AGROSTOPHYLLUM LKOU: A NEW ORCHID SPECIES FROM THE REPUBLIC OF PALAU, MICRONESIA

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Abstract. We present and illustrate a new species of *Agrostophyllum*, Orchidaceae, from Babeldaob Island, the Republic of Palau, in the Caroline Islands of the western Pacific. This species increases the number of orchids in Palau to at least 80. Authors of a previously unpublished checklist noted an unidentified *Agrostophyllum* sp. and have described the species as superficially similar to *A. majus* based on collections of non-flowering specimens and without direct observation of the original description or a flowering specimen. However, detailed analysis of newly collected material confirms that the species is undescribed, with visible traits that distinguish it from *A. majus*. The new species appears to be self-pollinating and displays an unusual column morphology that apparently facilitates autogamy. Upon comparing records and collections of *Agrostophyllum*, including *A. majus*, from elsewhere in the Pacific and Southeast Asia, this new species seems to be restricted to Palau. Our extensive surveys suggest that the species is limited in abundance and sparsely distributed despite having a somewhat wide range on the archipelago's largest island, Babeldaob. Accordingly, at present the species should be considered rare from a conservation perspective, meeting IUCN Red List criteria for Critically Endangered status. Further studies on its status are warranted to ensure its preservation.

Keywords: Epidendroideae, floristics, Orchidaceae, plant taxonomy, tropical epiphytes

Agrostophyllum Blume (1825) (Orchidaceae: Epidendroideae: Agrostophyllinae) is a Paleotropical genus of 135 currently accepted species (POWO, 2025) ranging from Madagascar to Samoa, with a clear center of diversity in New Guinea (Schuiteman, 1997; Ormerod, 2014). Members of this genus are usually epiphytes forming clumps of elongate stems with few to many distichous leaves. The stems are not, or only slightly fleshy, sometimes distinctly laterally flattened, and are commonly completely enveloped by the leaf sheaths that usually show a brownish scarious margin. In most species, 1–ca. 60 inflorescences are clustered in a terminal capitulum, with the individual inflorescences being short and sparsely flowered (with one to few flowers). In *A. paniculatum* J.J.Sm. of sect. *Dolichodesme*, however, the individual inflorescences may exceptionally carry as many as 20 flowers. A smaller number of species have lateral, very short or rarely elongate inflorescences. In section *Dolichodesme* Schltr., these inflorescences are produced on a leafless terminal portion of the stem and thereby resemble an elongate, terminal inflorescence. The flowers are up to about 2 cm in diameter, but usually much less, and are whitish or yellowish, sometimes with purple or yellow markings on the labellum or the column. The labellum is usually clearly divided

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into a concave hypochile and a concave to convex epichile. There are eight pyriform pollinia attached to a small, common viscidium (Wood, 2014).

Prior to recent surveys aimed specifically at documenting orchid diversity across the Republic of Palau as part of the Palau Orchid Conservation Initiative (Crain, 2018a, 2018b; Crain et al., 2022), only a single species of *Agrostophyllum* was believed to occur in the country: *A. elongatum* (Ridl.) Schuit. of section *Appendiculopsis* Schltr. (Hillman-Kitalong and Uesugi, 2017). However, a potential second species was collected from Aimeliik (Aimiriik [sic]) State, and from Kamset (Kamsett), Arumonogui (Armonogui [sic]), Ngeremlengui State, Babeldaob (Main Island), Palau (Pelew) (*Kanehira 524* [NY]; *Kanehira 1968* [n.v.]; both cited in Kanehira, 1935). This species remained unidentified.

Fukuyama (1939) later attributed an unnamed species from Kusaie Island (now Kosrae Island in the Federated States of Micronesia) to section *Euagrostophyllum* (now section *Agrostophyllum*; *NF 7340*, *7341*, and *7357* [all n.v.]). Many of Fukuyama's specimens have been lost, however, and although some were later rediscovered and moved to the Kanagawa Prefectural Museum of Natural History (NTUDAP, 2011), there are no records of *Agrostophyllum* specimens from Kusaie Island in the museum's database for comparison. The following year, Tuyama (1940) described *A. kusaiense* Tuyama in section *Dolichodesme*, citing Fukuyama's unidentified species as being the same. Tuyama does not refer to Kanehira's species.

Later, additional specimens with capsules but without flowers were collected from Babeldaob by Rinehart and Raulerson (*LR22833* and *LR26712* [GUAM; both n.v.]; Rinehart and Raulerson, 2002). In their unpublished compilation of the literature on the orchids of Micronesia, Rinehart and Raulerson (2002) note that they did not see the original collections listed by Kanehira (1935) or any associated description of them and make no mention of *A. kusaiense*. Still, the authors believed that their more recent collections matched Tuyama's description (which clearly describes the seemingly elongate inflorescence characteristic of sect. *Dolichodesme*). They apparently assumed, incorrectly, that Kanehira (1935) and Tuyama (1940) were referring to the same specimens and species. Yet, somewhat confusingly, they ultimately suggested that their plants appeared to be similar to *A. majus* Hook.f., a typical capitulum-bearing member of sect. *Agrostophyllum*, and were likely to be this species. Nevertheless, Rinehart and Raulerson (2002) represents the only current reference to the study species in question, and clearly, the true identity of the second *Agrostophyllum* species collected in Palau needs to be resolved.

Fortunately, the Palau Orchid Conservation Initiative (Crain, 2018a, 2018b; Crain et al., 2022) facilitated in-depth exploration of the majority of the Palauan archipelago by researchers from the North American Orchid Conservation Center. These expansive surveys of Babeldaob yielded encounters with an apparently similar *Agrostophyllum* species to those observed by Kanehira, Rinehart, and Raulerson. Flowering and fruiting specimens were collected, enabling formal identification to resolve the taxonomic uncertainties regarding *Agrostophyllum* in Palau. After consulting the literature and comparing specimens in herbaria (in person at US, K, BM, BNM, and online for other major herbaria), we concluded that the species was still undescribed and belonged to sect. *Agrostophyllum*.

MATERIALS AND METHODS

Surveys for orchid species were conducted throughout the Republic of Palau between 2017 and 2023, including on the vast majority of the main islands within the archipelago, on dozens of the mostly uninhabited smaller islands, and in each state on Palau's largest island, Babeldaob, where the unidentified *Agrostophyllum* species was first documented. Collectively, orchids were documented at over 1,500 sites, including at hundreds of sites on Babeldaob. In accordance with IUCN Red List guidelines (IUCN, 2025), a geographic assessment was conducted using the GeoCAT online tool (Bachman et al., 2011) to map spatial distributions from known point data. All surveys were conducted through MOUs and research permits issued by the federal and state

governments of Palau, as well as through permission from traditional leaders in individual states.

Photographs of the species were taken, and herbarium specimens and flowers preserved in spirits were collected and subsequently deposited at US and BNM. The species description is based on this material. All plant collections were permitted through MOUs and research permits, CITES permits, phytosanitary certificates, and certificates of origin from the federal government of Palau, and through APHIS Permits from the U.S. Department of Agriculture (Permit numbers: PCIP-17-00410, PCIP-18-00246, PCIP-20-00094, and 588-22-308-19991A1; please contact the corresponding author for details regarding additional permits). Comparisons were made with other records of *Agrostophyllum* species from Palau as well as elsewhere in Micronesia and Southeast Asia where related species occur. For this, we reviewed collections held at several herbaria in person (US, K, BM, BNM) and online (NY, BISH, KPM) and conducted additional searches for online records through the Global Biodiversity Information Facility and the Integrated Digitized Biocollections database. Lastly, DNA was extracted from collected material and amplified. Barcodes were generated for ITS and matK sequences and deposited in GenBank (Clark et al., 2016).

TAXONOMY AND NATURAL HISTORY

Agrostophyllum lkou Crain & Schuit., *sp. nov.* (sect. *Agrostophyllum*). TYPE: REPUBLIC OF PALAU, Babeldaob, Ngeremlengui, west of Palau Compact Road north of Ngeremlengui/Melekeok crossroad, 7.56174° N, 134.58551° E, 89 m, 7 January 2023, *B. J. Crain 215* (holotype: US [3745840]).

Additional specimens examined: PALAU, Ngatpang, Babeldaob, a preserved specimen and a living specimen in cultivation in the Belau National Museum's native plant garden, *Crain 154* (BNM, US). Kamsett [sic], Armonogui [sic], Ngeremlengui State, *Kanehira 524* (NY, barcode 03997128, photo seen online). *Kanehira 1968* and *NF 7340*, *7341*, and *7357* could not be located during online searches of the Kanagawa Prefectural Museum of Natural History, the Global Biodiversity Information Facility, and the Integrated Digitized Biocollections database as of 4 December 2025.

Diagnosis: Similar in habit to *A. papuanum* Schltr. and *A. kaniense* Schltr. (Figs. 1 and 2) in having relatively few oblong leaves that lie in the same plane as the bilaterally flattened stem, and with the largest leaves being about the same length as the stem (De Vogel et al., 2025). These two species differ from *A. lkou* in having widely opening flowers, a labellum with a convex mid-lobe that is wider than long (vs. concave, longer than wide in *A. lkou*), and an erect lamella separating the epichile and hypochile (vs. a cushion-shaped callus); *A. papuanum* additionally differs in having a column with a knob-like callus below the stigma (vs. no callus below the stigma). Among all known species of *Agrostophyllum*, *A. lkou* differs in having a hood-like projection on the dorsal side of the column apex.

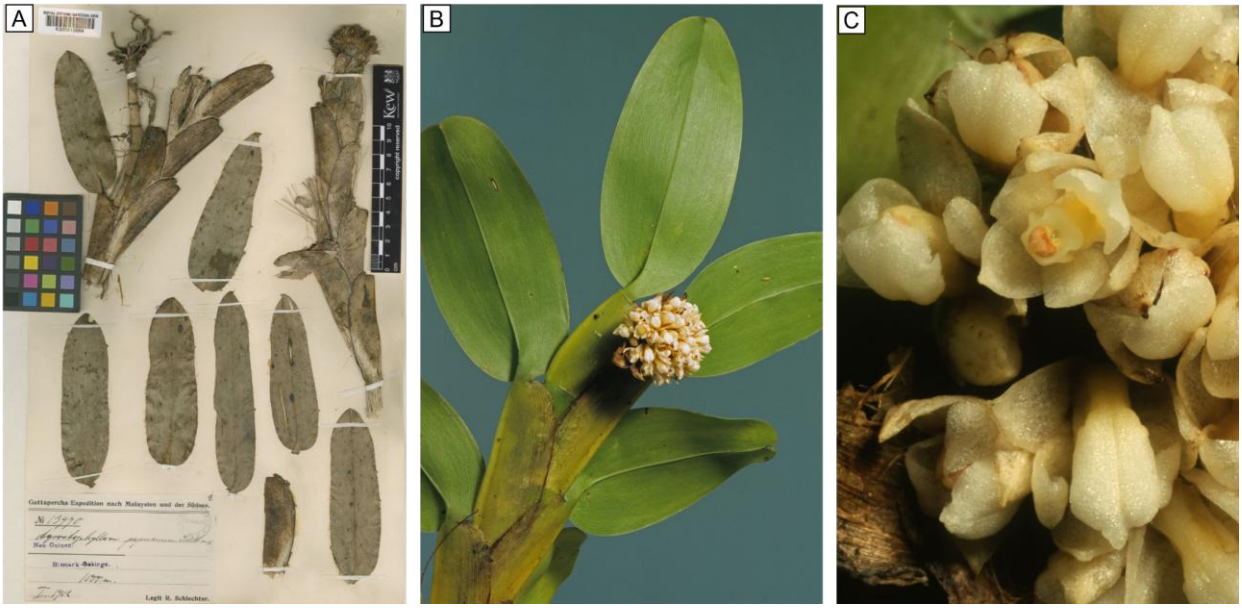

FIGURE 1. *Agrostophyllum papuanum* Schltr. **A**, specimen; **B**, flowering stem; **C**, flowers. **A** from *Schlechter 13970* from Papua New Guinea, K000810664; reproduced with permission of the Board of Trustees of the Royal Botanic Gardens, Kew. **B–C** from *Hortus Botanicus Leiden* "cult. 20030239" from Papua New Guinea. Photos by André Schuiteman.

Description: Epiphytic, caespitose *herb*. *Roots* numerous, flexuous, wiry, 2–15 cm long, 0.1–0.2 cm wide, with thin, sometimes pubescent velamen (Fig. 3). *Stems* 3–5, tufted, erect, patent, and/or pendent, unbranched, bilaterally compressed, 5–19 cm long, ca. 0.5–1.2 cm wide, completely enveloped by the leaf-sheaths, with 6–7 leaves. *Leaf-sheaths* suberect, partly overlapping in their basal part, conduplicate, dull pale green, with scarious, dark brown to black margins, ca. 5–9 cm long, 0.8–1.5 cm wide (not spread), slightly tapering towards the apex, apex at the abscission layer truncate, sometimes with a small, acute, curved tooth ('stipule') on each side. *Leaves* suberect, spreading in the same plane as the stem, thinly coriaceous, dull dark green, oblong to elliptic, often narrowing slightly

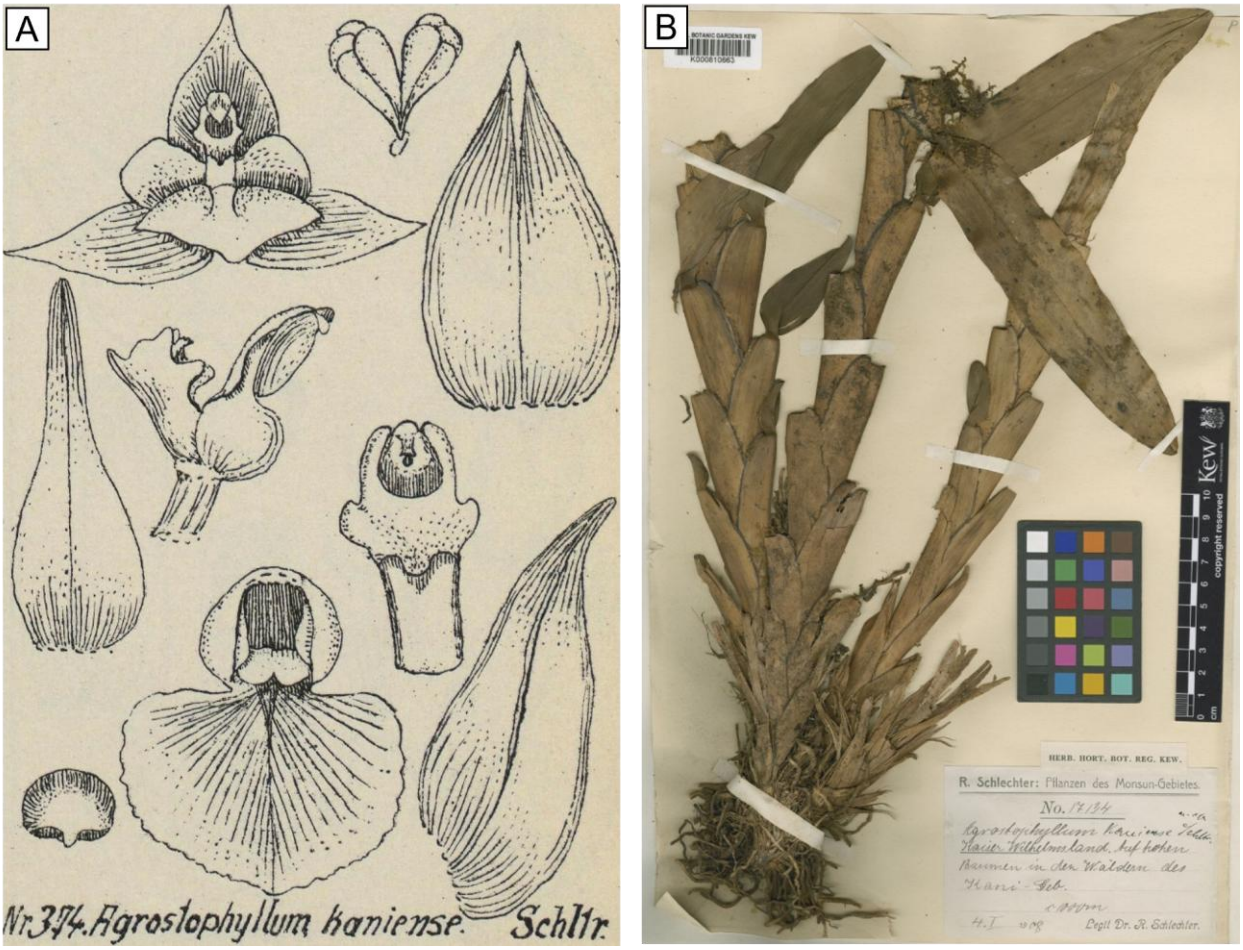

FIGURE 2. *Agrostophyllum kaniense* Schltr. **A**, drawn from *Atlas zu den Orchidaceen von Deutsch-Neu-Guinea*, Repertorium Specierum Novarum Regni Vegetabilis 21: t. 100, fig. 374 (1923). **B**, syntype specimen from *Schlechter 17134* from Papua New Guinea, K000810663. Reproduced with permission of the Board of Trustees of the Royal Botanic Gardens, Kew.

towards the apex, base obtuse, apex rounded, slightly emarginate, the largest leaves on the stem 13.8–21.3 × 1.9–2.7 cm, the leaves becoming much smaller towards the base of the stem, the smallest being ca. 1 × 0.8 cm, margins entire, veins parallel with the more prominent mid-vein. *Inflorescences* terminal, very short, densely 1–4-flowered with the flowers maturing in succession, clustered into a semi-globose capitulum 3–5 cm long, 4–5 cm wide, carrying ca. 25–70 flowers, with 3–4 scarious scales at the base of the capitulum, ca. 1.5 to 1.9 cm long and 0.4 to 0.9 cm wide. *Floral bract* clasping the ovary, elliptical, 0.4–0.6 × 0.3 cm, apex acute. *Pedicel-with-ovary* pale light green, cylindrical, 6-ribbed, 0.6–0.9 cm long, 0.2–0.3 cm wide, with scattered brown scale-hairs. *Flowers* not opening or only slightly opening between the lateral sepals, ca. 0.6 cm long, creamy white, the sepals abaxially with scattered brown scale-hairs (Fig. 4). *Dorsal sepal* ovate, 0.56 × 0.27 cm, acuminate, 5-veined. *Lateral sepals* obliquely ovate, 0.65 × 0.28 cm, acuminate, 5-veined, abaxially with a strong keel along the mid-vein that terminates as an apiculum. *Petals* ovate, slightly falcate, 0.47 × 0.21 cm, acute-acuminate, 3-veined, the mid-vein split below the apex into two very short, decurved branches. *Labellum* divided into a hypochile and an epichile, in total 0.51 × 0.25 cm, hypochile cup-shaped, broadly rounded at the base, abaxially bulbously inflated, 0.18 × 0.19 cm, adaxially with 3 thickened veins; epichile concave, ovate, 0.32 × 0.25 cm, subacute, abaxially with a median longitudinal groove; adaxially between

hypochile and epichile with a transverse, cushion-shaped callus, 0.09 cm long, which has a shallow longitudinal groove in the middle. *Column* stout, strongly curved in lateral view, ca. 0.39 cm long, sharply transversely folded ventrally below the stigma, without callosities, the lower stigma margin somewhat expanded laterally into a short tooth on each side, clinandrium dorsally with a hood-like, rostrate projection overtopping the rest of the column, 0.09 cm long, rostellum lacking (see notes), anther apparently sitting directly on top of the stigma, reniform, 0.2 cm wide. *Pollinia* ovoid-pyriform, 0.07 cm long. *Fruits* narrowly ovate-ellipsoid, 0.77 cm long, 0.23 cm wide, 6-ribbed, with 3 main ribs and weaker ribs between each of the main ones.

FIGURE 3. Detailed botanical drawing of *Agrostophyllum lkou* showing overall habit. Drawing by Alice Tangerini.

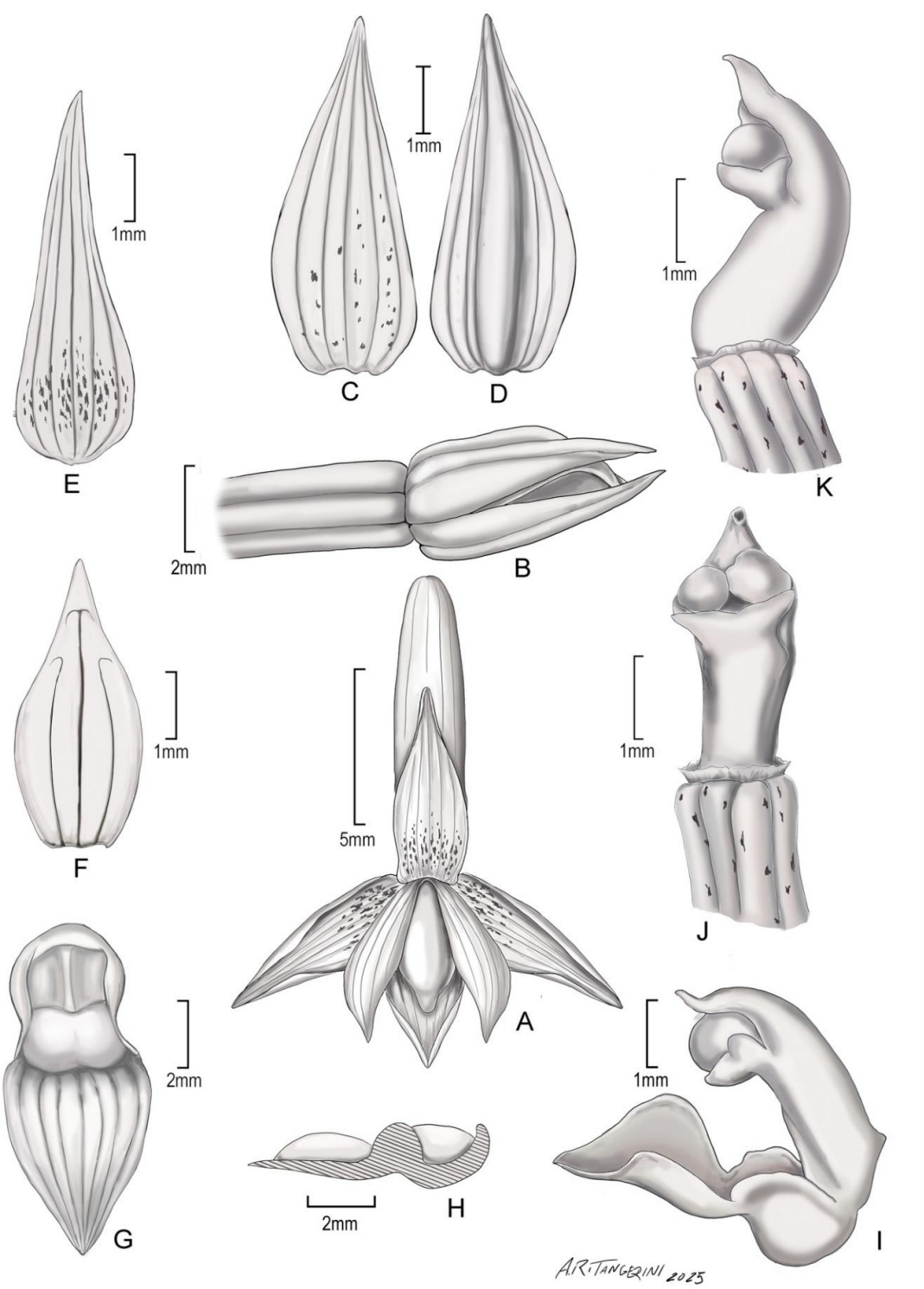

FIGURE 4. Detailed line drawings of dissected flowers of *Agrostophyllum lkou* showing details of individual floral

parts: **A**, artificially opened flower; **B**, flower as it appears naturally; **C**, lateral sepal (adaxial view); **D**, lateral sepal (abaxial view); **E**, dorsal sepal; **F**, lateral petal; **G**, labellum; **H**, labellum cross section; **I**, lip and column lateral view; **J**, dorsal view of column and ovary with perianth removed; **K**, lateral view of column and ovary with perianth removed. Note the distinctive hood-like projection, or "hat," at the apex of the column, which is a feature that distinguishes this species from all other known *Agrostophyllum* species. Drawing by Alice Tangerini.

Etymology: The epithet lkou (pronounced 'ool-ko'), a noun in apposition and a Palauan word for hat, alludes to the hood-like dorsal extension of the columnar apex.

Notes: *Agrostophyllum lkou* is easily distinguished from the only other member of this genus in Palau, *A. elongatum* (Fig. 5), by its shorter but much wider stems, up to 19 × ca. 1 cm, with at most 7 much larger, suberect leaves, up to ca. 21 × 3 cm, vs. stems up to 120 cm long and ca. 0.5 cm wide, leaves numerous, less than 3.5 cm long, at right angles to the stem (Fig. 3). Barcode sequences for ITS and matK differed between *A. lkou* and *A. elongatum*, with pairwise nucleotide divergence of 17/453 bp, or 3.75% (ITS), and 8/838 bp, or 0.95% (matK) (GenBank accession nos. PZ326089, PZ320980 and PZ326088, PZ320979). The new species had been tentatively identified as *A. majus* in the past, but *A. majus* is a western Malesian species with much taller stems (up to 60 cm or more) carrying at least 10 and often many more leaves that are much shorter than the stem (vs. about 7 leaves of which the largest is about as long as or a little longer than the stem in *A. lkou*). The widely opening flowers of *A. majus* differ in many respects, e.g., the lip epichile is convex, not concave; the epichile and the hypochile are separated by a thin ridge, not a thick callus, and the lower margin of the stigma has a tongue-shaped projection, which is lacking in *A. lkou*. More similar are a few New Guinean species, at least in vegetative morphology (Figs. 1 and 2). Those that are similar enough to warrant a closer comparison have been mentioned in the diagnosis above.

FIGURE 5. *Agrostophyllum elongatum* growing in situ in Palau. **A**, specimen growing on lower tree trunk (Johansson zone 1) in mature forest, exhibiting stems up to 120 cm long and ca. 0.5 cm wide, and numerous leaves less than 3.5 cm long and at right angles to the stem; **B**, close-up of inflorescence with mature but closed flower. Photos by Benjamin J. Crain.

Among all known species of *Agrostophyllum*, *A. lkou* differs in the unusual morphology of the column. This difference may be the result of a mutation that caused the rostellum to be displaced towards the back of the column, where it forms a hood-like structure overtopping the apex. A small patch of modified tissue on this 'hood' seems to denote where the viscidium would have been located in a functional rostellum. Due to its position, this displaced rostellum would be incapable of performing its usual function of separating the anther from the stigma. The unusual column morphology, with the anther positioned directly above the stigma, might suggest the loss of a functional rostellum and may facilitate autonomous self-pollination, potentially explaining why most, if not all, flowers set fruit and seed. This is further supported by the fact that the flowers do not open completely; they are almost cleistogamous.

Distribution

In the Republic of Palau, it is only known from Babeldaob Island (Fig. 6). Observed in Ngchasar, Ngatpang, Airai, and Ngeremlengui States, and probably occurring in Aimeliik State as well (see introduction). Endemic.

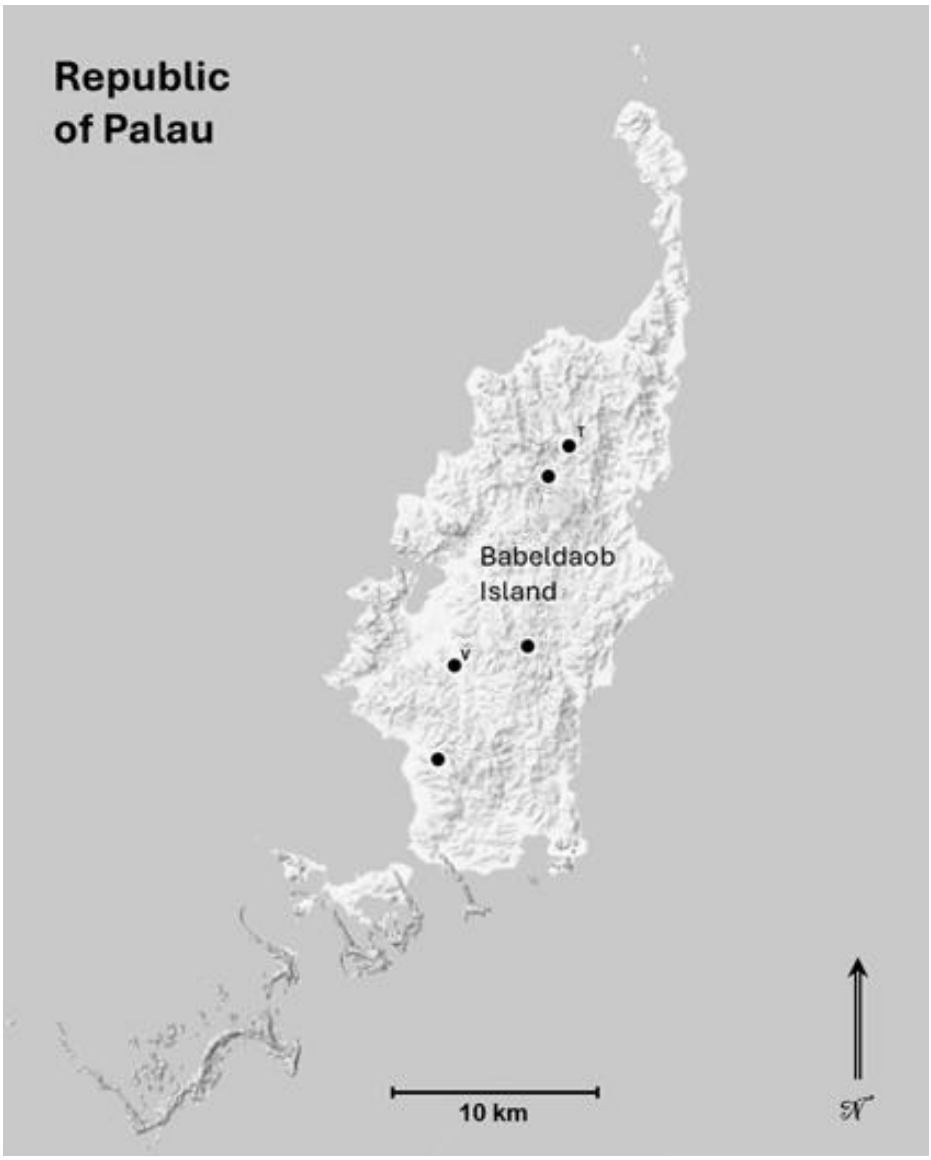

FIGURE 6. Map of the Republic of Palau's largest islands, including Babeldaob, and the known distribution of *Agrostophyllum Ikou*. All distribution data (black markers) are based on observed occurrences of *A. Ikou* in the field by the authors. The location where the type specimen was collected is indicated by a superscript T (for type) next to the map point and the location of a second voucher collection is indicated by a superscript V (for voucher). Both specimens are deposited at US, with a duplicate specimen of the voucher specimen deposited at BNM.

Habitat and Ecology

Epiphytes occur on tree trunks and innermost branches in Johansson canopy zones 1–3 (Johansson, 1974) in mature, humid tropical forest (Fig. 7). Observed on hardwood as well as palm phorophytes. Documented at ca. 30–131 m elevation.

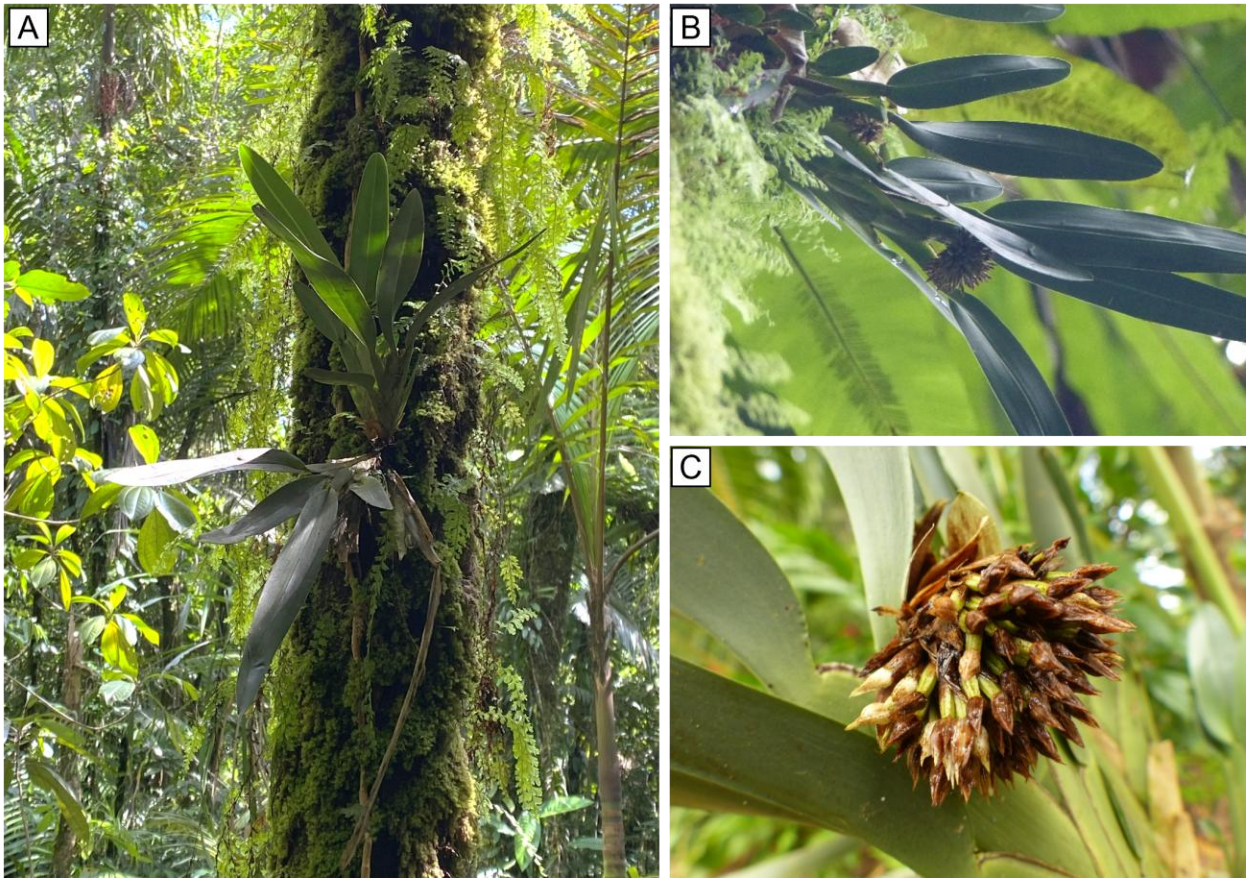

FIGURE 7. *Agrostophyllum lkou* growing in situ in Palau. **A**, specimen growing on lower tree trunk (Johansson zone 1) in mature forest; **B**, specimen growing on inner tree crown (Johansson zone 2) in mature forest near river channel; and **C**, close up of inflorescence with mature but closed flowers and spent flowers with maturing fruits. Photos by Benjamin J. Crain.

Phenology

Flowering appears to occur almost year-round. Plants have been observed in bloom from August to January, as well as in March and April, periods that encompass both the typical dry and wet seasons in Palau. Fruits are rather persistent and have been observed on plants over the same period.

Evolutionary Ecology and Historical Biogeography

We speculate that *A. lkou* may have evolved from a species that originated from the nearest sizable landmass, New Guinea, where *Agrostophyllum* is both common and species-rich. Notably, the orchid flora of Palau has clear affinities with that of New Guinea, e.g., in the presence of genera such as *Aglossorrhyncha* Schltr., *Platylepis* A.Rich., and *Sarcanthopsis* Garay. Given that most orchid seeds are dust-like and dispersed by wind (Dressler, 1981), it is conceivable that seeds may have been carried to Palau from New Guinea by prevailing trade winds (Bogdon and Edwards, 2001) that flow N–NE from New Guinea. It is also plausible that scarcity or absence of suitable pollinators, combined with a possible mutation enabling self-pollination, may have transformed an originally allogamous ancestral species into the present autogamous one (*A. lkou*).

Conservation Status

Despite surveying well over 1,500 individual sites in almost every state in the country over the course of ca. 6 years (2017–2023; logistics precluded

us from conducting surveys in remote states located up to 600 km from the main islands), we found *A. lkou* to be very rare. Utilizing the distribution data from our surveys, Extent of Occurrence (EOO) was estimated at 31.84 km^2, while Area of Occupancy (AOO) was estimated at 6.00 km^2 based on 1 km^2 grid cells. Given the very sparse distribution pattern the species exhibits (see Rabinowitz, 1981), which is potentially caused by a combination of habitat fragmentation and patchily distributed mycorrhizal associates, this may be considered a rather liberal estimate. According to these measures, *A. lkou* meets the IUCN criteria (IUCN, 2012) for being classified as Critically Endangered based on Criteria B1: EOO < 100 km^2 and Criteria B2a and b: AOO < 10 km^2, with a severely fragmented distribution and an inferred decline in habitat quality.

While forest cover in Palau is recovering overall, there are several trends that suggest a decline in the quality of habitat where *A. lkou* has been documented. Donnegan et al. (2007) note that Palauan forests have had a long history of human-caused and climatic disturbances, and estimates based on current and historical data suggest that 39% of Palau's forests have been subjected to disturbance of some type (Costion et al., 2012). At least 25% of Palau's forests showed distinct signs of disturbance as recently as 2014 (Dendy et al., 2024). Mechanisms of disturbance include clearing for agriculture, often via fire that expands into unintended areas, severe weather, and invasive species including pigs, rats, birds, and several species of vines and introduced trees (PNEPC, 2004; Kitalong, 2008; Dendy et al., 2024). Such disturbances appear to be increasing on the island, in part due to the construction of a new road encircling Babeldaob, where *A. lkou* is distributed (PNEPC, 2004; Donnegan et al., 2007; Kitalong, 2008; Dendy et al., 2024). Consequently, surveys have shown that Palau's forests are dominated by smaller-diameter trees less suited for hosting epiphytes such as *A. lkou* (Donnegan et al., 2007). Given its restricted range, the few sites that host the species could easily succumb to any number of potential disturbances (Costion et al., 2012).

Moreover, given the fact that there are fewer than 50 documented mature individuals, the species also meets Criterion D for Critically Endangered status. While future surveys could reveal a larger population size, fewer than 250 individuals are likely to exist given the results of the extensive surveys conducted for this assessment. In that case, the species would still meet the criteria for Category C2(a)(i) given ongoing habitat losses and the small number of mature individuals (≤ 50) in the currently documented subpopulations. Consequently, we assess *A. lkou* as a Critically Endangered (CR) species in accord with the IUCN Red List guidelines (IUCN 2012) and suggest that conservation strategies be developed accordingly.

KEY TO *AGROSTOPHYLLUM* OF PALAU:

1a. Stems slender, up to 120 cm; leaves numerous (50 or more), <3.5 cm … *A. elongatum*

1b. Stems short, <20 cm; leaves few, more than 13 cm long … *A. lkou*

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