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Source: Candollea, 71(1) : 117-126

Published By: The Conservatory and Botanical Garden of the City of Geneva (CJBG)

URL: <https://doi.org/10.15553/c2016v711a14>

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# A remarkable new species of *Clerodendrum* L. (Lamiaceae) from Madagascar

Peter B. Phillipson & Lucile Allorge

## Abstract

PHILLIPSON, P.B. & L. ALLORGE (2016). A remarkable new species of *Clerodendrum* L. (Lamiaceae) from Madagascar. *Candollea* 71: 117-126. In English, English and French abstracts. DOI: <http://dx.doi.org/10.15553/c2016v711a14>

A species new to science is formally described and named as *Clerodendrum kambyoae* Phillipson & Allorge. It is the third species of *Clerodendrum* L. (Lamiaceae) to be described from Madagascar that combines a long slender corolla tube with cauliflory, attributes that are uncommon in the genus. The prolific production of flowers along the trunk of the new species is quite extraordinary. Its possible relationships with other species of the genus are discussed and certain aspects of its reproductive biology are described. We provide line drawings, photographs and a distribution map for the new species, as well as an assessment of its conservation status using IUCN Categories and Criteria.

## Résumé

PHILLIPSON, P.B. & L. ALLORGE (2016). Une remarquable nouvelle espèce de *Clerodendrum* L. (Lamiaceae) de Madagascar. *Candollea* 71: 117-126. En anglais, résumés anglais et français. DOI: <http://dx.doi.org/10.15553/c2016v711a14>

Une espèce, nouvelle pour la science, est formellement décrite et nommée *Clerodendrum kambyoae* Phillipson & Allorge. C'est la troisième espèce de *Clerodendrum* L. (Lamiaceae), décrite de Madagascar, qui combine une corolle à tube long et mince avec la cauliflorie, attributs qui sont rares dans le genre. La production prolifique de fleurs sur le tronc de la nouvelle espèce est tout à fait extraordinaire. Ses relations présumées avec d'autres espèces du genre sont abordées, ainsi que certains aspects de sa reproduction biologique y sont décrits. Nous fournissons pour la nouvelle espèce des illustrations, des photos et une carte de distribution, ainsi que l'évaluation de son statut de conservation selon les Catégories et les Critères de l'IUCN.

## Keywords

LAMIACEAE – *Clerodendrum* – Madagascar – IUCN Red List – Hawk moth pollination – Taxonomy

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Submitted on February 27, 2016. Accepted on March 18, 2016.

First published online on April 29, 2016.

ISSN : 0373-2967 – Online ISSN : 2235-3658 – *Candollea* 71(1) : 117-126 (2016) © CONSERVATOIRE ET JARDIN BOTANIQUE DE GENÈVE 2016

## Introduction

The genus *Clerodendrum* L. (Lamiaceae, Ajugoideae) was revised for Madagascar over 60 years ago by Harold Moldenke who described no less than 41 new species and numerous varieties and taxonomic forms in a series of five articles (MOLDENKE, 1950a, 1950b, 1950c, 1951, 1953). He published a full treatment for the genus in the *Verbenaceae* volume of the “Flore de Madagascar et des Comores” in which he recognised a total of 56 native species (MOLDENKE, 1956) (at that time *Clerodendrum* was generally placed in *Verbenaceae* but is now correctly included in *Lamiaceae*, see HARLEY et al., 2004). Since the Flora treatment was published, the Malagasy *Clerodendrum* have received very little attention, and despite the wealth of new material that has become available, only three additional new species were published during this period, one by CAPURON (1972), and two by BOSSER (1987). The broad circumscription of the genus *Clerodendrum* that was adopted by most botanists during the twentieth century, for example by MOLDENKE (1956), has now been abandoned in the light of recent phylogenetic research and a global review (see YUAN et al., 2010). Several segregate genera have been resurrected to accommodate morphologically distinctive and phylogenetically coherent elements, and three of MOLDENKE’s (1956) Malagasy species are now placed in the genus *Rothea* Raf. (CALLMANDER & PHILLIPSON, 2012; CALLMANDER et al., 2013) and 18 require transfer to *Volkameria* L. (Phillipson & Callmander, unpubl. data). As currently delimited, *Clerodendrum* is native only to Africa (including Madagascar) and Asia, and Madagascar remains an important centre of diversity for the genus. One of us (PBP) has embarked on a full review of *Clerodendrum* and *Volkameria* in the context of the MADAGASCAR CATALOGUE (2016).

*Clerodendrum kamhyoae* Phillipson & Allorge, described in this article, was discovered by Marie H         Kam Hyo Zschocke in 2002 on a hill known as Ambinany (or Vinany), a site 3 km N of Antalaha at the mouth of the Ankavanana River adjacent to the village of the same name in the SAVA Region of Antsiranana Province in north-eastern Madagascar. Marie H        , a pharmacist and philanthropist working at Antalaha since 1969, describes her amazement at visiting the site, which she had owned since 1992, and seeing the plant in full flower – she had hardly even noticed it previously. The locally abundant small trees are an extraordinary sight at the peak of the flowering season, each trunk clothed with long elegant white flowers with their delicate protruding purple stamens and style (Fig. 1, 2). Marie H         dubbed the plant “Lamari    ” [“The Bride”], and in 2008 she opened her property to the public as an environmental education and conservation site, now baptized “Macolline” [“My Hill”]. With her growing interest in biodiversity and “Lamari    ” chosen as the flagship species of “Macolline”, Marie H         wanted to obtain the scientific name of the plant and more information

about it. To this end she distributed photographs to friends and colleagues for possible identification, and when we saw them we immediately recognised “Lamari    ” as a species of *Clerodendrum*. On further examination, we reached the conclusion that it might represent an undescribed species, and we have since undertaken a thorough study of available material at the relevant herbaria. We were able to confirm its status as a new species and we identified other collections of it from scattered localities in northern Madagascar, which had previously been identified wrongly or had remained unidentified. During visits to “Macolline” in 2009 and 2010 (LA) and twice in 2015 (PBP), we obtained representative specimens and adequate information to describe the remarkable plant.

Among the distinctive morphological features of the new species described here, two stand out: the very long (ca. 20 cm) but narrow (ca. 2.5 mm) corolla tube and its exceptionally prolific cauliflory. Corolla shape and size is extremely variable among the Malagasy species of *Clerodendrum*, and several other species with long narrow corolla tubes were included in the Flora treatment by MOLDENKE (1956). These include *C. cauliflorum* Vatke, *C. baronianum* Oliv., some elements of *C. aucubifolium* Baker, the introduced species *C. indicum* (L.) Kuntze and two species that have now been transferred to *Rothea* – *Clerodendrum incisum* Klotzsch (= *Rothea microphylla* (Blume) Callm. & Phillipson) and *Clerodendrum mirabile* Baker (= *Rothea mirabilis* (Baker) Callm. & Phillipson) (CALLMANDER et al., 2013). To this list should be added *Clerodendrum revolutum* Bosser, which was described later and was unknown to Moldenke. Cauliflory is generally rare in *Clerodendrum*, but in Madagascar it is displayed by *C. cauliflorum* and *C. revolutum*, both mentioned above, and by *C. tubulosum* Moldenke. Beyond Madagascar, members of the genus bearing long tubular flowers occur in both continental Africa and Asia, but no known species from these regions have corollas as long as those of “Lamari    ” and cauliflory appears to be uncommon.

In this article we provide a description of the new species which we name in honour of Marie H         Kam Hyo Zschocke, providing line drawings of its salient features and photographs of living plants in their natural habitat. We also provide a map of its known geographic distribution and evaluate its conservation status using IUCN Categories and Criteria (IUCN, 2012). In addition we discuss the possible relationships of the new species with other taxa in *Clerodendrum*, and aspects of its pollination and reproduction. Further information and additional photographs of the new species and other Malagasy taxa mentioned in this article can be found in the MADAGASCAR CATALOGUE (2016).

## Systematics

*Clerodendrum kamhyoe* Phillipson & Allorge, **spec. nova** (Fig. 1, 2).

**Typus:** MADAGASCAR. **Prov. Antsiranana:** SAVA, Antalaha, “Macolline”, at the mouth of the Ankavanana River, 14°52'25"S 50°15'37"E, 65 m, 18.V.2015, fl., *Phillipson 6500* (holo-: MO-6684200 sheet 1!, MO-6684201 sheet 2!, MO-6684202 sheet 3!; iso-: G [G00341303, G00341304, G00341305]!, K!, P [P00853258, P00853259, P00853260]!, TAN!).

*Clerodendrum kamhyoe* Phillipson & Allorge most closely resembles *C. revolutum* Bosser, but that species differs by its oblong to oblanceolate blade and shorter petiole, and its calyx which is more inflated with a shorter tube and revolute lobes.

Evergreen *shrub* or *small tree* to ca. 6 m high, suckering to form spreading colonies; trunk up to 2.5 m high, diameter at breast height up to ca. 10 cm; crown spreading; bark smooth, pale grey-brown somewhat mottled, conspicuously lenticellate, with a corky layer below the bark. *Stems* green or dark purple-brown when young, becoming pale grey-brown flattened at the nodes, lenticellate, with semicircular leaf scars. *Leaves* opposite (sometimes sub-opposite, occasionally in whorls of 3 or 4); blade narrowly elliptic to narrowly obovate, (8-)12-18(-28) × (2.5-)3-4.5(-7) cm, papery, glabrous, brochidodromous; midrib and secondary veins raised abaxially, somewhat depressed adaxially, principal secondary veins 9-12 on each side; tertiary veins finely reticulate, only weakly apparent when fresh but easily seen in dried specimens; apex long attenuate-acuminate, the acumen generally 1-2 cm long; base cuneiform; petioles channelled adaxially, green tinged purple-brown towards the base, (0.7-)1.5-4 (-6) cm long. *Inflorescences* predominantly borne on the trunk and often forming an almost continuous column around it, composed of solitary or paired fascicles of up to 60(-90) densely grouped flowers, occasionally present on upper branches or terminally on young growth; peduncle highly contracted; bracts linear, ca. 5 × 1 mm, green tinged purple, early caducous; bracteoles reduced to minute scales. *Flowers* borne on robust, arched-ascending pedicels ca. 1 cm long, protandrous; pedicels pale green, sometimes tinged dull purple. *Calyx* narrowly urceolate, ca. 4.0 × 1.4 cm, purple in early bud, becoming pale green (sometimes tinged dull purple-brown) by anthesis, glabrous, pleated in the distal half below the sinus, the surfaces smooth, venation hardly apparent; lobes 5, valvate, triangular, ca. 6 × 6 mm, erect or often one or two somewhat spreading, opening under the pressure of the expanding corolla, margins narrowly revolute. *Corolla* long-tubular, slightly zygomorphic, arching downwards under its own weight, glabrous, white; tube cylindrical, 19-22 cm long, 2.5 mm diameter, but expanding in the upper 8 mm above the points of insertion of the stamens

to form a trumpet-shaped, slightly laterally compressed, ca. 7 mm high × 5 mm wide throat; lobes subequal, reflexed, oblong, ca. 20 × 14 mm, the apex rounded. *Stamens* 4, ca. 33 mm long, exerted ca. 25 mm from the corolla mouth; filaments white below, shading gradually to purple in the upper 20 mm, the exerted portion becoming recurved downwards; anthers dark indigo-blue, thecae medifixed, united above, free below, mobile. *Style* ca. 225 mm long, becoming exerted by ca. 30 mm as the stamens become recurved, white in the corolla tube and shading to purple above the mouth, except for the green bifid apex. *Ovary* pale yellow. *Fruit* consisting of 2 united carpels, green at first, becoming purple, included in the calyx; seeds 1 or 2 per fruit, 13 × 8 × 7 mm, ovoid-ellipsoid, the outer surface curved, coarsely reticulate-ribbed, the inner surfaces flattened, smooth.

**Etymology.** – *Clerodendrum kamhyoe* is named on honour of Marie Hélène Kam Hyo Zschocke, who grew up in Andapa with her two brothers and two sisters. Their father, Jiang (Jean) Kam Hyo, had emigrated from Canton, China to Madagascar via Mauritius in 1933 to make a new life for himself. He eventually settled in Andapa, where he established a small shop, and met and married Marie Hélène's mother, Louise Germaine Iavy. Jean Kam Hyo is also honoured by the naming of the plant after his daughter. Marie Hélène moved to Antalaha in 1969 and established a flourishing business as a pharmacist, the first female to practice this profession in Madagascar. She became involved in local health-care issues and in particular the care of leprosy victims and their families, founding the NGO CALA (“Comité d'Aide aux Lépreux d'Antalaha” [“The Leprosy Relief Committee of Antalaha”]) in 1988, for which she continues to serve as President, and a school for the children of the leprosy victims. Her interests also turned towards environmental education and conservation, and she established an environmental association in Antalaha, the environmental education centre at “Macolline” and a nearby plant nursery. In her various endeavours, Marie Hélène is supported and encouraged by her husband Bernd Zschocke.

**Vernacular name.** – Local informants have indicated the name “Saguiramantogoro” for the plant on “Macolline”. In the local Betsimisaraka dialect, “saguira” is a stick or baton, and “mantogoro” is a snake, referring to the smooth bark, which resembles a species of snake that is common in the region (Kam Hyo Zschocke, pers. comm.).

**Distribution and Phenology.** – *Clerodendrum kamhyoe* occurs in intact and disturbed humid forest from near sea level to ca. 800 m, predominantly on volcanic substrates. It has been collected at four scattered localities in northern Madagascar: near Antalaha (at “Macolline” – the type locality), on the north-eastern edge of Marojejy National Park and twice



**Fig. 1.** – Line drawings of *Clerodendrum kamhyoae* Phillipson & Allorge. **A.** Leaf showing long attenuate-acuminate apex and arcuate secondary veins; **B.** Detail of secondary and tertiary leaf venation; **C.** Stem node showing lenticelles; **D.** Early flower bud with the corolla pushing open the sepals; **E.** Young flower bud with elongating corolla tube; **F.** Pre-anthesis flower bud; **G.** Mature calyx; **H.** Corolla seen from side (tube incomplete); **I.** Corolla seen from below; **J.** Corolla seen from front; **K.** Stamen with mobile anther thecae; **L.** Young inflorescences; **M.** Calyx surrounding an immature drupe showing an irregular split due to the expansion of the ovary; **N.** Part of infructescence, with calyx enveloping immature fruit and pedicels of fallen flowers visible; **O.** Fruit with calyx removed to show the upper surface of the drupe; **P.** Longitudinal section of the ovary showing the two locules. [A-K: Allorge 2839, P; L-P: redrawn from photographs] [Drawings: D. Storez]



**Fig. 2.** – Photographs of *Clerodendrum kamhyode* Phillipson & Allorge. **A.** Marie Hélène Kam Hyo Zschocke standing with a young flowering individual; **B.** Trunk with inflorescences; **C.** Young shoots bearing occasional terminal inflorescences; **D.** Young inflorescence showing pre-anthesis buds tinged dull purple-brown and open flowers; **E.** Bisected flower showing insertion of stamens; **F.** Young flower buds with caducous bracts visible; **G.** Developing fruits (upper part of calyx removed).

[Photos: **A:** R. Said; **B-E:** P. Phillipson; **F:** J. Moscovitch; **G:** M. Kam Hyo Zschocke]

on Montagne d'Ambre in the extreme north (one locality within the National Park and the other in Mahagaga forest south-west of the Park). The new species has been observed and photographed recently in the Galoko-Kalobinono Reserve north-east of the town of Ambanja town by Claude Christian, Missouri Botanical Garden's community-based conservation project facilitator at the site. Unfortunately specimens were not collected and precise locality information is not available, but the co-ordinates are estimated to be close to 13°38'S and 48°42'E at an elevation of ca. 300 m (Christian & Randriatsivry, pers. comm.). The unmistakable diagnostic characteristics of the species are clearly visible in the photographs, and there can be no doubt that the plant represents an additional locality for the new species (Fig. 3).

*Clerodendrum kamhyoe* has been collected in full flower from May to July, but observations at "Macolline" indicate that flowering typically starts in April and can continue sporadically until October (Kam Hyo Zschocke & Moscovitch, pers. comm.), and where flowering has been recorded at the site every year since its discovery. It has been collected in mature fruit in October ("Macolline", *Phillipson 6509*) and in December (Montagne d'Ambre, *Ramandimbimanana 177*).

**Conservation status.** – The paucity of collections of this species, which is so conspicuous (at least when flowering), from only five relatively distant localities suggests that *C. kamhyoe* is not a common species. With an EOO of 14,670 km<sup>2</sup> and an estimated maximum known AOO of 20 km<sup>2</sup> (based on 4 km<sup>2</sup> grid), and with two of the five isolated subpopulations lying outside Madagascar's formal protected area network (although at "Macolline" it is of course afforded a certain level of protection), *C. kamhyoe* is at risk locally from habitat degradation, ongoing forest clearing and wood collection. This risk is most severe at Magaga forest where the species is apparently uncommon, and which represents a location of no more than 10 km<sup>2</sup>, where the forest is under considerable pressure and is already severely degraded with some patches within the main forest block completely cleared (Andriamihajarivo, pers. comm.). Loss of this subpopulation would cause a decrease in the AOO of the species but would not impact the EOO significantly. The known subpopulations of the species each represent separate locations, and therefore *C. kamhyoe* is assigned a preliminary status of "Endangered" [EN B2ab(ii,iii,iv,v)] following IUCN Red List Categories and Criteria (IUCN, 2012). Conservation efforts of the new species at "Macolline" does significantly lower the risk of extinction, but observations of its low fertility at this site, which are discussed below, are an additional concern that requires further study.

**Notes.** – In addition to the collections cited, a specimen of *C. kamhyoe* is present in P [P00853061] that lacks label data. A note with the specimen, believed to be in Henri Humbert's hand, states: "Spécimens trouvés dans une chemise

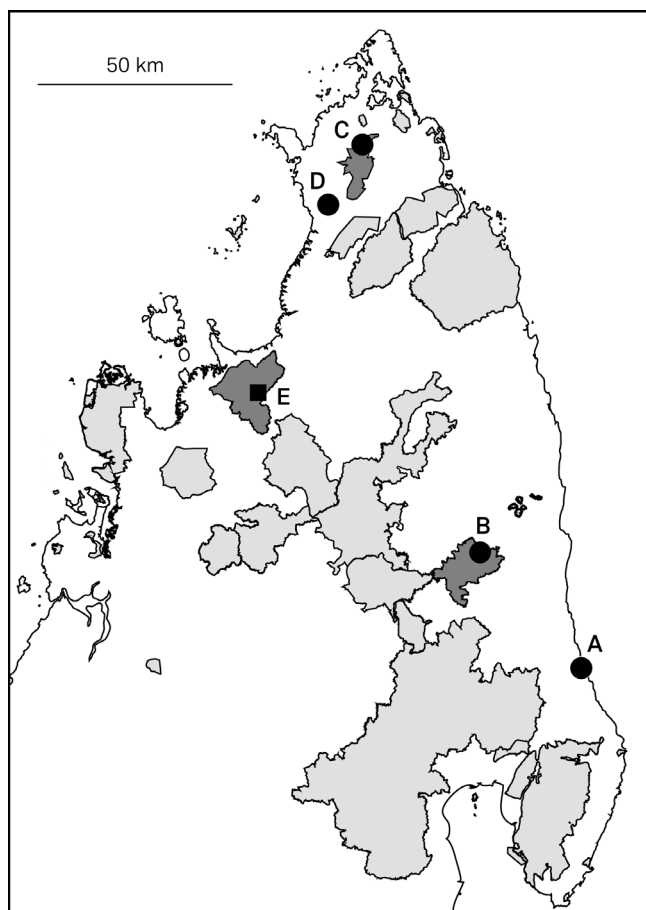


Fig. 3. – Distribution map of known localities for *Clerodendrum kamhyoe* Phillipson & Allorge, with the protected area network shaded (darker grey for the sites at which *C. kamhyoe* is known to occur).

A. "Macolline"; B. Marojejy National Park; C. Montagne d'Ambre National Park; D. Mahagaga Forest; E. Galoko-Kalobinono Reserve (obs. only).

portant l'indication: La Réunion, Jardin Colonial" et "voisin de *Decary 7937*". Although Humbert did not publish on *Clerodendrum*, he made many collections which he identified himself and is likely to have carefully consulted the specimens in the herbarium and annotated them accordingly. The *Decary* specimen referred to by Humbert later became one of the paratypes of *C. revolutum*. In his publication of *C. revolutum*, BOSSER (1988) did not cite the anonymous specimen, although he did provide it with a determination label bearing this name dated December 1987. Whether he changed his mind about its identity or he saw it only after the article went to press is not known. However, even though it is a poor quality specimen, there is no doubt that it represents the new species and not *C. revolutum*. We cannot determine whether it was from Reunion Island, and therefore presumably cultivated, or if it had simply been placed in a recycled paper folder that had originally been used for a specimen from Reunion, but the latter seems more likely.

**Table 1.** – Morphological and ecological features distinguishing *Clerodendrum kamhyoe* Phillipson & Allorge from *C. cauliflorum* Vatke and *C. revolutum* Bosser.

Characters	<i>C. cauliflorum</i>	<i>C. kamhyoe</i>	<i>C. revolutum</i>
Leaf blade	oblong to oblanceolate	(narrowly) elliptic to obovate	oblong to oblanceolate
Petiole: blade ratio	ca. 1:10	ca. 1:7	ca. 1:10
Calyx lobes	erect	erect	revolute
Calyx tube [cm]	ca. 1.5 x 1.0	ca. 3.4 x 1.4	2.5-3.5 x 1.5-1.7
Corolla tube length [cm]	6 to 8	19 to 22	19 to 22
Distribution	North	North	West and Central
Bioclimate	Sub-humid	Humid and sub-humid	Dry and sub-humid

*Related species.* – *Clerodendrum kamhyoe* most closely resembles *C. cauliflorum* and *C. revolutum*, the three species are predominantly cauliflorous, and have white corollas with long narrow tubes – a combination of characters that appears to be unique in the genus. They also have similar leaf venation with a fine tertiary network clearly visible in dried specimens, but the blade of *C. kamhyoe* is narrowly elliptic to narrowly obovate while the other species generally have oblong to oblanceolate blades and the petiole is generally longer in proportion to the blade than in the other two species (mostly ca. 1:7 vs. ca. 1:10), it also differs from *C. cauliflorum* by its much larger calyx (the tube ca.  $3.4 \times 1.4$  cm vs. ca.  $1.5 \times 1.0$  cm), and longer corolla (19–22 cm vs. 6–8 cm), its calyx also differs from that of *C. revolutum*, which is more inflated and tends to have a generally shorter tube ( $2.5\text{--}3.0 \times 1.5\text{--}1.7$  cm) with revolute vs. erect lobes (see Table 1). We consider the three species to be closely related, but while *C. cauliflorum* is partially sympatric with *C. kamhyoe*, occurring in the sub-humid areas of northern Madagascar (Nosy Be, Montagne d'Ambre, Loky Manambato), *C. revolutum* is a species of the dry west (Bemaraha, Beanka, Kasijy) and the dry to subhumid western slopes of the high plateau (Antokomaro Forest).

The only other species from Madagascar that is reported to be cauliflorous is *C. tubulosum*, which occurs at several localities in humid eastern escarpment forests and has thinner-textured (membranaceous) leaves, pedunculate inflorescences and quite different, short, curved corolla tubes. Based on these characters, we suspect that *C. tubulosum* is more closely related to a large group of Malagasy species centred on *C. laxiflorum*, but which all appear to produce their inflorescences only on their young growth.

In Madagascar there are other species that possess long-tubed corollas, but which are borne only on young growth. Of these, *C. baronianum* Oliv. closely resembles the three cauliflorous species due to its compact inflorescences with short peduncles and its similar calyx. The corolla is about as long as that of *C. cauliflorum* (ca. 7–9 cm) and it has generally smaller, thinly coriaceous leaf blades with the tertiary venation

hardly apparent (vs. papyraceous with the venation apparent). *Clerodendrum baronianum* occurs in humid coastal forests and its range overlaps with that of *C. kamhyoe* at Antalaha but extends onto the Masoala Peninsula and further south towards Toamasina. A different group of species, centred on the widespread *C. aucubifolium*, comprises taxa with relatively narrow, cylindrical corolla tubes of varying lengths, the longest of which are found in *C. aucubifolium* var. *longiflorum* Moldenke and *C. brunnescens* Moldenke, which reach ca. 13 and 10 cm long respectively. However in these species and others in the group, the tube is more robust and rigid than in *C. kamhyoe* and its allies, typically 3–5 mm in diameter, and the corolla often bears purple markings. The calyx in the *C. aucubifolium* group is also different, being coriaceous and drying grey or black (vs. green), the inflorescences tend to be pedunculate and the leaf blades are coriaceous with the tertiary venation not apparent, unlike those of *C. kamhyoe*. A few specimens of other long-tubed *Clerodendrum* from Madagascar that cannot be placed in known species are currently under study by PBP. An Asian species with long arching tubular flowers, *C. indicum* (L.) Kuntze, has been recorded from Madagascar as introduced and possibly naturalized (MOLDENKE, 1956). It is widely cultivated in many parts of the world as an ornamental and for medicinal purposes, and bears many flowers in a large, open, spreading, terminal panicle. Although the corolla of *C. indicum* has a very similar appearance to that of *C. kamhyoe*, it is much smaller (ca. 9 cm long), and its calyx differs in being short (ca. 5 mm long), deeply lobed and expanding in fruit, when the lobes spread and turn red. *Clerodendrum indicum* is also easily distinguished by its sub-shrubby habit, and narrow whorled leaves.

YUAN et al. (2010) note that *C. indicum* belongs to a small group of Asian species that are characterized by long, narrow corolla tubes, which form a strongly supported monophyletic group (*Clerodendrum* sect. *Siphonanthus* Schauer), which is sister to the other Asian clades recognised in their study. The species of the section included in the study were

*Clerodendrum floribundum* R. Br., *C. minabassae* Teijsm. & Binn., *C. quadriloculare* (Blanco) Merr. and *C. tomentosum* R. Br., however all of these species and others placed in the section have a shorter corolla than *C. kambyoe*, and like *C. indicum*, differ from the Malagasy species vegetatively and in characters of the calyx.

In continental Africa, there are also species of *Clerodendrum* with relatively long, white, tubular flowers, but they have quite a different habit. They are generally shrubby, often lianescent and sometimes growing high into the forest canopy, and they are often spiny due to the persistent petioles that become woody and rigid. The flowers of the African species are mostly borne in terminal heads with conspicuous bracts (unlike *C. kambyoe* and its presumed allies), which are mostly found on the young growth but in some species inflorescences may also develop on older branches. Like the Asian species, the calices of these African plants differ from those of the Malagasy taxa in size and in having relatively long lobes. No species is known from Africa that has a corolla as long as *C. kambyoe*, but among the longer-flowered species in Africa are *C. capitatum* (Willd.) Schumacher & Thonn., which has flowers in dense heads with corolla tubes up to ca. 8 cm long and is widespread throughout much of tropical Africa, and *C. rotundifolium* Oliv., widespread in East Africa, with slightly longer flowers in a lax terminal panicle. Both species were included in the analysis of YUAN et al. (2010), and are embedded in their African clade, thus appearing to be unrelated to the long-tubed species in Asia. YUAN et al. (2010) did not include any true *Clerodendrum* from Madagascar in their analysis, but suggested that many of them morphologically resemble *C. hildebrandtii* Vatke, from East Africa, and might therefore be related to this species, which is sister to all other African clades in their analysis. This short-tubed species is the sole member of VERDCOURT's (1992) *Clerodendrum* sect. *Cylindrocalyx* (Thomas) Verd., and in our opinion is not close morphologically to *Clerodendrum kambyoe* and its allies. A molecular study of *Clerodendrum* that includes representative species from Madagascar is clearly needed.

**Reproductive biology.** – The floral characteristics of *C. kambyoe*, specifically the white corolla with its long fine tube, the production of copious nectar, and the fine protruding stamens and style, clearly represent the characteristic adaptive syndrome for pollination by moths, and in particular, given the large size of the flowers, by hawk moths (Lepidoptera, family: Sphingidae). Hawk moth diversity in Madagascar is well-developed (NILSSON et al., 1987) and cases of presumed hawk moth pollination occur in diverse families and genera. Few have been studied in any detail, but some literature is available on this type of pollination in orchids (NILSSON et al., 1987; MARTINS & JOHNSON, 2007). Casual observations have been made at “Macolline” on several occasions, but confirmed

pollination visits have not been seen. Nevertheless green and white Sphingidae caterpillars are regularly seen browsing on the stems and young branches of *C. kambyoe*, and have been observed eating calices and leaves, and adult moths have been seen occasionally resting on the stems. They have been identified by Joël Minet (MNHN, Paris) as *Coelonia fulvinotata* (Butler) [= *C. mauritii* (Butler)]. The species is widespread and common in Africa and Madagascar (AFRICAN MOTHS, 2016), but its proboscis is too short (mean length: 103 mm, according to MARTINS & JOHNSON, 2007) to be able to reach the nectar at the base of the corolla tube, and therefore it is not a likely pollinator of *Clerodendrum kambyoe*. A related but larger species, *Coelonia solani* (Boisduval), which is known from Madagascar, other Western Indian Ocean Islands and parts of West Africa (AFRICAN MOTHS, 2016), is a more likely candidate having a proboscis up to 220 mm long (NILSSON et al., 1987), but it has not been observed at “Macolline”.

In some years Marie Hélène and her staff have looked for seeds of *Clerodendrum kambyoe* at “Macolline”, but have never found any that appeared to have developed fully, which is surprising given the prolific flowering of the plants. Nevertheless, *C. kambyoe* is locally very abundant at “Macolline”, where over 1,500 mature individuals were counted in 2015 within an area of less than one hectare (Moscovitch, Claudio, Yarozafo & Jaonina, pers. comm.). On visiting the site in 2015 we were able to determine that the species spreads extensively by means of suckers, which appear close to a main trunk and at distances of up to 3 m. In some places, dense thickets of mature trunks are present, presumably the result of the proliferating suckers. Marie Hélène and her staff have successfully transplanted suckers to propagate the plants vegetatively. Suckering ability has been noted in certain Asian species of *Clerodendrum*, but whether it reaches the extent of what is seen at “Macolline” is unknown (Wearn, pers. comm.), it does not appear to have been noted in other Malagasy species.

During 2015 we carefully followed the phenology of the subpopulation of *C. kambyoe* at “Macolline”, and recorded the development of fruits. While many flowers initially appeared to be developing fruits, the majority were abortive and on examination we saw that although the endocarp appeared healthy, the embryo had failed to develop. In a few (less than 1%) cases seeds did appear to be developing, but most of these failed to harden and were starting to rot. At the end of the season, after extensive searching, we collected less than 20 seeds from the entire site that appeared to be fully formed. Some of these seeds germinated successfully, producing a radicle and a short plumule (germination was hypogeal), but eventually died, while most failed to germinate. While the apparent failure of sexual reproduction of the plants may be due to the absence of a suitable pollinator, ‘late-acting’ self-incompatibility or severe ‘inbreeding depression’ may also be the cause. These phenomena can

occur between individuals that are genetically very similar (or identical) thereby inhibiting self-fertilisation, and are recorded as prevalent in woody species in the tropics (PROCTOR *et al.*, 1996). Given the impressive ability of the species to spread by means of suckers, we suggest that the subpopulation at “Macolline” may even be a clone that has spread vegetatively from a single founding, or that if limited genetic variability does exist in the subpopulation the opportunities for cross-pollination between genetically different individuals are low due to the prolific production of flowers by each individual.

The apparent lack of fertility of *C. kambyoe* at “Macolline” is cause for concern in terms of its successful conservation at the site. Nothing is known about the fertility of the other subpopulations of the species, and clearly the reproductive biology of the species requires further study.

*Paratypi.* – MADAGASCAR. Prov. Antsiranana: SAVA, sommet de la colline de Vinany, 3 km N d’Antalaha, rive S de la rivière Antavanana, 50° 60 m, 14° 52’ 21” S 50° 15’ 38” E, VI.2009, fl., *Allorge* 2839 (P [P00853254]); Masorolava, Mahagaga, partie NE, 115 m, 12° 45’ 41” S 049° 01’ 50” E, 22.IX.2007, fr., *Andriamihajarivo et al.* 1382 (MO, P [P00853064], TAN); Antalaha, village Ambinany, “Macolline”, 60 m, 14° 52’ 24” S 50° 15’ 37” E, 9.V.2010, fl., *Aubriot et al.* 95bis (MO, P [P00853253]); *ibid. loc.*, fl., *Aubriot et al.* 95ter (MO, P [P00853252]); Antalaha, “Macolline”, at the mouth of the Ankavanana River, 65 m, 14° 52’ 25” S 50° 15’ 37” E, 30.X.2015, fl., *Phillipson* 6509 (MO, P); PN de la Montagne d’Ambre, partie N, 676 m, 12° 28’ 23” S 049° 10’ 59” E, fr., *Ramandimbimanana & Randimbibarison* 177 (P [P00853063]); Marojejy RNI, au N d’Andapa, Andrahanjo, 805 m, 14° 02’ 30” S 49° 48’ 20” E, 8-16.VII.1994, fl., *Rasoavimbahoaka* 363 (MO, P [P00853062], TAN).

## Acknowledgements

First and foremost, we wish to thank Marie Hélène Kam Hyo Zschocke for her enthusiasm, encouragement and support. We also thank the “Macolline” team: Joey Moscovitch (JHA Fund), Rado Claudio, Ertice Yarozafo, Odon Jaonina, Jean-Luc Mora-Mahafeno and Mélanie Ravoahangiarisoa, and Denise Law Yew for their invaluable assistance and observations, in particular for counting trees and flowers, and for searching for and examining seeds, Josiane Ramarison for her tireless work in the “Macolline” nursery and Bernd Zschocke for his hospitality and friendship. We also wish to thank Odile Valat for initially bringing this remarkable plant to our attention, Dominic Storez for his drawings, Joey Moscovitch, Razia Said and Marie Hélène for the use of their photographs, Monique Randriatsivry and Claude Christian for information about *C. kambyoe* at Galoko-Kalabinono, and Joël Minet for information about hawk moths in Madagascar. We acknowledge also the valuable discussions we have had with James Wearn on the genus *Clerodendrum* in general and with George Schatz on his observations of the genus in Madagascar, and the staff at the relevant herbaria for access to their collections. We are

very grateful to Pete Lowry and Alan Paton for their reviews of the original manuscript and to Martin Callmänder for his editorial skills; their suggestions and corrections have significantly improved this article.

## References

- AFRICAN MOTHS (2016). *African Moths* [<http://www.africanmoths.com/index.html>].
- BOSSE, J. (1987). Description de deux nouvelles espèces de *Clerodendrum* L. (Verbenaceae) et identité de *C. brunsvigioides* Baker, *C. insolitum* Mold. et *C. villosicalyx* Mold. *Bull. Mus. Natl. Hist. Nat., B, Adansonia* 9: 341-347.
- CALLMÄNDER, M.W. & P.B. PHILLIPSON (2012). A new endemic species of *Rotheca* Raf. (Lamiaceae) from Madagascar. *Candollea* 67: 369-372.
- CALLMÄNDER, M.W., P.B. PHILLIPSON, J.A. WEARN & R.P.J. DE KOK (2013). Adieu *Adelosa* Blume (Lamiaceae): Further observations on *Rotheca* Raf. for Madagascar. *Candollea* 68: 316-320.
- CAPURON, R. (1972). Notes sur les Verbénacées de Madagascar. *Adansonia* ser. 2, 12: 45-53.
- HARLEY, R.M., S. ATKINS, A.L. BUDANTZEV, P.D. CANTINO, B.J. CONN, R. GRAYER, M.M. HARLEY, R.P.J. DE KOK, T. KRESTOVSKAJA, R. MORALES, A. PATON, O. RYDING & T.M. UPSON (2004). Labiatae. In: KADEREIT, J.W. (ed.), *Families and genera of flowering plants* 7: 167-275.
- IUCN (2012). *IUCN Red List Categories and Criteria: Version 3.1*. 2<sup>nd</sup> ed. IUCN Species Survival Commission, Gland & Cambridge.
- MADAGASCAR CATALOGUE (2016). *Catalogue of the vascular plants of Madagascar*. Missouri Botanical Garden, St. Louis & Antananarivo [<http://www.efloras.org/madagascar>].
- MARTINS, D.J. & S. D. JOHNSON (2007). Hawkmoth pollination of *Aerangoid* orchids in Kenya, with special reference to nectar sugar concentration gradients in the floral spurs. *Amer. J. Bot.* 94: 650-659.
- MOLDENKE, H.N. (1950a). Notes on new and noteworthy plants. XI. *Phytologia* 3: 307-321.
- MOLDENKE, H.N. (1950b). Novelties in the Eriocaulaceae and Verbenaceae, II. *Bull. Torrey Bot. Club* 77: 380-405.
- MOLDENKE, H.N. (1950c). Verbenaceous novelties, mostly from Madagascar, and miscellaneous taxonomic notes. *Lloydia* 13: 205-226.
- MOLDENKE, H.N. (1951). Verbenaceous novelties from Africa and South America. *Amer. J. Bot.* 38: 321-326.
- MOLDENKE, H.N. (1953). Notes on new and noteworthy plants. XVI. *Phytologia* 4: 285-295.

- MOLDENKE, H.N. (1956). Verbénacées. In: HUMBERT, H. (ed), *Fl. Madagascar Comores* 174.
- NILSSON, A., L. JOHNSSON, L. RALISON & E. RANDRIANJOHANY (1987). Angraecoid Orchids and Hawkmoths in Central Madagascar: Specialized Pollination Systems and Generalist Foragers. *Biotropica* 19: 310-318.
- PROCTOR, M.C.F., P. YEO & A. LACK (1996). *The natural history of pollination*. Timber Press.
- VERDCOURT, B. (1992). *Clerodendrum*. In: POLHILL, R.M. (ed.), *Fl. Trop. E. Africa: Verbenaceae*: 84-144. Rotterdam, Balkema.
- YUAN, Y.-W., D.J. MABBERLEY, D.A. STEANE & R.G. OLMSTEAD (2010). Further disintegration and redefinition of *Clerodendrum* (Lamiaceae): implications for the understanding of the evolution of an intriguing breeding strategy. *Taxon* 59: 125-133.