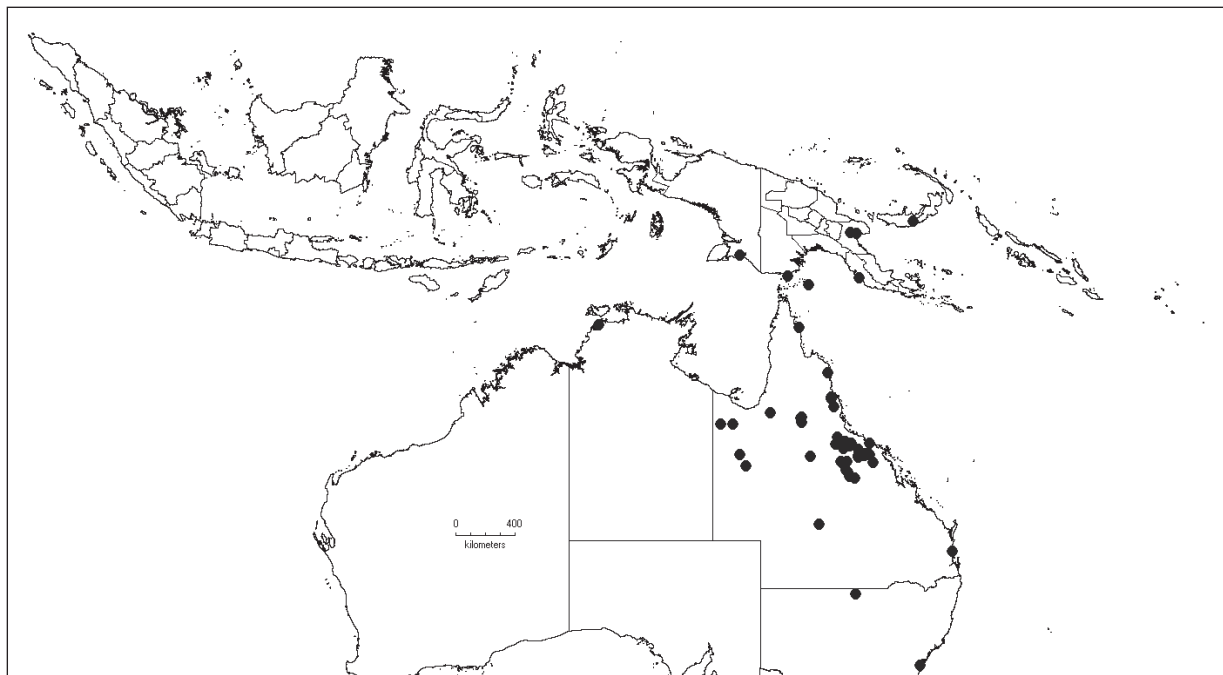
Lectotype (Paton 1992): probably cultivated Berlin, from seed of unknown origin, *Willdenow herbarium* 11064 (B-W).

*Ocimum* × *citriodorum* Vis. *Linnaea* 15: Litteratur Bericht 102 (1841).

Type: unknown, cultivated Padua (PAD).

Herb, erect, 0.3–1 m high, perennial, branched; branches moderately to sparsely hairy, with hairs more or less patent to spreading, multicellular, up to c. 1 mm long, particularly at nodes, and with short, retrorse, appressed hairs elsewhere (c. 0.5 mm long), also moderately to densely glandular. Leaves aromatic, frequently lemon- or citronella-scented, sparsely hairy, at least on petiole, midvein and margin, or densely hairy throughout; petiole 5–10 mm long; lamina narrowly elliptic, 15–30(–35) mm long, 6–11(–14) mm wide; base cuneate, or obtuse to rounded (*Bean* 2965); margin entire or slightly toothed (*Bean* 2965); apex obtuse to subacute. Inflorescences 100–350 mm long, simple or branched, slender, spike-like, with uniflorescences c. 6-flowered. Bracts broadly ovate, 3–4 mm long; apex abruptly acuminate. Pedicels 2–2.5 mm long. Calyx 2–3.5 mm long, enlarging in fruit to 5–6 mm long, usually sub-appressed to infructescence axis; inner surface densely hairy, with hairs long, white; abaxial lip with median lobe-pair almost as long as adaxial lip. Corolla violet-green to pale purple, c. 5 mm long; abaxial lobe c. 3 mm long; lateral and adaxial lobes 1.5–2 mm long. Adaxial staminal filaments with a distinct hairy appendage (0.7–1 mm long); anthers 0.8–1 mm across. Mericarps dark brown, 1.5–2 mm long, usually not or only very slightly mucilaginous when wet; calyx lobes not enclosing fruit.

*Distribution:* This hybrid is known from tropical Africa, Asia and America. In New Guinea it has been collected from Indonesian Papua (Digul) and Papua New Guinea (Morobe, Western, Gulf, Central, Milne Bay and New Britain). In Australia it has been collected from Queensland (Cook, Burke, North Kennedy, South Kennedy, Mitchell, Gregory North). **Fig. 1.**



**Fig. 1.** Distribution map of *Ocimum* × *africanum* in Papua New Guinea and Australia, based on authenticated herbarium collections. Collection from Indonesian Papua (Digul) is included.

*Ecology:* This hybrid is frequently cultivated and is naturalised in disturbed areas, on river banks and in secondary vegetation in both Papua New Guinea and Australia.

*Notes:* *Ocimum* × *africanum* (also referred to as *O. africanum*) is of hybrid origin derived from a cross between *O. basilicum* and *O. americanum* (Paton & Putievsky 1996). This name also refers to the plants produced by the doubling of the F1 chromosome number, as these forms are morphologically similar (Pushpangadan and Sobti 1982). This hybrid ‘freely hybridises with *O. basilicum* in cultivation and intermediates are not uncommon’ (Suddee et al. 2005, p. 29).

*Ocimum* × *africanum* is most readily identified when in flower by the hairy basal appendages on the adaxial staminal filaments. The identity of fruiting material is problematic and collections here identified as *O. caryophyllum* may prove to be of this hybrid since the fruiting calyx is sometimes less appressed to the infructescence axis than would be expected. Although the following collections lack flowers, *Fensham 292* (fruiting), *Fensham 2254* (fruiting), *Thompson BUC201* (fruiting), *Turpin 707* & *Thompson* (fruiting) and *R.W. Johnson 1807* (sterile), they are here regarded as likely to be collections of *O. × africanum*. The hybrid tends to have long, ± patent hairs on the branchlets as well as curled retrorse hairs, whereas *O. caryophyllum* has mostly retrorse hairs. Although, the fruiting calyx is characteristically sub-appressed to the infructescence axis, it sometimes remains more or less transversely held (*Bean 2965*, *Wannan 603*).

The identity of *Batianoff 900403E* & *Smith* is uncertain. The branchlets of this collections are covered with hairs that are spreading to antrorse or antrorsely curled; hairs of leaves are also antrorse; in general the leaves are hairier and thicker, with veins distinctly paler than lamina surface (lamina 20–35 mm long, 10–14 mm wide); base cuneate; margin less distinctly but still slightly toothed.

## 2. *Ocimum americanum* L. *Centuria I. Plantarum* 1: 15 (1755).

*Ocimum americanum* L. var. *americanum*: Paton (1992).

Lectotype (refer Paton 1992): America, *Linnean herbarium* 749.9 (LINN).

*Ocimum canum* Sims *Botanical Magazine* 51: t. 2452 (1823).

*Ocimum stamineum* Sims *Botanical Magazine* 51: t. 2452 (1823)

Type: cultivated, seed from China, illustration in Curtis’ *Botanical Magazine*, t. 2452 (1853).

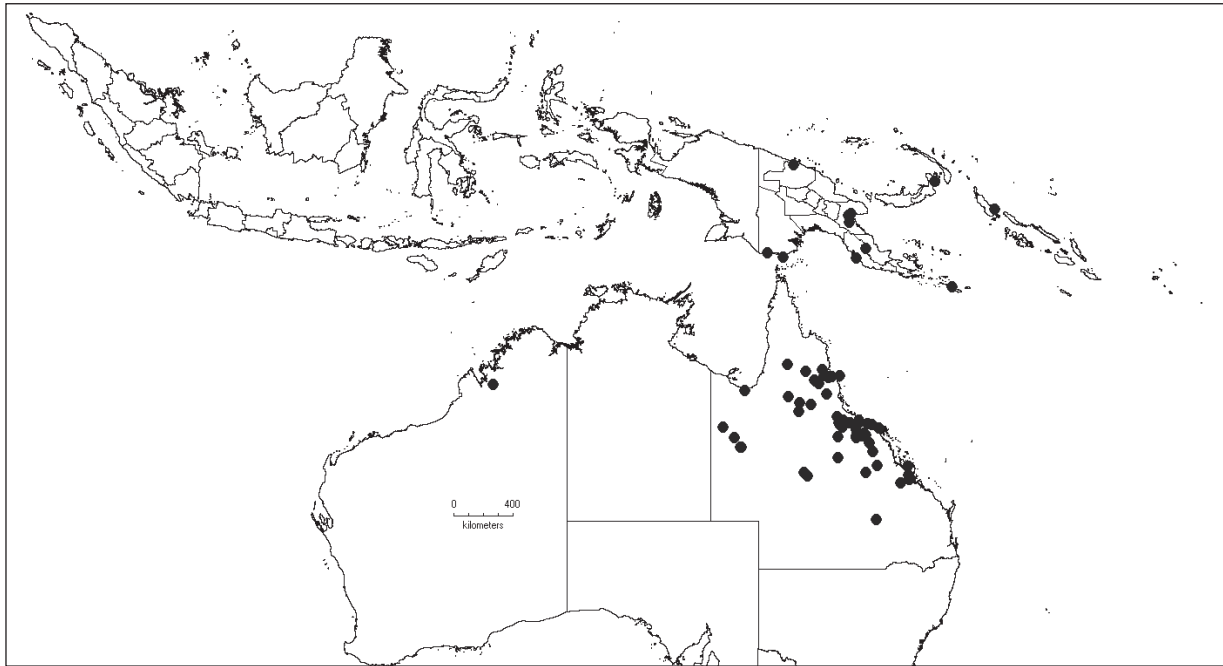
Herb, erect, 0.2–0.8(–1) m high; stem and branches moderately to sparsely hairy, with hairs more or less patent, multicellular, 1–3 mm long, particularly at nodes, and with short, retrorse, appressed hairs elsewhere (c. 0.5 mm long), also moderately to densely glandular. Leaves fragrant; petiole 3–10(–45) mm long, with a mixture of long and short, antrorse hairs; lamina narrowly elliptic, rarely elliptic, 11–22(–70) mm long, 3–8(–32) mm wide; base attenuate to cuneate; margin entire or with an occasional indistinct tooth; apex obtuse; both surfaces glabrous or with an occasional hair to densely hairy, especially on abaxial midrib and/or abaxial surface, with hairs antrorse, short, sometimes with 1 or a few long hairs. Inflorescence terminal, racemose, 70 to at least 110 mm long, with uniflorescences c. 6-flowered. Bracts broadly ovate; apex tapering, c. 3 mm long. Pedicels 1.5–2 mm long. Calyx 2–3.5 mm long, enlarging in fruit 4–5 mm long, usually sub-appressed to infructescence axis. Corolla white, tinted with lilac, c. 6 mm long; abaxial lobe c. 2 mm long; lateral and adaxial lobes c. 2 mm long. Adaxial staminal filaments with appendage indistinct or distinct (short, <0.5 mm long), flattened, glabrous, almost glabrous or sparsely hairy; anthers 0.3–0.5 mm across. Mericarps dark brown, c. 2 mm long, usually not or only very slightly mucilaginous when wet; calyx lobes not enclosing fruit.

*Distribution:* This species is widespread in Madagascar, tropical Africa and South Africa, Asia, Himalaya, India, Sri Lanka, China, South East Asia to Australia. In Papua New Guinea, it is known from the West Sepik, Morobe, Central, Milne Bay, New Britain and New Ireland districts. In Australia, this species occurs in Queensland (Cook, North Kennedy, South Kennedy, Port Curtis). **Fig. 2.**

*Ecology:* This species is naturalised in Papua New Guinea and Australia, occurring in open areas and in secondary regrowth. Altitude: sea level to 400 m.

*Notes:* It is frequently difficult to distinguish between this species and *O. × africanum*, particularly when fruiting. Both have relatively small fruiting calyces with similar indumentum on the branchlets. However, the staminal appendage and anther of this species are usually much smaller than those of *O. × africanum*. The staminal appendage of *O. americanum* is usually glabrous or almost so, rarely sparsely to moderately hairy (possibly the result of back-crossing between *O. × africanum* and *O. americanum*), whereas this appendage is moderately to densely hairy in *O. × africanum*.

This species is readily distinguishable from *O. basilicum* because the following features are smaller: corolla, branchlets. Therefore, the more densely hairy variants of *O. basilicum*, which may be back-crosses with



**Fig. 2.** Distribution map of *Ocimum americanum* in Papua New Guinea and Australia, based on authenticated herbarium collections.

*O. × africanum*, are difficult to distinguish from *O. americanum*. Occasionally, the branchlets are more or less covered with long spreading hairs. However, short retrorse hairs are usually also present. *Parkinson 59* (from the Bismarck Archipelago of Papua New Guinea) consists of two sheets that are here regarded as probably *O. × africanum*. Although the NSW456321 sheet of this collection has few leaves present and they are small, they are within the shape and range of typical specimens of *O. × africanum*. However, the second sheet (NSW388681) has very small, narrow leaves atypical of this species. Furthermore, the indumentum of the branchlets of this second sheet is very sparse, suggesting that indumentum density may be variable.

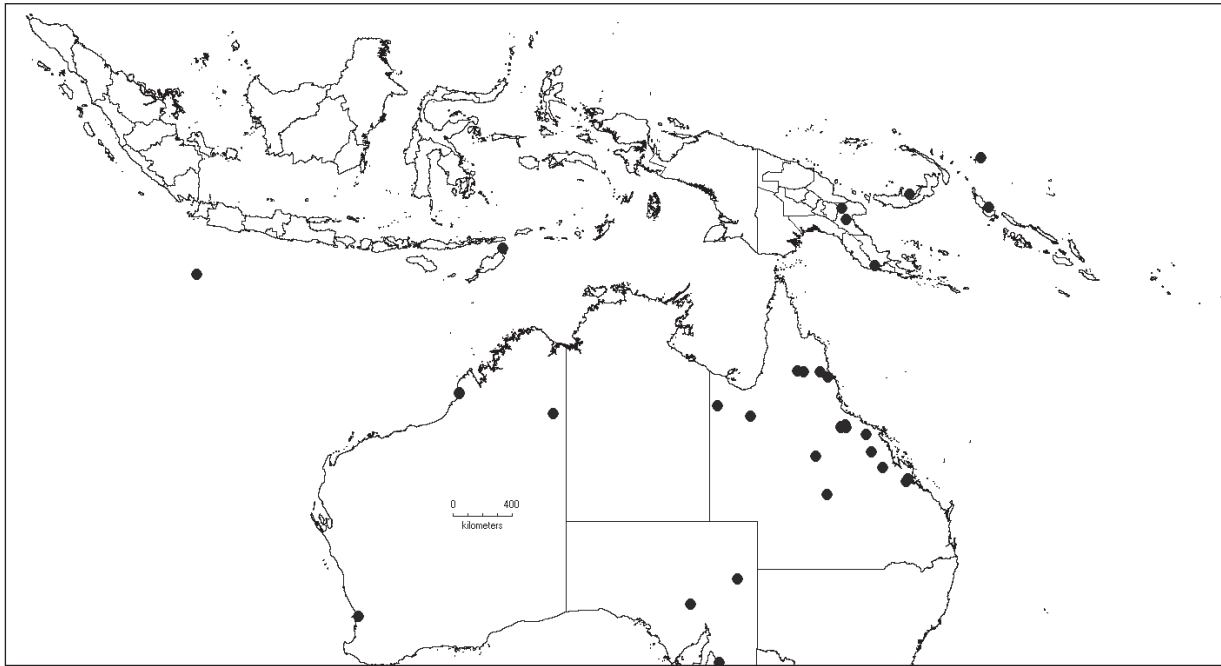
Paton (1992) recognised two varieties in this species, namely var. *americanum* and var. *pilosum* (Willd.) Paton; however Suddee et al. (2005) reduced the latter variety to the synonymy of *O. × africanum*.

### 3. *Ocimum basilicum* L. *Species Plantarum* 2: 597 (1753).

Lectotype (refer Paton 1992): Western Asia, *Linnean herbarium* 749.5 (LINN).

Herb, erect, 0.5–0.6 m high, branched; branches glabrous or minutely hairy with slightly stiff, retrorse hairs, hairs often restricted to opposing surfaces of branches or more densely hairy on two opposing surfaces compared to the other opposing surfaces, with or without long more or less spreading hairs at nodes. Leaves strongly aromatic, with a sweet spicy to lemon-scented aroma, usually sparsely hairy, at least on petiole and midvein; petiole 7–20 mm long; lamina ovate to elliptic, 30–50 mm long, 12–22 mm wide; base cuneate; margin entire or shortly toothed; apex obtuse to subacute. Inflorescences 100–150 mm long, simple or branched, slender, spike-like, with uniflorescences many-flowered. Bracts narrowly ovate, 2–3 mm long. Pedicels up to 3 mm long, very short. Calyx 1.5–3 mm long, enlarging in fruit to (5–)6–9 mm long, usually sub-appressed to infructescence axis. Corolla white, pinkish or mauve, 6–9 mm long; abaxial lobe c. 3 mm long; lateral and adaxial lobes 1.5–2 mm long. Adaxial staminal filaments with a distinct hairy appendage (c. 1 mm long); anthers c. 1 mm across. Mericarps dark brown to black, 1.5–2 mm long, copiously mucilaginous when wet; calyx lobes not enclosing fruit.

*Distribution:* This widely cultivated species extends from tropical Africa through Asia to New Guinea and Australia, and also occurs in tropical America. In Papua New Guinea, it occurs in the Morobe, presumably Western (since collected from Saibai Island, Cook region, Queensland, Australia), Gulf, Northern, Central and New Britain regions. In Australia this species occurs in Western Australia (Dampier, Canning); Queensland (Cook, Burke, Moreton, North Kennedy) and is recorded from South Australia (e.g., the Southern Lofty Ranges, *Bates 6817*), presumably as garden escapes. It is not known if any of these plants will become naturalised. **Fig. 3.**



**Fig. 3.** Distribution map of *Ocimum basilicum* in Papua New Guinea and Australia (including Christmas Island), based on authenticated herbarium collections. Collections from Timor Leste are also included.

*Ecology:* This species occurs in open areas, in secondary regrowth, and frequently grown in gardens where it may become a weed, occurring from sea level to elevations of 400 m.

*Notes:* In fruiting material, the basal portion of the pedicels usually bends upwards such that fruiting calyces are appressed to the axis. The distal half of the pedicel is bent downwards so that the mouth and lobes of the calyx are directed downwards.

**4. *Ocimum caryophyllum*** F.Muell. *Fragmenta Phytographiae Australiae* 4: 46 (1863).

Lectotype (here designated): ‘Heads of the Isaacs [Isaac] and Bowen River’ [menthol scent], *E.M. Bowman* 211, without date (MEL668752) [menthol scent, sparsely hairy, leaves c. 10 mm long, 6–8 mm wide].

Residual Syntypes: ‘Suttor River’, ‘flowers pure white’, *Anonymous* [? *E.M. Bowman*] 131, without date (MEL668751) [menthol scent, leaves 15–22 mm long, 5–8 mm wide, branchlets and leaves densely hairy, hairs long retrorse]; ‘Suttor River’, *Anonymous* [? *E.M. Bowman*] 92, without date (MEL668755) [menthol scent] – probable Syntype; ‘Bowen River’, *Anonymous* [? *E.M. Bowman*] s.n., without date (MEL668759) [menthol scent]; ‘Burdekin River et Peak Downs’, *Anonymous* [*F. Mueller*] s.n., without date (MEL668749) [sparsely hairy].

*Ocimum anisodorum* F.Muell. *Fragmenta Phytographiae Australiae* 4: 46 (1863);

*Ocimum tenuiflorum* var. *anisodorum* (F.Muell.) Domin *Bibliotheca Botanica* 89 (4): 562 (1928).

Syntypes: [Northern Territory] ‘Sturts [Sturt] Creek’, *Anonymous* [*F. Mueller*] s.n., without date (MEL668765) [faint aniseed scent, sparsely hairy, hairs retrorse, narrow leaves as in *O. santum* var. *angustifolium* Benth.]; s. loc. [‘Carpentaria Gulf, flumen Albert versus’ (Protologue), *W. Landsborough* s.n., without date (MEL668757) [leaves 16 mm long, 4 mm wide, sparsely hairy].

*Ocimum sanctum* L. var. *angustifolium* Benth. *Flora Australiensis* 5: 74 & 75 (1870).

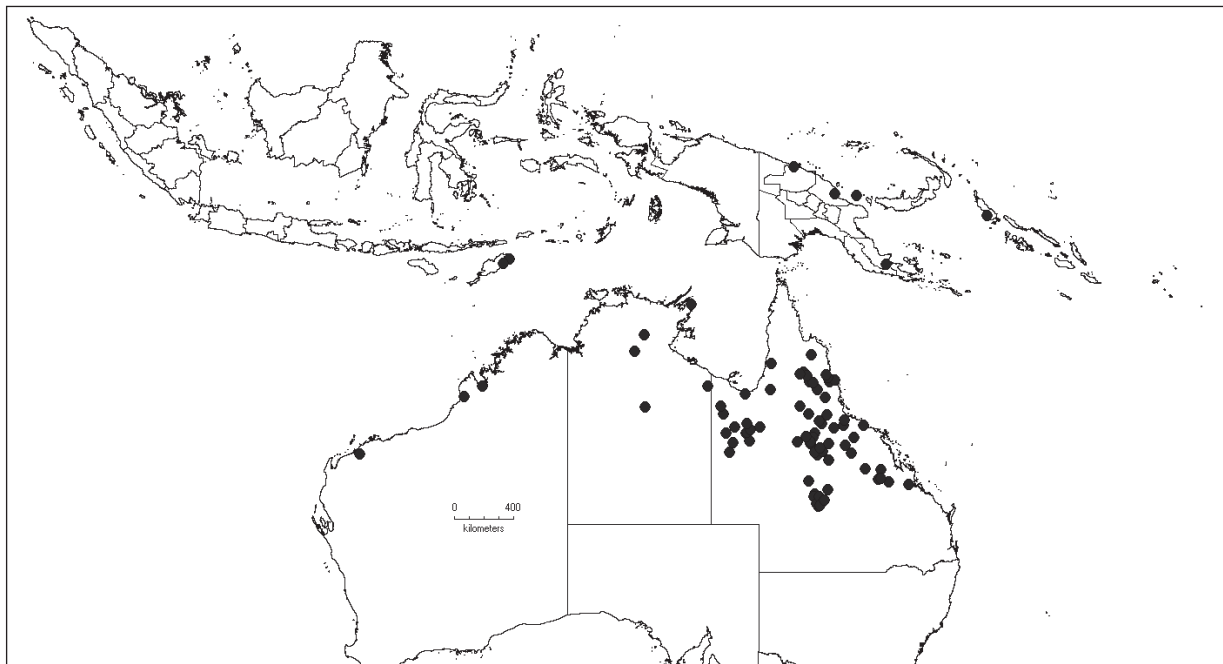
Type citation (Protologue): ‘N. Australia. Victoria river, Hooker’s and Sturt’s Creeks, *F. Mueller*; Gulf of Carpentaria, *F. Mueller, Landsborough*; N. Kennedy district, *Daintree*; in the interior, *M’Douall Stuart’s Expedition*. Queensland. Burdekin and Suttor rivers and Peak Downs, *F. Mueller*; Bowen, Isaacs and Suttor rivers, *Bowman*’.

Herb, erect, 0.3–1 m high; branches usually moderately to densely hairy, often consisting of long white hairs (0.7–2 mm long), ± straight for much of their length, usually spreading and/or ± appressed and retrorse, rarely antrorse (several collections from North Kennedy region, Queensland), often restricted to nodes (especially when short hairs present), or if hairs short (0.1–0.5 mm long), frequently ± curled, retrorse, rarely antrorse.

Leaves strongly aromatic, frequently aniseed-scented, sometimes lemon-scented to slight citronella (several collections from the North Kennedy and South Kennedy regions, Queensland), rarely with a musk to clove fragrance (Everist 5215), sometimes with menthol/camphor-like odour, usually moderately to densely hairy, particularly on petiole and main veins of abaxial surface, but often with indumentum equally dense throughout, less frequently sparsely hairy; hairs  $\pm$  appressed, antrorse, white, either long (to c. 1 mm long) or short (to 0.5 mm long); petiole short, (2–)4–10 mm long; lamina  $\pm$  glaucous, usually  $\pm$  ovate, often narrowly so, (6–)10–35 mm long, 4–10 mm wide, usually densely glandular (glands sessile), veins usually indistinct; base obtuse to very shortly attenuate; margin usually  $\pm$  bluntly serrate to serrulate, sometimes with only one or a few teeth or rarely entire (Byrnes 2576); apex obtuse. Inflorescence (15–)50–100(–120) mm long, racemose, simple or with 2 lateral branches, slender, open; axis retrorsely hairy (as for branches); uniflorescences (3–) or 6-flowered. Bracts broadly ovate, 2–4 mm long, 2–3 mm wide; base slightly cordate; apex shortly acuminate (acumen to 0.5 mm long). Pedicels 2–4.5 mm long, 4–6 mm long in fruit, hairy. Calyx 2–2.5 mm long, enlarging in fruit to 4–7 mm long, held somewhat distant and transverse to infructescence axis, becoming slightly downward pointing when mericarps mature; inner abaxial surface usually sparsely to moderately hairy on lower third (hairs to c. 0.5 mm long), rarely glabrous, podiate (stalked) glands often present. Corolla mauve, often with pink-tinge, 3.5–6 mm long; tube with  $\pm$  parallel sides to slightly funnel-shaped. Adaxial staminal filaments with a minute, indistinct ciliate appendage near base; anthers c. 1 mm across. Mericarps pale to medium brown, slightly flattened or angular sub-spherical, 1.3–1.5 mm long, usually not or only very slightly mucilaginous when wet; calyx lobes not enclosing fruit.

**Distribution:** This species is known from Timor-Leste, Papua New Guinea (East Sepik, Madang, Northern, Bougainville) and tropical Australia, occurring in Western Australia (Canning), the Northern Territory (Darwin & Gulf) and Queensland (Cook, Burke, Mitchell, Leichhardt, North Kennedy, South Kennedy, Gregory North, Warrego). **Fig. 4.**

**Ecology:** This species is often common near watercourses and drainage lines, but can often occur on hillsides. Common in a variety of vegetation types including, open monsoon forests, dry low open woodlands with *Eucalyptus erythrophloia*, *E. terminalis*, from margin of, or gaps in, low closed deciduous vine thickets with *Melaleuca citrolens*, *Terminalia*, and *Flindersia collina*, and from Brigalow scrub. It occurs on soils ranging from cracking gilgaied alluvial clays, loams to red sands, including basalt-, sandstone- and limestone-derived soils.



**Fig. 4.** Distribution map of *Ocimum caryophyllum* in Papua New Guinea and Australia, based on authenticated herbarium collections. Collections from Timor Leste are also included.

*Notes:* Many of the same herbarium collections cited above were used as type material for different taxonomic concepts.

In fruiting material, the pedicels remain more or less patent to the axis, such that the fruiting calyces are held distant from the axis with their mouth and lobes directed transversely away from the axis.

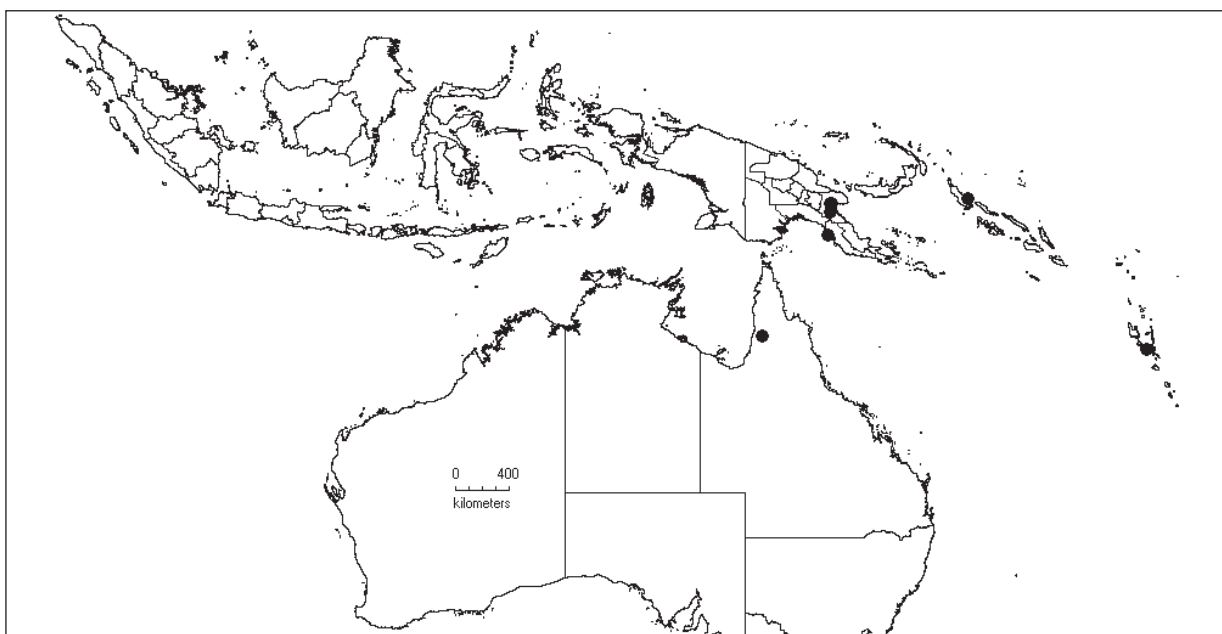
The leaves of this species are frequently greyish green, and although the odour of crushed leaves is variable, they are frequently distinctly aniseed- or clove-like, less frequently lemon-scented, and very rarely odourless. Although the leaves are usually moderately to densely hairy, *Michael 1278* and *Anonymous s.n. for F.M. Bailey* (BRI114507) are both very sparsely hairy. *A.R. Bean 5599* & *P.I. Forster* is somewhat intermediate between *O. caryophyllum* and *O. tenuiflorum*: some leaves narrower, thickish, grey-green with white hairs, but others leaves are more like *O. tenuiflorum* s. str., namely, thin, membranous with long petiole, some pedicels arching as found in *O. basilicum*, but only a few short hairs on staminal appendage.

**5. *Ocimum gratissimum* L. *Species Plantarum* 832 (1753).**  
subsp. *gratissimum*

Neotype (Paton 1992): cultivated Uppsala, originally from India, *Linnean herbarium* 749.2 (LINN).

Perennial herb, 1–3 m high, woody basally (up to 50 mm thick), strongly and frequently unpleasantly aromatic; stem and branches glabrous, pubescent when young. Leaves with petiole 20–45 mm long, slender, pubescent; lamina membranous, narrow, elliptic-ovate, 50–100 mm long, 25–45 mm wide; base cuneate; margin entire basally, elsewhere coarsely crenate-serrate or finely serrate to almost undulate, puberulent or pubescent; apex acute. Inflorescences 100–150 mm long, with whorls of flowers in simple or branched, slender open spike-like clusters. Bracts ovate, acuminate. Pedicels 3–4 mm long. Calyx 1.5–2 mm long, in fruit 4–7 mm long, held more or less patent to infructescence axis; abaxial lip with median lobe-pair minute, tooth-like, much shorter than adaxial lip; adaxial lip rounded and recurved. Corolla greenish white to pinkish-white, 3.5–4 mm long; outer surface pubescent. Staminal filaments distinctly exerted; adaxial filaments with a bearded appendage at base. Mericarps sub-globose, c. 1.5 mm long, brown, rugose, usually not or only very slightly mucilaginous when wet; calyx lobes and throat closed in fruit.

*Distribution:* This pantropical subspecies is widespread in America, Africa, India and South East Asia. It is naturalised in Papua New Guinea (East Sepik, Manus, Morobe, New Britain, New Ireland, and Bougainville) and once collected from Australia (Queensland). *Ocimum gratissimum* subsp. *iringense* Ayobangira ex Paton is endemic to Tanzania (Paton 1992). There are no known records of that subspecies occurring in Papua New Guinea or Australia. **Fig. 5.**



**Fig. 5.** Distribution map of *Ocimum gratissimum* subsp. *gratissimum* in Papua New Guinea, Australia and Vanuatu, based on authenticated herbarium collections.



*Ecology:* This commonly cultivated species occurs in villages and gardens, and in disturbed areas of coconut plantations, river banks, road sides and sea-side vegetation, from sea level to 1100 m.

*Notes:* The distribution of this subspecies is inadequately known because there are very few collections from this region. It may be more widespread in Australia, but only one collection from the Errk Oykangand (CYPAL) National Park, far N Cape York (Queensland: Cook) (*McDonald 9790*) is known. Paton (1992) recognised two varieties in the nominate subspecies (namely, var. *gratissimum* and var. *macrophyllum* Briq.). The usefulness of this varietal classification in the Papua New Guinea-Australian region is not known and was not applied. However, plants of Continental South East Asia have been classified according to these varietal concepts (Suddee et al. 2005) and so may also occur in the Papua New Guinea-Australian region.

#### 6. *Ocimum tenuiflorum* L. *Species Plantarum* 597 (1753).

Lectotype (refer Paton 1992): cultivated Uppsala, *Linnean herbarium* 749.13 (LINN).

*Ocimum santum* L. *Mantissa Plantarum* 85 (1767).

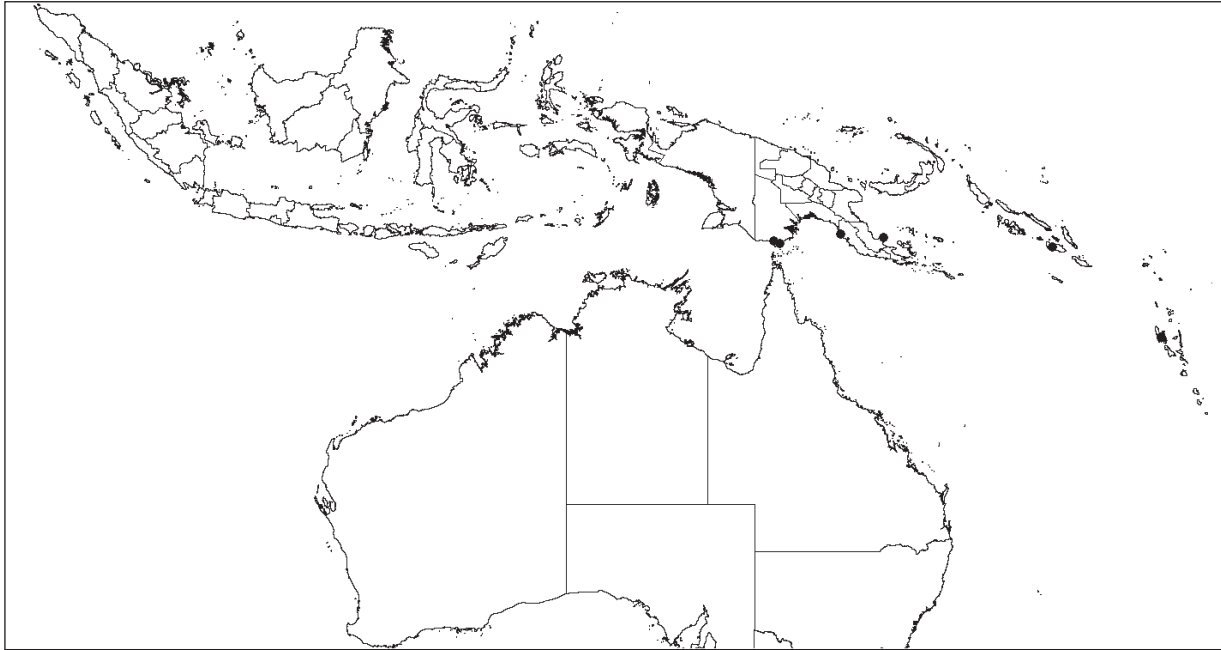
Lectotype (refer Paton 1992): cultivated Uppsala, *Linnean herbarium* 749.7 (LINN).

Herb, erect, 0.1–0.6(–1) m high; branches moderately to densely hairy with hairs short (0.5–1 mm long), retrorsely curled,  $\pm$  appressed and with long white hairs (to c. 2 mm long) that are frequently  $\pm$  spreading to slightly retrorse. Leaves  $\pm$  strongly aromatic, usually lemon-scented, moderately to densely hairy throughout or particularly on petiole, midrib and major veins; hairs white, antrorsely curled (hairs usually to c. 0.5 mm long, less frequently longer); abaxial lamina surface often more densely hairy than adaxial surface, densely glandular with sessile glands; petiole 9–20(–30) mm long; lamina green,  $\pm$  ovate to elliptic, (17–)20–50 mm long, 8–25 mm wide, membranous, veins  $\pm$  distinct; base cuneate to very shortly attenuate; margin bluntly serrate to with teeth sub-apiculate; apex obtuse. Inflorescence (30–)80–160 mm long, racemose, simple or 2- or more-branched, slender, open; axis retrorsely hairy with short,  $\pm$  curled and appressed; inflorescence unit 3-flowered; bracts broadly ovate, 2–3 mm long, 2–3 mm wide; base slightly cordate; apex distinctly acuminate (acumen 0.5–1 mm long). Pedicels 1–1.5 mm long, 2–3.5 mm long in fruit, hairy (as for inflorescence axis). Calyx 1.5–2 mm long, enlarging in fruit from 3.5–4 mm long, held somewhat distant and transverse to infructescence axis; inner surface glabrous or abaxially sparsely and minutely hairy (hairs c. 0.1 mm long), podiate glands sometimes present. Corolla mauve, often with pink tinge, or white and often purplish within, 2.5–3 mm long; tube with  $\pm$  parallel sides. Anthers c. 1 mm wide; adaxial staminal filaments with a minute indistinct ciliate appendage near base. Mericarps brown,  $\pm$  flattened ovoid, 1–1.5 mm long, 0.8–1 mm wide, usually not or only very slightly mucilaginous when wet; calyx lobes not enclosing fruit.

*Distribution:* This species is pantropical, possibly a native of tropical Asia (India and Malaysia, Paton 1992), extending from Sri Lanka and India, throughout continental South East Asia, Marianas Islands, Papua New Guinea, Australia, and Vanuatu to Fiji. It is also in Africa, cultivated in Tanzania, and probably occurs throughout East Africa (Paton 1992). In New Guinea, it is known from Indonesian Papua (Digul) and Papua New Guinea (East Sepik, Madang, Morobe and Central). In Australia, it is only known, with certainty, from the northern Torres Strait islands (Murray Island: *Lawrie 60* – used to perfume coconut oil; Boigu Island: *Clarkson 3851*, Cook region, Queensland). However, a few other collections from the Darwin and Gulf region of the Northern Territory are regarded as possibly of this species. **Fig. 6.**

*Ecology:* In New Guinea, this species is commonly cultivated in gardens, on brown clay soils, occurring from sea level to elevations of about 210 m.

*Notes:* Since *O. caryophyllum* has been included within the circumscription of *O. tenuiflorum*, the following morphological comparison is provided. *Ocimum tenuiflorum* (s. str.) has leaves with petiole 9–20(–30) mm long (cf. (2–)4–10 mm long in *O. caryophyllum*); lamina relatively thin and membranous (cf. thicker in *O. caryophyllum*), but the lamina of these species are similar in shape, both more or less ovate; *O. tenuiflorum* tends to have a larger lamina, usually c. 20–50 mm long and 8–c. 25 mm wide (cf. (6–)10–35 mm long, 4–10 mm wide in *O. caryophyllum*); base cuneate to very shortly attenuate (cf. obtuse to very shortly attenuate in *O. caryophyllum*); margin for both species is often similar, but in *O. tenuiflorum* the margin is usually (perhaps always) slightly toothed, whereas in *O. caryophyllum* margin is usually more or less bluntly serrate to serrulate, or sometimes with only one or a few teeth, rarely entire. The branchlets of both species are moderately to densely hairy and both have long hairs (up to c. 2 mm long); in *O. tenuiflorum* these long hairs are frequently more or less spreading (cultivated – Kebun Raya Bogor, Jawa, Indonesia, *Bakhuizen van der Brink 8153*, 13 Sep 1939, BRI), but in *O. caryophyllum* these hairs are usually spreading and/or appressed or subappressed and then retrorse, rarely antrorse. *Ocimum tenuiflorum* also has hairs that are retrorsely curled (hairs 0.5–1 mm long), but *O. caryophyllum* has shorter (0.1–0.5 mm long) retrorsely curled hairs, rarely antrorsely curled, and these are often restricted to the nodes. The density of hairs and type of indumentum on



**Fig. 6.** Distribution map of *Ocimum tenuiflorum* in Papua New Guinea and in the Torres Strait islands of Australia, based on authenticated herbarium collections. Collections from the Guadalcanal (Solomon Islands) and Espiritu Santo (Vanuatu) are also included.

the leaves of both species vary in a similar manner. Likewise, there is considerable variation in the odour of the crushed leaves of both species, varying from lemon- to clove-scented, to an aniseed aroma.

In fruiting material of both species, the pedicels remain more or less patent to the axis, such that the fruiting calyces are held distant from the axis with the calyx mouth and lobes mostly directed transversely away from the axis. However, the calyx may become slightly downward pointing when mericarps mature, more frequent in *O. tenuiflorum* than in *O. caryophyllum*.

Some specimens of *O. tenuiflorum* from outside the New Guinea-Australian region [for example, *P. Venkanna* 5023 (from India); *G. Davidse* 7349 (Sri Lanka); *R. W. Squires* 350 (Vietnam); *R. C. McGregor* BS32216, *M. Ramos* BS5330 (Philippines); *W. Greenwood* 115 (Fiji) and *S. F. Kajewski* 64 (Vanuatu)] have densely hairy branchlets with mostly long, spreading hairs. Furthermore, the leaf lamina tends to be less membranous, slightly thicker than typical *O. tenuiflorum*. Whether or not this hairy variant is present in Papua New Guinea or Australia is uncertain. *Brass* 3755, *Cowley* 2 and *Kajewski* 1825 (all from Papua New Guinea) have an indumentum that is similar to the previously mentioned specimens, but not as dense or with more hairs that tend to be slightly retrorse rather than just spreading. In mainland Australia, the leaves are less membranous than those of Papua New Guinea and the Torres Strait islands.

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and companionship for my extensive field study of populations of *Ocimum* in Queensland and northern New South Wales. We spent many hours crawling from plant to plant assessing the amount of morphological variation in each population that we visited. We were all pleasantly aromatic from a daily infusion of basil aromas! At the end of the long day's drive and field work, Elizabeth often provided freshly made pesto as a complement to our campfire meals.

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## Appendix

### Enumeration of selected collections of *Ocimum*

#### Legend

1=O. × *africanum*; 2=O. *americanum*; 3=O. *basilicum*; 4=O. *caryophyllum*; 5=O. *gratissimum* subsp. *gratissimum*; 6=O. *tenuiflorum*

Adams 1194: 1; Addicott 86 & Newton: 2; Alcock 11304: 1; Anonymous 1751, Feb. 1928 (BRI): 4; Anonymous s.n. [?382] ex J.H. Simmonds: 4; Augusteyn QH001: 2

Ballingall 1568: 3; Barker 628: 4; Barker 4756 & Chinnock: 4; Bateson 136: 2; Batianoff 411867: 2, 508605: 4; Batianoff 412353 & Halford: 2, 412229: 2, 412475: 2, 603105: 2, 60398: 2; Batianoff 900403E & Smith: ?1; Bailey 124: 3 (probably this species but no leaves present); Bates 37470: 3, 50023: 3, 6817: 3; Bean 2964: 1, 2965: 1, 3533: 2, 4683: 4, 5024: 4, 16497: 2, 18947: 1, 22149: 4, 31991: 1; 24928: 2, 28835: 2, 29865: 2; Bean 5599 & Forster: 4, 7440: 4; Beaumont 7034: 4; Bell s.n., (per J.J. Purcell), 9 Mar. 1944: 4; Bennett S6D: 2; Bennie s.n., 28 Sep. 1992: 4; Blake 8436: 4, 14679: 1, 19941: 2, 21822: 1; Booth 3558: 4, CAM04-5: 4, CAM20-9: 4; Boulton 541: ?1; Boyle BGQLD0555: 4; Bradthe 254: 2; Brass 73: 4; 1640: 3, 2815: 6, 3755: 6; Brynes 1298: 3, 2576: 4; Burton s.n., Jun–Dec 1889: 4

Carr 16214: 2; Carter 349: 3; Chippendale 1997: 4; Clarkson 3851: 6, 3890: 1, 5102: 2; Clarkson 9537 & Neldner: 4; Cole 214 & Provan: 4; Conn 4156, Brown & Leist: 4, 4157–4171, 4177, 4182–4184: 4, 4188: 2, 4189–4191, 4193, 4196, 4197: 1; Conn 4205, Kiapranis & Mavaii: 5; Coveny 6879 & P. Hind: 2; Cowley 2: 6, 18: 3; Cumming 16076: 2, 22231: 4, 23493: 4, 23696: 4; I.C. Cunningham s.n., 25 May 1964: 2

Dale 187: 1; Davidson 168: 6; Denley SAMP017: 2; Donner 9686: 3

Edye s.n., Jan. 1959: 1; Everist s.n., 4 Dec 1952: 5; Everist 5066: 3, 5068: 3, 5109: 2; 5215: 4, 7328: 4

Fell 830: 4, 1910: 1; Fell 5317 & Barrs: 4; Fell 4525, Stanton & Blackman: 4; Fensham 292: 1, 514: 4, 2254: 1, 3152: 4; Flecker 1180: 2; Flecker North Queensland Naturalists 2045: 2; Floyd NGF 3509: 3; Ford 5213, Jensen, Cooper & McKenna: 6; Forster 3624 & Bolton: 1; Forster 16527 & Figg: 4; Forster 18787 & Ryan: 4; Fox 34: 3; 2127: 2, 2345: 4, 2420: 2, 2867: 2; Fryar 3617: 6

Gittins 722: 1; Goetze s.n., Feb 2001: 3; Godwin C4433: 2; Gunther 133: 1

Halford Q164: 4, Q758: 4, Q9007: 2; Harris 33: 1; Henderson 2655: 1; Hubbard 6761 & Winders: 4; Hyland 5940: 2

Jacks 20: 1 (leaves & branchlets densely hairy); Jago 5283 & Wannan: 2; Jensen 89A: 4, 2249: 4; Jobson 636: 1, 671: 2; Johnson 1807: 1, 2378: 6 (similar to *O. caryophyllum*, but with longer retrorse hairs on branches), 3728: 2; Johnson and G. Turpin s.n., 31 Mar 2000: 4; Jolly 17: 2

Kajewski 1825: 6, 2195: 6; Kearney s.n., 19 Jul. 1937: 4; Kenneally 9026: 2; Kelly s.n., 22 Jul 1959: 2; Kemp 6359: 2; Kemp 879 & Fairfax: 4; Kemp 11327 & Radford: 1; Kendall s.n., Mar. 1991: 4; Kerenga LAE76432: 5, LAE76433:

2; G.R. le Hunte s.n., Jan. 1900: 1; Lelean LAE 76436: 2, LAE76437: 2; Kupsch 2: 2  
Lauterbach 749: 1; Lawrie 27: 1, 60: 6, 61: 1; Lepschi 1933 & Lally: 2; Lewandowsky 50: 3  
Mann NGF43340: 2; McDonald 1875: 4, 2815: 4, 4816: 6, 6139: 2, 8857: 2, 9790: 2, 12745.1: 2; McDonald 5465 &  
Covacevich: 4; McDonald 8745, Turpin, Couburn & Schuler: 6; McDonald 9790: 5; McKenna 828: 5; Metreyard  
TWR313: 2; Michael 1278: 4; Millar 1923: 3; Millar & Vandenberg NGF 40930: 2; Milson 581: 4; Mitchell 3089:  
3, 4301: 3, 4317: 3, 5526B: 3, 6763: 4; Mitchell 5689 & Brockway: 3  
Neldner 1622: 1; Neldner 3508 & Thompson: 2; Newton & Skerman s.n., Jul. 1950: 4  
O'Keefe s.n., 8 Jan 1989: 4  
Parkinson 59 (NSW456321): 1, (NSW388681): 1; Pearson 151: 4; Pegler 170: 4; Perry 1094: 4; Phelps 55: 4;  
Pickering 44: 2; Pollock 2203: 6, 2304: 2; Pullen 6495: 3, 8997: 4  
Roche s.n., 25 Jun 1997: 2; Rozefelds 10: 4; Ryan 1456: 4  
Sankowsky 1888 & N. Sankowsky: 4; Schencker s.n., anno 1909: 6; Schiefenhoewel 29: 3; Schmid 587: 4; Setter  
RV16: 2; Sharpe 2798: 4; Sikdar 188: 1; L. Smith s.n. 1 May 1985: 2; Smith T195: 1 (probably, but leaves small,  
less likely to be *O. basilicum*); Stevens LAE50142: 4; Story & Yapp 145: 4; Streimann & Kairo NGF44428: 3;  
Swarbrick 9434: 5; Swinburne s.n., 22 May 1942: 4; Swinbourne 652: 3  
Tan s.n., Apr. 1987: 3; Thompson 2614: 2, 2648: 2, CHA639: 3; Thompson 283 & Dillewaard: 1, 492: 3; Thompson  
72 & Henderson: 1; Thompson NOR402 & Newton: 4; Thompson BUC481 & Sharpe: 1, CHA74 & Sharpe: 2;  
Thompson BUC201 & Simon: 1; Thompson LON6 & Turpin: 4; Thompson TAN250 & Wilson: 4; Thorne 20968  
& Jones: 2; Trapnell s.n., 28 Dec. 1961: 3; Trudgen & Butler BES MST 350: 3; Turpin 707 & Thompson: 1, 425: 4  
Volger 4: 2  
Walser s.n., Apr 1953: 2; Wannan 556: 2, 603: 1, 1172: 4; Wannan 5037 & Graham: 1, 5038: 4; Wannan 2086 &  
Jago: 1; Waterhouse 3879: 6, 6193: 2, 6364: 6; Weinland 207: 2; White 66: 3, 764: 6, 1425: 1 (fruiting; possibly  
hybrid – densely hairy), 10727: 2; Whitehead 6: 3; Wiakabu & M.C. LAE73476: 5, LAE73562: 3; Williams 8: 2,  
77065: 1, Williams 85061: 4; Witten 1: 3; Womersley NGF24782: 6

