



The first record of the boreal bog species *Drosera rotundifolia* (*Droseraceae*) from the Philippines, and a key to the Philippine sundews

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Key words

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Abstract *Drosera rotundifolia*, a species of the temperate Northern Hemisphere with a disjunct occurrence in high montane West Papua, has been discovered in a highland peat bog on Mt Limbawon, Pantaron Range, Bukidnon on the island of Mindanao, Philippines, which mediates to the only other known tropical, Southern Hemisphere location in New Guinea and the closest known northern populations in southern Japan and south-eastern China. A dichotomous key to the seven *Drosera* species of the Philippines is given, and distribution maps are provided.

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INTRODUCTION

The Philippines are rich in carnivorous plants, with about 47 species known from the islands, most of which belong to the pitcher plant genus *Nepenthes* L. This genus has more than 30 species in the Philippines, all except *Nepenthes mirabilis* (Lour.) Druce endemic to the country. Most species occur on Mindanao and Palawan, while several are confined to a single highland or even mountain peak (Robinson et al. 2009, McPherson & Amoroso 2011, Cheek & Jebb 2013, 2014, Gronemeyer et al. 2014). Six species of sundews, *Drosera* L., are thus far known to occur in the Philippines, all of them (sub)tropical Australasian taxa that are more or less widespread in Malesia, and none are endemic to the Philippine islands. Three of these are generally montane perennial species, occurring in wet nutrient poor soils in highlands, in the Philippines ranging from 1000–2400 m altitude. *Drosera lunata* Buch.-Ham. ex DC. (syn. *D. peltata* Thunb. var. *lunata* (Buch.-Ham. ex DC.) C.B. Clarke, in most local Flora treatments referred to as *D. peltata*) is known from Luzon and Mindoro, *D. spatulata* Labill. from Luzon and Mindoro and *D. ultramafica* A. Fleischm., A.S. Rob. & S. McPherson is in the Philippines only known from Palawan (Merrill 1907, 1922, Van Steenis 1953, Fleischmann et al. 2011, Gibson et al. 2012). On the other hand, three annual species are confined to lowland areas (c. 10–700 m). *Drosera burmannii* Vahl occurs in Luzon and Western Visayas: Malalison and Panay (Van Steenis 1953, Pelser & Suarez 2014, Galang 2014,). *Drosera indica* L. and *D. serpens* Planch. have been reported as rarely occurring on the island of Luzon. The latter species has been recently separated from *D. indica* again (Barrett & Lowrie 2013). *Drosera indica* occurs also on Culion island of Palawan province and Malalison island of Western Visayas (Planchon 1848, Merrill 1922, Croizat 1952, Barrett & Lowrie 2013, C. Lee, pers. comm.).

Drosera rotundifolia L. (the generic type) is a temperate, winter dormant species that is widespread in the Northern Hemisphere, from Pacific North America across large parts of northern America and Europe to Siberia and the Kamchatka Peninsula, South Korea and Japan. It is the *Drosera* species covering the largest range, spanning the entire Northern Hemisphere from 180° Western Longitude to about 180° East, however, not forming a continuous circumboreal range (Diels 1906, Meusel et al. 1965). It is almost exclusively confined to the temperate zone. In the Northern Hemisphere its northernmost occurrences lie in Arctic Eurasia, Alaska and Greenland, its southernmost limits at about 24.5°N in south-eastern China in the mountains of northern Guangdong province (e.g., *L. Tang 1061*, IBSC photo, KUN photo, all herbarium specimens reported for this species from more southern locations in Guangdong and Guangxi provinces turned out to be *D. spatulata* or *D. burmannii*, on closer examination), at c. 30°N on the island of Yakushima in Japan (Croizat 1952, Komiya & Shibata 1978, Pott 2005, Kagawa 2015), at c. 34°N in northern Georgia and Alabama, USA (Radford et al. 1968, Jones & Coile 1988, Schnell 2002, Wolf et al. 2006) and at c. 33°N in Eurasia at isolated outposts in montane central Lebanon (e.g., at Felugha [Falougha], *Schweinfurth s.n.* B; Diels 1906; also at Bikfaya, Dhour El Choueir, Mayrouba, Col de Zahlé and others, Mouterde 1970). A single, outlying occurrence is known thus far from the Southern Hemisphere, at the Paniai Lakes (Wissel Lakes) of the central highlands of West Papua, Indonesia, where it grows in high montane peat bogs (Van Steenis 1955, Conn 1980).

During a recent expedition to the Pantaron Range, Bukidnon Province on the island of Mindanao, *D. rotundifolia* has been discovered in a highland peat bog at 1880 m on Mt Limbawon, one of the remote peaks of Pantaron Range – this represents its first record for the Philippines, and the second of the species from Malesia and from the tropics.

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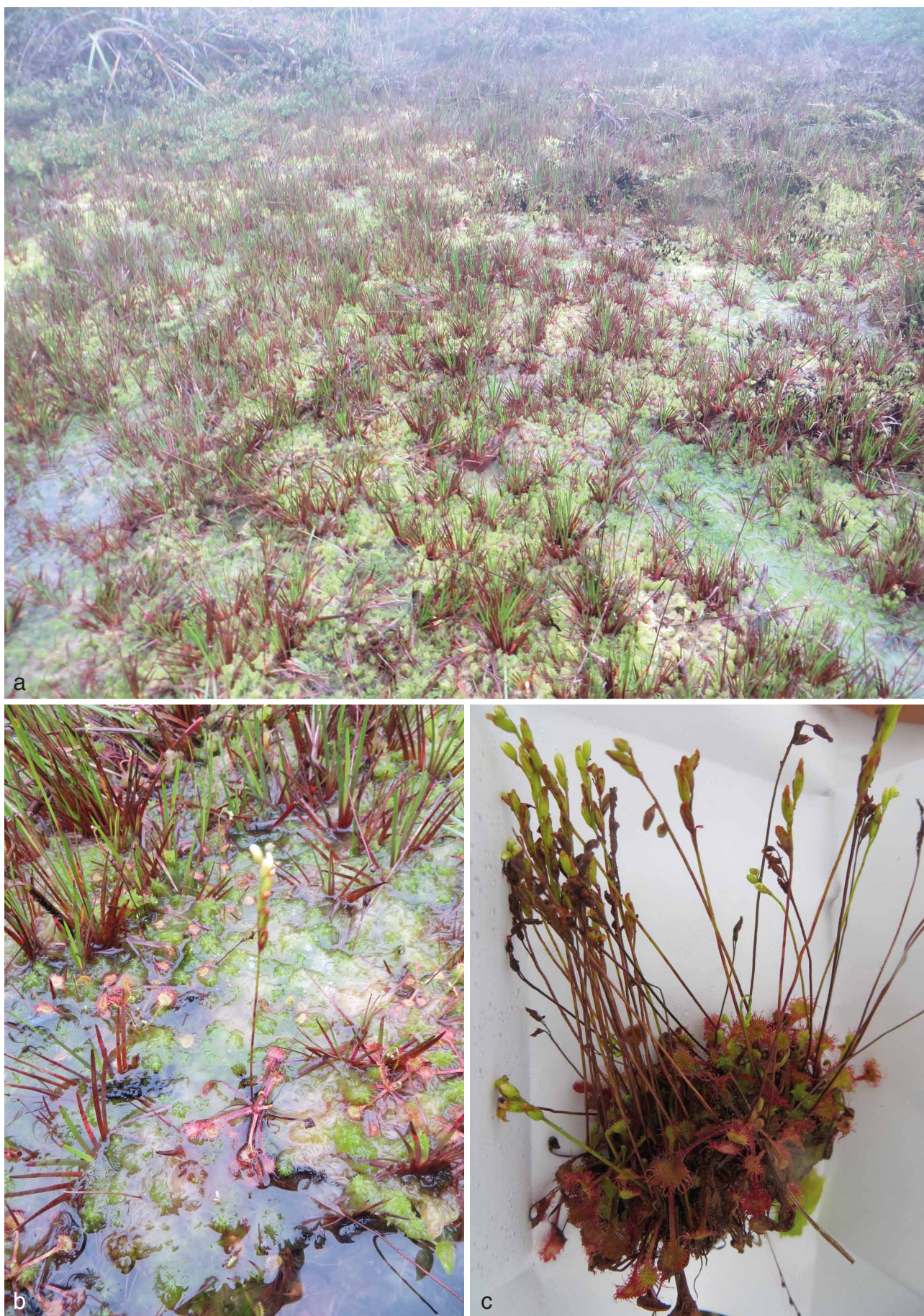


Fig. 1 a. Single population of *Drosera rotundifolia* on the Philippines at 1881 m on Mt Limbawon; b. habit of *D. rotundifolia* with leaves submerged in water, same location; c. close-up of specimens collected for herbarium records. — Photos by Fulgent Coritico.

MATERIAL AND METHODS

Field research was conducted in July 2015 by F.P.C. and researchers from the Central Mindanao University (CMU) and the California Academy of Sciences (CAS) at Mt Limbawon, Pantaron Range, Barangay Kibalabag, Malaybalay City. Prior informed consent from the indigenous people of the Talaandig tribe, and gratuitous permit was obtained from the Barangay Kibalabag and CENRO of Malaybalay City, respectively. Herbarium specimens and alcohol material were prepared and deposited in the Central Mindanao University Herbarium (CMUH). Herbarium specimens of Malesian *Drosera* were studied by A.F. for taxonomic comparison in B, K, L, M, P (photos), of Chinese specimens additionally from HNWP, IBK, IBSC, IFP, KUN, WUK as digitized images hosted on the Chinese Virtual Herbarium (www.cvh.org.cn; last acc. 13.10.2015) (herbarium acronyms following Index Herbariorum; Thiers 2015) and notes on habitat and ecology were recorded from the field in Mindanao by F.P.C. The distribution maps were created using DIVA-GIS 7.5 (Hijmans et al. 2005).

RESULTS

Distribution in Malesia

PHILIPPINES, Mindanao, Bukidnon Province, Pantaron Range, Mt Limbawon. – INDONESIA, West Papua region, Papua Province, Snow Mountains district, central highlands, Paniai Lakes.

Habitat & Ecology

In Malesia, *D. rotundifolia* is confined to high montane (1750–1880 m) *Sphagnum* bogs (Fig. 1). The single population on Mt Limbawon was observed in an open area of a peat bog on ultramafic soil, growing associated with *Xyris* sp. (*Xyridaceae*), sedges and *Sphagnum* spp. The associated vegetation around the peat bog consists primarily of dwarf trees 2–3 m high, such as *Leptospermum flavescens* Sm. (*Myrtaceae*) and *Dacrydium elatum* (Roxb.) Wall. ex Hook. (*Podocarpaceae*), and the shrub *Medinilla myrtiformis* Triana (*Melastomataceae*), as well as several species of grasses and ferns. Two site endemic species of pitcher plants (*Nepenthaceae*), *Nepenthes ceciliae* Gronem., Coritico, Micheler, Marwinski, Acil & V.B.Amoroso and *N. pulchra* Gronem., S.McPherson, Coritico, Micheler, Marwinski & V.B.Amoroso were also observed about 50 m distant from the *D. rotundifolia* population.

Conservation status of the species in Malesia

Since the single known Philippine population of *D. rotundifolia* is restricted to a very small area (c. 100 m²) of *Sphagnum* bog, and the area is prone to drying and habitat destruction by local people, we recommend to list the species as 'critically endangered' for the country. The New Guinean populations are in reach of human settlements (C. Lee pers. comm.), and hence are under potential threat as well, despite the remote location. Conn (1995) states that the species only had been found once in Western Papua, fortunately there are a few more recent observations of *D. rotundifolia* from montane bogs in the Paniai Lakes area (e.g., Danau Tigi, c. 1600 m, C. Lee pers. obs. 2001).

Notes

Due to subtle morphological differences in the floral bracts, the New Guinea plants of *D. rotundifolia* have been described as *D. rotundifolia* subsp. *bracteata* J.Kern & Steenis (Van Steenis 1955). However, these differences fall within the morphological variation observed in the bracts of *D. rotundifolia* throughout its range, and specimens with ligulate, glandular-denticulate

Table 1 Morphological comparison of the specimens of *Drosera rotundifolia* from Mindanao, Philippines with temperate and New Guinean plants (data based on herbarium measurements and Diels 1906, Kagawa 2015).

Character	Mindanao specimens	Temperate and New Guinea specimens
Lamina	4–7 by 5–8 mm	4–10 by 5–18 mm
Petiole	14–17 mm long	(6–)13–50(–70) mm long
Inflorescences per plant	1–5	1–2(–5)
Flowers per peduncle	4–6	1–25
Bracts	scale-like; linear oblong to lanceolate; acute; glabrous	scale-like to foliar; linear oblong or lanceolate to narrowly cuneate to obovate-spatulate; tip acute to obtuse to glandular ciliate; glabrous to tentaculate-glandular
Petals	5.4–5.5 mm long; spatulate; white	5–6 mm long; spatulate; white (rarely tinged pinkish)

bracts have also been described from Europe on various occasions (e.g., Lange 1851), to an extreme this is observed in plants from Lac de Creno, Corse (Maire 1904, Briquet 1913). Hence the New Guinean subspecies is considered of minor taxonomic value, and is here treated as part of *D. rotundifolia*. The Malesian specimens of *D. rotundifolia* agree in overall morphology with plants from the temperate Northern Hemisphere, except that their laminae are slightly smaller (4–7 by 5–8 mm, compared to 4–10 by 5–18 mm in Eurasian and North American specimens, Diels 1906; Table 1). However plants of both the Philippine and New Guinean populations still fall well within the morphological range displayed by the temperate specimens of *D. rotundifolia*.

The newly discovered population of *D. rotundifolia* is about 2100 km distant from the closest known populations in south-eastern China (in Guangdong, Fujian, and Hunan provinces; Ruan 1981, 1984, Lu & Kondo 2001), c. 2500 km from the closest populations in southern Japan (on Yakushima island), and about 1800 km from the New Guinean population at Paniai Lakes, West Papua, Indonesia (Fig. 2). The Philippine occurrence could thus be interpreted as a mediating stepping stone ('mountain hopping') in the phylogeographic history of the New Guinean populations, but the tropical populations could equally likely represent independent colonization events from the Northern Hemisphere by direct long-distance dispersal (see also Van Steenis 1962).

Similar species-disjunctions of temperate Northern Hemisphere flora elements that also occur in the highlands of Papua New Guinea and/or the Philippines, are found for example in the genus *Androsace* (*Primulaceae*; the Asian-Himalayan species *A. umbellata* (Lour.) Merr. also occurs on Luzon, Philippines and in Eastern New Guinea; Merrill 1924, Van Steenis 1955), *Hydrocotyle vulgaris* (*Apiaceae*; Europe, N-Africa, New Guinea, Australia; Van Steenis 1955), or the bipolar *Carex canescens* L. (*Cyperaceae*; temperate Northern Hemisphere, Himalayas, New Guinea, South-East Australia, southernmost Latin America; Moore & Carter 1971). In the case of bryophyte flora, 21 species of widespread Northern Hemisphere boreal to temperate mosses and liverworts have a disjunct occurrence at high elevations in New Guinea (Norris et al. 1999). Such remarkable range disjunctions have been largely explained by long-distance dispersal events, rather than by vicariance (Van Steenis 1962, Nathan et al. 2008, Escudero et al. 2010), though coinciding geographical disjunctions must of course be considered separately for each taxon (see Thorne 1972).

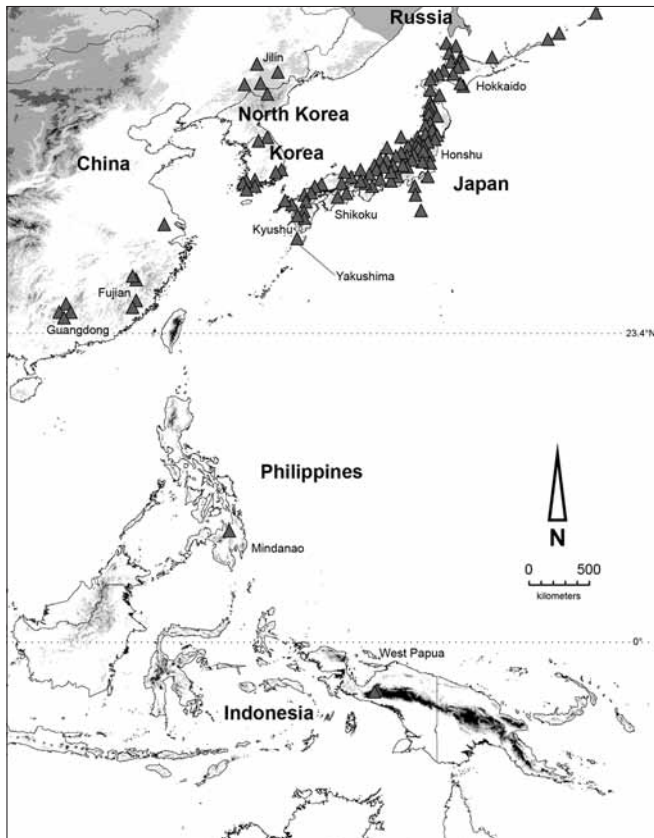


Fig. 2 Distribution of *Drosera rotundifolia* in Malesia and adjacent NE Asia. Triangles: single records; shading: species generally common in the area. Distribution data based on herbarium records, as well as on Komiya & Shibata 1978 (for Japan), Chung et al. 2013 (for Korea) and Meusel et al. 1965 (for Russian Far East).

Utricularia minor L. (*Lentibulariaceae*), likewise a carnivorous plant that is widespread in the temperate Northern Hemisphere, and which inhabits nutrient poor habitats like *Sphagnum* bogs (thus has similar ecological needs to *D. rotundifolia*), has been recorded from shallow pools in high alpine swamps of Mt Hagen, Papua New Guinea at 2500–3660 m elevation (Taylor 1977). Hence it shows a remarkably similar disjunct distribution pattern to *D. rotundifolia*, although it has not been recorded from the Philippines yet. Migratory birds have been cited as an explanation for this disjunction by Taylor (1977). Interestingly, the few New Guinean specimens available of *U. minor* show turion formation (a condensed apical shoot formed for hibernation in temperate aquatic species of *Utricularia*), although growing at tropical latitudes. It is not known yet whether the Papuan and Philippine populations of *D. rotundifolia* also form hibernacula like their Northern Hemisphere congeners do, or if they grow as tropical perennials. In case of the other two temperate Eurasian sundew species having occurrences in the tropics (*D. anglica* Huds. with disjunct outliers on Hawaii, and *D. intermedia* which is widely reaching into Latin America), the tropical populations display a tropical growth type and do not from winter resting buds. On the growth of northern temperate elements in montane Malesia, see Van Steenis (1962).

Malesian specimens examined. PHILIPPINES, Mindanao, Bukidnon Province, Malaybalay, Pantaron Range, Mt Limbawon, 1881 m, 30.06.2015, V.B. Amoroso VBA6223 (CMUH00009862). – INDONESIA, Western [Papua] Province, Wissel Lakes [Panai Lakes], in swamp near Arupa, 1750 m, 24.03.1955, C. Versteegh BW 3076 (L, holotype of *D. rotundifolia* subsp. *bracteata*; iso K).

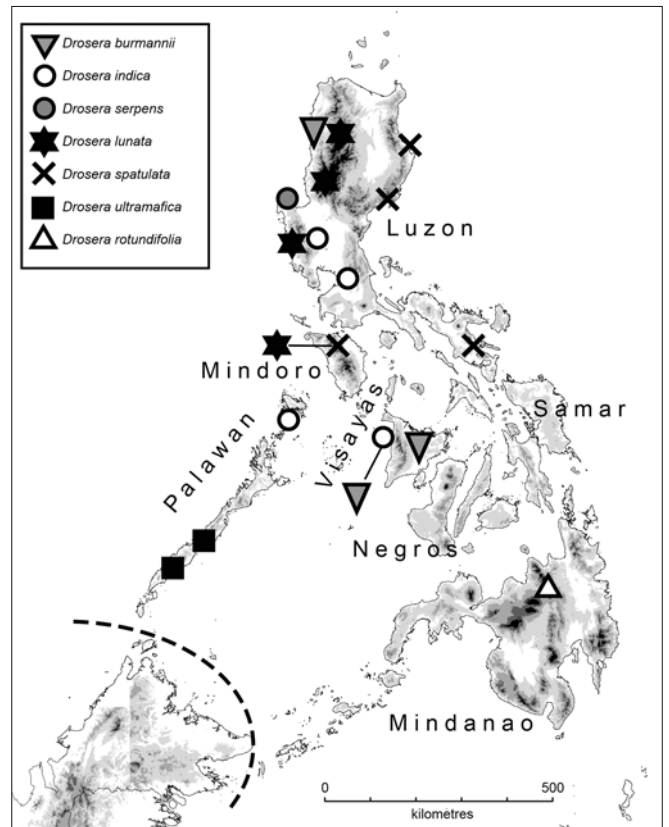


Fig. 3 Distribution of the seven species of *Drosera* in the Philippines.

KEY TO THE DROSERA SPECIES OF THE PHILIPPINES

Note — Islands and provinces of known occurrences are mentioned after the m-dash, synonyms as appearing in the Philippine floras are given in parentheses behind the species names; distribution data based on (and updated from) Planchon 1848, Merrill 1922, Van Steenis 1953, Fleischmann et al. 2011, Pelser & Suarez 2014, Galang 2014. For a distribution map of the Philippine species, see Fig. 3.

1. Plants caulescent, with distinctive, elongated internodes 2
1. Plants rosetted, sometimes forming columns of dead leaves with age 4
2. Lamina filiform, linear; stem and scapes finely glandular pubescent; annual plant from lowland areas 3
2. Lamina peltate, auriculate; stem and scapes glabrous; tuberous perennial from highland areas. — Luzon: Bontoc, Benguet, Zambales; Mindoro: Mt Halcon *D. lunata* (syn. *D. peltata* var. *lunata*, *D. peltata* s.l.)
3. Plants 5–10 cm tall, leaves 2–5 cm long, scapes 3–5(–8)-flowered; leaves with short petiole (a space of 1–10 mm on the leaf between stem and carnivorous glands), petioles with microscopic glandular trichomes; stem with microscopic translucent glandular hairs; stipules reduced to 2 filiform setae or absent. — Luzon: Central Luzon, Rizal; Western Visayas: Malalison island; Palawan: Culion island *D. indica* (syn. *D. hexagynia* Blanco)
3. Plants (9–)15–30 cm tall, leaves (6–)10–15 cm long, scapes (6–)10–20-flowered; leaves with distinct petiole (a space of 10–12 mm on the leaf between stem and carnivorous glands), petioles with scattered, microscopic Y-shaped trichomes and non-glandular hairs; stem with microscopic translucent non-glandular hairs and scattered larger, red glands; stipules always absent. — Luzon: Pangasinan *D. serpens*

4. Styles 5; scapes entirely glabrous, calyx densely glandular; leaves broadly cuneate, with very short inconspicuous petioles. — *Luzon*: Bontoc; *Western Visayas*: Malalison and Panay islands. *D. burmannii*
4. Styles 3; scapes glandular or glabrous; leaves spatulate to narrowly cuneate or oblong to oblanceolate, petiolate 5
5. Scapes and calyx glabrous; lamina orbicular, wider than long (4–7 by 5–8 mm); ripe seeds fusiform, brown. — *Mindanao*: Budnikon (Mt Limbawon). *D. rotundifolia*
5. Scapes and calyx (sparsely) glandular; lamina spatulate to oblong, much longer than wide (not wider than 5 mm); ripe seeds ellipsoid, black. 6
6. Leaves erect to semi-erect; lamina narrowly oblong to oblanceolate; plants frequently forming columns; stipules of living plants reddish. — *Palawan*: Palawan (Mt Mantalingahan, Mt Victoria) *D. ultramafica*
6. Leaves flat on the ground; lamina spatulate to narrowly cuneate; plants occasionally forming columns; stipules of living plants papery white. — *Luzon*: Albay (Mt Mayon), Isabela (Northern Sierra Madre), Aurora (Mt Mahojeg); *Mindoro*: Oriental Mindoro (Mt Halcon) *D. spatulata*

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