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Nocturne for an unknown pollinator: first description of a night-flowering orchid (*Bulbophyllum nocturnum*)

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Bulbophyllum nocturnum, a species of section *Epicrianthes* from New Britain, is described and illustrated. It is the first known example of an orchid species in which the flowers open after dark and close in the morning. The poorly understood pollination biology of section *Epicrianthes*, a clade with highly unusual flowers, is discussed. Attention is drawn to the close resemblance between the petal appendages of some species and the fruiting bodies of certain Myxogastria. *Botanical Journal of the Linnean Society*, 2011, **167**, 344–350.

ADDITIONAL KEYWORDS: Myxogastria – New Britain – Orchidaceae – Papua New Guinea – pollination.

INTRODUCTION

A few plant species have flowers that open after dark and close before or shortly after sunrise. Examples include the queen of the night [*Selenicereus grandiflorus* (L.) Britt. & Rose; Cactaceae], the midnight horror (*Oroxylum indicum* Vent.; Bignoniaceae) and the night blooming jasmine (*Cestrum nocturnum* L.; Solanaceae), but no night-flowering orchid species have been reported, even though Orchidaceae is the largest plant family, with more than 25 000 species (Hassler, 2001). Orchids display a wide range of phenologies and pollination syndromes (van der Pijl & Dodson, 1966; van der Cingel, 2001; Jersáková, Johnson & Kindlmann, 2006). Many orchid species are pollinated by nocturnal Lepidoptera. A well-known example is *Angraecum sesquipedale* Thouars from Madagascar, for which Darwin correctly predicted that the pollinating moth species would have a 30-cm-long proboscis to match the spur of the flower (Darwin, 1862; Micheneau, Johnson & Fay, 2009). Moth-pollinated orchids may time their fragrance emissions to attract nocturnal insects, but all have flowers that remain open during the day. We describe the first example of a truly nocturnal orchid, *Bulbophyllum nocturnum* J.J.Verm., de Vogel, Schuit. & A.Vogel, sp. nov., which was recently discovered in New Britain, Papua New Guinea. It has flowers opening at around 22:00 h and closing at around 10:00 h, lasting only a single night. This was observed in cultivation in the Netherlands in winter, which implies that the flowers closed a few hours after sunrise. We also draw attention to the remarkable and largely unexplained floral morphology of this species and others in *Bulbophyllum* Thouars section *Epicrianthes* (Blume) Hook.f.

PHENOLOGY AND POLLINATION BIOLOGY

The pantropical genus *Bulbophyllum* contains about 2000 known species, which makes it by far the largest genus of Orchidaceae. The greatest diversity in terms of number of species occurs in South-East Asia and Australasia, in particular in New Guinea, where more than 600 species are found (Schuiteman, Vermeulen & de Vogel, 2010). Members of this genus are

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Figure 1. Six species of *Bulbophyllum* section *Epicrianthes*: *B. johannuli* J.J.Verm. (top left; flower, photograph P. Jongejan); *B. macneiceae* Schuit. & de Vogel (top centre; flower, photograph P. Jongejan); *B. tarantula* Schuit. & de Vogel (top right; flower, photograph E.d.V.); *B. xanthomelanon* J.J.Verm. & P.O'Byrne (bottom left; centre of flower, photograph A.S.); *B. macrorhopalon* Schltr. (bottom centre; centre of flower, photograph A.S.); *B. cimicinum* J.J.Verm. (bottom right; centre of flower, photograph A.S.).

Figure 2. ***Bulbophyllum nocturnum*** J.J.Verm., de Vogel, Schuit. & A.Vogel: A, habit; B, flower; C, dorsal sepal, petal, lip and lateral sepal; D, lip; E, column and lip; F, pollinia; G, anther. All after *Hortus Botanicus Leiden cult. 20080300* (drawing J.J.V.).

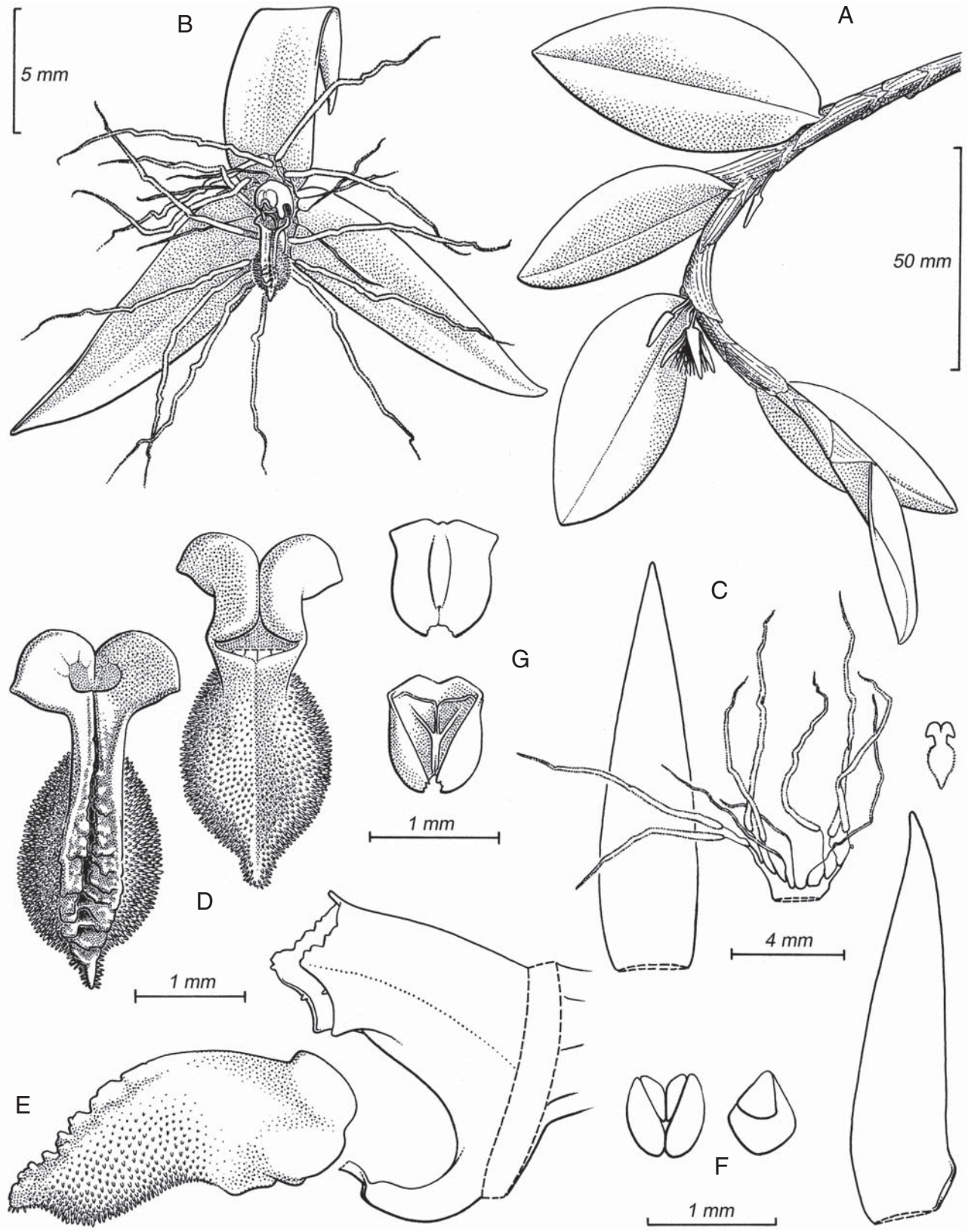
typically myophilous, but at the same time display a great variety of pollination strategies. We have observed blowflies visiting and detaching pollinia from the foetid flowers of *B. lasianthum* Lindl. and *B. wakoi* Howcroft in the Hortus Botanicus Leiden, and other diptera, including fruit-flies and midges, have been reported as pollinators of *Bulbophyllum* (Jones & Gray, 1976; Bartareau, 1994; Borba & Semir, 1998; Tan & Nishida, 2007). Most *Bulbophyllum* spp. probably have deceptive flowers (Jersáková *et al*., 2006), offering no reward, but some offer nectar, for example *B. longiflorum* Thouars (Jones & Gray, 1976). One of us (A.S.) observed a satyroid butterfly visiting the inflorescence of *B. macrocoleum* Seidenf. in Laos, probing each lip with its proboscis, but the detachment of pollinia did not occur and the butterfly was probably not a pollinator.

As many *Bulbophyllum* spp. flower only for a short period, they are rarely seen in flower during field work. As a result, they are under-represented in herbarium collections. Hundreds of species are only known from the type specimen. *Ex situ* cultivation of plants until flowering, at which time specimens can be preserved (as described by Schuiteman & de Vogel, 2003), has added much to our knowledge of the genus. Recent botanical exploration in the island of New Britain (Papua New Guinea) by one of us (E.d.V.) yielded many orchid plants now cultivated at the Hortus Botanicus Leiden. Among these was a *Bulbophyllum* sp. which soon produced flower buds, but these all seemingly aborted the night before they were expected to open. Only a close watch one night revealed its nocturnal flowering habit. We established for several subsequently observed flowers that they all opened at around 22:00 h and closed at around 10:00 h.

The plant proved to represent an undescribed species of *Bulbophyllum* section *Epicrianthes*, a clade with 38 species, 18 of which are endemic to New Guinea. The flowers in these orchids, although small, are noteworthy for their bizarre morphology (Fig. 1). They are short lived, usually not lasting more than 1 day. Collectively, the authors have observed 23 species of section *Epicrianthes* flowering in glasshouse conditions and/or in the field. All, except *B. nocturnum* described below, were seen with open flowers in the middle of the day or during the afternoon. The petals carry intricate appendages that probably serve to attract pollinators; these appendages are often suspended by extremely fine, thread-like stalks (clearly visible in Fig. 1, bottom centre), so that they are capable of moving about in the slightest air current. In only a few species are the appendages rigidly attached (e.g. *B. cheiropetalum* Ridl. and *B. macneiceae* Schuit. & de Vogel). The petal appendages of several species rather closely resemble in shape and size the fruiting bodies of slime moulds (Myxogastria). Those of *B. cimicinum* J.J.Verm. (Fig. 1, bottom right), for example, resemble the fruiting bodies of *Arcyria* spp.; those of *B. xanthomelanon* J.J.Verm. & P.O'Byrne (Fig. 1, bottom left) resemble *Stemonitis* spp. As yet, we do not know whether this resemblance is more than coincidental. Other visual stimuli may include light effects caused by the glistening vesicles (enlarged cells) on the lip. A fungus-like scent has been reported for *B. epicrianthes* Hook.f. (Carr, 1928), but has not been noticed by us in the species that we observed.

Field studies are difficult because members of this section usually occur sporadically in remote areas and flower briefly and intermittently. It is uncommon to find more than one or two specimens growing in close proximity. However, *B. hexarhopalon* Schltr. is reported to be common in New Caledonia (Société Néo-Calédonienne d'Orchidophilie, 1995). We are aware of only one published report of 'tiny flies' visiting the flowers of *B. epicrianthes*, in Peninsular Malaysia (Carr, 1928). Photographs by T. M. Reeve (reproduced in Schuiteman *et al*., 2010), taken in Papua New Guinea, show a flower of *B. macrorhopalon* Schltr. being visited by two small, midge-like, black flies, about 4 mm long, similar to those reported by Carr. These two independent observations of small flies as potential pollinators, and their behaviour as described by Carr (1928), contradict the hypothesis that the flowers are pollinated by pseudocopulation, like many other orchids with insect-like flowers, or that they mimic prey animals. The zoomorphic appearance of these flowers is likely to be coincidental, and mycomyophily would appear to be the most probable pollination syndrome in this group of orchids.

The floral morphology of *B. nocturnum* is similar to that of several other diurnal species, but the species is unusual for having its flowers open during the dark for most of their lifetime. This suggests that nocturnal insects, most likely small diptera, are among its potential pollinators, but, in the absence of field studies, this must remain speculation. It also remains to be investigated whether the timing of the opening and closing of the flowers relative to sunset and sunrise would be different in the wild.


B
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4 mm
E
F
1 mm

Figure 3. Flower of ***Bulbophyllum nocturnum*** J.J.Verm., de Vogel, Schuit. & A.Vogel, *Hortus Botanicus Leiden cult. 20080300* (photograph J.J.V.).

TAXONOMY

BULBOPHYLLUM NOCTURNUM J.J.VERM., DE VOGEL, SCHUIT. & A.VOGEL, **SP. NOV.,** FIGS. 2 & 3

Bulbophyllo corrugato et *B. hexarhopalo* appendicibus generum duorum (crassioribus et tenuioribus) in margine apicali petalorum distributis simile, sed a *B. corrugato* appendicibus crassioribus pluribus (7, non 4) multo angustioribus et ad apicem acutum attenuatis (non obtusis), a *B. hexarhopalo* appendicibus tenuioribus quam appendicibus crassioribus minus (non magis) quam dimidio brevioribus et foliis abaxialiter corrugatis (non laevibus), a speciebus ambabus labelli superficie adaxiali verrucosa, differt; flores noctu aperti.

Type: Papua New Guinea, West New Britain Province, Asengseng logging area, Upper Agulo River, *Hortus Botanicus Leiden cult. 20080300* (holotype LAE, isotypes K, L).

Description: Rhizome patent to pendulous, up to 15 cm long, 3–4 mm in diameter, sections between pseudobulbs 2.4–3 cm long, cataphylls persistent. Pseudobulbs 1.0–1.5 × 0.4–0.5 cm, distant, ellipsoid-cylindrical. Leaves subsessile, 5.3–6.2 × 2.1–3.2 cm, index (length/width) 1.8–2.5, elliptic to ovate, acute, abaxial surface corrugated. Inflorescence *c.* 2 cm long, one-flowered; peduncle porrect, *c.* 0.5 cm long; peduncle scales two, the longest *c.* 4 mm long; floral bract *c.* 6 mm long, tubular, acute. Flowers opening widely, without noticeable smell, lasting about 12 h, largely nocturnal, opening from 22:00 h to 10:00 h in cultivation. Pedicel with ovary *c.* 10 mm long, basal node on a *c.* 4-mm-long stump. Dorsal sepal *c.* 14 × 4 mm, index *c.* 3.5, spreading, ovate, acute, margins entire, base broadly attached, thick, surface glabrous. Lateral sepals *c.* 15 × 4 mm, index 3.7–3.8, free, triangular, otherwise as the dorsal sepal. Petals *c.* 1 × 2 mm, index *c.* 0.5, porrect, forming a narrow seam along the base of the column, entire (excluding the appendages), surface glabrous; with two types of stalked, papillose appendages along the apical margin; the first type thick, widest near the base and gradually tapering distally, 5.5–8.0 × 0.2–0.3 mm, acute, abruptly narrowed into a thread-like stalk *c.* 2 mm long, the second type much thinner, subulate, 3.0–3.5 mm long, gradually passing into a 1.5–2.0 mm thread-like stalk; these appendages divided into three groups: three and four of the first type at the upper and lower edge of the petal respectively, three of the second type in between. Lip *c.* 3.3 × 1.3 mm, index 2.5–2.6, straight, three-lobed with patent, triangular, acute lobes attached to the proximal 1/4–1/5 of the length of the lip, midlobe obovate, acuminate, thick; adaxial surface constricted to a narrow, deeply furrowed, irregularly verrucose strip with irregular edges; abaxial surface inflated, somewhat furrowed, increasingly papillose with elongated papillae towards the tip. Column *c.* 2.4 mm long; foot slightly widened distally; stelidia *c.* 0.7 mm long, triangular, obtuse, upper margin erose, lower with a patent, deltoid, subacute tooth with a much smaller tooth on its front margin; anther cap abaxially with a narrow crest, surface glabrous, front margin drawn out into a retuse beak; pollinia four, inner ones about half as long as the outer.

Colours: Plant green, not flushed with purple. Sepals yellowish green, somewhat tinged red proximally. Petals with greyish appendages. Lip dark red. Column yellow tinged red.

Ecology: Epiphyte in rainforest; altitude 240–300 m.

Notes: In the distribution of the two types of appendage (thin and thick) on the petals, *B. nocturnum* resembles *B. hexarhopalon* and *B. corrugatum* J.J.Verm. From the first it differs by the abaxially corrugated leaves (smooth in *B. hexarhopalon*) and by the thin petal appendages being more than half as long as the thick ones (less than half as long as the thick ones in *B. hexarhopalon*). From the second it differs by the larger number of thick petal appendages (seven versus four), these in addition being much thinner and gradually tapering into an acute tip (obtuse in *B. corrugatum*). It differs from both by the verrucose adaxial surface of the lip. Finally, it may be worth noting that Schlechter originally spelt the epithet of *B. hexarhopalon* as *hexarhopalos*. However, he undoubtedly intended to use a classical Greek word for club, '*rhopalon*', which refers to the club-shaped appendages of the petals, not the name *Rhopalos* of a mythological figure. Therefore, *hexarhopalon* is the correct spelling. Schlechter later described several related species with epithets ending in *-rhopalon*, which supports this correction.

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