



Monograph of African Costaceae

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Abstract A taxonomic revision of the African genera of *Costaceae* (*Costus* and *Paracostus*) is given. Within the genus *Costus* 24 species are recognized, 8 of which are here described as new and one is given a new name. Included are chapters on the history of the taxonomy of the family, morphology, flower biology, pollination, dispersal, distribution, ecology, phylogeny and molecular studies and conservation. The species treatments include descriptions, full synonymy, geographical and ecological notes and taxonomic notes. For all species distribution maps are provided. A complete identification list with all exsiccatae studied and an index to scientific names is included at the end.

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INTRODUCTION

In Africa, the family of *Costaceae* comprises two genera: *Paracostus* and *Costus*. The genus *Costus* is widespread in tropical Africa and tropical America, with dispersal from a basal African grade likely leading to the Neotropical radiation (Specht & Stevenson 2006, Salzman et al. 2015). *Paracostus englerianus* is the only representative of its genus in Africa. *Paracostus* was recently split off from a previously paraphyletic *Costus* by Specht & Stevenson (2006), based on phylogenetic analyses using nuclear and chloroplast sequence data combined with morphological characters. In their morphological key, they characterize *Paracostus* as prostrate plants with few leaves, a few-flowered inflorescence and inconspicuous bracts. *Costus* plants are characterized as rhizomatous herbs with unbranched, erect shoots (rarely acaulescent) with many spirally arranged leaves and having shoots that terminate in a single, unbranched inflorescence (spike) with coriaceous and often brightly coloured bracts. The genus *Costus* is represented in Africa by 24 species, 8 of which are described as new in this monograph.

GENERAL MORPHOLOGY

Habit

The plants are herbaceous, but shoots can become lignified at the base where they emerge from the rhizome. *Costus* species are mostly terrestrial but some are epiphytic (*C. lateriflorus*, *C. lila-ceus* and *C. talbotii*). The terrestrial taxa are generally 1.5–4 m tall. The tallest species is *C. giganteus* reaching a height of up to 8 m. There is also a group of species of smaller-sized plants reaching up to c. 1.5 m. The acaulescent (*C. macranthus* and *C. spectabilis*) and prostrate (*Paracostus englerianus*) species do not exceed 0.3 m in height.

The rhizomes, composed of clearly demarcated nodes and internodes, are most commonly constricted in a cluster from which the above ground shoots grow vertically, but can be horizontally

creeping more or less above ground and repeatedly branched (*Paracostus englerianus*) or can be vertically oriented, terminating in a rosette and provided with axillary horizontal runners (*C. macranthus* and *C. spectabilis*). According to Hallé (1979) they are pachymorphic and represent the model of Tomlinson.

The shoots often form a spiral, elongating between nodes to present a spiral monostichous phyllotaxy. On the label of *C. gracillimus* (Chevalier 19717) we found that the shoot completed two spirals. Hallé (1967) observed a left-handed spiral as well as a right-handed one in *C. dinklagei*. However, the younger leaf-bearing shoots are often straight. The green shoot is composed of nodes and internodes. The nodes are the place where roots, any side branches and/or inflorescences can develop in taxa where axillary inflorescences form (e.g. *C. lateriflorus*); also the leaves originate at the node with sheathing leaf bases. The lower portion of each internode is covered by this sheathing leaf base. The leaf lamina and the ligule emerge from the apex of the sheath. The family of *Costaceae* is characterized by sheathing leaf bases that fully enclose the shoot. Depending on their length they can completely cover the shoot, extending to the node above from which they emerge. In some species the sheaths are falling apart into separate fibers with age (*C. acutissimus*, *C. fenestralis* and *C. ligularis*). In *C. acutissimus* the decayed sheaths leave a distinct horizontal rim at the nodes around the lower part of the reproductive shoot. In some species with few nodes prior to forming the inflorescence, the sheaths together with the leaf bases form a cup around the inflorescence (*C. macranthus*, *C. spectabilis* and *Paracostus englerianus*). Sheaths (as well as leaves and bracts) emerge along the shoot in either a left- or a right-handed spiral (Hallé 1967). Shoots can be completely vegetative or can terminate in an inflorescence. These reproductive shoots can bear fully developed leaves or leaf sheaths only. A single plant can have all three kinds of shoots, although most species either produce separate vegetative and reproductive shoots (heterophyadic) or produce a single shoot type combining vegetative and reproductive portions (homophyadic).

Leaves

The texture of the vegetative parts (leaves, ligule, bracts and sheathing leaf bases) is described as membranous (thin and transparent), chartaceous (papery), or coriaceous (leathery).

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The ligule, when present, is found at the apical margin of the sheaths where the petiole emerges from the sheathing leaf base. It is absent in the acaulescent or creeping species *C. macranthus*, *C. spectabilis* and *Paracostus englerianus*. When present, the ligule is generally herbaceous and green like the shoot. However, it can be brown to reddish brown or even orange in several species. In the epiphytic *C. lateriflorus* and *C. lilaceus* the very long (20–60 mm), reddish brown ligule almost completely covers the green internode, or even surpasses it in length (Fig. 1). *Costus ligularis*, *C. phyllocephalus* and *C. talbotii* are characterized by a distinctly brown ligule. The texture of the ligule is membranous to chartaceous. The shape of the ligule is tubular, its apical part can be described as truncate to 2-lobed, including intermediate forms like obliquely truncate. The length of the ligule varies from 1–60 mm, sometimes varying with its position along the shoot. In *C. phyllocephalus* the upper brown membranous part of the ligule may be deciduous only leaving the lower green tubular part. The base of the ligule can be encircled with a rim which is either glabrous (*C. acutissimus*), sometimes hairy (*C. afer*) or always covered with 2–6 mm long hairs (*C. lucanusianus*). In *C. afer* this rim is never

complete. The indument of leaf sheaths, ligule and petiole is generally reminiscent of that of the leaf lamina (see below).

The number of leaves per shoot can vary from one (*Paracostus englerianus*) to many as in most species of the genus *Costus*. There also can be few (mostly 4) horizontally spreading leaves forming a horizontal rosette on the ground (*C. macranthus*, *C. spectabilis*). Or, few leaves (1–)4–7(–8) do form a rosette at the top of the shoot (*C. fenestralis*, *C. ligularis*, *C. loangensis*). The lamina (as well as sheaths and bracts) develop along the shoot in either a left- or a right-handed spiral (Hallé 1967). The colour of the lamina is generally green, varying from dark green (*C. louisii*) to yellowish green (*C. macranthus* and *C. spectabilis*). The lower side is often paler to greyish or whitish green or even glaucous (*C. lilaceus*). The lower side of the lamina of *C. lucanusianus* is sometimes silvery due to a dense indument of appressed hairs. However, in some species (*C. gabonensis*, *C. ligularis*, *C. lilaceus*, *C. macranthus*, *C. phyllocephalus*, *C. spectabilis* and *C. tappenbeckianus*) the lower side of the lamina can be reddish to purple-red. A specimen of *C. gabonensis* had leaves that were completely reddish purple on both sides (Wieringa 3551). *Costus macranthus* and *C. spectabilis* have

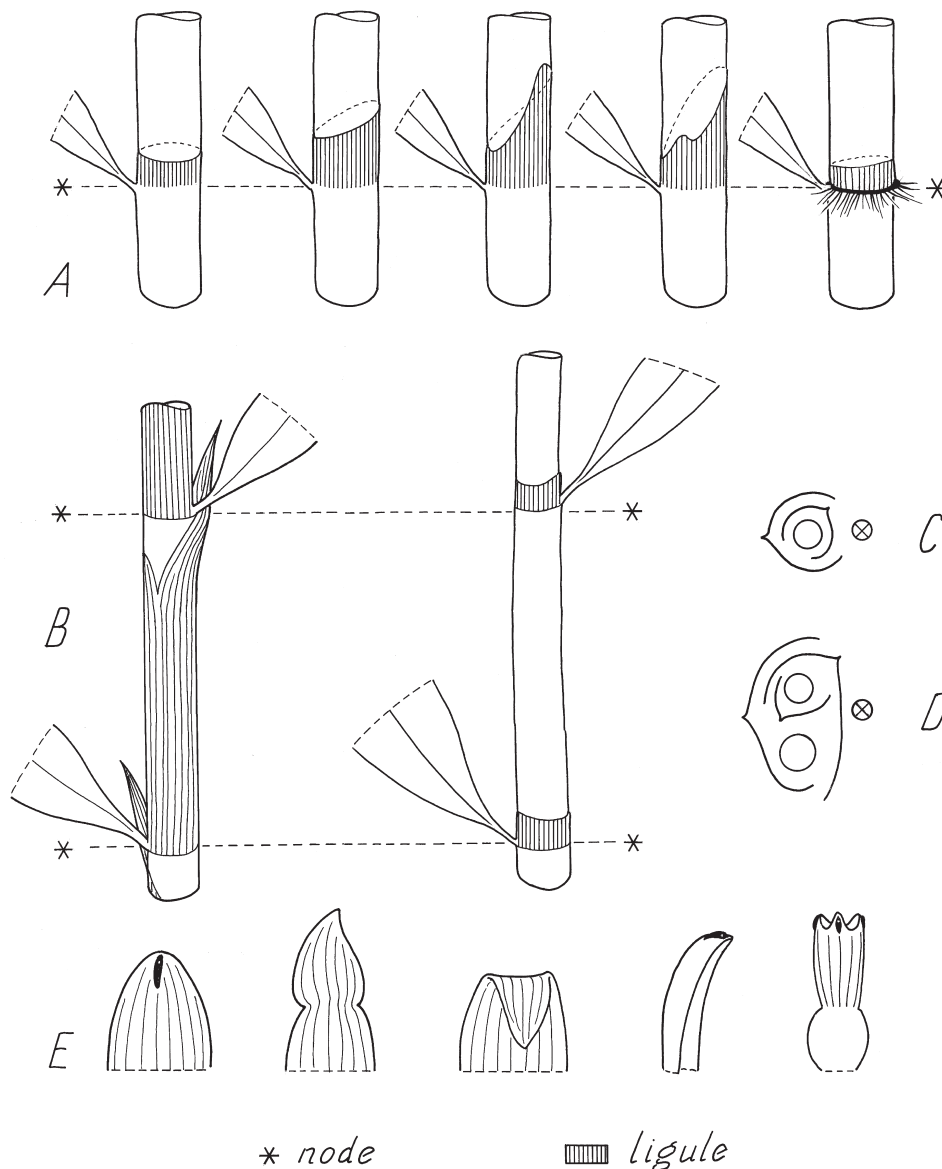


Fig. 1 Schematic details (* = node of shoot). a. Ligule shapes (the utmost right one: *C. lucanusianus*); b. ligule lengths (left: *C. lateriflorus*); c. 1-flowered bract with 1 bracteole and 1 flower; d. 2-flowered bract with 2 bracteoles and 2 flowers; e. drawing of bract with nectary, 2 appendaged bracts, bracteole with nectary, and ovary and calyx with nectary on apex of lobes. — Drawing by Hendrik Rypkema.

distinctly reddish leaf margins, similar to *Monocostus uniflorus* of the Peruvian Amazon. The leaves can be shiny on both sides (*C. aureus*, *C. louisii*) or only on the upper side (*C. gabonensis*, *C. gracillimus*, *C. lilaceus*). The texture of the lamina is generally herbaceous. It can be coriaceous (*C. gracillimus*) or more or less succulent (*C. dubius*). The leaves of *C. macranthus* and *C. spectabilis* are definitively thickened and fleshy. The leaves of the epiphytic *C. lateriflorus*, *C. lilaceus* and *C. talbotii* are coriaceous, distinctively thickened and somewhat fleshy. The shape of the lamina is generally elliptic, but can be ovate or obovate and varies from narrowly to broadly so. The lamina in *C. lilaceus* is often falciform, that of *C. tappenbeckianus* often slightly asymmetrical. The size of the lamina varies from 4–52 by 2–22 cm. Leaves can also be definitively bullate, forming convex shapes between the veins as in *C. tappenbeckianus*. Some species have plicate leaves with various distinctly raised veins (folded like the plaits of a closed fan), ranging from 3–5-plicate in *C. ligularis* to 20-plicate in *C. fenestralis*. This character is difficult to ascertain in dried specimens and must be recorded in living material. Most data given here are derived from labels of herbarium specimens and photographs of living material. *Costus albiflos*, *C. aureus*, *C. gracillimus* and *C. tappenbeckianus* are reported to show plicate leaves, too. The indument of the lamina is absent in about half of the species, the lamina being completely glabrous on both sides. In 6 species the lamina is generally hairy on both sides (*C. fenestralis*, *C. gabonensis*, *C. ligularis*, *C. loangensis*, *C. macranthus* and *C. tappenbeckianus*). In the remaining species the upper side of the lamina is glabrous but the lower side is hairy. The hairs themselves can be erect to appressed and minute (< 1 mm long) or up to 3 (*C. ligularis*, *C. phyllocephalus*) or 4 mm long (*C. tappenbeckianus*). The indument in some species can be quite variable. Schumann (1904) even created a variety *a major* of *C. lucanusianus* based largely on this character: it has a generally glabrous lower leaf side instead of the characteristic densely silvery hairy lower side. The base of the lamina where it contacts the petiole is generally acute, but can be obtuse as well and even cordate. In the acaulescent species (*C. macranthus*, *C. spectabilis* and *Paracostus englerianus*) the extreme base of the leaves (10–33 mm long) is positioned at an angle of 45–90° with the horizontal upper part of the lamina. Together with the uppermost sheaths these bases form a cup around the inflorescence. The apex of the lamina is generally acuminate with an acumen of 5–40 mm long. In the acaulescent species the apex of the leaf lamina is obtuse and mucronate (mucro c. 1 mm long). The petiole varies from 1–33 mm long, but is absent in some species (*C. macranthus*, *C. spectabilis*, *Paracostus englerianus*).

Inflorescences

The inflorescence can terminate a leafy shoot emerging from the rhizome (14 species), terminate a separate, typically shorter leafless shoot emerging from the rhizome (8 species), or be borne laterally in the axil of a leaf (3 species). As is the case in Neotropical *Costus* species, botanists have separated species groups based on 'inflorescence terminal' (terminating a leafy shoot) vs 'inflorescence basal' (terminating a short, separate leafless shoot). This character has been found to be imprecise, as many species can bear inflorescences that terminate both leafy and separate leafless shoots emerging directly from the rhizome. Ker Gawler (1857: t. 4979) already recognized this in *C. afer*. Because both types of inflorescences are morphologically terminal in that they terminate the shoot apex, we refer to these as terminating a leafy shoot or terminating a separate leafless shoot rather than 'terminal' or 'basal', respectively.

In addition to these inflorescences terminating a leafy shoot, several species bear lateral inflorescences in the axils of the

leaves. According to Specht & Stevenson (2006) the 'terminal' inflorescence of *Paracostus englerianus* emerges from the axil of the leaf and only appears terminal due to secondary displacement. Hallé (1979) when researching the inflorescence of *C. dinklagei* found it emerging from a lateral shoot at the base of a leafy shoot rather than directly from the rhizome, i.e. in the axil of a leaf sheath. Additional developmental studies including emergence from the rhizome will be necessary to completely characterize 'lateral' or 'terminal' inflorescences in some species. The shape of the spike is formed by the arrangement of the bracts and can be ellipsoid to cylindrical, or ovoid to globose. Rarely the inflorescence is branched. The inflorescences can be few-flowered (4–9-flowered), several-flowered (10–19-flowered) or many-flowered (more than 20-flowered). The size of the inflorescence ranges from 1–20 by 1–10 cm, the smallest ones are found in *C. lateriflorus*, *C. ligularis* and *C. lilaceus* (1–5 by 1–4 cm), the largest one in *C. giganteus* (12–20 by 7–10 cm). The epiphytic species *C. lateriflorus* and *C. lilaceus* have more than one axillary inflorescence per flowering shoot. As with Neotropical taxa, the inflorescence is sometimes reported to contain water or a mucilaginous liquid between the bracts. This has been reported for *C. dubius*, *C. giganteus* and *C. nimba*, all of which have coriaceous bracts.

The length of the separate leafless reproductive shoot is generally 5–50 cm, shortest in *C. kupensis*, *C. lateriflorus*, *C. ligularis*, *C. lilaceus*, *C. talbotii* and *C. tappenbeckianus* (0.5–9 cm) and longest in *C. giganteus* (up to 300 cm). The indument of the inflorescence (comprising indument of bracts, appendages of bracts, bracteoles, calyx, ovary and capsule) varies from generally to completely hairless/glabrous (*C. afer*, *C. dubius*, *C. giganteus*, *C. gracillimus*, *C. louisii*, *C. nimba* and *C. tappenbeckianus*) to rather densely hairy. The hairs are erect to appressed and very small (< 1 mm long).

The bracts (as well as lamina and sheaths) are placed along the shoot in either a left-handed or a right-handed spiral (Hallé 1967). In the axil of each bract one finds one bracteole and one flower, or two bracteoles and two flowers: so the number of flowers per bract can be 1 or 2. The presence of 1 or 2 flowers per bract has long been a main discerning key character to identify African *Costus* species. However, our studies have proved that this character is not always reliable. Already Schumann (1904: 383, number 2) in his key to the species of *Costus* recognized the possibility of the presence of "Bracteae bibracteolatae, bracteole secunda multo (duplo et ultra) minor, uniflorae cum rudimento saepe minute floris alterius". We ourselves collected a specimen of *C. afer* in Gabon (Maas et al. 10023) with 1- and 2-flowered bracts (and in the same specimen with inflorescences on leafy and leafless shoots). Generally only one or a few flowers per inflorescence are at anthesis at the same time, although there are some reports of many flowers at anthesis at the same time in certain species (*C. afer*, *C. giganteus*). Flowers are arranged in a spiral, each in the axil of a bract. Bracts can be coloured green, red or brownish. Their texture is either membranous (*C. macranthus*, *C. spectabilis*, *Paracostus englerianus*), chartaceous (*C. acutissimus*, *C. fenestralis*, *C. gabonensis*, *C. lateriflorus*, *C. ligularis*, *C. lilaceus*, *C. loangensis*, *C. tappenbeckianus*) or most commonly coriaceous. Some of the coriaceous bracts are shiny (*C. louisii*, *C. tappenbeckianus*). When bracts are coriaceous they are often more or less convex with their margin apically rolled inwards. When dried the top of these bracts can rupture at the midpoint (*C. afer*). The illustration of Nicolas Hallé (1967: pl. 3B) shows a 'massue inflorescentielle très développée' with distinctly convex bracts compared to the flowering inflorescences in the same drawing. The same can be seen in the coloured drawing in the diary of Hallé at the Paris Herbarium (Plate 1d). It is possible that the developing flowers and fruits

are causing these bulging convex bracts depicted by Hallé. In most species the shape of the bracts is ovate to triangular or elliptic, sometimes broadly or depressed so. The size of the bracts varies from 0.5–4 by 1–3 cm. Bracts can fall apart into separate fibers with age (*C. fenestralis*), a process comparable with the decomposition of old leaves (which lose the mesophyll but retain the veins). Near the apex of the bract a callus can be found, which can be seen as a slightly thickened vertical line of a slightly different colour than the surrounding bract tissue. The cells forming this callus produce nectar. In Neotropical species where the extrafloral nectaries have been studied, the nectar attracts ants that protect the inflorescence against oviposition by flies. These flies oviposit in immature fruit and their larvae destroy the seeds and arils of the plant resulting in seed loss (Schemske 1980, 1982). The length of the calli ranges from 1–3 mm. In species with appendaged bracts, the callus is not well developed. In this case, however, a callus on the bracteole may be very distinctive. The appendages of the bracts seem to represent the reduced lamina of the leaves, especially if the bracts are interpreted as homologous to the sheathing leaf bases. The transition between vegetative leaves and reproductive inflorescence bracts occurs gradually, not abruptly, in most species. Often the lowest bracts are appendaged and retain characteristics of the leaf lamina, while the upper ones are not. 'Bracts appendaged' (in the key and the description of the species) means that all bracts are appendaged and the bracts are significantly different from the subtending leaves (in colour, form, etc.). The presence of appendages on only the lowest bracts is not mentioned as this is considered a gradual transition between vegetative and reproductive phases of the shoot. About one third of the species have appendaged bracts. The appendages are generally the same colour as the bracts and never develop a callus. They can be pointed upwards (ascending), horizontally spreading, or pointed downwards (reflexed). Their shape varies from broadly ovate to narrowly triangular. The size of the appendages varies from 0.5–4.5 by 0.5–3.5 cm. There is always one bracteole enclosing each flower. The colour of the bracteole is generally the same colour as the bracts. The bracteole is boat-shaped (1-keeled or sometimes 2-keeled) or rarely tubular (*C. lateriflorus*, *C. lilaceus*). This may depend on the space inside the bracts forming the inflorescence: when there is less space available bracteoles will be more flattened causing the 1-keeled bracteole to change into a 2-keeled one. Each bracteole can develop a callus. In the epiphytic *C. lilaceus* and *C. lateriflorus*, the tubular bracteole often splits on the side opposite the callus. The length of the bracteoles varies from 7–35 mm.

Flowers

The calyx of *Costus* is generally the same colour as the bracts and bracteoles. It is tubular in shape and 3-lobed (but 2-lobed in *C. macranthus* and *C. spectabilis*) and it is sometimes split on one side. The length of the calyx ranges from 5–30 mm. In some species the calyx exceeds the length of the bracts especially in fruit (*C. aureus* and *C. lucanusianus*). The lobes are typically erect, but are horizontally spreading to reflexed in *C. lucanusianus*. The shape of the calyx lobes is narrowly to very shallowly triangular, or shallowly to broadly ovate-triangular to deltate and they measure 1–12 mm in length. Each of the calyx lobes can develop a callus.

Calli can be found on the bracts, on the bracteoles and on the calyx lobes. They never have been found on the appendages of the bracts. Calli on the bracts are described in 9 species, calli on the bracteoles in 20 species and calli on the calyx lobes in 8 species. The number of calli present and their place in the inflorescence can be quite different: in 5 species bracts, bracteoles and calyx lobes all develop calli, whereas in 3 spe-

cies no calli were found at all (*C. acutissimus*, *C. macranthus*, *Paracostus englerianus*). Some species have indistinct or small calli on the bracts, but distinct ones on the bracteoles. Large calli on both bracts and bracteoles also can be present, as in *C. giganteus*. Sometimes the calli are very distinctive in colour (e.g. yellow calli on dark brownish red bracteoles in *C. ligularis*; yellowish green calli on reddish brown to dark green bracts in *C. lilaceus*).

The flowers comprise a 3-lobed calyx, a corolla with three petals, a single petaloid labellum (formed from the fusion of five staminodes), one petaloid fertile stamen and a gynoeceum that contains an inferior 3-locular ovary. The style is thin and threadlike and is positioned between the thecae of the fertile stamen. The stigma is 2-lamellate in *Costus*, and composed of a funnel-shaped upper part and a reflexed lamellate part in *Paracostus*.

The colour of the flowers (mainly corolla and labellum) can be white, yellow, orange, pink, lilac, dark red, reddish brown, purple, or a combination of these colours; rather often these colours are mixed with reddish dots. Some flower parts can be hyaline instead of opaque in several species. The 'size' of the flowers in the descriptions refers to the length of the corolla tube plus the length of the labellum. The overall shape of the flower is formed by the tubular base of the corolla and the shape of the labellum.

The corolla is 20–130 mm long and consists of a tube with three erect lobes. It can be white, yellow, orange, pink, lilac or reddish brown in colour. The length of the corolla tube ranges from (5–)10–45(–90) mm. The longest tube is 50–90 mm in *C. macranthus*, the shortest is 5–7 mm in *C. gracillimus*. The shape of the corolla lobes is (narrowly) elliptic-ovate, the lobe opposite the labellum being generally wider than the other two. The length of the lobes is 20–80 mm. The corolla lobes can be hyaline with reddish dots in several species. The apex of corolla lobes can be provided with a callus-like thickening (*C. loangensis*). Generally the corolla is glabrous, but those of *C. gabonensis* and *C. loangensis* are covered by small erect to appressed hairs < 1 mm long. In *C. giganteus* and *C. loangensis* two corolla lobes bend towards each other forming a hood over the fertile stamen, opposite the labellum.

The labellum, which forms the showy part of the flower, is composed of five fused staminodes. The lower part of the labellum is united with the stamen into a second tube of rather variable length (Maas 1972: 7). Its colour can be white, yellow, orange, pink, lilac, dark red, reddish brown, purple, or a combination of these colours. The outer (abaxial) side of the labellum is often whitish, the inner (adaxial) side is often coloured. In several species, the lateral edges and the central upper margin of the adaxial side are prominently coloured and sometimes also striped. Moreover, the inner side of the labellum almost always has a central yellow 'nectar guide' or 'honey mark' presumed to be used in pollination. The shape of the labellum can be horizontally flattened (Plate 3e, *C. phyllocephalus*), funnel-shaped (Plate 1a, *C. afer*), or rarely tubular (Plate 2d, *C. gracillimus*). The first form is generally not completely horizontally flattened, but the upper part of the labellum provides a horizontal landing platform for a possible pollinator; at the base the labellum is funnel-shaped (*C. lateriflorus*, *C. lilaceus*, *C. loangensis*). A completely funnel-shaped labellum can be found in *C. afer*, *C. dinklagei* and *C. dubius*. The shape of the labellum is tubular in *C. giganteus* and *C. gracillimus*. When spread out, the shape of the free part of the labellum is (narrowly to broadly) obovate to subcylindrical. The size of the (free part of the) labellum ranges from 15–80 by 15–70 mm; it can be longer than or almost as long as the corolla. The margin of the labellum can be more or less 5-lobed (*C. ligularis*, *C. phyllocephalus*, *C. talbotii*) or irregularly lobed (*C. gabonensis*). The margin can be undulate

to crenulate and sometimes fimbriate with fimbriae 2–3 mm long (*C. dinklagei*, *C. ligularis*, *C. loangensis*, *C. tappenbeckianus*). These characters are not well recognizable in dried material and therefore have to be examined in living flowers. The labellum is generally glabrous, except for the fimbriae mentioned above and some hairs in the throat.

The nectar guide is a yellow to yellow-orange blotch of a contrasting colour in the centre of the inner side of the labellum. It is present in the flowers of almost all species, except *C. ligularis* and not distinct in those with completely yellow flowers (*C. gabonensis*, *C. giganteus*, *C. gracillimus*, *C. lateriflorus*, *C. macranthus*, *C. spectabilis*). The nectar guide can extend towards the upper margin of the funnel-shaped labellum (sometimes in *C. lucanusianus*, *C. afer*) but in the same species it can be restricted to two longitudinal stripes not reaching to the margin, or in some species it is found only in the throat of the flower (*C. phyllocephalus*, *Paracostus englerianus*). In *C. ligularis* the nectar guide is absent and only the reflexed apex of the fertile stamen is yellow.

The stamen is generally yellow or white and narrowly elliptic in shape. The size of the free part ranges from (10–)20–60(–80) by (3–)6–15(–20) mm. It is typically bent downwards closing the throat, but in *C. giganteus* it is erect. The apex of the stamen is reflexed with the very tip turned upwards. Sometimes it is differently from the stamen itself. The tip of the apex is sometimes triangular with 1–many teeth (*C. louisii*, *C. lucanusianus*, *C. phyllocephalus*, *C. talbotii*). In *C. giganteus*, the apex of the stamen is cucullate. The length of the anther varies from (2–)5–12 mm. The gynoecium is composed of an inferior 3-locular ovary with a single style and stigma. The ovules are anatropous and placed in two rows on three axile placentae. The white, filiform style is in *Costus* topped by a 2-lamellate stigma which has a dorsal 2-lobed to rounded appendage. In *Paracostus englerianus* the stigma is composed of a funnel-shaped upper part and a reflexed lamellate part; the appendage is absent. The style lies embedded between the two narrowly elliptic thecae forming the anther. It is hooked between the apices of the thecae by the appendage of the stigma. After anthesis when the flower has withered and fallen off the style sometimes remains attached to the ovary (*C. afer*, *C. giganteus*).

Fruit

The fruit is a capsule generally obovoid in shape, but varying from ellipsoid to subglobose. When ripe it opens loculicidally via three longitudinal slits. It measures 6–20 by 4–20 mm. In some acaulescent species the capsule is said to be subterranean. The many seeds (we once counted 50–80 seeds per capsule in living material of *C. dubius*) are shiny black and subglobose to irregularly angular presumably caused by the very tight compacting inside the capsule. The seeds measure 1–3 by 1–2 mm and are provided with a distinct, white and lacerate aril.

FLOWER BIOLOGY AND POLLINATION

As far as we know, no data have been recorded concerning the pollination of species of *Costus* in Africa, but many characteristics of their flower morphology provide hypotheses. The main characters forming potential pollination syndromes are the colour and the texture of the flower and the shape of the labellum (which can be horizontally flattened, funnel-shaped or tubular) which forms the arena for pollination. Kay & Schemske (2003) published an article on pollination of flowers of Neotropical species of *Costus* by bees and hummingbirds demonstrating unique morphologies associated with bird and bee pollination. Specht et al. (2001) and Salzman et al. (2015) placed the evolution of these pollination syndromes in a phylogenetic context. For the African species, the same two possible pollination syndromes are suggested and described here:

A. Insect pollination syndrome

Morphological characters — A horizontally flattened labellum as found in 16 species of this monograph strongly suggests that it functions as a landing platform. The flowers with this type of labellum are all either completely yellow or white to pink with a yellow nectar guide. Upon landing, an insect pollinator would follow the nectar guide towards the centre of the flower, pushing up the reflexed apex of the fertile stamen to access the floral throat. As they enter the flower, large insects inadvertently brush pollen from the fertile stamen onto their backs. Upon entering a subsequent flower, the pollen is transferred to the stigmatic surface located above the thecae, promoting outcrossing.

Odour — A scent has been reported on the collection labels of some species (a strong scent of jasmine in *C. gabonensis*; of violets or roses in *C. lucanusianus*). The hairs present at the base of the inner side of the labellum around the throat in several species could be the source of this scent and/or could act to facilitate scent volatilization.

B. Bird pollination syndrome

Morphological characters — Two species of African *Costus* (*C. giganteus*, *C. gracillimus*) have bright yellow flowers with a firm or rigid texture and a tubular labellum. Both *C. giganteus* and *C. gracillimus* have inflorescences with red bracts and the flowers are completely yellow, lacking markings or nectar guides.

In *C. giganteus* the three erect corolla lobes bend towards each other forming a hood over the stamen at anthesis. The narrow labellum opens downward with its lateral margin curved upward. The apically cucullate stamen does not bend down to close the throat but remains erect. The filament is not flat but rolls inwards lengthwise along its margins, especially at the base of the stamen. These flowers have a relatively narrow labellum with lateral upcurved margins and erect cucullate stamen presenting an open throat to pollinators, contrary to the situation in all other species of African *Costus* where the stamen blocks the throat and visitors have to force their way in.

In *C. gracillimus* the corolla, stamen and labellum are of about the same length together creating a tubular-shaped flower. They are also reported to be fleshy and yellow. The shape of the flower does not widen at anthesis; rather, it stays tubular.

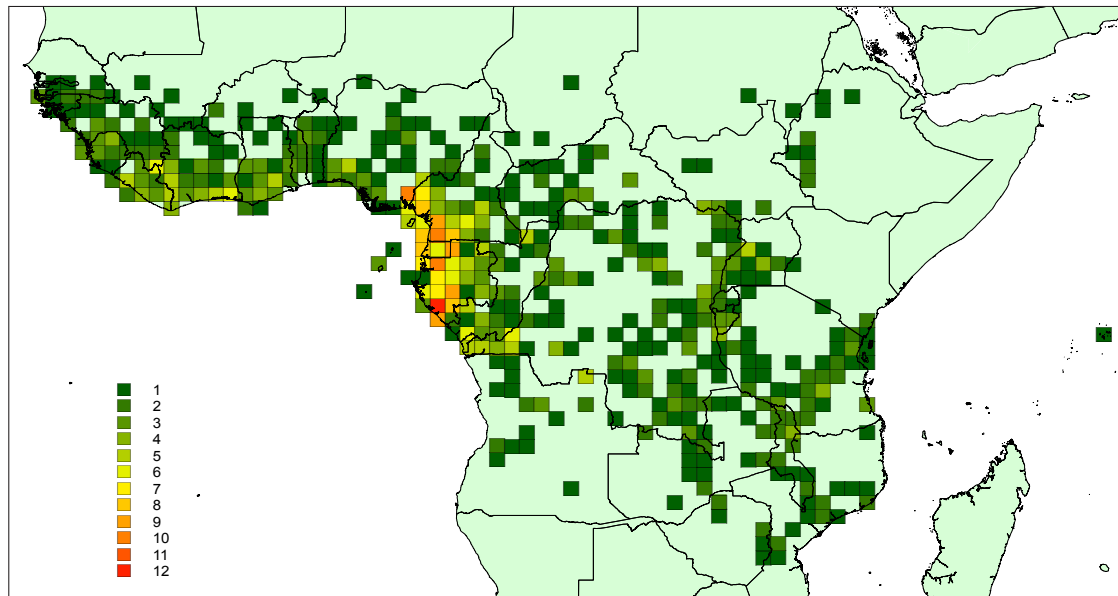
Reward — No reports indicate the amount or content of nectar produced by African *Costus*; such data have been used for Neotropical species to indicate pollinator preferences.

DISPERSAL AND PROPAGATION

Seed dispersal occurs largely by the spontaneous opening of the dried capsule (*C. dubius*). All seeds of *Costus* have a white, lacerate aril. Ants or other small animals may be attracted by these arils and thus distribute the seeds. The plants of *C. dubius* are notorious for disseminating themselves all over the greenhouses of the world thereby replacing other species of *Costus* growing in the pots next to them. It is the only African species of *Costus* that can self-pollinate, leading to copious seed production (pers. obs.).

Typically *Costus* species are propagated by vegetative reproduction.

Ker Gawler in 1857 describing *C. afer* remarked: "A peculiarity of its growth is, that it has no seed, nor does it propagate from suckers: but the flower-head ... by its weight bending the long leafy shoot to the ground, gradually withers, while a new plant arises from its base and obtains nourishment from it, while forcing its roots into the soil...". Young sprouts are often found germinating from the old infructescence in a case of vivipary. In



Map 1 Species density per 1° grid cells of *Costaceae* in Africa.

addition, bulbils can form in the axils of bracts instead of flowers, leading to vegetative propagation from the inflorescence axes. Sometimes bulbils are found sprouting from the nodes through the vegetative sheaths (*C. afer*) or from the axillary buds of the lowest bracts (*C. phyllocephalus*). These mechanisms are common among species with apical inflorescences. Plants also reproduce vegetatively through splitting of the rhizome.

DISTRIBUTION AND ABUNDANCE

Distribution in the African countries has been split in six different entities according to the following system:

- *North Africa*: Egypt.
- *North East Africa*: Ethiopia, South Sudan, Sudan.
- *West Africa*: Benin, Burkina Faso, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo.
- *Central Africa*: Burundi, Cabinda (Angola), Cameroon, Central African Republic, Chad, Congo Brazzaville, Congo Kinshasa, Equatorial Guinea, Gabon, São Tomé & Príncipe.
- *East Africa*: Kenya, Tanzania, Uganda.
- *Southern Tropical Africa*: Angola, Malawi, Mozambique, Zambia, Zimbabwe.

Some species have a very wide distribution (*C. afer*, *C. dubius*, *C. lucanusianus*), while others are only known from a very small area (*C. giganteus*) or only from the type locality (*C. loangensis*).

The number of collections per species is quite variable, ranging from 1 to over 450. **Bold-italic** names indicate newly described species or new names:

- Some species are often collected (*C. afer* 462 times collected; *C. dubius* 226; *C. lucanusianus* 387; *C. phyllocephalus* 258; *C. spectabilis* 344; *Paracostus englerianus* 149).
- Some are less often collected (***C. aureus*** 67; *C. dinklagei* 56; *C. gabonensis* 24; ***C. gracillimus*** 58; *C. lateriflorus* 31; *C. ligularis* 59; ***C. lilaceus*** 76; *C. macranthus* 90; ***C. nimba*** 22; *C. tappenbeckianus* 68).
- Some are rarely collected (***C. acutissimus*** 2; ***C. albiflos*** 10; ***C. fenestralis*** 11; *C. giganteus* 12; ***C. kupensis*** 4; *C. loangensis* 1; ***C. louisii*** 3; *C. maboumiensis* 10; *C. talbotii* 3).

Four of the nine newly described or named species were already represented by 22–76 specimens (*C. nimba* 22; *C. lilaceus* 76; *C. gracillimus* 58; *C. aureus* 67).

The centre of diversity of the African species of *Costaceae* is Gabon and Cameroon in Central Africa (Map 1). Most species have been found in Gabon (17) and Cameroon (15), followed by Nigeria (9) and Congo Brazzaville (9). The new species we describe are from West and Central Africa, a pattern seen in many families (Hoekstra et al. 2016 and references therein). Also our new species are concentrated in Gabon (6) and Cameroon (5). East and Southern Tropical Africa yielded no new species, which is a discrepancy with many other groups (e.g. Couvreur et al. 2006). The East African forests are hardly diverse in *Costaceae* and do not contain any endemics. This pattern of high diversity only in West and Central Africa seems rather typical for groups with poor seed dispersal.

This monograph contains five narrowly endemic species: *Costus kupensis* from Cameroon and *C. gabonensis*, *C. loangensis* and *C. louisii* from Gabon. *Costus talbotii* has only been collected twice in Oban, Cross River State, Nigeria.

In this monograph there are no references to uses and/or vernacular names. For these data, see the various local African floras (Gabon, Cameroon, West Tropical Africa (Appendix)) and books specialized in this field such as Burkill (1985), Neuwinger (2001) and PROTA (<http://www.PROTA4U.org>).

HISTORICAL SURVEY

1813 — The first mention of an African species of *Costus* in literature is in a publication on medicinal plants from Africa compiled by Afzelius (1813). In this publication, juice of the plant *Zingiber dubium* Afzel. is recorded to be used for the treatment of nausea and fever in Sierra Leone. Schumann (1904) transferred this species to the genus *Costus* as his *Costus dubius* (Afzel.) K.Schum.

1823 — Ker Gawler (1823) published *Costus afer* in 'Botanical Register'. He gave a description and a drawing on t. 683.

1824–1828 — Roscoe published his monumental work on Monandrian Plants, then very much 'en vogue' with the wealthy people who cultivated them in their greenhouses. In the title it is mentioned that the plates are "chiefly drawn from living specimens in the Botanic Garden at Liverpool". In 1825 he describes one single species of *Costus* originating from Africa: *C. maculatus* Roscoe, now put in synonymy with *C. dubius*.

1835–1901 — In this period several species were described by various authors: Bojer (1835), Fenzl (1865), Ridley (1887),

- Bull (1887), Braun & Schumann (1889), Brown (1892), Baker (1898), Durand & De Wildeman (1899), Schumann (1901). Of these publications Baker is by far the most important one with four new taxa, two of which are still maintained today (*C. ligularis* Baker and *C. lateriflorus* Baker).
- 1902, 1903 — Gagnepain (1902a, b, 1903) described five new African species of *Costus*, based on material from the Paris Herbarium (P), with reticulate and beautiful pencil sketches providing details of the flowers. He worked with herbarium material in addition to some living plants in the Greenhouse of the Botanical Garden in Paris for comparison.
- 1904 — By far the most important contribution to our knowledge of *Costaceae* is by Schumann in 1904 in his worldwide monograph of *Zingiberaceae* in Engler's 'Das Pflanzenreich'. His study was based on herbarium material only, therefore the descriptions of the floral characters are incomplete and the taxonomic value consequently is restricted. His work, however, is of the greatest importance as a summary of all species known at that time, with all possible references to literature. He divided the family *Zingiberaceae* in 2 subfamilies: *Zingiberoideae* and *Costoideae*. His *Costoideae* included the genera *Costus*, *Dimerocostus*, *Monocostus* and *Tapeinochilos*. In his vision the genus *Costus* consisted of five subgenera: (*Eu*)*Costus*, *Metacostus*, *Epicostus*, *Cadalvena* and *Paracostus*. Schumann enumerated 93 species of *Costus*. Of these, 34 species originate from Africa. Schumann himself described or recombined 20 African species, 7 of which are retained in the present study. The other 13 names created by Schumann now are put into synonymy. For example, *C. anomocalyx*, *C. deistellii*, *C. megalobracteata*, *C. oblitterans*, *C. pterometra*, *C. subbiflorus* and *C. trachyphyllus*, all described by Schumann are now synonyms of *C. afer* Ker Gawl.
- 1913–1920 — During this period Chevalier travelled and collected extensively in Central and West Africa from Senegal to Sudan. In 1917 he published *C. pulcherrimus* from Ivory Coast (now renamed as *C. gracillimus*) and in his 1920 publication he enumerates seven species of *Costus*, all based on his own collections.
- 1929–1938 — In this period several species of *Costus* were described by Pellegrin (1929, 1938), based on plants collected by G. Le Testu in the Mayombe region, Gabon. In 1930 Loesener published his treatment of *Zingiberaceae* in Engler & Prantl's 'Die Natürlichen Pflanzenfamilien'. His publication did not add much new information to Schumann's monograph of 1904.
- 1943 — In this year the Berlin Herbarium (B), the place where most important *Costus*-collections were housed, was bombed. A large part of the monocotyledonous collections was lost, including all *Costaceae* with all (type) material studied by Schumann. We have checked the Berlin Herbarium, including its spirit collection, and did not find any of the pre-1943 collections. A similar disaster occurred with the Vienna Herbarium (W) in 1945, but here photographs made of the specimens before the war survived.
- 1964, 1965 — Koechlin published two treatments of the genus *Costus* (then in *Zingiberaceae*) for 'Flore du Gabon' (1964) and 'Flore du Cameroun' (1965). Although his work was not too critical, it is the first publication on African *Costaceae* which provides rather good descriptions and, even more important, nice illustrations.
- 1967–2010 — In this period there appeared few publications: Hallé (1967) made a thorough study of *C. dinklagei*, meticulously describing the specimen with a strong focus on subterranean parts. In his second article from 1979 he constructed a key to 14 species of African *Zingiberaceae* (incl. *C. dinklagei*) only based on characters of their rhizome. In

1984 Lock, working on the 'Flora of Tropical East Africa', published some notes, e.g. on four species of *Costus*. He especially studied the difference between *C. spectabilis* and *C. macranthus*. In 1985 Lock published the *Zingiberaceae* in the 'Flora of Tropical East Africa', distinguishing seven species of *Costus*. Specht & Stevenson (2006) raised the subgenus *Paracostus* from subgeneric to generic rank based on their phylogenetic analyses. In 2010 Lock & Diniz published the *Costaceae* in 'Flora Zambesiaca'.

2010–present — Maas-van de Kamer, Maas and Specht started their revision of African *Costaceae*, combining intensive herbarium work and field work in Gabon and Cameroon. Their current work is the first critical revision of *Costus* since Schumann's monograph (1904). Their first contribution was in 2012 on *C. loangensis* from the Parc National de Loango in Gabon.

Finally, in the current monograph eight new species are described and one new name is given. The total number of African *Costaceae* based on this monograph is now 24 species of *Costus* and one species of *Paracostus*.

MATERIAL AND METHODS

Terminology: The following terminology is applied to standardize comparisons for both the dichotomous key and the species descriptions.

Frequency: 'sometimes' is used when c. 1/4 of the specimens shows the described form (e.g. bracts red); 'generally' is used when 3/4 of the bracts are red; 'rarely' is used in case less than 1/4 of the bracts are red.

Number of leaves, flowers or bracts: 'few' means 4–7; 'several' means 10–18; 'many' means more than 20 leaves, flowers or bracts.

Indument: to describe the indument a combination of the following characters is used: 1. length of hairs (mm); 2. density of hairs (sparsely, rather densely, densely); 3. position of hairs relative to the surface (erect, half-appressed, appressed); and 4. structure of hairs (soft, stiff). Former publications have used specific terms to define these combinations of characters. Therefore, 'villose' is translated in this manuscript into 'covered with soft erect hairs' and 'hirsute' is replaced by 'covered with stiff erect hairs'. Length and density are included when appropriate.

Characters are only described when they are distinct: for example, leaf colour is only described when it varies from the typical green, such as 'lower side red' or 'upper side dark green' in some species. The ligule is normally green, thus colour is only noted when it is brown or reddish brown. Leaves are generally herbaceous and thus noted when coriaceous (leathery). Ligules are generally chartaceous.

Most measurements were taken from herbarium material; however, measurements taken from living material or material preserved in spirit have been included when available. The following herbaria (A, AAU, AMD, B, BENIN, BM, BR, BRLU, C, CGE, E, EA, ENT, F, FI, G, GC, GH, K, KRIBI, L, LBV, LE, LG, LIB, LIL, LISC, LMA, LMU, LY, M, MA, MAL, MHU, MO, MPU, NHT, NY, P, POZG, PRE, S, SCA, SEGC, SRGH, U, UC, UPS, US, W, WAG, WRSL, YA) and living collections contributed to this study (Burgers' Bush, greenhouse of Burgers' Zoo, Arnhem, The Netherlands; Botanic Garden, Meise, Belgium; Royal Botanic Gardens, Kew, London, Great Britain).

IUCN conservation status assessments were performed following the IUCN Red List Category Criteria (IUCN Standards and Petitions Subcommittee 2016), the EOO and AOO were calculated using GeoCAT (Bachman et al. 2011), the AOO with a grid cell size of 2 × 2 km.

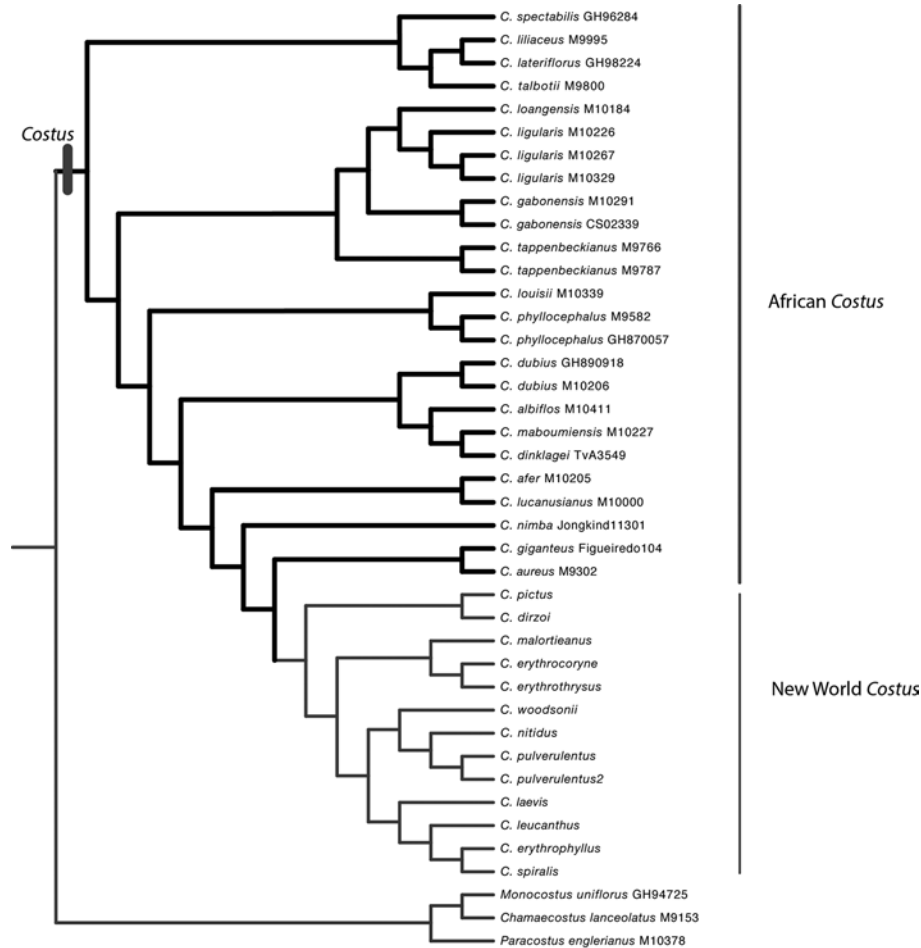


Fig. 2 Phylogenetic hypothesis for African *Costus* based on a 4-marker (ITS, ETS, CAM, rpb2) dataset, including species from genera *Monocostus*, *Dimercostus* and *Chamaecostus* as outgroup taxa and including 12 species from the Neotropical *Costus* clade to demonstrate the paraphyly of the African taxa with respect to the New World radiation. African taxa (dark lines) with accession information indicated.

PHYLOGENETIC ANALYSIS

To assess monophyly and synonymy proposed in this monograph, and to evaluate some evolutionary and functional aspects of the characters, we use the results of a preliminary phylogenetic analysis (Fig. 2). This analysis is based on four molecular markers (ITS, ETS, CaM and rpb2) and 38 individuals of African *Costus* representing 18 of the currently accepted 24 African *Costus* species, with multiple individuals sampled from certain species (e.g. *C. ligularis*, *C. phyllocephalus*, *C. tappenbeckianus*), 11 New World *Costus* as well as 1 species from each of the genera *Monocostus*, *Chamaecostus* and *Paracostus* as outgroups. The datamatrix used to build the phylogeny can be downloaded from FigShare (Specht et al. 2016).

The only African member of the *Costaceae* not placed in the genus *Costus* is *Paracostus englerianus*. It is considered as an outgroup in this analysis, together with the Neotropical genera *Monocostus* and *Chamaecostus*. Previous analyses including specimens from across *Costaceae* (Specht 2006) indicate that *Paracostus englerianus* may be more closely related to the Asian genera *Hellenia* and *Tapeinochilos* than to other African taxa.

Within *Costus*, the African taxa form a basal grade leading to the New World *Costus* radiation (Fig. 2; grey lines). Several clades comprise this African grade. The first lineage to diverge is a clade containing *C. spectabilis* as sister to a clade of *C. talbotii*, *C. lateriflorus* and *C. lilaceus*. *Costus spectabilis* is the only species included in this phylogeny that is completely acaulescent and occupies drier, savanna-type habitats. While

C. macranthus was not included in this analysis, we hypothesize that it is closely related with *C. spectabilis* based on shared morphological characters and would likely appear within this clade, probably as sister to *C. spectabilis*. *Costus lateriflorus* and *C. lilaceus* are both epiphytic and are quite similar to one another vegetatively, with only floral colour differing between the two species. More complete sampling (data not shown) indicates that these may indeed be a single lineage with different colour morphs. *Costus talbotii*, recovered as sister to *C. lateriflorus* and *C. lilaceus*, is also epiphytic and is the only other epiphytic species of *Costaceae*, indicating that epiphytism has only evolved once in the family.

The next clade to diverge from the remaining *Costus* contains *C. gabonensis*, *C. ligularis* and *C. tappenbeckianus*, and the recently described *C. loangensis*. *Costus loangensis* is sister to *C. ligularis* and differs from this species mostly by floral colour, with *C. loangensis* bearing a yellow flower and *C. ligularis* bearing a purple flower. The single population of *C. loangensis* may indeed be a locally diverging population of *C. ligularis*, but further work at the population level will be necessary to determine the status of this species. *Costus tappenbeckianus* (8 individuals sampled in total) demonstrates the most morphologically and genetically diverse species sampled in this analysis; additional sampling of populations from this species may result in identifying segregate species provided structured morphological and geographic differentiation can be found.

Following the 'ligularis' group is a clade containing *C. phyllocephalus* and the newly described *C. louisii*. *Costus louisii* has been identified from a single population, but is much taller than

most observed plants of *C. phyllocephalus*. In addition, *C. phyllocephalus* has appendaged bracts while those of *C. louisii* are generally not appendaged.

The next diverging clade contains *C. dubius*, *C. albiflos*, *C. maboumiensis* and *C. dinklagei*. Based on morphology alone, it was surprising that *C. dubius* was not more closely related to *C. afer*, however, this could be due to shared plesiomorphic characteristics found in many of the species examined. All four of the *Costus* species with at least two samples per species are resolved as monophyletic.

The remainder of the African *Costus* grade comprises clades with few species: *C. afer* and *C. lucanusianus* as sister taxa to one another, *C. nimba* as a single lineage, and finally *C. giganteus* and *C. aureus* as the sister clade to the New World *Costus* radiation. *Costus aureus* and *C. lucanusianus* are almost identical vegetatively with the only difference being floral colour, providing an example of when floral colour as a character can indeed indicate support for separate species. The fact that *C. giganteus* is not alone sister to the New World radiation indicates that the ancestral condition for the New World taxa was bee-pollinated, with bird pollination evolving independently in *C. giganteus* and perhaps also independently in *C. gracillimus* (not included in this phylogeny!), completely separate from the evolution of bird pollination in Neotropical species.

TAXONOMIC TREATMENT

Costaceae

Costaceae Nakai (1941) 203. — Type: *Costus* L.

The African *Costaceae* (*Costus* spp. and *Paracostus englerianus*) are perennial, rhizomatous herbs, terrestrial or epiphytic, rarely gigantic, tall (max. 6 m), low or acaulescent herbs; shoot erect or prostrate, unbranched, generally spirally shaped, composed of nodes and internodes; leaf sheaths, petioles and ligules originating at the nodes. *Leaves* 1, or few to many, spirally arranged along the shoot; shootless species with few leaves rosulate; prostrate species with 1 leaf per shoot (*Paracostus*); leaf sheaths fully closed around the shoot; ligule present or rarely absent, membranous to chartaceous, tubular at the base and truncate to 2-lobed at the apex; petiole present or sometimes absent; lamina generally green, sometimes shiny, or plicate, herbaceous to coriaceous, generally elliptic with acuminate apex and acute base, sometimes extreme base of leaf fleshy surrounding the inflorescence (*Paracostus*). *Inflorescence* a many-, several- or few-flowered spike, either terminating a leafy shoot, or terminating a separate leafless shoot, or lateral in the axil of a leaf, sometimes partially enclosed by the overlapping margins of the bases of the leaf lamina and the uppermost 1–3 sheathing leaf bases (*Paracostus*); inflorescence ellipsoid to ovoid or globose when terminating a leafy shoot, loosely arranged when axillary; bracts spirally arranged, each carrying 1 or 2 flowers, yellow, green, red or brownish, membranous, chartaceous or coriaceous, generally ovate to triangular or elliptic, imbricate, callus linear, nectariferous, absent or present; foliaceous appendages absent or present, generally coloured as the bracts, ascending, horizontally spreading, or reflexed, broadly ovate to narrowly triangular; each flower enclosed by 1 bracteole, generally coloured as the bracts, boat-shaped or tubular and 1-keeled or sometimes 2-keeled, callus absent or 1 or 2 calli present. *Flowers* epigynous, bisexual, zygomorphic; calyx generally coloured as the bracts, tubular, 3-lobed or rarely 2-lobed, lobes erect, horizontally spreading, or reflexed, callus absent or present; corolla white, yellow, orange, pink, lilac or reddish brown, or a combination of these colours, tubular, 3-lobed, lobes erect, narrowly obovate to elliptic, rarely hyaline;

labellum large, longer than or as long as the corolla, white, yellow, orange, pink, lilac, dark red, reddish brown, purple, or a combination of these colours, sometimes with darker lateral parts and/or striped upper margin and central yellow nectar guide, horizontally flattened, funnel-shaped or rarely tubular, narrowly elliptic, ovate, obovate or subcylindrical when spread out, rarely lateral margins curved upwards (*C. giganteus*), margin undulate to crenate, sometimes fimbriate; stamen 1, petaloid, generally yellow or white, apex recurved or erect and cucullate (*C. giganteus*), anther longitudinally centred, composed of 2 narrowly elliptic 2-sporangiate thecae; base of stamen and labellum joined into a tube; gynoecium composed of a single ovary with attached style and stigma; ovary inferior, 3-locular, placentation axile, ovules many, organized in 2 rows per locule, anatropous; septal nectaries 2 at the apex of the ovary secreting nectar into the base of the floral tube; style 1, filamentous, supported between the thecae of the anther; stigma 1, 2-lamellate, hooked between the apices of the thecae by a dorsal 2-lobed to rounded appendage. In *Paracostus englerianus* the stigma is composed of a funnel-shaped upper part and a reflexed lamellate part, and the appendage is absent. *Fruit* capsular, 3-locular, placentation axile, generally obovoid, crowned by the persistent calyx, dehiscent loculicidally by three longitudinal slits, or indehiscent and irregularly breaking when old. *Seeds* numerous, black, shiny, irregularly angular reflecting tight packing in fruit; aril white, lacerate.

KEY TO THE AFRICAN GENERA OF COSTACEAE

- 1. Plants erect, leaves generally more than two, occasionally in a basal rosette; inflorescence many-flowered, bracts conspicuous and often brightly coloured *Costus*
- 1. Plants prostrate, leaves solitary, never in a basal rosette; inflorescence few-flowered, bracts inconspicuous and not brightly coloured *Paracostus*

Costus

Costus L. (1753) 2. — Type: *Costus arabicus* L.

Perennial, rhizomatous herbs, terrestrial or epiphytic, rarely gigantic, tall, low or shootless herbs; shoot erect, unbranched, generally forming a spiral, composed entirely of sheathing leaf bases forming conspicuous nodes and internodes. *Leaves* few or many, spirally arranged along the shoot; shootless species with few leaves rosulate; leaf sheaths closed around the shoot; ligule present or rarely absent, membranous to chartaceous, tubular at the base and truncate to 2-lobed at the apex, surrounding the shoot above the proximal lobe as a continuation of the sheathing leaf base; petiole present or sometimes absent; lamina generally green, sometimes shiny, or plicate, herbaceous to coriaceous, generally elliptic with acuminate apex and acute base, upper side and lower side with various indument. *Inflorescence* a many-, several- or few-flowered spike, either terminating the leafy shoot, or terminating a separate leafless shoot, or lateral in the axil of a leaf, ellipsoid to ovoid or globose; bracts spirally arranged, each carrying 1 or 2 flowers, green, red or brownish, membranous, chartaceous or coriaceous, generally ovate to triangular or elliptic, imbricate, callus linear, nectariferous, absent or present; foliaceous appendages absent or present, generally coloured as the bracts, ascending, horizontally spreading or reflexed, broadly ovate to narrowly triangular; each flower enclosed by 1 bracteole, generally coloured as the bracts, boat-shaped or tubular and 1-keeled or sometimes 2-keeled, callus absent or 1 or 2 calli present. *Flowers* epigynous, perfect, zygomorphic; calyx generally coloured as the bracts, tubular at the base, 2(–3)-lobed, lobes erect, horizontally spreading, or reflexed, callus absent or present;

corolla white, yellow, orange, pink, lilac or reddish brown, or a combination of these colours, tubular, 3-lobed, lobes erect, narrowly obovate to elliptic, rarely hyaline; labellum large, longer than or as long as the corolla, white, yellow, orange, pink, lilac, dark red, reddish brown, purple, or a combination of these colours, sometimes with darker lateral parts and/or striped margin and central yellow nectar guide, horizontally flattened, funnel-shaped, or rarely tubular, obovate to subcylindrical when spread out, margin undulate to crenate, sometimes fimbriate; stamen 1, petaloid, generally yellow or white, apex recurved, anther longitudinally placed in the middle, composed of two narrowly elliptic 2-sporangiate thecae; base of stamen and labellum joined into a tube; gynoecium composed of a single ovary, style and stigma; ovary inferior, 3-locular, placentation axile, ovules many, organized in 2 rows, anatropous, septal nectaries 2 at the base of the floral tube; style 1, terminal, cylindrical, filamentous, held between the thecae of the anther; stigma 1, 2-lamellate, hooked between the apices of the thecae by a dorsal 2-lobed to rounded appendage. *Fruit* capsular, 3-locular, generally obovoid, crowned by the persistent calyx, dehiscent loculicidally by three longitudinal slits or indehiscent and irregularly breaking when old. *Seeds* numerous, black, shiny, irregularly angular; aril white, lacerate.

Distribution — Tropical to subtropical sub-Saharan Africa.

Habitat & Ecology — Along with *Marantaceae* and *Zingiberaceae*, *Costaceae* form a significant part of the understory of the African tropical and subtropical rainforests. All three families form part of important herbaceous communities along forest margins, in forest gaps, and in the regrowth of disturbed forests (Dhetchuvi 1996).

KEY TO THE AFRICAN SPECIES OF COSTUS

- 1. Herbs acaulescent 2
- 1. Herbs with shoots 0.5–6 m tall 3
- 2. Calyx 35–75 mm long; anthers (6–)7–12(–15) mm long. 19. *C. macranthus*
- 2. Calyx 15–30 mm long; anthers 4–7(–12) mm long. 22. *C. spectabilis*
- 3. Epiphytic plants with inflorescences lateral in the axil of a leaf, or terminating a leafy or leafless shoot 4
- 3. Terrestrial plants with inflorescences terminating a leafy or leafless shoot 6
- 4. Bracts 1-flowered; flowers yellow or pale lilac with yellow nectar guide 5
- 4. Bracts 2-flowered; flowers white to dark pink with yellow nectar guide 23. *C. talbotii*
- 5. Flowers completely yellow 12. *C. lateriflorus*
- 5. Flowers pale lilac with yellow nectar guide 14. *C. lilaceus*
- 6. Inflorescence generally terminating a separate leafless shoot, emerging directly from the rhizome 7
- 6. Inflorescence generally terminating a leafy shoot 18
- 7. All bracts provided with appendages (Fig. 1e). 8
- 7. Bracts generally without appendages (often the lowermost bracts appendaged but all the other ones not) 11
- 8. Flowers white with yellow nectar guide 9
- 8. Flowers differently coloured 10
- 9. Ligule 1–2 mm long; petiole 1–3 mm long; flowers 2 per bract, appendages ascending; inflorescence globose (6–8 by 6–8 cm) on a separate leafless shoot 10–30 cm long. 1. *C. acutissimus*
- 9. Ligule 10–30 mm long; petiole 5–10 mm long; flower 1 per bract, appendages horizontally spreading; inflorescence ovoid (4–12 by 3–8 cm) on a separate leafless shoot 10–50 cm long 3. *C. albiflos*

- 10. Flowers with white to purplish grey or reddish brown labellum; plant glabrous; bracts green; bracteole with an inconspicuous callus; leaf sheaths green with reddish margin; apex of leaves acuminate (acumen 15–40 mm long) 18. *C. maboumiensis*
- 10. Flowers with white labellum with pink to purple margin; upper and lower side of leaves densely covered with soft erect hairs to c. 3 mm long; bracts dark brown-red; bracteole with a distinct callus; leaf sheaths dark red; apex of leaves acute to acuminate (acumen c. 10 mm long) 13. *C. ligularis*
- 11. Bracts green 12
- 11. Bracts red to brown 15
- 12. Sheaths, ligule, petiole and leaves glabrous 13
- 12. Sheaths, ligule, petiole and leaves very densely covered with brown hairs 0.5–2 mm long 14
- 13. Flowers white to purplish grey or reddish brown 18. *C. maboumiensis*
- 13. Flowers white with yellow nectar guide 6. *C. dubius*
- 14. Corolla lobes salmon-coloured; labellum white with 2 dark pink patches at the base and a yellow nectar guide, horizontally flattened 20. *C. nimba*
- 14. Corolla lobes whitish; labellum white to pale pink with yellow nectar guide, funnel-shaped 5. *C. dinklagei*
- 15. Bracts brown to reddish brown, 1- or 2-flowered; labellum not tubular; separate leafless shoot 1–9 cm long 16
- 15. Bracts red, 1-flowered; labellum tubular; separate leafless shoot 100–150 cm long 9. *C. giganteus*
- 16. Bracts 2-flowered; flowers white to dark pink with yellow nectar guide 17
- 16. Bracts 1-flowered; flowers completely yellow 11. *C. kupensis*
- 17. Labellum white to dark pink with yellow nectar guide; ligule 40–55 mm long; leaves not bullate nor plicate, base obtuse to acute 23. *C. talbotii*
- 17. Labellum dark pink to white with yellow nectar guide; ligule 1–5 mm long; leaves bullate and 5–10-plicate, base cordate 24. *C. tappenbeckianus*
- 18. All bracts provided with appendages 19
- 18. Bracts generally without appendages (often the lowermost bracts appendaged but all the other ones not) 23
- 19. Flowers completely yellow 20
- 19. Flowers differently coloured 21
- 20. Ligule 1–5 mm long; appendages of bracts green, ascending; flowers not aromatic 4. *C. aureus*
- 20. Ligule 5–35 mm long; appendages of bracts pinkish red to purplish brown, strongly reflexed; flowers strongly aromatic 8. *C. gabonensis*
- 21. Bracts soon falling apart into separate fibers (Fig. 4c), leaves obovate, 4, c. 20-plicate; petiole 0–3 mm long 7. *C. fenestralis*
- 21. Bracts not falling apart into separate fibers, leaves not obovate, not plicate, generally more than 4; petiole 3–15 mm long 22
- 22. Bracts apically dark brown-red; labellum white with pink to purple, without nectar guide; callus on bracteole distinct, 1.5–2 mm long; inflorescence few- to several-flowered, 1–4 by 1–4 cm; upper side of leaves covered with soft erect hairs to c. 3 mm long 13. *C. ligularis*
- 22. Bracts green to reddish purple; labellum pink to dark pink or white, with yellow nectar guide; callus on bracteole present, 2–3.5 mm long (Fig. 1e); inflorescence many-flowered, 2.5–10 by 3–7 cm; upper side of leaves generally glabrous 21. *C. phyllocephalus*

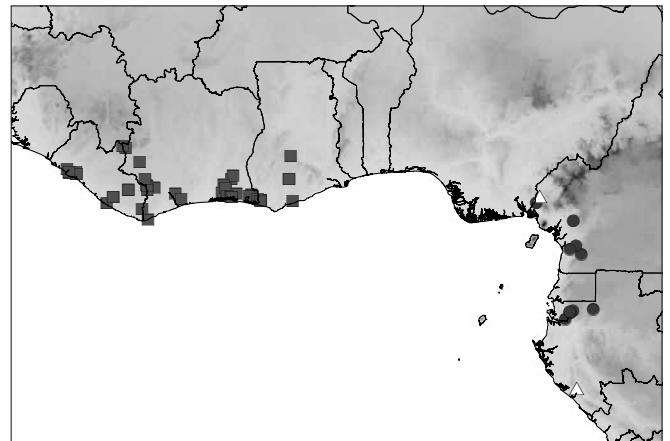
- 23. Bracts red to reddish brown 24
- 23. Bracts completely green 26
- 24. Labellum horizontally flattened, either completely yellow or dark pink; leaf sheaths 6–11 mm diam; calyx 11–20 mm long 25
- 24. Labellum tubular; flowers red or yellow to orange; leaf sheaths 2–6 mm diam; calyx 7–10 mm long 10. *C. gracillimus*
- 25. Herbs 1.5–2.5 m tall; leaves distinctly shiny, glabrous; calyx 17–20 mm long; flowers white and pink . . . 16. *C. louisii*
- 25. Herbs to 0.6 m tall; leaves not shiny, densely covered with erect to half-appressed hairs 1.5–2 mm long on both sides; calyx 11–12 mm long; flowers completely yellow 15. *C. loangensis*
- 26. Corolla lobes not hyaline, white; labellum white with yellow and pink or red; ligule 1–11 mm long, with distinct rim around its base 27
- 26. Corolla lobes hyaline, salmon-coloured; labellum white with salmon and 2 dark pink zones at the base; ligule 14–23 mm long without a distinct rim 20. *C. nimba*
- 27. Flowers white with yellow and pink; calyx in fruit about as long as the bracts, lobes erect; ligule 4–11 mm long, generally with a glabrous incomplete rim around its base; leaves glabrous 2. *C. afer*
- 27. Flowers white with yellow, orange and dark red; calyx in fruit exceeding the bracts, lobes horizontally spreading to reflexed; ligule 1–4 mm long, with a complete hairy rim around its base; lower side of leaves often silvery (covered with mainly erect hairs to c. 2 mm long) 17. *C. lucanusianus*

1. *Costus acutissimus* Maas & H.Maas, sp. nov. — Fig. 3; Map 2

Costus acutissimus is characterized by narrow leaves with a long-acute apex (hence the specific name), a very short ligule (1–2 mm long), a globose inflorescence (6–8 cm diam) terminating a separate flowering shoot, green appendaged bracts and white flowers with yellow nectar guide. — Type: *Van Valkenburg et al.* 2768 (holo WAG 3 sheets [WAG0120332, WAG0120333, WAG0120334]; iso BR, LBV [LBV0003152, LBV0003153], MO, P), Gabon, Nyanga, Moukalaba, Doudou National Park, Chantier SFN-Bakker, 250 m, 16 Feb. 2004.

Terrestrial herb to c. 3 m tall. *Leaves* many; sheaths 0.5–2 cm diam, falling apart into separate fibers with age and leaving a distinct horizontal rim at the nodes near the base of the shoot; ligule chartaceous, 2-lobed, 1–2 mm long; petiole 1–3 mm long; sheaths, ligule and petiole glabrous to sparsely covered with minute appressed hairs < 1 mm long and upper margin of ligule and sheaths with irregular curly fibers to c. 10 mm long; lamina narrowly elliptic, 17–30 by 3.5–7 cm, glabrous on both sides, base obtuse to cordate, apex long-acute to sometimes acuminate (acumen to c. 20 mm long). *Inflorescence* many-flowered, globose, 6–8 by 6–8 cm, terminating a separate leafless shoot 10–30 cm long; bracts, appendages of bracts, bracteoles, calyx, ovary and capsule sparsely covered with appressed hairs < 1 mm long to glabrous; margin of bracts and calyx lobes densely covered with irregular curly fibers c. 1 mm long. *Flowers* 2 per bract; bracts pale green, chartaceous, broadly ovate-triangular, 2–4 by 2–3 cm, callus absent; appendages green, ascending, broadly ovate-triangular, 1–2 by 1–2 cm; bracteole boat-shaped, 20–25 mm long, callus absent; calyx 25–28 mm long, sometimes split to the base on one side, lobes narrowly triangular, 5–7 mm long, callus absent; corolla white (not seen); labellum white, inner side with yellow nectar guide (not seen); stamen yellow (not seen). *Capsule* ellipsoid to obovoid, 10–17 by 7–10 mm. *Seeds* c. 1.5 by 1–1.5 mm.

Distribution — Central Africa (Cameroon, Gabon).



Map 2 Distribution of *Costus acutissimus* Maas & H.Maas (▲), *C. albiflos* Maas & H.Maas (●) and *C. aureus* Maas & H.Maas (■).

Habitat & Ecology — In moist valley bottom and on steep hill side. At elevations of 250–500 m. Flowering and fruiting: February, May.

IUCN Conservation Status — Based on an AOO of only 8 km² in two quite disjunct locations that both are part of National Parks, we assess this species as Vulnerable (VU): D2.

Other specimen examined. CAMEROON, **South-West Province**, S of Esukutang, 300–500 m, 25 May 1988, *Thomas et al.* 7938 (MO).

Note — Young shoots of *C. acutissimus* often show swollen nodes and small bulbils in the upper part of the shoot (Fig. 3b). Old shoots have distinct horizontal rims of c. 1 mm high, presumably remnants of withered sheaths (Fig. 3a).

2. *Costus afer* Ker Gawl. — Plate 1a; Map 3

Costus afer Ker Gawl. (1823) t. 683; K.Schum. (1904) 392. — Type: *A specimen from cultivated material in the greenhouses of the Horticultural Society at London (Chelsea) from material collected in Sierra Leone by G. Don* (holo CGE).

Costus sarmentosus Bojer (1835) 262, t. 8; K.Schum. (1904) 394, syn. nov. — Type (lectotype selected by Lock (1985: 7): *Bojer (1835) plate 8*, drawn from a plant from Zanzibar.

Costus trachyphyllus K.Schum. (1892) 420; (1904) 409, syn. nov. — Type: *Schweinfurth ser. III, n. 206* (lecto K, selected by Lock (1984) 842), Congo Kinshasa, Orientale, Mbrwole River ('bei Mruole am Nabambisso'), 1 Mar. 1870.

Costus edulis De Wild. & T.Durand in Durand & De Wildeman (1899) 141. — Type: *Dewèvre 916a* (holo BR), Congo Kinshasa, Nyangwe, Mossungulore, anno 1896.

Costus oblitterans K.Schum. (1904) 393, syn. nov. — Syntypes: *Unknown collector s.n.* (B destroyed), Ghana ('Goldcoast'), without location; *Millen s.n.* (B destroyed), Nigeria, Lagos.

Costus deistellii K.Schum. (1904) 393, syn. nov. — Type: *Deistel 498* (holo B destroyed), Cameroon, South-West Province, Buea, Feb. 1900.

Costus subbiflorus K.Schum. (1904) 394, syn. nov. — Type: *Volkens 50* (B destroyed; lecto BM, designated here), Tanzania, Lushoto Distr., 'Usambara, von Derema bis Magila ('Msassaberg)', häufig im Urwald z. B. bei Punga Ninga', 900 m, 21 Jan. 1893; other syntypes: *Engler 715* (B destroyed), Tanzania, 'Usambara', Amani, 800–900 m, Nov. 1902; *Buchwald 360* (B destroyed), Tanzania, 'Usambara', Mt Lutindi between Kwa Mburaka and Kisula, 19 Jan. 1896; *Liebusch 17* (B destroyed), Tanzania, 'Usambara', Tanga, Pamota, 800–1000 m, 15 Mar. 1900.

Costus pterometra K.Schum. (1904) 394, syn. nov. — Type: *Schweinfurth III-204* (holo B destroyed; lecto K 2 sheets, designated here), South Sudan, 'Ghasaquellengebiet, Land der Niamniam am Nabambisso', 20 Feb. 1870.

Costus anomocalyx K.Schum. (1904) 396, syn. nov. — Type: *Baumann 8* (holo B destroyed), Togo, 'Misahöhe, 496 m ü. M.', 15 Mar. 1894.

Costus megalobracteata K.Schum. (1904) 407, syn. nov. — Type: *Braun s.n., anno 1888* (holo B destroyed), Cameroon, South Province, Gross-Batanga.

Costus bingervillensis A.Chev. (1920) 627, syn. nov. — Type: *Chevalier 15214* (lecto P, designated here), Ivory Coast, Bingerville region, Abidjan, Dabou, 19 Mar. 1905; other syntypes: *Chevalier 17280* (LY, P p.p.), Ivory



Fig. 3 *Costus acutissimus* Maas & H.Maas. a. Habit showing distinct horizontal rims on base of shoot; b. bulbil in leaf axil; c. leaves with ligule; d. bract with 2 bracteoles and 2 calyces (a, b, d: Van Valkenburg et al. 2768, BR; c: Thomas et al. 7938, MO). — Drawing by Hendrik Rypkema.

Coast, Bingerville, 14–18 Dec. 1907; the specimen in P is a mixed collection of *C. afer* and *C. lucanusianus*; Chevalier 19883 (P), Ivory Coast, Tabou, banks of Bas-Cavally, between Prolo and Bliéron, 11 Aug. 1907. *Costus insularis* A.Chev. (1920) 627, nom. nud. Based on Chevalier 13058 (P), Guinea, Iles de Los, 25 Feb. 1905.

Terrestrial herb, erect but in fruit sometimes individual shoots bending down, 0.5–4(–5) m tall. *Leaves* many; sheaths 0.8–1(–1.5) cm diam; ligule chartaceous, 2-lobed to truncate, (2–)4–11 mm long, with a basal horizontal rim c. 1 mm high, not completely encircling the shoot, sometimes bearing erect hairs to c. 3 mm long; petiole 5–14 mm long; sheaths, ligule and petiole glabrous to densely covered with erect to half-appressed white hairs < 1 mm long; lamina narrowly elliptic to narrowly obovate, 7–25(–40) by (3–)4–10(–19) cm, upper side glabrous, lower side glabrous to rarely midrib densely covered with erect to half-appressed white hairs 1–2 mm long, margin often with a row of hairs < 1 mm long, base cordate to acute, apex acuminate (acumen 15–30 mm long). *Inflorescence* many-flowered, globose to ellipsoid, (2.5–)4–14(–20) by

2.5–6(–8) cm, terminating the leafy shoot or rarely terminating a separate leafless shoot 10–30 cm long; bracts, appendages of bracts, bracteoles and calyx glabrous, sometimes sparsely to rather densely covered with erect hairs < 1 mm long, upper part of capsule densely covered with erect hairs < 1 mm long. *Flowers* (1 or) 2 per bract; bracts (pale) green often with reddish upper margin, coriaceous, ovate-triangular to depressed ovate-triangular, 2–3 by 2–2.5 cm, callus 2–3 mm long; appendages rarely present, green, horizontally spreading to reflexed, narrowly triangular, 4–10 by 2.5–3 cm; bracteole boat-shaped, 14–25 mm long, callus 1–4 mm long; calyx 12–19(–22) mm long, lobes broadly ovate-triangular, (2–)4–5 mm long, erect and sometimes exceeding the bracts in fruit, callus 1–2 mm long; corolla white to yellowish, 30–45 mm long, glabrous, tube 5–10 mm long, lobes (narrowly) elliptic, 20–40 mm long; labellum at the outer side white, inner side white with (pale to dark) pink lateral marginal parts and yellow nectar guide, sometimes completely white with or without yellow nectar guide, funnel-shaped, broadly obovate when spread out, 30–45 by

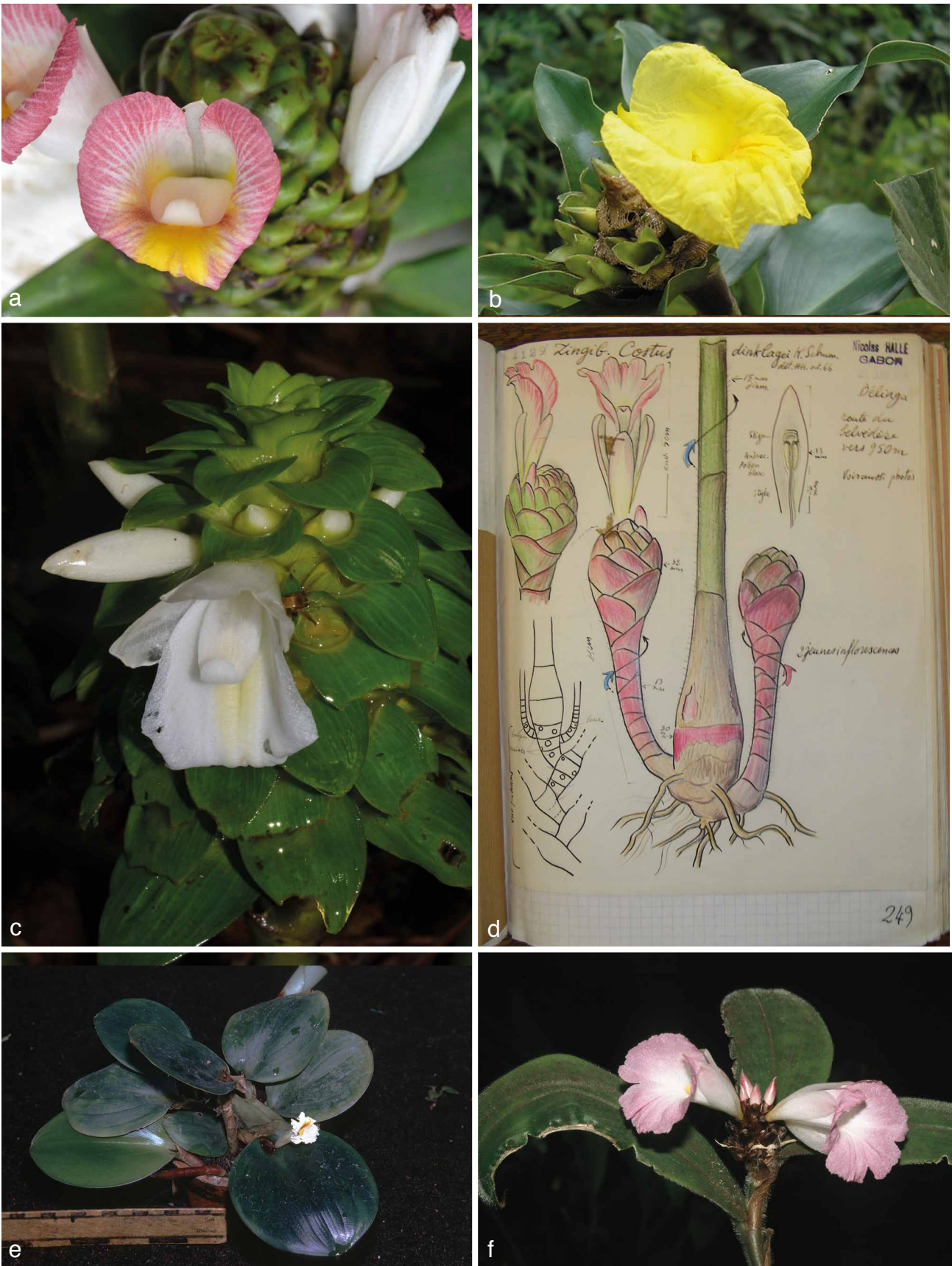
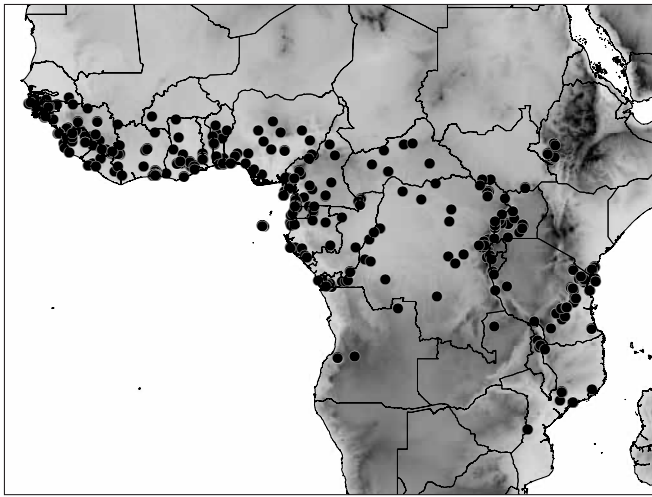


Plate 1 a. *Costus afer* Ker Gawler. Flower. – b. *Costus aureus* Maas & H.Maas. Inflorescence. – c. *Costus albiflos* Maas & H.Maas. Inflorescence. – d. *Costus dinklagei* K.Schum. Habit and details. – e. *Paracostus englerianus* (K.Schum) C.D.Specht. Habit with flower. – f. *Costus ligularis* Baker. Inflorescence (a: Maas et al. 10023; b: photographed in Ghana, no specimen collected; c: Maas et al. 10411; d: N. Hallé 4129, drawing in his collecting book; e: photographed in Botanical gardens Utrecht, no specimen collected; f: Maas et al. 9794). — Photos: a, c, f: P.J.M.Maas; b: T.R.van Anandel; d: C.D.Specht; e: L.Y.T.Westra.



Map 3 Distribution of *Costus afer* Ker Gawl.

35–50 mm, margin crenulate; stamen white, 25–40 by 10 mm, apex white, anther 6–9 mm long. *Capsule* broadly obovoid, to 15(–20) mm diam. *Seeds* 1–2 mm diam.

Distribution — North East Africa (Ethiopia, South Sudan); West Africa (Benin, Burkina Faso, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Liberia, Nigeria, Senegal, Sierra Leone, Togo); Central Africa (Burundi, Cameroon, Central African Republic, Congo Brazzaville, Congo Kinshasa, Equatorial Guinea, Gabon, São Tomé & Príncipe); East Africa (Kenya, Tanzania, Uganda); Southern Tropical Africa (Angola, Malawi, Mozambique, Zambia, Zimbabwe).

Habitat & Ecology — In open places like roadsides and forest margins, in secondary or savanna forest, often on wet places, near rivers; on sandy soil and on rocky outcrops, at elevations of 0–1770 m. Flowering and fruiting: all year through.

IUCN Conservation Status — Least Concern.

Notes — *Costus afer* is characterized by an incomplete horizontal rim around the nodes of the shoot which is covered with only some erect hairs to c. 3 mm long, a 4–11 mm long ligule and erect calyx lobes that are sometimes exceeding the bracts in fruit. The corolla is white, the labellum is white with yellow nectar guide and reddish margins and the stamen is white with reddish apical part.

Costus afer has often been confused with *C. dubius*, both species sharing green, unappendaged bracts and more or less white flowers, but *C. afer* is generally characterized by inflorescences terminating leafy shoots and flowers with a white labellum that has a yellow nectar guide and pink margins, while *C. dubius* generally has inflorescences on short, separate leafless shoots near the base of the plant and white flowers with a labellum bearing a yellow nectar guide but lacking pink margins. The bracts of *C. afer* are 1- or 2-flowered and sometimes appendaged, those of *C. dubius* are always 1-flowered and generally not appendaged.

For the differences with *C. lucanusianus*, a species with which it has been sometimes confused, see under that species.

For the differences with the similar looking *C. louisii*, see under that species.

The inflorescence of *C. afer* can terminate a leafy or leafless shoot as is known in many species of *Costus*; moreover, plants with 1- and/or 2-flowered bracts can be found all over the distribution area (Maas et al. 10023).

The flower colour of *C. afer* is often (incorrectly) described on the collection label as 'white'. This was the case in about 1/4 of the dried specimens included in this study. Indeed the corolla

and the outer side of the labellum are white, but the inner side of the labellum is not completely white, but always has more or less reddish margins and a yellow nectar guide. The apical part of the stamen is white to pink.

3. *Costus albiflos* Maas & H.Maas, *sp. nov.* — Plate 1c; Map 2

Costus albiflos is very easily recognizable by its leafless flowering shoot, green appendaged bracts and completely white flowers (with only a slightly yellow nectar guide). Its petiole, ligule and sheaths are covered with appressed, 0.5–1 mm long hairs with a thickened base creating a 'rough' feeling. — Type: Maas et al. 10411 (holo WAG 2 sheets [WAG0380170, WAG0380171]; iso BR, K, L [L.2079937], LBV, MO, P, UC), Gabon, Estuaire, side road at km 46 of road from Kougouleu to Méla, on the border of Parc National Monts de Cristal, 15 m, 21 Nov. 2011.

Terrestrial herb 1–3 m tall. *Leaves* many; sheaths 1–1.5 cm diam; ligule chartaceous, 2-lobed, 10–30 mm long; petiole 5–10 mm long; sheaths, ligule and petiole rather densely covered with appressed hairs < 1 mm long; lamina pale green below, narrowly elliptic to narrowly obovate, 20–40 by 5–8 cm, slightly 6–10-plicate, upper side glabrous or sparsely covered with appressed hairs < 1 mm long, lower side sparsely covered with appressed hairs < 1 mm long to glabrous, midrib rather densely so and hairs longer, base acute, apex acuminate (acumen 15–20 mm long). *Inflorescence* many-flowered, ovoid, 4–12 by 3–8 cm, terminating a separate leafless shoot 10–50 cm long; bracts, appendages of bracts, bracteoles and calyx sparsely covered with appressed hairs < 1 mm long, ovary and capsule glabrous. *Flowers* 1 per bract; bracts green, coriaceous, broadly ovate, 1.5–2 by 1–2.5 cm, callus absent; appendages green, horizontally spreading, broadly ovate-triangular to ovate-triangular, 1–3.5 by 1–2.5 cm; bracteole boat-shaped, 18–20(–25) mm long, with 1 or 2 calli 1–1.5 mm long; calyx 9–14 mm long, lobes ovate-triangular, 2–4 mm long, callus absent; corolla white, 50–55 mm long, glabrous, tube c. 15 mm long, lobes narrowly ovate, 35–40 mm long; labellum white, inner side sometimes with a pale yellow nectar guide, horizontally flattened, broadly obovate when spread out, 30–35 by 30 mm; stamen white, 30–40 by 10 mm, anther 5–6(–9) mm long. *Capsule* ellipsoid, 10–15 by 6–8 mm. *Seeds* 1–2 by 1–2 mm.

Distribution — Central Africa (Cameroon, Gabon).

Habitat & Ecology — In lowland rainforest, often near streams, at elevations of 0–700 m. Flowering and fruiting: February, April and May.

IUCN Conservation Status — Based on an AOO of 40 km² from seven locations of which only one is part of a National Park, while most others face several logging threats, we assess this species as Vulnerable (VU): B2ab(ii,iii,iv).

Other specimens examined. CAMEROON, **South Province**, Collines BOG, 5 km W of Atogboga (25 km NNE of Bipindi), 30 Jan. 1974, Letouzey 12829 (P); Colline Nkol Tsia, 18 km NW of Bipindi, near Gouap, 488 m, 5 Feb. 1974, Letouzey 12913 (P); Nyangong, transect 8, 700 m, 12 Dec. 1996, Van Gernerden 101 (WAG). **South-West Province**, Ndian, Ekundu Kundu, 200 m, 26 Apr. 1996, Cheek et al. 8204 (K, WAG). — GABON, **Estuaire**, Crystal Mountains, 3 km along track Alen Nkomo-Andok Foula, 30 m, 21 Nov. 1986, J.J.F.E. de Wilde et al. 8895 (LBV, MO, WAG); Parc National de Monts de Cristal, road L108 from Kinguélé to Tchimbélé, past Kinguélé, c. 300 m, 24 Oct. 2011, Maas et al. 9968 (LBV, WAG). **Woleu-Ntem**, Chantier Oveng, c. 500 m, 7 May 1986, A.M. Louis 2185 (LBV, WAG); Crystal Mountains, 1 km S of Tchimbélé, 450 m, 14 Nov. 2004, Wieringa et al. 5423 (WAG).

4. *Costus aureus* Maas & H.Maas, *sp. nov.* — Plate 1b; Map 2

Costus aureus is characterized by flowers that are completely yellow and arranged in an inflorescence terminating a leafy shoot and composed of green and generally appendaged bracts. Vegetatively it looks very similar to *C. lucanusianus* by having a rim at the base of the ligule. However, this rim is hairless in *C. aureus*, while it is distinctly hairy in *C. lucanusianus*. — Type: Berg 186 (holo U 4 sheets [U0123675, U0123676, U0123677, U0123678]; iso B, MO, NY), Ivory Coast, near Akoupé (NW of Abidjan), 31 July 1972.

Costus luteus A.Chev. (1920) 628, nom. illeg. non Blanco (1837) 4. — Type: *Chevalier 17125* (lecto P, designated here), Ivory Coast, 'Vallée de l'Agniéby à Guébo', 31 Jan. 1907; other syntype: *Chevalier 17454* (LY, P), Ivory Coast, Attié, near Alépé, 26–28 Feb. to 1–3 Mar. 1907.

Terrestrial herb 0.5–3 m tall. *Leaves* many; sheaths 0.5–3 cm diam; ligule chartaceous, truncate, 1–5(–8) mm long, with a prominent glabrous rim at its base; petiole 5–18 mm long; sheaths, ligule and petiole sparsely to rather densely covered with erect to appressed hairs < 1 mm long; lamina shiny on both sides, lower side dull greyish green, narrowly elliptic, rarely narrowly obovate, 15–30 by 4–8 cm, slightly plicate, margins often somewhat undulate, upper side sparsely covered with appressed hairs < 1 mm long (mainly along midrib) to glabrous above, lower side sparsely to rarely rather densely covered with appressed hairs < 1 mm long, base acute, the very base sometimes somewhat rounded, apex acuminate (acumen 5–20 mm long), sometimes acute. *Inflorescence* many-flowered, very broadly to depressed ovoid to subglobose, 3.5–7 by 4–8 cm, terminating the leafy shoot; bracts, appendages of bracts, bracteoles, calyx, ovary and capsule sparsely to rather densely covered with erect hairs < 1 mm long to glabrous. *Flowers* 2 per bract; bracts green, coriaceous, broadly ovate, 1.5–2.5 by 1–2.5 cm, sometimes falling apart into separate fibers with age, callus absent; appendages mostly present, green, ascending, broadly ovate-triangular, 1–1.5 by 1–2 cm; bracteole boat-shaped, 15–20 mm long, callus 2–3 mm long; calyx 15–25 mm long, in fruit exceeding the bracts, lobes triangular, 2–7 mm long, callus absent; corolla yellow, 30–40 mm long, glabrous, tube c. 10 mm long, lobes narrowly elliptic, 20–30 mm long; labellum yellow, inner side with darker yellow nectar guide, horizontally flattened, broadly obovate when spread out, 40–45 by 35–40 mm; stamen yellow, c. 25 by 8 mm, apex darker yellow, anther 7–8 mm long. *Capsule* ellipsoid, 10–12 by 4–6 mm. *Seeds* 1.5–2 by 1–1.5 mm.

Distribution — West Africa (Ghana, Ivory Coast, Liberia).

Habitat & Ecology — In primary or secondary rainforest, often in wet places, on clay to sandy soil, at elevations of 0–600 m. Flowering and fruiting: all year through.

IUCN Conservation Status — Least Concern.

Selected specimens examined. GHANA, **Ashanti Region**, Distr. Sefwi Wiawso, Anhwiaso Forest Reserve, 1 Sept. 1984, *Andoh FH 5241* (K); 10 miles S of Mampong, 8 Dec. 1953, *Morton GC 9675* (K); Fumso, 24 Mar. 1950, *Obeng-Darko 545* (K). **Central Region**, Wassa Atobiase, road to Rock Shrine, 70 m, 21 July 2010, *Van Andel 5769* (GC, WAG). **Western Region**, Elubo, 22 km ESE towards Takoradi, 80 m, 14 July 1995, *Harder 3435* (K, MO); Ankasa Game Reserve near entrance, 100 m, 28 Feb. 1995, *Jongkind 2072* (MO, WAG); Ankasa River Forest Reserve, along dirt road to centre of reserve, 60 m, 30 July 2010, *Van Andel 5865* (GC, L, U, WAG). — IVORY COAST, Banco Forest Reserve, 25 July 1975, *W.J. van der Burg 673* (BR, FR, MO, UCJ, WAG); Vallée de l'Agneby à Guébo, 31 Jan. 1907, *Chevalier 17125* (P); pays de l'Attié, Alepe, 25 Feb. 1903, *Chevalier 17454* (LY, P); Banco Forest Reserve, 11 Dec. 1972, *De Koning 887* (BR, E, MO, WAG); km 25–30 on new road Abidjan-Ndouci, 21 Aug. 1979, *De Kruif 305* (UCJ, WAG); Forêt de l'Angeledou, c. 15 km NW of Abidjan, 40 m, 3 Nov. 1958, *Leeuwenberg 1874* (BR, F, K, UC, WAG); Forêt l'Anguédodou near Adiopodoumé, 25 Dec. 1957, *H.C.D. de Wit 7850* (WAG). **Aboisso**, 2 km E of Maféré, near road to Afiéno, 50 m, 18 June 1975, *Beentje 447* (AMD, UCJ, WAG); 12 km SE of Aboisso, 25 July 1968, *Breteler 5297* (WAG). **Adzopé**, SOFALCO plantations, 2 km S of Adzopé, 100 m, 14 Dec. 1972, *Leeuwenberg 10716* (WAG); Aouabo, 16 May 1969, *Thijssen 21* (WAG). **Agboville**, Forêt de la Mambo, lisière Est de la forêt de Mambo, piste Albéric, 28 Jan. 1992, *Chatelain 962* (CSRS, WAG); Gare des Makaugnié, Chemin de fer km 75, 22 Jan. 1907, *Chevalier 16951* (P); Forêt d'Yapo, 9 Oct. 1957, *Farron s.n.* (G). **Danané**, Danipleu region, 27 Mar. 1982, *César 1716* (P); 20 km N of Danané, 18 Dec. 1967, *Geerling 1862* (WAG). **Guiglo**, route de Tabou, near Siéblo Oula, 29 Dec. 1985, *Aké Assi 17212* (G, MO); Forêt de Tai, near station, 21 Nov. 1982, *C.C. Berg 1460* (U); Tienkoulou, 4 Aug. 1962, *Jangoux 255* (BR). **Man**, F.C. Scio, Pinhou, Lobykro, 2 Sept. 2001, *Nusbaumer 693* (G). **Sassandra**, Along road from Dakpadou to Sago, N of Sassandra, 30 Mar. 1968, *Geerling 2352* (WAG); on border of River Niégré, c. 64 km N of Sassandra near village Baléko, 16 June 1963, *W.J.J.O. de Wilde 254* (WAG). **Tabou**, Tabou

campment, 4 Sept. 1975, *W.J. van der Burg 930* (WAG). — LIBERIA, **Grand Gedeh**, east slope of the Putu Hills East Range west of Tiama Town, 240 m, 25 May 2005, *Jongkind 6379* (WAG); Putu Hills, East ridge, 628 m, 29 Sept. 2013, *Jongkind 12192* (WAG). **Maryland**, Webo District, Nyaake, 24 June 1947, *Baldwin 6126 a!* (K). **Montserrado**, Firestone Plantation along Dukwai R., 170 m, 1 Nov. 1928, *G.P. Cooper 14* (BM, F, GH, K, NY, P, US); New University Site, 30 km from Monrovia, 27 Sept. 1963, *Harten 127* (WAG); Road Monrovia to Kakata, c. 13 miles from Monrovia, near Mount Barclay, 1 Feb. 1966, *Van Meer 349* (WAG). **Sino**, road from Greenville to African Fruit Company, 27 July 1977, *De Gier 13* (WAG); Sapo NP, buffer zone, around Safari Camp on short distance of Sinoe River, 115 m, 22 Nov. 2002, *Jongkind 5274* (BR, G, WAG); near Jalay's Town, 29 Jan. 2016, *Jongkind 12849* (BR).

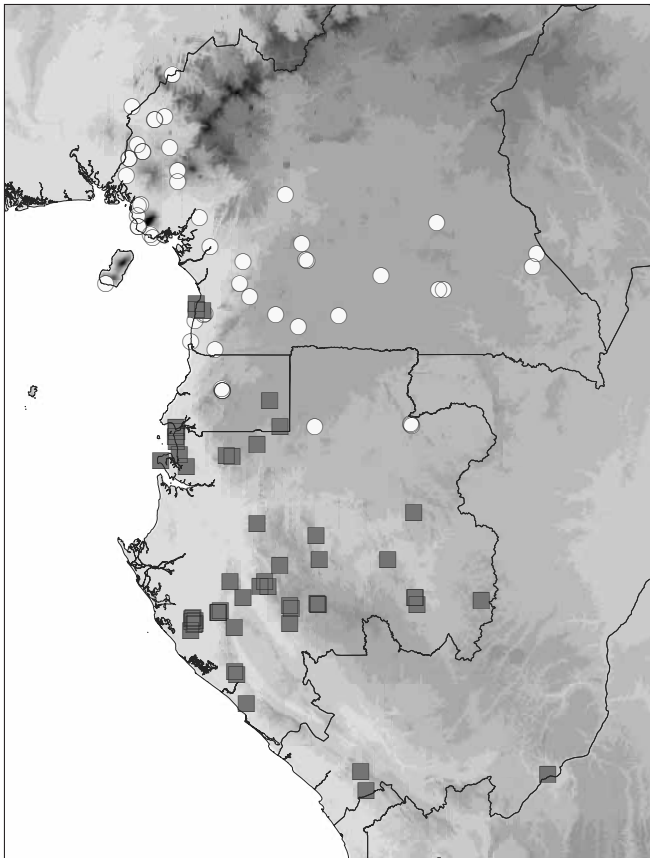
Note — *Costus luteus* A.Chev. has a doubtful status. The introduction of the work in which it was published (*Chevalier 1920*) states that new names in that work are only mentioned and will be described later, but it is clear that they are nevertheless accepted, so art. 36.1 of the ICBN (McNeill et al. 2012) does not apply. However, often the names of this work are also not considered as validly published because the descriptions it contains are not recognized as such. But *Chevalier* often copies his own field descriptions when citing the specimens, which we consider as validating descriptions. In the case of *C. luteus* the name, when considered validly published, is a later homonym of *C. luteus* Blanco (nowadays *Roscoea lutea* (Blanco) Hassk.), and cannot be used in any case. However, to circumvent any discussion about the validity of *Chevalier's* publication, we describe this species here independently as new and refrain from only using the nom. nov. construction. Because the name *C. luteus* had already been used, we name this yellow-flowered species *C. aureus*.

5. *Costus dinklagei* K.Schum. — Plate 1d; Map 4

Costus dinklagei K.Schum. (1904) 408. — Type: *Dinklage 987* (holo B destroyed), Cameroon, South Province, Gross-Batanga. As the holotype at Berlin was destroyed and no other original material has been located, we hereby select a neotype from a locality not far from the type locality: *Van Andel et al. 3549* (neo WAG 2 sheets [WAG0146035, WAG0380166]; isoneo KRIBI, SCA, U [U0064546], WAG-spirit [WAG0028342], YA), Cameroon, South Province, Mont d'Éléphant, road Bidou-Akom II, foot of the hill, 23 m, 10 June 2001.

Terrestrial herb 1–3 m tall. *Leaves* many; sheaths 0.5–2.5(–3) cm diam; ligule chartaceous, truncate, 10–20 mm long; petiole 3–10 mm long; sheaths, ligule and petiole hairy as the lower side of the leaves; lamina narrowly elliptic, sometimes narrowly obovate, 15–40 by 5–13 cm, upper side glabrous, lower side densely to sparsely covered with erect to appressed brown hairs 0.5–2 mm long, base acute, apex acuminate (acumen 15–40 mm long). *Inflorescence* many-flowered, ovoid to ellipsoid, 4–15 by 2.5–6 cm, terminating a separate leafless shoot 5–30 cm long, rarely terminating a leafy shoot; bracts, bracteoles, calyx, ovary and capsule densely covered with erect hairs < 1 mm long. *Flowers* 1 per bract; bracts green to dark green, sometimes reddish, coriaceous, broadly ovate-elliptic, 1.5–5.5 by 1–3.5 cm, callus 1–2 mm long; appendages absent; bracteole boat-shaped, 16–35 mm long, callus 3–4 mm long; calyx 12–20 mm long, lobes shallowly to broadly ovate-triangular, 2–6 mm long, callus 1–2 mm long; corolla hyaline, white to pale pinkish, 45–55 mm long, glabrous, tube 15–20 mm long, lobes narrowly elliptic, 30–40 mm long; labellum at the outer side white to (pale)pink, inner side white to pink with darker coloured margin and often pale yellow nectar guide, funnel-shaped, broadly obovate when spread out, 40–60 by 30–50 mm, margin crenate or undulate, fimbriate; stamen white, 20–35 by 10–13 mm, apex pink, anther 6–7 mm long. *Capsule* not seen. *Seeds* c. 2 by 1 mm.

Distribution — West Africa (Nigeria); Central Africa (Cameroon, Equatorial Guinea, Gabon).



Map 4 Distribution of *Costus dinklagei* K. Schum. (●) and *C. ligularis* Baker (■).

Habitat & Ecology — In rainforest, often near streams or in wet places, on clay soil, at elevations of 0–1100 m. Flowering and fruiting: from March to July and in December.

IUCN Conservation Status — Near Threatened.

Notes — *Costus dinklagei* can be recognized by its inflorescence terminating a separate leafless shoot with 1-flowered bracts and hyaline whitish erect corolla lobes. The labellum is white to pale pink with yellow nectar guide, basally funnel-shaped but with the upper part horizontally flattened. The lower side of the leaf lamina, the sheaths and the petioles are hairy. The apex of the stamen of *C. dinklagei* is narrowly triangular (Hallé 1967).

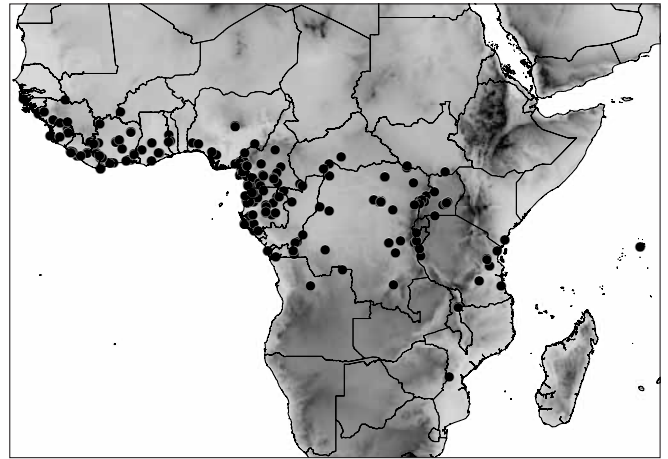
Costus dinklagei can be confused with *C. dubius* both having a basal inflorescence with green, unappendaged bracts, but *C. dinklagei* has hyaline, whitish corolla lobes and a white to pale pink labellum with yellow nectar guide and dark pink margin, whereas in *C. dubius* the white corolla lobes are not hyaline and the labellum is white with only a yellow nectar guide. Moreover, in *C. dinklagei* the lower side of the lamina, the petioles and the sheaths are distinctly hairy, while all vegetative parts are glabrous in *C. dubius*.

6. *Costus dubius* (Afzel.) K.Schum. — Plate 2a; Map 5

Costus dubius (Afzel.) K.Schum. (1904) 409. — *Zingiber dubium* Afzel. (1813) 9. — Type: A collection by Afzelius, Sierra Leone, without location. As no original material of Afzelius could be traced we here designate the following neotype from the same country: *Pyne 88* (neo K; isoneo P), Sierra Leone, Moyamba District, Kori Chiefdom, Gbonjema, ('Bonjema (Kori)'), 21 Dec. 1955.

Costus maculatus Roscoe (1825) 218, pl. 82; K.Schum. (1904) 408. — *Costus afer* var. *maculatus* (Roscoe) Baker (1898) 299, syn. nov. — Type: Roscoe's plate 82 (1825).

Costus littoralis K.Schum. (1904) 395. — Type: *Dinklage 1701* (holo B), Liberia, Grand Bassa, near Fishtown, 14 Aug. 1896.



Map 5 Distribution of *Costus dubius* (Afzel.) K. Schum.

Costus albus A.Chev. (1920) 627 (for the status of this name see the notes under *C. aureus*). — Type: *Chevalier 15217* (lecto P, designated here; isolecto LY), Ivory Coast, Bingerville region, Abidjan, Dabou, 19 Mar. 1905; other syntype: *Chevalier 17579* (P), Ivory Coast, lower Comoé River, Bettié, 15–17 Mar. 1907.

Terrestrial herb 0.5–3 m tall. *Leaves* many; sheaths 0.5–2 cm diam; ligule chartaceous, truncate to 2-lobed, (3–)5–20(–30) mm long; petiole (3–)10–20(–25) mm long; sheaths, ligule and petiole generally glabrous; lamina shiny above, more or less succulent, narrowly elliptic, 15–36 by (4–)6–12 cm, upper side glabrous, lower side glabrous, margin often with a row of hairs < 1 mm long, base acute, obtuse, or cordate, apex acuminate (acumen 10–30 mm long). *Inflorescence* many-flowered, ovoid to ellipsoid or narrowly so, 5–20(–30) by 3–6 cm, terminating a separate leafless shoot 5–40(–100) cm long, or rarely terminating the leafy shoot; bracts, appendages of bracts, bracteoles, calyx, ovary and capsule glabrous, except for some erect hairs < 1 mm long at the base of the calyx and apex of the ovary. *Flowers* 1 per bract, rarely 2; bracts green with reddish margins, sometimes becoming red in fruit, coriaceous, bulging, very broadly ovate, 1.5–3 by 2–3.5 cm, callus sometimes present and then to c. 2 mm long; appendages generally absent; bracteole boat-shaped, 20–25 mm long, callus 2–3 mm long; calyx 12–18 mm long, lobes broadly ovate-triangular to deltate, 3–5 mm long, callus very inconspicuous; corolla white to cream, 25–55 mm long, glabrous, tube 12–15 mm long, lobes narrowly elliptic, 25–40 mm long; labellum white, inner side with central yellow nectar guide, funnel-shaped, broadly obovate when spread out, 35–40 by 30 mm, margin crenate; stamen white, 25–30 by 8–9 mm, anther 6–8 mm long. *Capsule* ellipsoid to obovoid, 10–15 by 6–12 mm. *Seeds* 2–2.5 by 1.5 mm.

Distribution — North East Africa (South Sudan); West Africa (Burkina Faso, Ghana, Guinea, Ivory Coast, Liberia, Nigeria, Senegal, Sierra Leone, Togo); Central Africa (Burundi, Cameroon, Central African Republic, Congo Brazzaville, Congo Kinshasa, Equatorial Guinea, Gabon); East Africa (Kenya, Tanzania, Uganda); Southern Tropical Africa (Angola, Malawi, Mozambique).

Habitat & Ecology — In primary rainforest, savanna forest, coastal forest, secondary forest, or swamp forest, in shady places, also along roads and rivers and in plantations, on clayish soil at elevations of 0–1400 m. Flowering and fruiting: all year through.

Field observations — *Costus dubius* plants are the only cultivated species of *Costus* often setting seed in greenhouses. Their seedlings germinate easily and tend to take over other pots with different species of *Costus* growing beside them.

IUCN Conservation Status — Least Concern.

Notes — *Costus dubius* can be recognized by its inflorescence generally near the base of the plant terminating a separate leafless shoot, inflorescence composed of 1-flowered green unappendaged bracts and flowers having a white labellum with a yellow nectar guide. The leaves of this species are glabrous and the shoot is often covered by reddish dots.

For the differences between *C. dubius* and *C. afer* see under *C. afer*.

For the differences between *C. dubius* and *C. dinklagei*, see under *C. dinklagei*.

Of the two syntypes of *C. trachyphyllus* (now in the synonymy of *C. afer*) Schweinfurth 3268 (B destroyed, K), from South Sudan, Western Ecuatoria, 'am Turu bei Uando's Dorf', 10 Mar. 1870, probably belongs to *C. dubius*, because of its white flowers mentioned on the label ('fl. albo').

As in many species of *Costus*, inflorescences are generally terminating a leafless shoot but can (rarely) terminate a leafy shoot. Plants with both types of inflorescences have both been included in the description.

Some specimens of *C. dubius* do have a very long ligule (1-lobed or obliquely truncate, acute, 25–30 mm long). These specimens are: *Breteler 1209* from Cameroon, *Ekwuno 12* from Nigeria and *Harris 3211* from Congo.

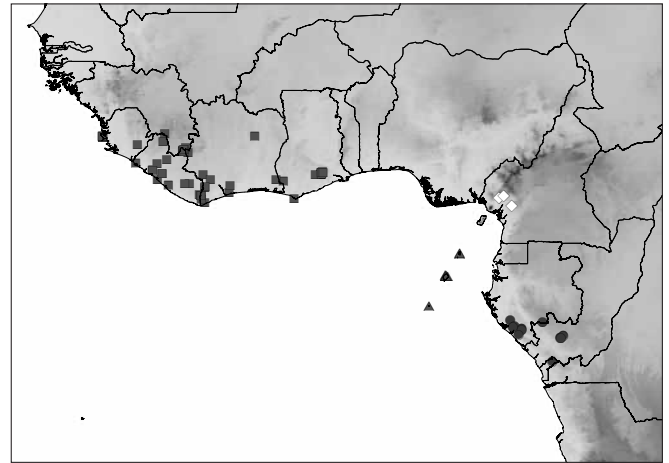
The collection by *Friedmann 3919* has been found East of the African continent on the Seychelles, on the island of Mahé. Because on the label is written: 'subsponané', we suppose this collection might not represent a natural distribution.

7. *Costus fenestralis* Maas & H.Maas, sp. nov. — Fig. 4; Map 6

Costus fenestralis can be recognized by a low number of obovate, densely hairy leaves concentrated at the top of the shoots and bracts soon falling apart into fibers. — Type: *Jongkind et al. 5811* (holo WAG 2 sheets [WAG0159192, WAG0159193]; iso BR, K, LBV [LBV0004878], MO, UC, WAG-spirit [WAG0115124]), Gabon, Nyanga, Doudou Mountains, Chantier SFN-Bakker, 310 m, 29 Nov. 2003.

Etymology. *Costus fenestralis* has been named for its bracts which have a 'gauze-like' appearance caused by the withering of the mesophyll tissue between the veins creating a net-like structure like in rotting old leaves. The same happens in the sheaths on the shoot creating bunches of long fibers around the shoot below the insertion of the leaves.

Terrestrial herb 0.5–1 m tall. *Leaves* 1–4, crowded in a rosette at the top of the shoot; sheaths 0.5–1.5 cm diam, falling apart into separate fibers with age; ligule membranous, obliquely truncate to 1-lobed, 15–20 mm long; petiole absent or up to c. 3 mm long; sheaths, ligule and petiole densely covered with erect hairs < 1 mm long to glabrous; lamina pale green on lower side, obovate, 22–35 by 10–15 cm, slightly c. 20-plicate, upper side rather densely covered with appressed to erect hairs 0.5–2 mm long, lower side densely so, base obtuse to cordate, apex acuminate (acumen 5–20 mm long). *Inflorescence* many-flowered, ovoid, 5–8 by 3.5–5 cm, terminating the leafy shoot; bracts and appendages on both sides densely covered with minute erect hairs < 1 mm long, bracteoles with a row of hairs < 1 mm long on the keel below the callus, calyx, ovary and capsule glabrous. *Flowers* 1 per bract; bracts green, chartaceous, depressed ovate, 1.4–1.5 by 2 cm, soon falling apart into separate fibers, callus sometimes present and then 1–2 mm long; appendages green, reflexed, broadly ovate, 0.7–1 by 2 cm; bracteole boat-shaped, 14–15 mm long, callus c. 2 mm long; calyx 13–15 mm long, split on one side, lobes triangular, 2–5 mm long, callus absent; corolla white, 40–60 mm long, glabrous, tube c. 10 mm long, lobes apically purplish, narrowly ovate, 30–50 mm long; labellum lilac, inner side with a yellow nectar guide, horizontally flattened, broadly obovate when spread out, 50–60 by 50–60 mm, margin crenate;



Map 6 Distribution of *Costus fenestralis* Maas & H.Maas (●), *C. giganteus* Welw. ex Ridl. (▲), *C. gracillimus* Maas & H.Maas (■) and *C. kupensis* Maas & H.Maas (◆).

stamen colour unknown, c. 30 by 10 mm, anther 6–7 mm long. *Capsule* and *seeds* not seen.

Distribution — Central Africa (Angola (Cabinda), Congo Brazzaville, Gabon).

Habitat & Ecology — In primary or secondary rainforest. At elevations of 300–650 m. Flowering and fruiting: November and December.

Field observations — The flowers of *C. fenestralis* have been reported to be slightly fragrant (*Jongkind et al. 5811*).

IUCN Conservation Status — Based on an AOO of 44 km² from six locations of which only two are located in a protected area, while the others recently experienced logging or face several logging threats, we assess this species as Vulnerable (VU): B2ab(ii,iii,iv).

Other specimens examined. ANGOLA. Cabinda, Belize, 1 Jan. 1919, Gossweiler 8232 (BM). — CONGO BRAZZAVILLE, Lékoumou, Komono, 17 Jan. 1965, Bouquet 956 (P); Vouala Mongomo, 5 Feb. 1965, Bouquet 1198 (P); Route de M'bila, après le village Mouyabi, 12 Jan. 1968, Bouquet 2292 (P). — GABON, Ngounié, route Malinga-Moukouagna, après village Nzinzi, 641 m, 12 June 2011, Bissengou 1319 (LBV, WAG). Nyanga, route Tchibanga-Mayumba, 19 Oct. 2009, Bissengou et al. 337 (WAG); Doudou Mts, Chantier SNF-Bakker, 310 m, 29 Nov. 2003, Jongkind et al. 5811 (LBV, WAG); Mouabissako, 8 Dec. 1907, Le Testu 1259 (BM, P); Forêt du Mayombe, Ndabiliba ('Dabiliba'), c. 300 m, 5 Feb. 1908, Le Testu 1299 (BM, P); 50 km SSW of Doussala, 480 m, 14 Apr. 1987, Reitsma et al. 3230 (MO, NY, WAG). Ogooué-Maritime, Doudou Mts, Reserve de Faune de Moukalaba, 350 m, 5 Dec. 1984, Arends et al. 651 (BR, MO, P, WAG).

8. *Costus gabonensis* Koechlin — Plate 2b; Map 7

Costus gabonensis Koechlin (1964) 82, pl. 18, 1–5. — Type: *Le Testu 2240* (holo P; iso A, B, BM, BR, G, K, L [L.1480436], P), Gabon, Ngounié, Tsamba, 27 Oct. 1917.

Terrestrial herb 0.5–2.5 m tall. *Leaves* several; sheaths 0.5–1 cm diam; ligule membranous, 2-lobed, 5–35 mm long; petiole 2–5 mm long; sheaths, ligule and petiole densely to sparsely covered with erect hairs to c. 5 mm long; lamina green, sometimes purple-red at lower side, shiny at upper side, narrowly elliptic, 13–28 by 5–9 cm, upper side covered with stiff, erect hairs 1.5–2 mm long to glabrous, lower side sparsely to rather densely covered with soft erect hairs c. 1.5 mm long, base acute, obtuse to subcordate, apex acuminate (acumen 5–10 mm long). *Inflorescence* many-flowered, ellipsoid to ovoid, 5–9 by 2–4 cm, terminating a leafy shoot; bracts, appendages of bracts, bracteoles, calyx, ovary and capsule densely to rather densely covered with erect to appressed, white hairs < 1 mm long. *Flowers* 1 per bract; bracts white at base, greenish pink



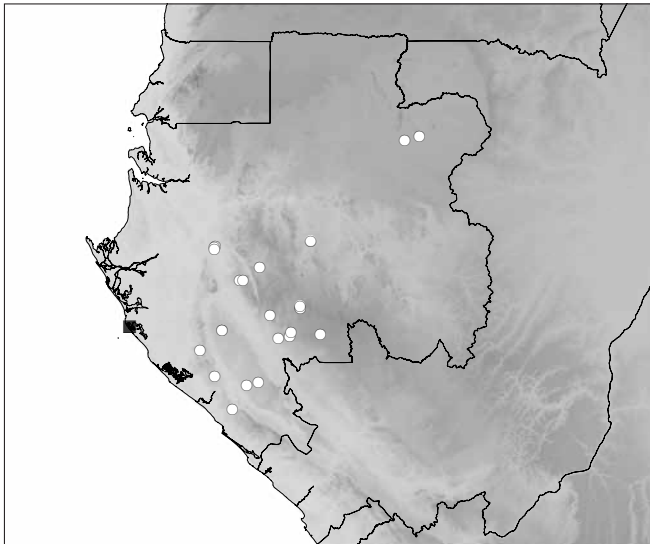
Fig. 4 *Costus fenestralis* Maas & H.Maas a. Habit showing few leaves in an apical rosette; b. detail of sheaths dilacerating into fibers; c. detail of withered bract; d. detail of bracteole and calyx; e. inflorescence (all: Jongkind et al. 5811, WAG). — Drawing by Hendrik Rykema.

to red or purplish brown at apex, chartaceous, broadly obovate to obovate, 1–1.5 by 0.5–1.5 cm, callus absent; appendages pinkish red to purplish brown, strongly reflexed, narrowly triangular to triangular, 1–3 by 0.6–1.5 cm; bracteole boat-shaped 15–20 mm long, callus green, 1–3 mm long; calyx 9–10 mm long, lobes deltate to very shallowly triangular, 1.5–3 mm long, callus absent; corolla yellow to dark yellow, 40–50 mm long, densely to rather densely covered with (erect to) appressed, white hairs < 1 mm long, tube 10–20 mm long, lobes narrowly elliptic, 20–30(–40) mm long; labellum completely yellow, horizontally flattened, broadly obovate when spread out, 35–50 by 40–50 mm, margin irregularly lobed; stamen yellow, 35–40 by 7–10 mm, apex slightly orange, anther 7–8 mm long. *Capsule* obovoid, 9–10 by 6–7 mm. *Seeds* c. 3 by 2 mm.

Distribution — Central Africa (Gabon).
Habitat & Ecology — In primary and secondary rainforest, at elevations of 300–1000 m. Flowering and fruiting: September to December.
Field observations — The flowers of this species are quite aberrant from any other species of *Costus* in that they emit a strong scent reminiscent of jasmine (A.M. Louis et al. 853, Van Valkenburg et al. 2649).
IUCN Conservation Status — Based on an AOO of 88 km² from about 14 locations of which only two are located in a protected area, while the others are located in areas currently being logged or face logging threats, we assess this species as Near Threatened (NT).



Plate 2 a. *Costus dubius* (Afzel.) K.Schum. Basal inflorescence. – b. *Costus gabonensis* Koechlin. Inflorescence. – c. *Costus giganteus* Welw. ex Ridl. Inflorescence. – d. *Costus gracillimus* Maas & H.Maas. Inflorescence with red bracts (a: photographed in Burgers' Bush, Arnhem, The Netherlands, no specimen collected; b: Maas et al. 10465; c: Scharf 221; d: Maas et al. 10571). — Photos: a, b, d: P.J.M.Maas; c: L.Y.T.Westra.



Map 7 Distribution of *Costus gabonensis* Koechlin (●) and *C. loangensis* H. Maas & Maas (■).

Notes — *Costus gabonensis* is unique by its combination of bracts with reflexed red to purplish brown appendages, yellow flowers and a densely hairy corolla. It is endemic to Gabon and it superficially resembles the Neotropical *C. comosus* (Jacq.) Roscoe.

The boat-shaped bracteole of *C. gabonensis* is 2-keeled to almost 2-winged presumably caused by the compactness of the inflorescence. The base of the shoot is red or purplish brown.

9. *Costus giganteus* Welw. ex Ridl. — Plate 2c; Map 6

Costus giganteus Welw. ex Ridl. (1887) 131; K. Schum. (1904) 407. — Type: Welwitsch 6465 (holo BM 2 sheets [BM000617218, BM000617219]; iso LISU, NY), São Tomé & Príncipe, 'Ilha de S. Thomé, Monte Caffé', 600–850 m ('2000–2800ft'), Dec. 1860.

Terrestrial herb 1.5–8 m tall. *Leaves* many; sheaths to c. 2 cm diam; ligule chartaceous, truncate, 15–25 mm long; petiole 15–30 mm long; sheaths, ligule and petiole subglabrous; lamina shiny above, narrowly elliptic to narrowly obovate, rarely ovate, 28–52 by 7–16 cm, upper side glabrous, lower side initially densely covered with soft, erect hairs 1–1.5 mm long, soon glabrous, base acute to obtuse, apex acuminate (acumen 10–15 mm long). *Inflorescence* many-flowered, ovoid, 12–20 by 7–10 cm, terminating a separate leafless shoot 100–150(–300) cm long; bracts, bracteoles, calyx, ovary and capsule glabrous. *Flowers* 1 per bract; bracts red, coriaceous, broadly ovate to ovate, 3.5–6 by 3–5 cm, callus 5–10 mm long; appendages absent; bracteole boat-shaped, 28–45 mm long, callus (3–)5–10 mm long; calyx basally white, apically pinkish red, 13–25 mm long, lobes shallowly ovate-triangular, 3–5(–7) mm long, callus absent; corolla yellow, 75–85 mm long, glabrous, tube (25–)35–40 mm long, lobes narrowly elliptic, 40–45(–50) mm long, sometimes bending towards each other forming a kind of hood over the stamen; labellum completely yellow, tubular, narrowly elliptic to ovate when spread out, 40–45 by 15–20 mm, lateral marginal parts curved upwards, upper margin crenulate; stamen erect, not bending downwards and not closing the throat, yellow, 40–50 by 5–10 mm, apex cucullate, anther 10–12 mm long. *Capsule* obovoid to subglobose, 15–20 by 10–20 mm. *Seeds* 3–3.5 by 2–2.5 mm.

Distribution — Central Africa (both islands São Tomé and Príncipe and one specimen (Wrigley & Melville 270) from Annobon (Equatorial Guinea)).

Habitat & Ecology — In rainforest. At elevations of 0–1450 m. Flowering and fruiting: October to January.

Field observations — Unlike most species of *Costus*, many flowers of the same inflorescence can be at anthesis at the same time.

IUCN Conservation Status — Based on an EOO of 3764 km² and an AOO of 32 km² from three locations which all are only partially protected, while the remainder of these locations show severe habitat degradation (most records are actually very old and the species has not recently been found in those localities), we assess this species as Endangered (EN) B1ab(ii,iii)+2ab(ii,iii).

Notes — *Costus giganteus* is unique among the African species of *Costus* by the combination of separate flowering shoots, combined with red bracts and yellow, tubular flowers. In these aspects it resembles some Neotropical species like *C. erythrocoryne* K. Schum. The only other African species of *Costus* with the same type of yellow, tubular flowers is *C. gracillimus*, a species of much smaller stature from the African continent.

The flowers of *C. giganteus* have a relatively narrow labellum with upcurved lateral margins and an erect cucullate stamen. The flower presents an open throat to pollinators, in contrast with all other species of African *Costus* where the single fertile stamen closes the throat and visitors have to force their way in. The filament is not flat but rolled inwards lengthwise along its margins, especially at its base. The corolla lobes bend towards each other forming a kind of hood over the stamen and the apex of the stamen is cucullate. This type of flower is unique to this species.

The style of *C. giganteus* is often persistent after flowering. Young leaf lamina are shiny above, while older ones are dull green. The aril is relatively large, measuring up to 2 times the length of the seed.

10. *Costus gracillimus* Maas & H. Maas, *nom. nov.* — Plate 2d; Map 6

Costus gracillimus Maas & H. Maas. — *Costus pulcherrimus* A. Chev. (1917) 304, *nom. illeg.*, non Kuntze (1898) 301. — Type: Chevalier 19568 (holo P), Ivory Coast, Tabou, 'Bassin du Cavally, pays des Tépos, entre Toula et Nekaougnié', 25 July 1907.

Terrestrial herb 1–3 m tall. *Leaves* many; sheaths 0.2–0.6 cm diam; ligule chartaceous, obliquely truncate, 10–15(–20) mm long; petiole 5–10 mm long; sheaths, ligule and petiole glabrous or rarely sparsely covered with erect hairs < 1 mm long; lamina greyish to brown on upper side, lower side paler, coriaceous, narrowly elliptic to elliptic, 13–21 by 4–8 cm, slightly 4–6-plicate, glabrous on both sides, but margins and apex rarely covered with some hairs, base acute, apex acuminate (acumen 10–15 mm long). *Inflorescence* few-flowered, broadly ovoid to globose, 1.5–5 by 1.5–5 cm, terminating the leafy shoot; bracts, bracteoles, calyx, ovary and capsule glabrous, rarely rather densely covered with erect hairs < 1 mm long. *Flowers* 1(–2) per bract; bracts red, orange-red to red-purple, coriaceous, broadly ovate to ovate, 1.5–2.5 by 1.5–2.5 cm, callus mostly absent or present and then c. 1 mm long; appendages generally absent; bracteole boat-shaped, 9–14 mm long, callus 1–2 mm long; calyx 7–10 mm long, lobes very shallowly triangular, c. 1 mm long, callus absent; corolla fleshy, 20–29 mm long, red, orange or yellow, glabrous, tube 5–7 mm long, lobes narrowly ovate to elliptic, 15–22 mm long; labellum fleshy, red, orange or yellow, tubular, broadly obovate when spread out, 15–23 by 15–20 mm, margin crenulate; stamen yellow, 13–15 by 6–8 mm, anther 7–8 mm long. *Capsule* obovoid, 9–10 by 5–6 mm. *Seeds* 1.5–2 by 1.5 mm.

Distribution — West Africa (Ghana, Guinea, Ivory Coast, Liberia, Sierra Leone).

Habitat & Ecology — Mostly in rainforest, along paths or in open places and/or disturbed areas, often in wet places, at elevations of 0–850 m. Flowering and fruiting: all year through.

IUCN Conservation Status — Based on all collections *C. gracillimus* has an AOO of 184 km² from about 20 locations of which only four are partially protected, while the remainder of these locations are already lost or face severe habitat degradation. If we only use records collected since 1970, this species has only 10 locations left (with an AOO of 68 km²), of which the majority is lost or threatened. We therefore assess this species as Vulnerable (VU) A2; B2ab(i,ii,iii,iv,v).

Notes — *Costus gracillimus* is a relatively small herb with a slender spiralling shoot (0.2–0.6 cm diam), a long ligule (10–15 mm long) and relatively small, tubular, fleshy flowers. The leaves of *C. gracillimus* have relatively narrow and long petioles. The labellum is about as long as the corolla, forming a tube with its longitudinally incurved margins. The majority of plants studied have red bracts with red-orange flowers. However, *Jongkind et al. 11941* from Liberia has green bracts and yellow flowers. Based on the overall similarities of this single collection, we do not believe it to be a separate species but rather a lighter-coloured form of *C. gracillimus*.

Costus gracillimus has often been misidentified as *C. deistelii* K.Schum. That species, known only from the type collection *Deistel 498* (B destroyed), now placed in the synonymy of *C. afer*, differs from *C. gracillimus* by a shorter ligule, longer inflorescence and bracteole, and the presence of a rim at the base of the ligule not completely encircling the shoot.

11. *Costus kupensis* Maas & H.Maas, *sp. nov.* — Fig. 5; Plate 3a; Map 6

Costus kupensis can easily be recognized by its yellow flowers and an inflorescence terminating a separate leafless shoot, a combination of characters not seen in any other African species of *Costus*. — Type: *Cheek et al. 7111* (holo K; iso L, SCA, WAG, YA), Cameroon, South-West Province, hunters path from Kupe Village to mountain top, 840 m, 24 Jan. 1995.

Costus sp. A. Cheek in Cheek et al. (2004) 434, pl. 15E.

Terrestrial herb 1.5–3 m tall. *Leaves* many; sheaths 1–2.5 cm diam, dark red; ligule chartaceous, 2-lobed, 5–18 mm long; petiole 5–10 mm long; sheaths, ligule and petiole rather densely covered with appressed to erect hairs < 1 mm long; lamina narrowly obovate-elliptic, 20–27 by 6–9 cm, upper side glabrous, lower side sparsely to rather densely covered with erect hairs < 1 mm long on margin and midrib to glabrous, base acute, apex acuminate (acumen 15–20 mm long). *Inflorescence* many-flowered, ovoid, 4–9 by 3–4 cm, terminating a separate leafless shoot 3–15 cm long; (upper part of) bracts and capsule sparsely to rather densely covered with appressed to erect hairs < 1 mm long, bracteole with a row of erect hairs on the keel, calyx glabrous. *Flowers* 1 per bract; bracts dark reddish brown, coriaceous, broadly to depressed ovate, 1–2 by 1.5–2.5 cm, callus sometimes present and then c. 2 mm long; appendages absent; bracteole boat-shaped, 18–22 mm long, callus c. 1 mm long; calyx 12–16 mm long, in fruit exceeding the bracts, lobes narrowly to broadly triangular, 2–5 mm long, callus absent; corolla yellow, upper part of lobes pinkish, 55–60 mm long, glabrous, tube c. 15 mm long, lobes narrowly elliptic, 40–45 mm long; labellum yellow, with dark yellow nectar guide, funnel-shaped to horizontally flattened, broadly obovate when spread out, c. 50 by 50 mm; stamen yellow, c. 40 by 14 mm, apex recurved, anther 7–8 mm long. *Capsule* ellipsoid, c. 11 by 6 mm. *Seeds* c. 2 by 1.5 mm.

Distribution — Central Africa (Cameroon).

Habitat & Ecology — In rainforest. At elevations of 800–1000 m. Flowering and fruiting: January, May and October.

IUCN Conservation Status — Based on an EOO of 1419 km² and an AOO of 12 km², occurring on 3 locations, none of which currently has a protected status and one might be already lost, we assess this species as Endangered (EN) B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v).

Other specimens examined. CAMEROON, **Littoral Province**, Ebo proposed National Park, Yingui, CRES camp on trail to Iboti, 800 m, 23 Apr. 2005, *Cheek et al. 12498* (K, YA); Mont Nlonako, 5 km SSE of Nkongsamba, 1000 m, 17 Mar. 1976, *Letouzey 14456* (K, P). **South-West Province**, Kupe-Muanenguba Division, Kupe Village, vicinity of saprophyte site on Daniel Ajang's bush, 870 m, 20 May 1996, *Cable et al. 2471* (K, U, WAG, YA).

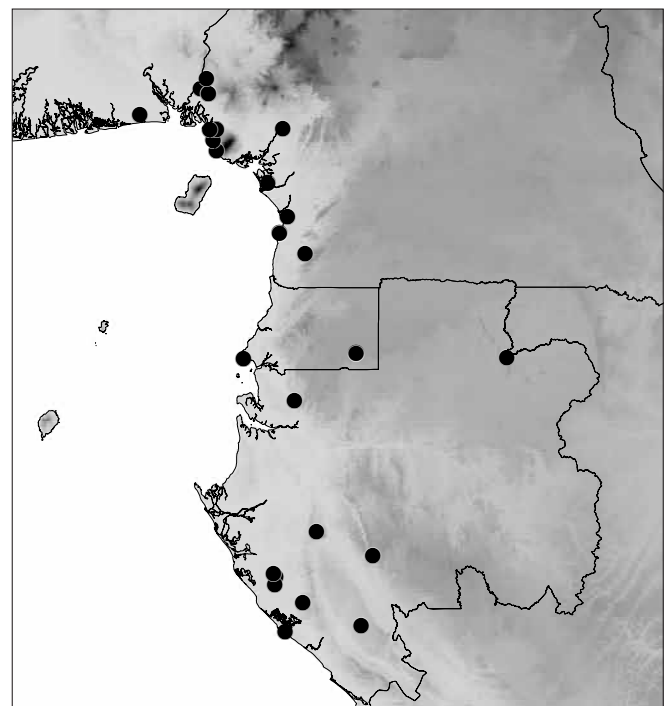
Note — The description is partly based on our observations on a living plant in Burgers' Bush, vouchered as *Maas & Maas 10575*.

12. *Costus lateriflorus* Baker — Plate 3b; Map 8

Costus lateriflorus Baker (1898) 301; K.Schum. (1904) 413. — Type: *Mann 1629* (holo K; iso P), Equatorial Guinea, Littoral Prov., Corisco Bay, Mount John, River Kongui, Aug. 1862.

Costus letestui Pellegr. (1929) 220 (as '*Le Testui*'), syn. nov. — Type: *Le Testu 1683* (holo P; iso BM, K), Gabon, Nyanga, Tchibanga area, Mayombe bayaka, Ighouma, 8 km NE from Mouila, 12 Jan. 1913.

Epiphytic or sometimes terrestrial herb to c. 1.5 m tall. *Leaves* many; sheaths 0.4–0.7 cm diam; ligule reddish brown, membranous, truncate, 25–40 mm long, sometimes longer than the internode; petiole 4–10 mm long; sheaths, ligule and petiole glabrous; lamina sometimes purplish on lower side, coriaceous and somewhat fleshy, narrowly elliptic, 9–20 by 2–6.5 cm, glabrous on both sides, base acute to obtuse, apex acuminate (acumen 5–12 mm long). *Inflorescences* generally several per flowering branch, each one few- to several-flowered, ovoid, 2–4 by 1–3 cm, lateral in the axil of a leaf with a peduncle 1–4 cm long or terminating a separate leafless shoot c. 1 cm long or terminal on a leafy shoot; bracts, bracteoles, calyx, ovary and capsule rather densely to densely covered with erect hairs < 1 mm long, rarely glabrous. *Flowers* 1 per bract; bracts pale brownish green to reddish brown, slightly dotted with pink, chartaceous, ovate, 0.5–1 by 0.3–0.8 cm, callus sometimes present and then c. 1 mm long; appendages absent; bracteole tubular, 8–12 mm long, callus sometimes present and then



Map 8 Distribution of *Costus lateriflorus* Baker.

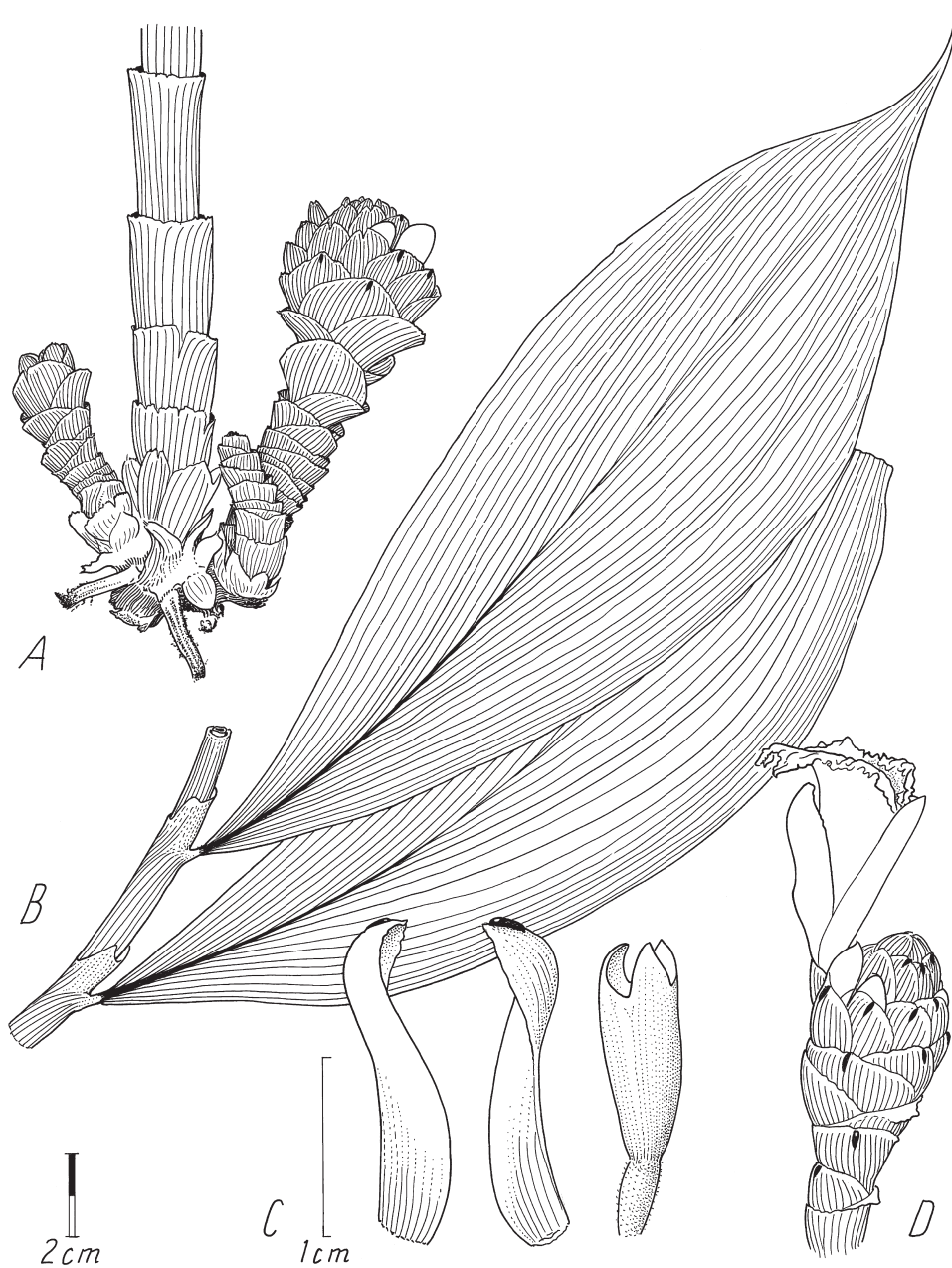


Fig. 5 *Costus kupensis* Maas & H.Maas. a. Habit showing 2 basal inflorescences; b. leaves with ligules; c. bracteole, calyx and ovary; d. inflorescence with flower (a, b: Cheek 7111, K; c: Cable 2471, K; d: after slide of Cheek 7111). — Drawing by Hendrik Rypkema.

c. 1 mm long; calyx pale pinkish green to reddish brown with pale green lobes, 12–18 mm long, lobes shallowly ovate-triangular, 1–2 mm long, callus distinct, green, 1–2 mm long; corolla hyaline, whitish with some pink or brown and red dots, 35–50 mm long, glabrous, tube 15–20 mm long, lobes narrowly elliptic-ovate, 20–35 mm long; labellum at the inner and outer side bright yellow, horizontally flattened with funnel-shaped base, broadly obovate when spread out, 40–60 by 35–60 mm, margin crenulate; stamen white with red dots, 20–27 by 8–11 mm, apex yellow, anther 7–10 mm long. *Capsule* ellipsoid, c. 12 by 6 mm. *Seeds* c. 1.5 by 1 mm.

Distribution — West Africa (Nigeria); Central Africa (Cameroon, Central African Republic, Equatorial Guinea, Gabon).

Habitat & Ecology — In primary or sometimes secondary rainforest rich in *Caesalpinioideae* and *Sacoglottis gabonensis*, sometimes epiphytic on *Baillonella toxisperma* and *Tetraberlinia bifoliolata*, or on sandy to rocky soil, at elevations of 0–800 m. Flowering and fruiting: all year through.

IUCN Conservation Status — *Costus lateriflorus* occurs in about 17 locations with an AOO of 104 km². Six of these locations have a protected status. Since we are unable to identify material of this species or *C. lilaceus* where the petal colour is not apparent, this species is likely to be more common than currently assessed. We therefore assess it as Least Concern (LC).

Notes — *Costus lateriflorus* can be recognized by its mostly epiphytic habit, flowers with a bright yellow labellum and its inflorescences placed laterally in the axil of a leaf or terminating a separate leafless shoot. However, it is almost impossible to distinguish *C. lateriflorus* from *C. lilaceus* except for the striking difference they show in the colour of their labellum: yellow in *C. lateriflorus* and lilac in *C. lilaceus*. In the material studied we found 12 specimens to be unidentifiable due to lack of information regarding flower colour on the label. The shoot of *C. lateriflorus* is brown (ligule) alternating with green (internodal part of the stem).



Plate 3 a. *Costus kupensis* Maas & H.Maas. Basal inflorescence. – b. *Costus lateriflorus* Baker. Habit showing lateral inflorescences. – c. *Costus tappebeckianus* J.Braun & K.Schum. Inflorescence with flower. – d. *Costus lilaceus* Maas & H.Maas. Lateral inflorescence. – e. *Costus phyllocephalus* K.Schum. Inflorescence. – f. *Costus maboumiensis* Pellegr. Inflorescence (a: Maas *et al.* 10575; b: photographed in Lyon Arboretum Hawaï, no specimen collected; c: Burgers' Bush number 20140016; d: photographed in Burgers' Bush, Arnhem, The Netherlands, no specimen collected; e: Maas *et al.* 10407; f: Maas *et al.* 10227). — Photos: a, c–f: P.J.M.Maas; b: J.Mood.

The labellum of the flowers of *C. letestui* Pellegr., now in synonymy with *C. lateriflorus*, was described by Koechlin (1965, 1965) as being pink. However, the flowers of *C. letestui* are yellow, as in *C. lateriflorus* Baker, because the label of the type specimen *Le Testu 1683* (P) reads: 'Epiphyte à fleurs jaunes'.

13. *Costus ligularis* Baker — Fig. 1f; Map 4

Costus ligularis Baker (1898) 298; K.Schum. (1904) 390. — Type: *Mann 1628* (holo K 2 sheets), Equatorial Guinea, Litoral Prov., Corisco Bay, Muni River ('Danger River'), Aug. 1862.

Costus araneosus Gagnep. (1902a) 95, syn. nov. — Type: *De Brazza 100* (holo P), Congo Brazzaville, Brazzaville, Sept.-Oct. 1884.

Costus fimbriatus Pellegr. (1929) 220, syn. nov. — Type: *Le Testu 1817* (holo P; iso BM, BR, P), Gabon, Nyanga, Tchibanga area, Maboumi Camp, Mayombe bavili, 27 Oct. 1914.

Costus ngouniensis Pellegr. (1938) 41, nom. nud., without Latin description. — Based on: *Le Testu 2238* (BM, BR, P), Gabon, Ngounié, Nzouna, 22 Oct. 1917.

Terrestrial herb 0.3–0.5(–1.5) m tall. *Leaves* 2–6(–8), often condensed at the top of the shoot in an apical rosette; sheaths dark red, 0.2–1.5 cm diam, sometimes creamy, falling apart into separate fibers with age; ligule dark reddish brown, membranous, truncate or 2-lobed, 5–50 mm long; petiole 3–15 mm long; sheaths, ligule and petiole densely to sparsely covered with erect hairs to c. 3 mm long; lamina sometimes red to purple on lower side, narrowly obovate to elliptic, 9–23 by 4–10.5 cm, 3–5-plicate (*Maas et al. 10212*), chartaceous, upper and lower side densely to sparsely covered with soft erect hairs to c. 3 mm long, base acute, apex acute to acuminate (acumen 10(–15) mm long). *Inflorescence* few- to several-flowered, broadly ovoid to globose, 1–4 by 1–4 cm, terminating the leafy shoot or rarely terminating a separate leafless shoot 2–7(–20) cm long; bracts, appendages of bracts, bracteoles, calyx and ovary sparsely to rather densely covered with appressed hairs < 1 mm long. *Flowers* 1 per bract; bracts apically dark brown-red with darker dots, chartaceous, ovate to broadly ovate, 0.8–1.8 by 0.5–2.4 cm, callus absent or present and 1–2 mm long; appendages generally present, brownish red, ascending, horizontally spreading or reflexed, broadly ovate, 0.2–0.7(–2) by 0.2–0.5(–2) cm, bracteole boat-shaped, 7–15 mm long, callus distinct, yellowish to whitish, 1.5–2 mm long; calyx whitish with pink upper part, 5–12 mm long, lobes shallowly triangular, 1–2 mm long, callus absent; corolla hyaline, pink to red to brown, 55–65 mm long, glabrous, tube 10–15 mm long, lobes narrowly elliptic, 45–55 mm long; labellum white to pink on the outer side, inner side white with broad pink to purple margin, base of throat often yellow, no nectar guide present, horizontally flattened, broadly obovate when spread out, 50–80 by 40–70 mm, margin fimbriate, more or less 5-lobed, and crenate; stamen white, 30–40 by 10–20 mm, apex yellow to orange, very tip pink, anther 5–8 mm long. *Capsule* and *seeds* not seen.

Distribution — Central Africa (Cameroon, Congo Brazzaville, Equatorial Guinea, Gabon).

Habitat & Ecology — In rainforest, sometimes growing along river banks, in lateritic to sandy soils, at elevations of 0–800 m. Flowering and fruiting: all year through, especially in January.

IUCN Conservation Status — Least Concern.

Notes — *Costus ligularis* is a species of small stature that can be distinguished by its dark red sheaths, softly hairy leaves (on both sides), small and dark reddish brown appendaged bracts, very distinct calli on the bracteoles, a pinkish labellum without nectar guide and a relatively small inflorescence (1–4 by 1–4 cm). The absence of a nectar guide inside the throat of the *C. ligularis* flower is functionally 'replaced' by the yellow apex of the stamen, which is turned upwards and highly visible.

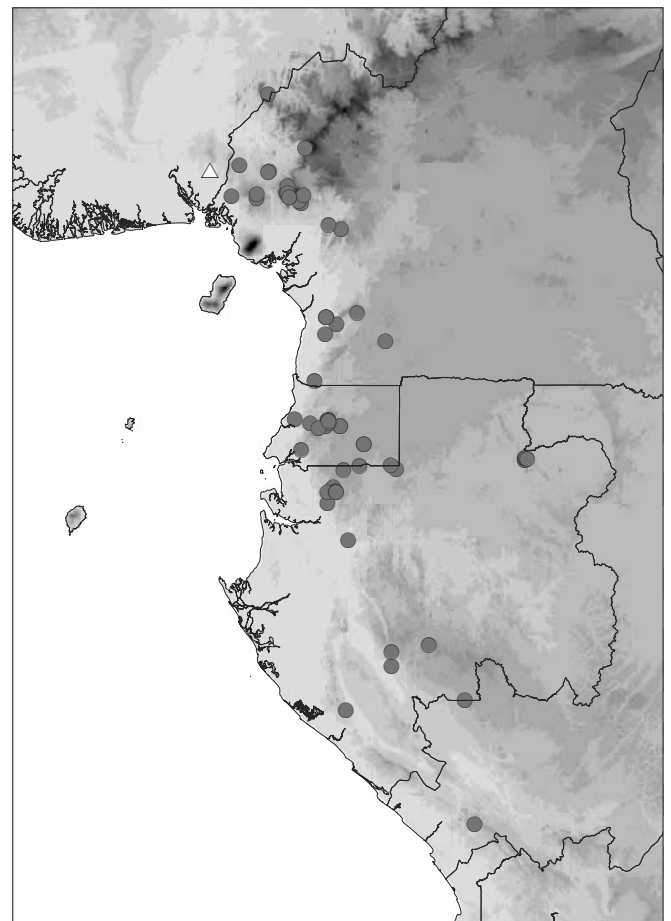
Costus ligularis differs from the similarly looking *C. phyllocephalus* by having a small inflorescence of 1–4 by 1–4 cm, com-

posed of relatively small dark reddish brown bracts, bracteoles and calyx. The bracts are 0.8–1.8 cm long, the appendages 0.2–0.7 cm long. The bracteoles are 7–15 mm long with a callus of 1.5–2 mm long. This yellowish callus is prominently visible contrasting with the dark reddish brown bracteole. In contrast *C. phyllocephalus* has an inflorescence of 2.5–10 by 3–7 cm, composed of relative large, green to reddish purple bracts, bracteoles and calyx. The bracts are 1–2.5 cm long, the appendages 1–4.5 cm long. The bracteoles are 11–21 mm long with a callus 2–3.5 mm long; this callus is not very distinct.

14. *Costus lilaceus* Maas & H.Maas, *sp. nov.* — Plate 3d; Map 9

Costus lilaceus can be recognized by its often epiphytic habit, pink to lilac flowers and its inflorescences placed laterally in the axil of a leaf or terminating a separate leafless shoot. — Type: *J.J.F.E. de Wilde et al. (WALK-B series) 40* (holo WAG 2 sheets [WAG0114490, WAG0114491]; iso BR, C, LBV, MO, P), Gabon, Woleu-Ntem, Crystal Mountains, 7 km along the road from Tchimbélé to Kinguélé, 620 m, 18 Jan. 1983.

Epiphytic or sometimes terrestrial herb 0.3–1.6 m tall. *Leaves* many; sheaths 0.3–0.8 cm diam; ligule reddish brown to orange, membranous, truncate, 20–60(–80) mm long, often longer than the internode; petiole 2–15 mm long; sheaths, ligule and petiole glabrous; lamina shiny bright or pale green at upper side, less shiny, sometimes purplish or glaucous at lower side, (narrowly) elliptic or rarely (ob)ovate, more or less falciform, 9–30 by 3–8 cm, coriaceous and somewhat fleshy, glabrous on both sides, base acute to obtuse, apex acute to acuminate (acumen 15–20 mm long). *Inflorescences* generally several per flowering branch, each one few- to several-flowered, ovoid to ellipsoid, (1–)1.5–5 by 1–2.5 cm, lateral in the axil of a leaf with a peduncle 0.5–2.5 cm long or terminating a separate leafless



Map 9 Distribution of *Costus lilaceus* Maas & H.Maas (●) and *C. talbotii* Ridl. (▲).

shoot emerging from the rhizome 0.8–1 cm long or terminating a leafy shoot; bracts, bracteoles, calyx, ovary and capsule sparsely to rather densely covered with erect hairs < 1 mm long. *Flowers* 1 per bract; bracts dark reddish brown to dark green with red dots, old bracts (pale) brown, chartaceous, narrowly to broadly elliptic-obovate, 0.3–1.1 by 0.1–1.1 cm, callus yellowish green, 0.5–1.5 mm long, sometimes inconspicuous; appendages absent; bracteole tubular, 7–9 mm long, callus green, 1–1.5 mm long; calyx pale green to crimson to dark reddish brown, 7–23 mm long, lobes shallowly triangular 1–2.5 mm long, callus yellowish green, 1–2 mm long; corolla hyaline, white, 30–50 mm long, glabrous, tube 10–15 mm long, lobes narrowly elliptic, 30–40 mm long; labellum at the outer side basally white, upper part pale lilac, inner side pale pink to lilac or rarely white (see note), with bright yellow to orange nectar guide and reddish dots and hairs at the base, horizontally flattened with funnel-shaped base, broadly obovate when spread out, 35–70 by 30–65 mm, margin irregularly crenate undulate; stamen white to pale pink with reddish dots, 30–35 by 10–12 mm, apex bright yellow, anther 9–10 mm long. *Capsule* ellipsoid to broadly ellipsoid, 6–7 by 4 mm. *Seeds* c. 1 mm diam.

Distribution — West Africa (Nigeria); Central Africa (Cameroon, Congo Brazzaville, Congo Kinshasa, Equatorial Guinea, Gabon).

Habitat & Ecology — In primary or sometimes secondary rainforest, in wet places (epiphytic specimens), but also in savanna forest in rocky places or on outcrops (terrestrial specimens), at elevations of 80–1530 m. Flowering and fruiting: all year through, especially in January.

IUCN Conservation Status — This species with about 22 locations and an AOO of 248 km² is assessed as Least Concern (LC).

Representative specimens examined. CAMEROON, **Littoral Province**, Forêt de Bakaka, 3 km E of Eboné (on km 11 of Nkongsamba-Loum Road), 520 m, 28 Jan. 1972, *Leeuwenberg 9317* (BR, K, MO, P, WAG, YA). **South Province**, Lolodorf, 8 Jan. 1968, *Bamps 1748* (BR). **South-West Province**, Mts Rumpi, near Dikome Balue, 35 km NNW of Kumba, 1200 m, 25 Mar. 1976, *Letouzey 14578* (P), Bakossi Mts, W of Bangem, 1400 m, 3 Jan. 1986, *D.W. Thomas 5262* (MO, NY). — CONGO BRAZZAVILLE, **Kouilou**, cultivated at Pointe Noire, originating from Maiombe, région de Dimonika, 29 Oct. 1988, *De Foresta 1739* (P). **Niari**, border of Congo Brazzaville and Gabon, 500 m from the Loambitsi River, 4 Feb. 1975, *Sita 3884* (BR). — CONGO KINSHASHA, **Nord-Kivu**, Kitshanga, 1300 m, 7 Jan. 1959, *A. Léonard 2348* (BR). **Sud-Kivu**, Territoire Kalehe, km 110 of road from Kavumu to Walikale, Irangi, near River Luhoho, 850 m, 6 Dec. 1956, *Christiaensen 1920* (BR, U). — EQUATORIAL GUINEA, **Centro Sur**, Bata-Monte Alén, 18 Mar. 1994, *Carvalho 5488* (WAG); Parque Nacional de Monte Alén, near Lago Atok, 2 July 1998, *Pérez Viso 19* (WAG). — GABON, **Estuaire**, Monts de Cristal, Mkam-Mela, 950 m, 30 Jan. 1968, *Hallé & Villiers 4746* (P). **Ngounié**, 25 km NE of Mouila, 19 Dec. 1985, *Wilks 1166* (WAG). **Nyanga**, 25 km SW of Doussala, 11 Jan. 1987, *Reitsma & Reitsma 2835* (MO, NY, WAG). **Ogooué-Ivindo**, road on Babel-Nord, few kms W of Bellinga, 900 m, 18 July 1985, *Bos et al. 10685* (BR, MO, WAG). — NIGERIA, **Ogoja**, Ikvette-Balegeta path, 4500 ft, 29 Dec. 1948, *Savory & Keay FHI 25202* (K, P).

Notes — *Costus lilaceus* can only be separated from *C. lateriflorus* by the colour of the labellum of the flowers being yellow in *C. lateriflorus* but pink to lilac in *C. lilaceus*. Many specimens have wrongly been identified as *C. letestui*, assuming the flowers of this species were lilac in colour (Koechlin 1964, 1965). As *C. letestui* turned out to be a synonym of *C. lateriflorus* (see under that species), these specimens with pink to lilac flowers needed a new name: *C. lilaceus*.

Costus lilaceus has been found epiphytic in trees up to 25 m high on *Parkia bicolor* (*Bamps 1612*), *Gilbertiodendron dewevrei* (*Christiaensen 1826* and *1920*) and *Julbernardia* (*Letouzey 12730*). The plant forms a clump with pendant shoots. When terrestrial it is often found at high altitude growing over rock, forming a 'dense mat of *Costus* between the trees and shrubs' (*A.M. Louis 2318*).

Studying the distribution of *C. lilaceus* and *C. lateriflorus* we found a difference in the altitude where both species occur: *C. lilaceus* is generally found growing at higher elevations (80–1530 m), avoiding the sedimentary basin; *C. lateriflorus* seems to prefer the coastal sedimentary areas of Gabon and Cameroon (0–800 m).

Some specimens of *C. lilaceus* have flowers with a very pale lilac to almost white labellum and a bright yellow nectar guide.

15. *Costus loangensis* H.Maas & Maas — Map 7

Costus loangensis H.Maas & Maas (2012) 12, f. 1. — Type: *Maas et al. 10184* (holo WAG 2 sheets [WAG0380168, WAG0380169]; iso K, LBV, MO, P, UC), Gabon, Ogooué-Maritime, Parc National de Loango, between Lodge and Staff building, wet forest on white sand, along forest trail, at about sea level, 9 Nov. 2011.

Etymology. *Costus loangensis* is named after the place where it has been collected near Loango Lodge, in Parc National de Loango in Gabon. *Costus loangensis* was discovered upon seeing a photograph of an unknown *Costus* in Vande Weghe's book on plants and animals of Gabon's National Parks (2007: 278, f. 623). He describes and publishes a photo of a specimen of *Costus* 'which seems to be quite typical for these coastal forests'. We, however, found only a single population.

Terrestrial herb, 0.5–0.6 m tall, shoots dark brownish red. *Leaves* few (6–7) concentrated at the apex of the shoot; sheaths dark red, 0.6–0.8 cm diam; ligule membranous, 2-lobed, 15–18 mm long; petiole 5–6 mm long; sheaths sparsely to rather densely covered with erect to half-appressed hairs c. 2 mm long, ligule and petiole densely to rather densely so; lamina dark olive-green, zone along midrib sometimes reddish, narrowly elliptic to elliptic, 14–16 by 5–6 cm, densely to rather densely covered with erect to half-appressed hairs 1.5–2 mm long on both sides, base attenuate, apex acute. *Inflorescence* 3–5-flowered, ovoid, c. 2 by 1–1.5 cm, terminating the leafy shoot; outer side of bracts, bracteoles and calyx densely covered with appressed to half-appressed hairs < 1 mm long, ovary sparsely so. *Flowers* 1 per bract; bracts reduced, brown to reddish brown, chartaceous, narrowly ovate-triangular to ovate-triangular, 1.7–2 by 0.5–1 cm, callus 2.5–3 mm long; appendages absent; bracteole boat-shaped, 15–18 mm long, callus 1.5–2 mm long; calyx 11–12 mm long, lobes deltate, c. 2 mm long, callus c. 1 mm long; corolla yellow, 50–55 mm long, rather densely covered with half-appressed hairs < 1 mm long, particularly near the apex, tube 20–25 mm long, lobes narrowly elliptic, 30–35 mm long, together forming a hood over the throat opposite the labellum, apex with a callus-like thickening; labellum completely yellow, horizontally flattened with funnel-shaped base, broadly obovate when spread out, 30–40 by 40–50 mm, margin fimbriate (fimbriae 2–3 mm long); stamen yellow, 25–30 by 7–10 mm, anther 5–7 mm long. *Capsule* and *seeds* not seen.

Distribution — Central Africa (Gabon). Only known from the type collection.

Habitat & Ecology — In wet rainforest, on white sand, at elevations of about sea level. Flowering and fruiting: November.

IUCN Conservation Status — *Costus loangensis* has only been collected once (AOO = 4 km²), just outside a National Park. Although this locality is within the buffer zone around the park, this locality is used for the construction of tourist accommodations. To our knowledge there exist only few mature individuals of this species. We therefore assess this species as Critically Endangered (CR) B2ab(iii,v); D.

Notes — *Costus loangensis*, known only from the type collection, is a species of small (c. 0.5 m tall) plants with few (6 or 7) leaves, completely yellow flowers and unappendaged bracts. Shoots and leaves are covered with a dense indument of erect to half-appressed hairs.

Costus loangensis differs from the very similar *C. ligularis*, another species of small size with a dense indument, by the colour of its flowers; those of *C. ligularis* are pale pink rather than bright yellow in *C. loangensis*. Moreover, the bracts of *C. ligularis* are generally appendaged.

16. *Costus louisii* H.Maas & Maas, *sp. nov.* — Plate 4f; Map 10

Costus louisii looks superficially like *C. afer* but can be distinguished by having shiny leaves, 1 flower per bract, shiny green bracts and completely pinkish red flowers. — Type: *Maas et al.* 10339 (holo WAG; iso K, L-spirit [L0298233], LBV, MO, UC), Gabon, Estuaire, Libreville, Glass, garden of A.M. Louis, at sea level, 6 Nov. 2011, cultivated from a specimen collected by A.M. Louis, 30 km S of Mayumba, within walking distance of the ocean, on white sand, in swampy low forest.

Terrestrial herb 1.5–2.5 m tall. Leaves many; sheaths 0.8–1.1 cm diam; ligule chartaceous, unequally 2-lobed, 10–29 mm long, apical margin with white curly fibers; petiole 5–10 mm long; sheaths, ligule and petiole glabrous except for some long hairs at the very base of the leaves, many on the upper margin of the ligule and also some on the border between the petiole and the sheath; lamina upper side dark green, lower side pale green, shiny at both sides or only at the upper side, narrowly ovate-elliptic (to obovate), 20–29 by 6–10 cm, both sides and margin glabrous except for some erect hairs < 1 mm long, base acute (to slightly cordate), apex acuminate (acumen 15–35 mm long). Inflorescence many-flowered, ovoid, (4–)7–10 by 4–6 cm, terminating the leafy shoot; bracts, appendages of bracts, bracteoles, calyx and ovary glabrous. Flowers 1(–2) per bract; bracts basally green with shiny brown to dark red upper part, coriaceous, broadly ovate-triangular to ovate-triangular, 2–3 by 2–3 cm, callus absent; appendages generally absent; bracteole

boat-shaped, 20–21 mm long, callus (pale) green c. 2 mm long; calyx 17–21 mm long, lobes triangular, 3–4 mm long, callus absent; corolla white, 50–60 mm long, glabrous, tube 10–15 mm long, lobes white with pink apex and yellow base, narrowly elliptic, 40–45 mm long; labellum at the outer side white, inner side basally white, upper part completely (striped with) dark pink, throat and nectar guide yellow, horizontally flattened, broadly obovate to circular when spread out, 45–50 by 50–55 mm, margin crenate and undulate; stamen white with dark pink apex, 30–35 by 10–15 mm, apex (dark) pink, anther 7–8 mm long. Capsule and seeds not seen.

Distribution — Central Africa (Gabon).

Habitat & Ecology — In swampy low forest or savanna, on white sand, at elevations of about sea level. Flowering and fruiting: November.

Field observations — The plants are pollinated by small birds; capsule and seeds were never seen (A.M. Louis, pers. comm.).

IUCN Conservation Status — This species is only known from a single wild collection (AOO = 4 km²) from a small population, and one plant in cultivation. This location does not have any protected status. Although it is not immediately threatened, there is some tourism development in the area. We assess this species as Critically Endangered (CR) B2ab(iii,v); D.

Notes — *Costus louisii* looks very much like *C. afer*, both having many-flowered inflorescences that terminate the leafy shoots. In *C. louisii*, however, the leaves are shiny at both sides, whereas the leaves of *C. afer* are never shiny. Moreover, the labellum of the flowers of *C. louisii* is horizontally flattened and completely dark pink with yellow nectar guide, while that of *C. afer* is funnel-shaped and white with a yellow nectar guide and red colouring restricted to the margins.

The material of *C. louisii* has all been collected from plants now in cultivation in the greenhouses of Burgers' Bush, Arnhem, The Netherlands and of Royal Botanic Gardens, Kew, London, Great Britain. They originate from the type specimen growing in the garden of A.M. Louis, who collected it 30 km S of Mayumba, Gabon, within walking distance of the ocean, on white sand, in swampy low forest (S3°36' E10°52').

17. *Costus lucanusianus* J.Braun & K.Schum. — Fig. 4d; Map 11

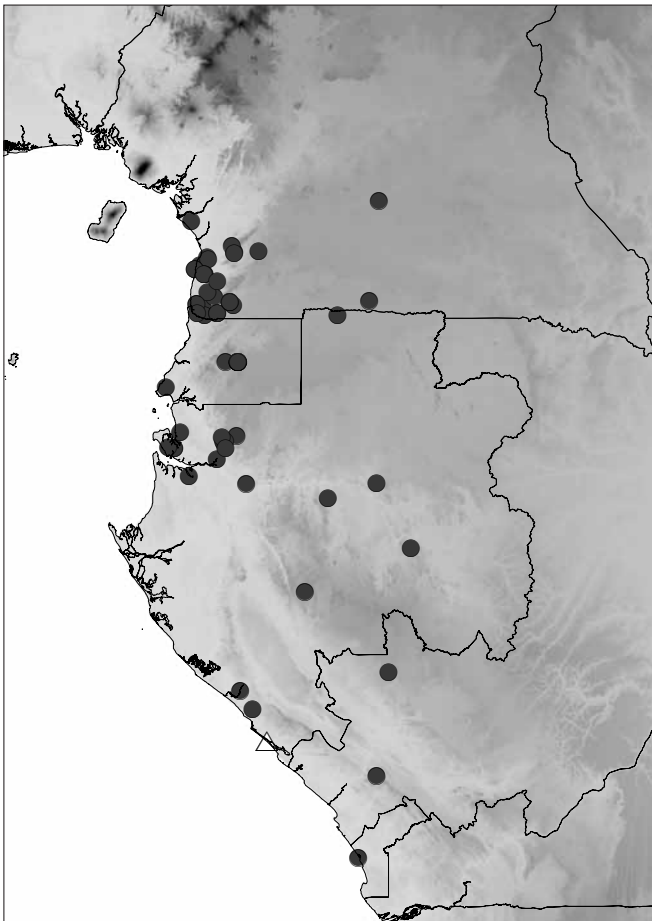
Costus lucanusianus J.Braun & K.Schum. (1889) 151; K.Schum. (1904) 392.

— Type: *Braun s.n.* (holo B destroyed), Cameroon, South Province, Batanga. As the holotype was destroyed in Berlin and no other type material has been located we hereby select a neotype from a locality not far from the type locality: *Van Andel et al.* 3406 (neo WAG [WAG0145874]; isoneo KRIBI), Cameroon, South Province, Campo-Ma'an National Park, Ntem River, Ebiamemeyong, at the foot of Asuangale falls, 350 m, 6 May 2001.

Costus lucanusianus J.Braun & K.Schum. var. *major* K.Schum. (1904) 392, syn. nov. — Syntypes: *Braun s.n.* (B destroyed), Cameroon, South Province, Gross-Batanga; *Zenker 1595* (BM, E, G, K, L, LE, M, MO, P, S, WRSL), Cameroon, South Province, Bipindi, 14 Dec. 1894.

Costus dussii K.Schum. (1904) 402, f. 45B; Maas (1972) 121. — Type: *Duss 2109b* (holo B destroyed; lecto NY, selected by Maas 1972), Martinique, 'Hauteurs du Carbet et Fonds Saint Denis'.

Terrestrial herb, erect but in fruit often bending down, 1–5 m tall. Leaves many; sheaths 0.5–2 cm diam; ligule truncate to slightly 2-lobed, 1–4(–8) mm long, with a basal horizontal rim 1–2 mm high provided with a prominent row of needle-like hairs 2–6 mm long; petiole 4–10 mm long; sheaths, ligule and petiole rather densely to sparsely covered with erect hairs < 1 mm long to glabrous; lamina narrowly elliptic, 12–33 by 3–10 cm, upper side glabrous, lower side densely to sparsely covered with silvery, mainly erect hairs to c. 2 mm long to glabrous, base obtuse to cordate, apex acuminate (acumen 10–20 mm long), margin undulate. Inflorescence many-flowered, broadly ovoid to



Map 10 Distribution of *Costus louisii* H.Maas & Maas (▲) and *C. tappenbergianus* (●).



Plate 4 a. *Costus macranthus* K.Schum. Habit, flower and details of stamen, stigma and style. – b. *Costus nimba* H.Maas & Maas. Basal inflorescence. – c. *Costus spectabilis* (Fenzl) K.Schum. Habit with flowers. – d. *Costus lucanusianus* J.Braun & K.Schum. Inflorescence with 4 flowers. – e. *Costus talbottii* Ridl. Flower. – f. *Costus louisii* H.Maas & Maas. Inflorescence (a: Wright 1905: t 7992; b: Jongkind 11301; c: photographed in Rumonge, SW Burundi, no specimen collected; d: Maas et al. 10000; e: Maas et al. 9800; f: Maas et al. 10339). — Photos: a, b, d–f: P.J.M.Maas; c: E. Fischer.

globose, 2–12 by 2–9 cm, sometimes elongating to c. 20 cm in fruit, terminating the leafy shoot; bracts, bracteoles, calyx, ovary and capsule glabrous or sparsely covered with erect and appressed hairs < 1 mm long, calyx lobes often rather densely hairy, particularly along the margins. *Flowers* 2 per bract; bracts green, coriaceous, broadly to very broadly ovate-triangular, 1.5–3 by 1.5–3 cm, falling apart into separate fibers with age, callus inconspicuous, up to c. 2 mm long; appendages absent; bracteole boat-shaped, 17–20 mm long, callus 2–4 mm long; calyx 18–25 mm long, lobes broadly ovate-triangular to triangular, 4–12 mm long, horizontally spreading to reflexed, in fruit distinctly exceeding the bracts, callus sometimes present and then 2–3 mm long; corolla white, 30–45 mm long, glabrous, tube 10–15 mm long, lobes elliptic, 25–30 mm long; labellum at the outer side white with dark red upper part, inner side basally white with wide dark reddish margin and yellow to orange nectar guide, funnel-shaped, broadly obovate when spread out, 40–50 by 40–45 mm, margin crenate; stamen white, 30–35 by 10–15 mm, apex dark pink, anther 6–11 mm long. *Capsule* ellipsoid to broadly ellipsoid, 10–20 by 5–15 mm. *Seeds* 1–2 by 1–1.5 mm.

Distribution — North East Africa (Ethiopia, South Sudan); West Africa (Benin, Ghana, Guinea, Ivory Coast, Liberia, Nigeria, Sierra Leone, Togo); Central Africa (Burundi, Cameroon, Central African Republic, Congo Brazzaville, Congo Kinshasa, Equatorial Guinea, Gabon, São Tomé & Príncipe); East Africa (Uganda); Southern Tropical Africa (Angola).

Habitat & Ecology — In savanna forest, secondary forest and swamp forest, in wet places along rivers and road sides, and in plantations, at elevations of 0–1700 m. Flowering and fruiting: all year through.

Field observations — Often plants are viviparous, the seedlings emerging from the ripe fruit. As the shoot with the heavy infructescence bends down and reaches the ground, the plantlets can start their life easily.

IUCN Conservation Status — Least Concern.

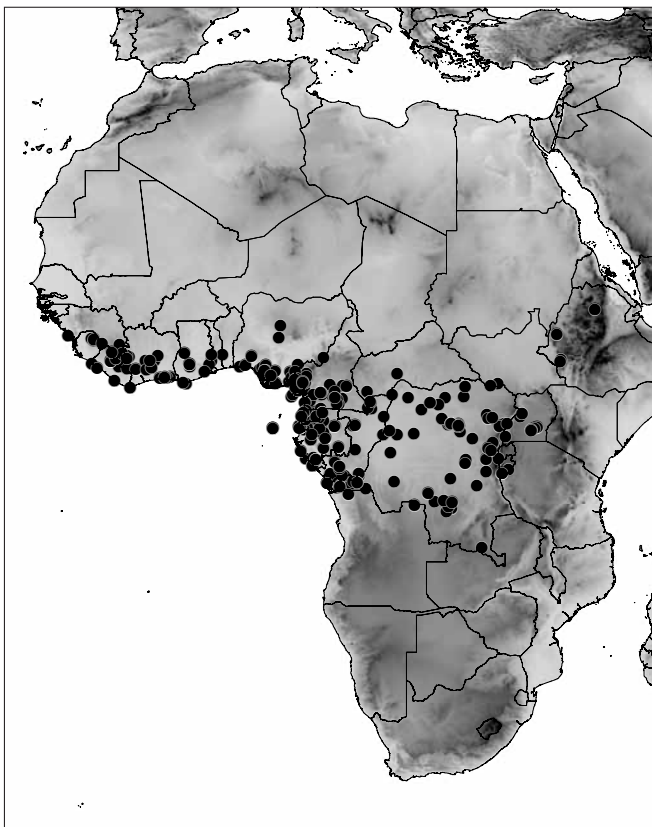
Notes — *Costus lucanusianus* can easily be recognized by having a row of distinct erect hairs on a horizontal rim at the base of a very short ligule. The flowers have horizontally spreading to reflexed calyx lobes. The labellum is completely white at the outer side contrasting with the inner side which has a dark red margin and dark yellow nectar guide. The lower side of the leaves is densely to sparsely covered with silvery hairs to glabrous. The apex of the stamen is pink and narrowly triangular. Boat-shaped bracteoles can be so compressed inside the inflorescence that they become 2-keeled.

Costus lucanusianus is sometimes confused with *C. afer*. *Costus lucanusianus* is characterized, however, by a complete ring of hairs on the nodes, while in *C. afer* this ring is incomplete and less hairy. The lower side of the leaves is generally hairy in *C. lucanusianus* and glabrous in *C. afer*. The calyx lobes of *C. lucanusianus* are horizontally spreading to reflexed and those of *C. afer* are erect. The ligule in *C. lucanusianus* is 1–4 mm long vs 4–11 mm in *C. afer*. The bracts of *C. lucanusianus* are green, those of *C. afer* are reddish.

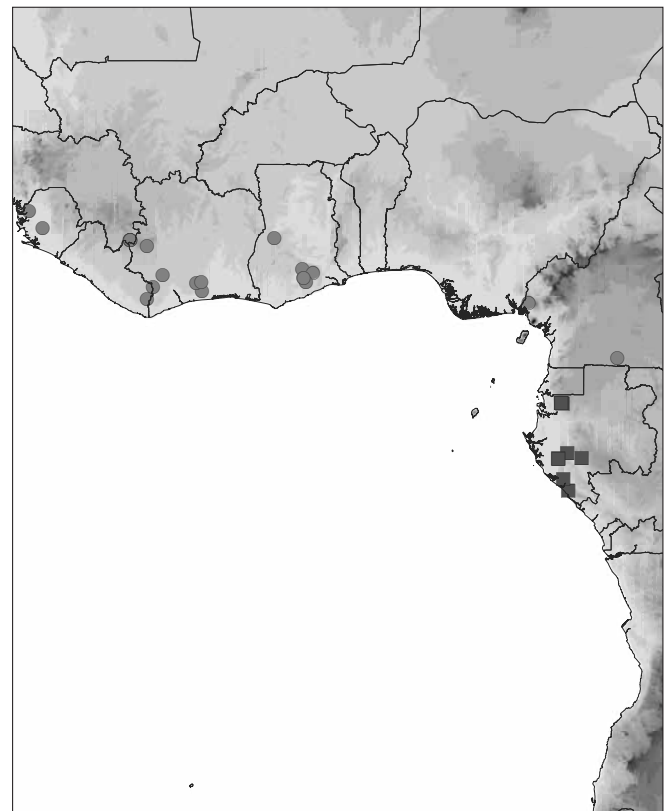
18. *Costus maboumiensis* Pellegr. — Plate 3f; Map 12

Costus maboumiensis Pellegr. (1929) 220. — Type: *Le Testu 1820* (holo P; iso BM 2 sheets, BR, MO, P 2 sheets), Gabon, Nyanga, Tchibanga area, 'Mayombe bavili, campement de la Maboumi', 27 Oct. 1914.

Terrestrial herb 1–2.6 m tall. *Leaves* many; sheaths 0.7–2 cm diam; shoots reddish, sheaths green with reddish margin, ligule chartaceous, truncate to 2-lobed, 5–20 mm long; petiole 2–10 mm long, tinged with reddish brown; sheaths, ligule and petiole glabrous; lamina narrowly elliptic, sometimes narrowly obovate, 15–30 by 5–10.5 cm, glabrous on both sides, base acute, the very base sometimes obtuse to cordate, apex acuminate (acumen 15–40 mm long). *Inflorescence* many-flowered, ovoid to subglobose, 4–10 by 3–4.5 cm, terminating a separate leafless shoot 20–50 cm long; bracts, appendages of bracts, bracteoles, calyx and ovary glabrous. *Flowers* 1 per bract; bracts somewhat



Map 11 Distribution of *Costus lucanusianus* J. Braun & K. Schum.



Map 12 Distribution of *Costus maboumiensis* Pellegr. (■) and *C. nimba* H. Maas & Maas (●).

bulging, pale to bright green, sometimes with narrow dark red margin, coriaceous, ovate to broadly ovate, 2–2.5 by 1–2 cm, callus green to yellow, generally present, 1–2 mm long; appendages absent or present, green, horizontally spreading, ovate-triangular, 1–4 by 2.5–3.5 cm; bracteole boat-shaped, 23–25 mm long, callus whitish, 2–4 mm long; calyx pale green to white, 12–20 mm long, lobes broadly ovate-triangular, 3–5 mm long, callus absent or present and then < 1 mm long; corolla hyaline, reddish brown to purplish grey to white, 40–50 mm long, glabrous, tube 15–20 mm long, lobes with dark red margins, narrowly ovate, 30–35 mm long; labellum at the outer basal part whitish, outer upper part reddish brown to purplish grey, inner side white with yellow to white central nectar guide and brown purplish-striped lateral parts, funnel-shaped, broadly obovate when spread out, 35–40 by 35–40 mm, margin crenulate; stamen white, c. 30 by 10 mm, apex white with narrow pink margin, anther 8–10 mm long. *Capsule* and *seeds* not seen.

Distribution — Central Africa (Gabon).

Habitat & Ecology — In primary or secondary rainforest. At elevations of 0–530 m. Flowering and fruiting: October and November.

IUCN Conservation Status — *Costus maboumiensis* has an AOC of 36 km² and occurs in five locations (we consider the southern and northern Doudou Mountains as two locations) of which only one partly has a protected status, while the others are in areas with more or less logging pressure. We assess the species as Endangered (EN) B2ab(ii,iii).

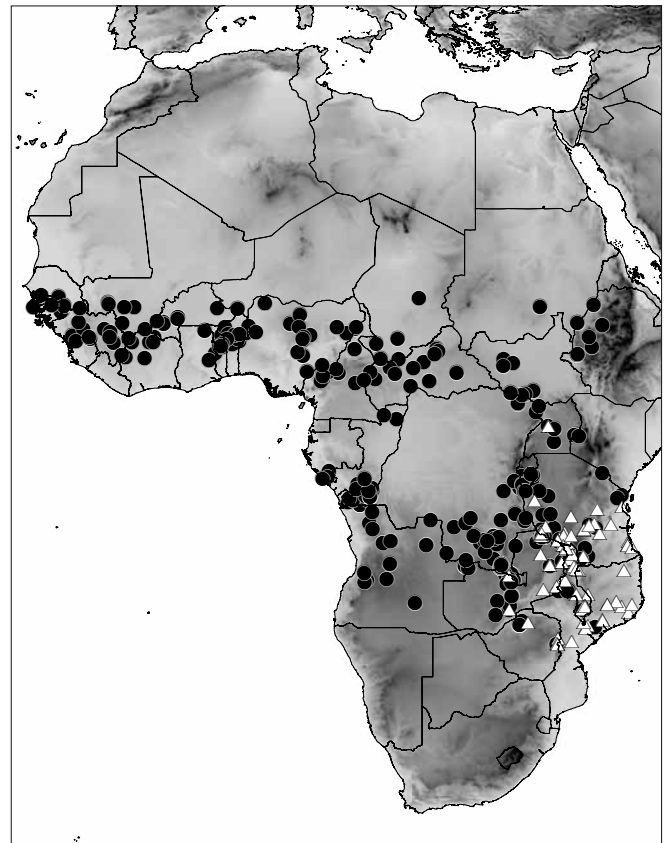
Notes — *Costus maboumiensis* is recognizable by a combination of the following characters: inflorescence terminating a separate shoot covered with reddish brown sheaths and reddish brown flowers, a colour never seen in any other African species. Furthermore all parts of the plant lack indument.

Costus maboumiensis shares with *C. dubius* a basal inflorescence, but strongly differs by the colour of the flowers, which are dark reddish brown in *C. maboumiensis* and white in *C. dubius*.

19. *Costus macranthus* K.Schum. — Plate 4a; Map 13

Costus macranthus K.Schum. (1901) 279, t. 7, 8; (1904) 421 — Type: Goetze 1488 (holo B destroyed; lecto E, designated here; isoleccto BM, BR, EA), Tanzania, T7, 'Rungwe District, Kondeland, im Kivirithal, am Kasimulo hügel im Buschwald bei 600 m', Nov. 1899.

Terrestrial shootless rosulate herb 0.1–0.2 m tall; rhizomes vertically directed, to c. 10 cm deep; horizontal runners to c. 40 cm long, 3–5(–7) mm diam, both rhizomes and runners covered with pale brown, membranous, imbricate sheaths 1.3–2 cm long; roots with side roots to c. 13 cm long. *Leaves* (3–)4(–5) per shoot, spreading horizontally and forming a cruciform rosette flat on the ground; ligule rarely seen, c. 0.5 mm long; petiole absent; lamina pale to yellowish green above, greenish purple below, with hyaline, red-purple to pink margins < 1 mm wide, distinctly thickened and fleshy, elliptic, broadly elliptic, obovate, or suborbicular, 7–20(–30) by 5–22(–25) cm, upper side glabrous to rather densely covered with soft erect hairs < 1 mm long, lower side glabrous to rather densely, rarely densely, covered with soft, erect hairs < 1 mm long, margin densely ciliate, base acute, extreme base of leaf 20–30 mm long, at an angle of 90° with the lamina, surrounding the inflorescence, apex obtuse and mucronate (mucro c. 1 mm long). *Inflorescence* terminal, formed in the centre of the rosette, few-flowered, basally enclosed by the more or less overlapping thickened extreme base of the leaves and by the uppermost 4–6 sheaths; sheaths 2–6.5 by 1–6 cm, apex obtuse to rounded, together forming a cup of 1–3 cm diam around the inflorescence; upper part of uppermost sheaths rather densely covered with soft erect hairs < 1 mm long with thickened base; upper part of bracts, bracteoles, calyx and ovary rather densely



Map 13 Distribution of *Costus macranthus* K.Schum. (▲) and *C. spectabilis* (Fenzl) K.Schum. (●).

covered with soft erect hairs < 1 mm long, capsule glabrous. *Flowers* 1 per bract; bracts whitish green, membranous, narrowly ovate-triangular, 1.7–4 by 0.4–0.8 cm, callus absent; appendages absent; bracteole boat-shaped, c. 15 mm long, callus absent; calyx 35–75 mm long, split on one side, lobes 2, broadly triangular, 2–5 mm long, callus absent; corolla (pale) yellow, 90–130 mm long, glabrous, tube 50–90 mm long, lobes narrowly ovate-triangular, 40–80 mm long; labellum bright yellow to orange, horizontally flattened, basally funnel-shaped, obovate to suborbicular when spread out, 70–110 by 60–110 mm, margin crenate; stamen yellow, 60–80 by 7–10 mm, anther (6–)7–12(–15) mm long. *Capsule* subterranean, subglobose, c. 10 by 9 mm. *Seeds* not seen.

Distribution — East Africa (Tanzania, Uganda); Southern Tropical Africa (Malawi, Mozambique, Zambia, Zimbabwe).

Habitat & Ecology — In non-inundated forest, open grass land, often on steep, rocky soil, sometimes around ant hills, plants growing in colonies, locally common, at elevations of (250–)500–1700 m. Flowering and fruiting: November and December and rarely from January to March.

IUCN Conservation Status — Least Concern.

Notes — *Costus macranthus* can be recognized by four horizontally spreading leaves forming a cruciform rosette flat on the ground and a central inflorescence producing large yellow flowers, in this aspect very much resembling *C. spectabilis*. Lock (1984) differentiates the two species based on the length of several flower parts. Of these, the length of the anther is the most reliable in herbarium material. In *C. macranthus* the anther is (6–)7–12(–15) mm long (we recorded a length of 10 mm for 15 specimens studied) and in *C. spectabilis* 4–7(–12) mm long (we recorded 5 mm for a total of 17 specimens). Among other distinguishing characters are the length of calyx, corolla tube, corolla lobes and labellum. These are all larger in *C. macranthus* than in *C. spectabilis*.

Many other possible distinctive characters still have to be studied in the field, e.g. difference in flower colour, time of floral and vegetative development (if flowers emerge before leaf emergence, at the same time as leaf development, or after leaf dehiscence) and morphology of the underground parts.

Both *C. macranthus* and *C. spectabilis* occur in the region between E28–35° and S6–15° in Malawi, Mozambique, Tanzania, Uganda, Zambia and Zimbabwe.

All collections of *C. macranthus* have been found in an area where *C. spectabilis* has also been collected. In this area the majority of the (c. 50) herbarium specimens of both species available for this study were collected flowering in November to December. Both species were found between 500 and 2000 m altitude. In this geographic range, at this altitude and with flower, specimens of both species were collected either with very young leaves or with senescent leaves. For *C. macranthus* we also recorded 5 specimens collected without any leaves. Lock wrote in *Flora Zambesiaca* (Lock & Diniz 2010: 117): “Inflorescence developing with the leaves or just before, but flowering continuing until leaves are almost fully developed”.

20. *Costus nimba* H.Maas & Maas, *sp. nov.* — Plate 4b, d; Map 12

Costus nimba is characterized by the dense brown indument of its vegetative parts, an inflorescence on a relatively long separate leafless shoot, green bracts and white to salmon pink flowers with a horizontally flattened labellum. — Type: *Phillipson 6415* (holo WAG 2 sheets; iso MO, P), Guinea, Nzérékoré, Nimba Mountains, lower Zié Valley, at edge of World Heritage Site, along river bank in sandy soil, 591 m, 10 July 2012.

Terrestrial herb 1.5–2.5 m tall. *Leaves* many; sheaths, 0.8–2.5 cm diam; ligule chartaceous, obliquely truncate to slightly unequally 2-lobed, 14–23 mm long; petiole 13–33 mm long; sheaths, ligule and petiole densely to very densely covered with erect, brown hairs 1–2 mm long; lamina chartaceous, narrowly obovate to narrowly elliptic, 24–36 by 6–10 cm, upper side glabrous except for the midrib, lower side and midrib on upper side (very) densely covered with appressed hairs 1–1.5 mm long, base acute, apex acute to acuminate (acumen 15–20 mm long). *Inflorescence* many-flowered, ovoid-ellipsoid to cylindrical, 10–17 by 4–5.5 cm, terminating the leafy shoot or terminating a separate leafless shoot 24–30 cm long; bracts, bracteoles, calyx, ovary and capsule glabrous. *Flowers* 1 per bract; bracts green, coriaceous, broadly ovate, 3–3.5 by 2.5–3.5 cm, callus indistinct; appendages absent; bracteole boat-shaped, 30–35 mm long, callus present, 2–4 mm long; calyx 18–22 mm long, lobes broadly ovate-triangular, 4–6 mm long, callus 1–2 mm long; corolla hyaline, salmon-coloured, 40–60 mm long, glabrous, tube 15–20 mm long, lobes narrowly obovate-elliptic, 25–35(–40) long; labellum at the outer side white, inner side white to very pale salmon pink with pale yellow nectar guide and two dark pink basal zones covered with erect hairs c. 1.5 mm long, horizontally flattened, depressed obovate when spread out, 40–45 by 40–45 mm, margin crenulate; stamen white, c. 30 by 12–18 mm, anther 7–8 mm long, apex acute. *Capsule* ellipsoid to obovoid, 14–17 by 8–11 mm. *Seeds* c. 2 by 1 mm.

Distribution — West Africa (Ghana, Guinea, Ivory Coast, Liberia, Sierra Leone); Central Africa (Cameroon).

Habitat & Ecology — In rainforest along river bank, in sandy soil, at elevations of 0–1150 m. Flowering and fruiting: May to December.

Field observations — The flowers of *C. nimba* emit a ‘fragile sweet scent’ (*Jongkind & Bilivogui 11301*).

IUCN Conservation Status — Least Concern.

Additional specimens examined. CAMEROON, **South Province**, Djoum, 600 m, anno 2014, *Cheek 17660* (K, WAG, YA). **South-West Province**, Mondemba-Fabe Road, 22 Nov. 1986, *Nemba & Thomas 331* (K, WAG). —

GHANA, **Brong-Ahafo Region**, between Wenchi and Bamboi, 350 m, 3 Oct. 1996, *Jongkind 3138* (WAG). **Eastern Region**, Kade, 2 June 1968, *Hall GC 38519* (GC, K); Busoso-Begoso Road, 16 June 1969, *Hossain & Enti GC 35403* (GC); ‘Ex Garden Legon, original from Kade’, 18 Dec. 1956, *Morton GC 8334 = P 2051* (GC); Kwahu West District, Akoase, 196 m, 8 July 2010, *Van Andel et al. 5735* (WAG). — GUINEA, **Nzérékoré**, Nimba Mts, Zié Valley, 590 m, 21 Sept. 2011, *Jongkind & Bilivogui 11163A* (WAG); Nimba Mts, Zié River, 667 m, 10 July 2012, *Jongkind & Bilivogui 11301* (BRLU, WAG); Nimba Mts, inside the WHS site close to the Zié River bridge, 540 m, 28 Oct. 2012, *Jongkind et al. 11620* (WAG). — IVORY COAST, **Divo**, between Divo and Lakota, 18 Apr. 1968, *Aké Assi 10030* (G); Divo, 5 km SE of Guity, 20 m, 1 Nov. 1975, *Beentje 1283* (WAG); Forêt de Divo, 10 Aug. 1975, *Hall & Abbiw GC 45357* (GC). **Guiglo**, Taï, between Sakré and Nigré, 28 Dec. 1987, *Aké Assi 17871* (G). **Man**, Man, near climatic station on Mt Tonkoui, 1150 m, 28 May 1975, *Beentje 341* (WAG). **Soubré**, Haut Sassandra, Pays des Byolas, entrée du village de Dyedeougou, 10 May 1909, *Chevalier 21517* (P). — LIBERIA, **Eastern Province**, Webo District, Sarbo, 6 July 1947, *Baldwin Jr. 6410a!* (K). — SIERRA LEONE, **Northern Province**, 15 miles N of Port Loko, in garden at FBC, 28 Apr. 1965, *Morton s.n.* (K). **Southern Province**, near Mokebi (Kori), 26 May 1953, *Jordan 900* (K); without location, 1915, *Thomas 8455* (K).

Notes — *Costus nimba* comes closest to *C. dubius*, both sharing a basal inflorescence with green, unappendaged bracts. It differs, however, by the dense brown indument of its vegetative parts (absent in *C. dubius*), its horizontally flattened labellum with two basal salmon pink patches and yellow nectar guide (funnel-shaped with yellow nectar guide in *C. dubius*) and its hyaline salmon pink corolla lobes (white and not hyaline in *C. dubius*).

Costus nimba differs from *C. dinklagei*, another species having a basal inflorescence with green, unappendaged bracts and hyaline corolla lobes by its salmon pink corolla lobes (whitish in *C. dinklagei*), by its horizontally flattened white labellum with two basal salmon pink patches and yellow nectar guide (pale pink, funnel-shaped with yellow nectar guide in *C. dinklagei*) and its generally larger inflorescence and a longer separate leafless shoot.

21. *Costus phyllocephalus* K.Schum. — Plate 3e; Map 14

Costus phyllocephalus K.Schum. (1892) 420; (1904) 386. — Type: *Von Mechow 508* (holo B destroyed; lecto Z, designated here; iso M), Angola, Prov. Malanje, Malanje (‘Malane’), Quango River, June–Aug. 1880.

Costus nudicaulis Baker (1898) 300, syn. nov. — Type: *Mann 1033* (holo K), Gabon, Estuaire, Gaboon River, July 1861.

Costus dewevrei De Wild. & T.Durand in Durand & De Wildeman (1899) 139, syn. nov. — Type: *Dewèvre 334* (holo BR; iso BR), Congo Kinshasa, Kinganga (‘Chinganga’), 29 Aug. 1895.

Costus fissiligulatus Gagnep. (1902a) 93, syn. nov. — Type: *A plant cultivated at Bot. Gard. Paris as ‘Gabon N° 639’*, July 1902 (holo P; iso P).

Costus fissiligulatus Gagnep. var. *major* Gagnep. (1902a) 94, syn. nov. — Type: *Griffon du Bellay s.n.* (holo P), Gabon, without locality, ‘Donné par l’Exposition Coloniale. Cat. 1864 N° 4’.

Costus ubangiensis Gagnep. (1902a) 97, syn. nov. — Type: *Viancin s.n.* (holo P), Central African Republic, ‘Haut-Oubangui’.

Costus nudicaulis Baker var. *pilosa* Gagnep. (1902b) 19, syn. nov. — Type: *Lecomte B25* (holo P), Congo Brazzaville, ‘Nounzi’, Oct. 1893.

Costus violaceus Koechlin (1964) 88, pl. 20, syn. nov. — Type: *N. Hallé 1543* (holo P), Gabon, Ogooué-Maritime, Port-Gentil, 2 Apr. 1959.

Costus foliaceus Lock & A.D.Poulsen in Poulsen & Lock (1997) 614, f. 3, pl. 2a, syn. nov. — Type: *Poulsen et al. 503* (holo K; iso C, ENT, MHU), Uganda, Bushenyi District, Kasyoha-Kitomi Forest Reserve, NE of Kyambura River, 1250 m, 4 June 1994.

Costus sp. A Lock & Diniz (2010) 120.

Terrestrial herb 0.2–3 m tall. *Leaves* many; sheaths 0.5–2 cm diam; ligule brown, upper margin reddish, membranous, split into 2 very unequal obtuse to acute lobes, 10–50 mm long; petiole 3–10 mm long; sheaths, ligule and petiole sparsely to densely covered with erect, brown hairs to c. 3 mm long; lamina green to purple below, rarely red on both sides, narrowly ovate to narrowly obovate, 10–31 by 4–12 cm, upper side glabrous or rarely sparsely to densely covered with erect hairs to c. 3

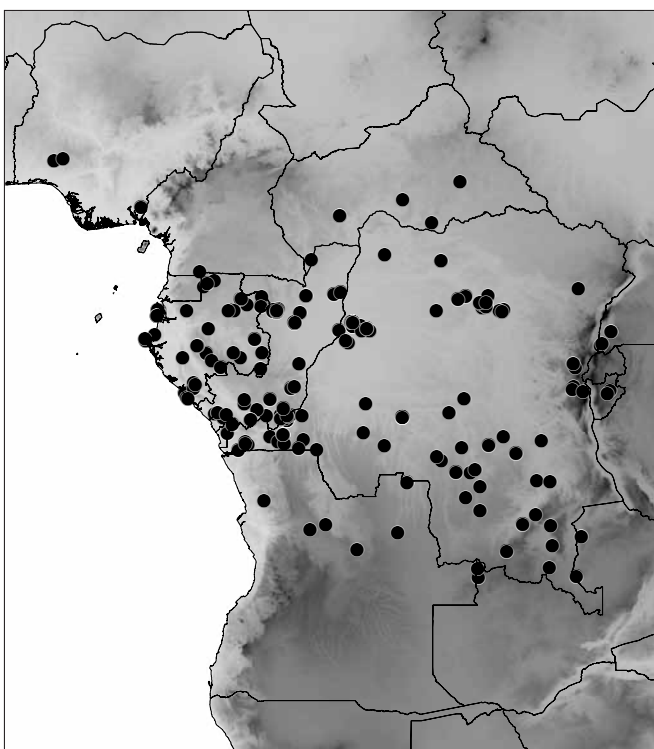
mm long, lower side rather densely to sparsely covered with erect brown hairs to c. 3 mm long to glabrous, base obtuse, rarely subcordate, apex acuminate (acumen 15–25 mm long). *Inflorescence* (few- to) many-flowered, ovoid to globose, 2.5–10 by 3–7 cm, terminating the leafy shoot, sometimes sprouting from the axils of the lower bracts; bracts, appendages of bracts, bracteoles, calyx, ovary and capsule sparsely to densely covered with erect hairs < 1 mm long to glabrous. *Flowers* 1 per bract; bracts green to reddish purple, coriaceous, ovate-elliptic to broadly so, 1–2.5 by 1–2.5 cm, callus sometimes present and then 1–2 mm long; appendages mostly present, green, horizontally spreading to reflexed or rarely erect, narrowly triangular to rarely broadly ovate-triangular, 1–4.5(–6.5) by 5–20 cm; bracteole boat-shaped, 1(–2)-keeled, 11–21 mm long, callus 2–3.5 mm long; calyx 10–27 mm long, lobes shallowly to broadly triangular, 2–4 mm long, callus absent; corolla white to pale pink to lilac, 40–65 mm long, glabrous, rarely covered with erect hairs < 1 mm long, tube 10–20 mm long, lobes narrowly obovate to narrowly elliptic, 30–55 mm long; labellum white to pale pink on the outer side, inner side white with the upper half striped dark pink to lilac to dark purplish pink, or completely white to very pale pink, with yellow nectar guide, horizontally flattened, broadly obovate when spread out, 40–70 by 50–70 mm, fimbriate, margin crenulate and/or undulate, sometimes 5-lobed; stamen white to yellow or dark pink, 30–45 by 10–15 mm, apex yellow, tip of apex pink or pale yellow, toothed, anther 7–9 mm long. *Capsule* subglobose to obovoid, 6–15 by 6–15 mm. *Seeds* 2–3 by 1–1.5 mm.

Distribution — West Africa (Nigeria); Central Africa (Burundi, Cameroon, Central African Republic, Congo Brazzaville, Congo Kinshasa, Gabon); East Africa (Uganda); Southern Tropical Africa (Angola, Zambia).

Habitat & Ecology — In primary or secondary rainforest, gallery forest, sometimes in coastal forest or in wet places near savannas, rivers or creeks, or along roads, at elevations of 0–1500 m. Flowering and fruiting: all year through.

Field observations — On the label of the specimen *Le Testu* 2374 is written 'fleurs très odorantes'.

IUCN Conservation Status — Least Concern.



Map 14 Distribution of *Costus phyllocephalus* K.Schum.

Notes — *Costus phyllocephalus* can be recognized by a combination of green appendaged bracts, leaves on flowering shoot concentrated just below the inflorescence, flowers of which the horizontally flattened labellum is whitish pink to striped with dark purplish pink and a long brown membranous ligule (10–50 mm long). The upper brown membranous part of this ligule can be deciduous only leaving the lower green tubular part.

Costus phyllocephalus looks quite similar to *C. ligularis*. For the differences between both species see under the latter.

In *C. phyllocephalus* young shoots are sometimes formed from the lower bracts; these shoots have relative small ligules. In the fruiting stage the calyx is often protruding beyond the bracts.

Some collections are aberrant from typical *C. phyllocephalus* in having unappendaged bracts. Sometimes there are transitions between the uppermost leaves and the appendages of the lowest bracts. The shoots are reddish and the leaves tend to be concentrated at the top of the shoot. The yellow central blotch (nectar guide) is situated in the throat of the flower and does not reach the outer margin of the labellum as in *C. lucanusianus*.

22. *Costus spectabilis* (Fenzl) K.Schum. — Plate 4c; Map 13

Costus spectabilis (Fenzl) K.Schum. (1892) 422; (1904) 421. — *Cadalvena spectabilis* Fenzl (1865) 140. — *Kaempferia spectabilis* (Fenzl) Baker (1898) 297. — Type: *Boriani s.n.* (holo W destroyed), Sudan, Fazughli ('in Aethiopiae terra Fassoglu'). The following collection is selected here as neotype: *Schweinfurth* 1345 (neo BM, designated here; isoneo G, K, L, P), Sudan, Gallabat ('Am linken Ufer der Gendua'), June 1865. A drawing in the B herbarium with annotation: '18 Juni 1865, Ethiopia, in Gallabas, an der Gendua' is probably made of *Schweinfurth* 1345, the present neotype of this species.

Costus pistiifolius K.Schum. (1892) 424. — *Cadalvena pistiifolia* (K.Schum.) Baker (1898) 297. — Type: *Von Mechow* 315 (holo B destroyed; lecto Z, designated here), Angola, Prov. Malanje, Malanje ('Malandsche'), Oct. 1879.

Cadalvena dalzielii C.H.Wright (1912) 195; C.H.Wright (1915) t. 3013, syn. nov. — Type: *Dalziel* 229 (lecto K, designated here), Nigeria, Yola Province, Kilba Country, 30 July 1909; other syntype: *Dalziel* 560 (K 2 sheets, E 2 sheets), Nigeria, South of Sokota Province and throughout Kontagora Province, 12 June 1911.

Terrestrial shootless rosulate herb to c. 0.1 m tall; rhizomes vertically directed, to c. 18 cm deep; horizontal runners to 5–20 cm long, (1–)3–9 mm diam, both rhizomes and runners covered with brownish, imbricate, membranous sheaths; roots with side roots up to c. 10 cm long. *Leaves* 4 per shoot, forming a funnel when young, later spreading horizontally and forming a rosette of partly overlapping leaves flat on the ground; ligule and petiole absent; lamina bright yellowish green above, paler green with reddish venation to completely reddish below, often with (dark) reddish margins 0.5–1 mm wide, definitely thickened and fleshy, imbricate, broadly obovate to broadly elliptic to suborbicular, 4–15(–17) by 4–17 cm, upper side glabrous, lower side densely covered with soft, erect hairs < 1 mm long, margin ciliate, base attenuate, extreme base of leaf fleshy to c. 5 mm thick and 10–35 mm long, at an angle of 90° with the lamina surrounding the inflorescence, apex obtuse and often mucronate. *Inflorescence* terminal, formed in the centre of the rosette, up to 17-flowered, basally enclosed by the more or less overlapping fleshy extreme base of the leaf laminas and by the uppermost 4–5 (whitish and fleshy) sheaths; sheaths 2–4 by 1.5–3.5 cm, apex rounded, upper part reflexed with a horizontal rim of 0.7–0.8 cm high, together forming a cup of 0.8–2.5 cm diam around the inflorescence; the uppermost sheaths, outer side of bracts, bracteoles, calyx and apex of ovary densely to sparsely covered with soft, erect hairs < 1 mm long to glabrous, capsule glabrous. *Flowers* 1 per bract, erect; bracts reddish, membranous, narrowly triangular, 1.7–3.2 by 0.6–0.8 cm, callus yellow, inconspicuous; appendages absent; bracteole boat-shaped, 8–25 mm long, callus absent; calyx

reddish, green, or purple, 15–30 mm long, split on one side, lobes 2, narrowly triangular, c. 1 mm long, callus inconspicuous; corolla hyaline, pale yellow to pale orange, 40–100 mm long, glabrous, tube 20–45 mm long, lobes narrowly ovate-triangular, 20–55 mm long; labellum dark yellow to orange, horizontally flattened, obtriangular to obovate to suborbicular when spread out, 50–70 by 30–50 mm, margin crenate; stamen orange to yellow, 15–40(–60) by 5–7 mm, anther 4–7(–12) mm long. *Capsule* subterranean, ellipsoid, 6–12 by 4–7 mm. *Seeds* c. 2 by 2 mm.

Distribution — North Africa (Egypt); North East Africa (Ethiopia, South Sudan, Sudan); West Africa (Benin, Burkina Faso, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo); Central Africa (Burundi, Cameroon, Central African Republic, Chad, Congo Brazzaville, Congo Kinshasa, Gabon); East Africa (Kenya, Tanzania, Uganda); Southern Tropical Africa (Angola, Malawi, Mozambique, Zambia, Zimbabwe).

Habitat & Ecology — Often in savanna woodland (with e.g. *Brachystegiae*, *Primary*, etc.), on clayey to loamy soil, or on rocky outcrops, often on ant hills, at elevations of 0–2000 m. Flowering and fruiting: April to December, mostly in October and December.

Field observations — Completely leafless flowering specimens have been collected in May–June and October–December. Information on the labels of *Michel & Reed 70* and *Schlieben 1560* mentions the appearance of *C. spectabilis* soon after burning.

IUCN Conservation Status — Least Concern.

Notes — *Costus spectabilis* can be recognized by its four horizontally spreading leaves forming a cruciform rosette flat on the ground, with an inflorescence in the centre producing large yellow flowers.

For morphological differences between *C. spectabilis* and the only other shootless rosulate species *C. macranthus* see under the latter.

Both *C. spectabilis* and *C. macranthus* occur in the region between E28–35° and S6–15° in Malawi, Mozambique, Tanzania, Uganda, Zambia and Zimbabwe. All collections of *C. spectabilis* have been found in an area where *C. macranthus* has also been collected. However, *C. spectabilis* has been collected in a much wider area than *C. macranthus*: between W13°–E33° and N12°–S15° and therefore in more countries, especially in Western Africa (see map 1 of Lock 1984).

23. *Costus talbotii* Ridl. — Plate 4e; Map 9

Costus talbotii Ridl. (1913) 111. — Type: *Talbot 1521* (lecto BM 2 sheets, designated by Turner (2000); isolecto K), Nigeria, Cross River State, Oban, anno 1912.

Epiphytic or terrestrial herb c. 0.5 m tall. *Leaves* several; sheaths 0.2–0.5 cm diam; ligule brown, membranous, truncate, 40–55 mm long; petiole 3–10 mm long; sheaths, ligule and petiole glabrous; lamina narrowly elliptic, 10–18 by 3–5 cm, glabrous on both sides, coriaceous and somewhat fleshy, base obtuse to acute, apex acuminate (acumen 10–20 mm long). *Inflorescence* few-flowered, broadly ovoid, 2–3 by 1.5–2.5 cm, terminating a separate leafless shoot < 1 cm long, lateral in the axil of a leaf, or rarely terminal, sheaths dark brown, broadly to transversely elliptic, 6–14 by 9–15 mm; bracts sparsely to rather densely covered with appressed hairs < 1 mm long, bracteoles, ovary and capsule rather densely covered with erect hairs < 1 mm long, calyx glabrous or sparsely covered with appressed to erect hairs < 1 mm long. *Flowers* 2 per bract; bracts reddish brown to dark brown, coriaceous, broadly ovate-triangular, 1.2–2 by 1.3–2 cm, callus absent or sometimes present and c. 0.5 mm

long; appendages absent; bracteole boat-shaped, 15–20 mm long, callus green, 1–2 mm long; calyx green, dark reddish dotted, 11–15 mm long, lobes broadly to shallowly triangular, 2–4 mm, callus 1–2 mm long; corolla tube white, lobes hyaline, dark pink, 35–40 mm long, glabrous, tube c. 10 mm long, lobes narrowly elliptic, 25–30 mm long; labellum white on the outer side, inner side white to dark pink with pink dots in the throat and yellow nectar guide, horizontally flattened, broadly obovate when spread out, 30–40 by 30–40 mm, margin indistinctly irregularly 5-lobed, crenate; stamen white with pink dots, c. 25 by 8–9 mm, apex pink, 3-lobed, lobes linear, middle lobe longer than the lateral ones, anther 5–6 mm long. *Capsule* ovoid to broadly ovoid, 9–15 by 7–9 mm. *Seeds* 2–2.5 by 1 mm.

Distribution — West Africa (Nigeria, near the border with Cameroon). At unknown elevations.

Habitat & Ecology — Unknown. Flowering and fruiting: unknown.

IUCN Conservation Status — *Costus talbotii* was collected as a herbarium specimen twice in the wild, both collections were made in the same area over 100 years ago without precise locality information (one location, AOO of 4 or 8 km²). However, since it apparently was collected more recently (1978) for cultivation in a botanical garden, we do not consider this species as Extinct in the Wild. The area where it was collected (SE Nigeria) is poorly explored over the past 40 years, so it is not a surprise there are no recent collections: on the other hand it was not collected in the decades before that (or only once as living plant) when there was more botanical activity in the region. In this area there are extensive protected areas present, but satellite images show there is also logging, cultivation and mining going on in the area, including in some of the protected areas. So it seems at least part of this area is under serious threat for habitat destruction. We therefore assess the species as Critically Endangered (CR) B2a(iii,v).

Notes — *Costus talbotii* is distinct from the two other epiphytic African species of *Costus* by its much broader (to c. 2 cm wide) coriaceous bracts vs the chartaceous bracts (to 1.1 cm wide) in *C. lateriflorus* and *C. lilaceus*. Moreover, the flower colour of the three species is clearly different.

Costus talbotii is a very incompletely known species: it is only known from the type collection and from cultivation. This plant has been cultivated at the Cambridge Botanical Garden in England under the accession number 19780014. It had been collected in Oban, Cross River State, Nigeria (the type locality) in 1978, where it was gathered by P.W. Richards, then Professor at the Cambridge University. This material died in the Cambridge Botanical Garden in 1996. Luckily living material had been sent to the Delft Botanical Garden in The Netherlands where it is still cultivated under the number Delft 46-490. From Delft some living plants were sent to Burgers' Zoo in Arnhem (The Netherlands), where it is now grown under the number Burgers' Bush 2008-0109009. The plant flowered in 2009 and was photographed, described and collected by the second author (*Maas et al. 9800*).

Of the two syntypes of *C. talbotii*, *Zenker 3823* (BM, E, G, K, US, WRSL), anno 1909, from Bipindi, Cameroon does not represent *C. talbotii* but belongs to *C. lateriflorus* or to *C. lilaceus*.

24. *Costus tappenbeckianus* J.Braun & K.Schum. — Plate 3c; Map 10

Costus tappenbeckianus J.Braun & K.Schum. (1889) 152; K.Schum. (1904) 416. — Type: *Braun s.n.* (holo B destroyed), cultivated and flowering in April 1889 in the Hort. Bot. Berlin from material collected in Gross-Batanga, South Province, Cameroon. As the holotype in Berlin was destroyed and no other type material was located, we hereby select a neotype from a locality not far from the type locality: *J.J.F.E. de Wilde 8702* (neo WAG 2 sheets

[WAG0114484, WAG0114485]; isoneo BR, EA, K, MA, MO, P, PRE, YA), Cameroon, South-West Province, Dipikar Island, 3 km SE of the bridge crossing the Bongola River, along forest exploitation track, 3 Dec. 1975.

Costus pauciflorus K.Schum. (1892) 421, syn. nov. — Type: *Soyaux 119* (holo B destroyed; lecto K, designated here), Gabon, Estuaire, 'in ditione Munda, Sibange-Farm', 3 Sept. 1880.

Costus radicans Gagnep. (1903) 262, syn. nov. — Type: *Bates 519* (holo P; iso BM, G, K), Gabon, Estuaire, Mfôa, 85 miles E of Gaboon, Oct. 1896.

Costus nemotrichus K.Schum. (1904) 414, f. 47, syn. nov. — Type: *Dinklage 954* (holo B destroyed), Cameroon, South Province, Gross-Batanga.

Costus phaeotrichus Loes. (1909) 392, syn. nov. — Type: *Zenker 3694* (B destroyed; lecto P, designated here; isolecto BM, E, G, K, L, M, P, S, US, W), Cameroon, South Province, Bipindi ('Bipindihof', 'blühend vom Dezember bis Februar, 1908'; other syntype: *Ledermann 945* (B destroyed), Cameroon, South Province, Mfosse, near Nkolebunde, 180 m,

Terrestrial herb 0.2–1 m tall. *Leaves* several; sheaths brownish red, shiny, more or less turbinate, 0.3–1 cm diam, upper margin irregularly denticulate; ligule chartaceous, truncate, 1–5 mm long; petiole 0–3 mm long; sheaths, ligule and petiole densely to sparsely covered with half-appressed to erect, brown, needle-like hairs to c. 4 mm long to glabrous; lamina often irregularly bullate and 5–10-plicate (*Maas 9962*), upper side shiny, bright green, lower side reddish to purplish, elliptic to obovate, often slightly asymmetrical, 5.5–18(–22) by 2.5–7(–14) cm, both sides rather densely to sparsely covered with half-appressed to erect, brown, needle-like hairs to c. 4 mm long to glabrous, base cordate, apex acute to acuminate (acumen to c. 10 mm long). *Inflorescence* few-flowered, (narrowly) ovoid to ellipsoid, 2.5–4 by 1–1.5 cm, terminating a separate leafless shoot 1–9 cm long, or rarely terminating a leafy shoot; bracts, bracteoles, calyx, ovary and capsule glabrous or nearly so. *Flowers* 2 per bract; bracts brownish red to dark purple, shiny, chartaceous, ovate-triangular, 2–3.5 by 0.7–3 cm, callus brown, 2–4 mm long; appendages absent; bracteole boat-shaped, 22–35 mm long, callus green to yellow, c. 2 mm long; calyx (5–)10–13 mm long, lobes broadly triangular, 1–2 mm long, callus absent; corolla hyaline, whitish pink, 55–90 mm long, glabrous, tube 15–30 mm long, lobes narrowly elliptic, 30–60 mm long; labellum at the outer side white with dark pink upper half, inner side with white throat, dark pink upper part, or completely dark pink, or rarely completely white, with yellow nectar guide, funnel-shaped to horizontally flattened, broadly obovate when spread out, 35–70 by 40–60 mm, margin undulate and fimbriate; stamen white to pink, 20–45 by 9–12 mm, apex pink to red, anther 5–6 mm long. *Capsule* broadly obovoid, c. 8 by 7 mm. *Seeds* 2–3 by 3–4 mm.

Distribution — Central Africa (Cabinda (Angola), Cameroon, Congo Brazzaville, Equatorial Guinea, Gabon).

Habitat & Ecology — In non-inundated primary or secondary rainforest, in swamp forest, in dark wet places, on loamy or sandy soil. At elevations of 0–800 m. Flowering and fruiting: all year through.

IUCN Conservation Status — Least Concern.

Notes — *Costus tappenbeckianus* is characterized by a few-flowered inflorescence terminating a separate leafless shoot with pink (or rarely white) flowers and subsessile leaves with a cordate base. The sheaths, especially those of the separate reproductive leafless shoot, are more or less turbinate with an irregularly denticulate reddish upper margin. The corolla lobes are relatively narrow. Left and right margin of the labellum are not touching each other, thus not forming a complete funnel. A specimen with white flowers is cultivated in Burgers' Bush, Arnhem, The Netherlands; it was originally collected in Gabon (*Maas & Maas 9787*).

Costus tappenbeckianus was placed by Schumann (1904: 414) in his new subg. *Epicostus* together with *C. bicolor*, *C. dendrophilus*, *C. lanceolatus*, *C. nemotrichus*, *C. nudicaulis*, *C. pauciflorus* and *C. radicans*. According to him these species were all

epiphytic ('saepissime epiphytici'), except for *C. tappenbeckianus*, had a small and few-flowered inflorescence and nicely coloured, but never yellow, flowers. *Costus nudicaulis* (now included in *C. phyllocephalus*) and the Neotropical species *C. lanceolatus* were different from the other six species of this subgenus by an inflorescence terminating a leafy shoot. After an intensive study of the six other species of the subg. *Epicostus* with an inflorescence terminating a separate leafless shoot, we found that they only differed in minor indument features.

Costus bicolor and *C. dendrophilus*, of which no material is available (as that has been destroyed) are here considered insufficiently known species (see below)

Paracostus

Paracostus C.D.Specht in Specht & Stevenson (2006) 162. — Type: *Tafel 13 of K. Schumann (1892)*, (the lectotype of *Costus englerianus* K.Schum.)

Costus L. sect. *Paracostus* K.Schum. (1899) 343. — *Costus* subg. *Paracostus* (K.Schum.) K.Schum. (1904) 381. — Type: *Paracostus paradoxus* (K.Schum.) C.D.Specht (= *Costus paradoxus* K.Schum.).

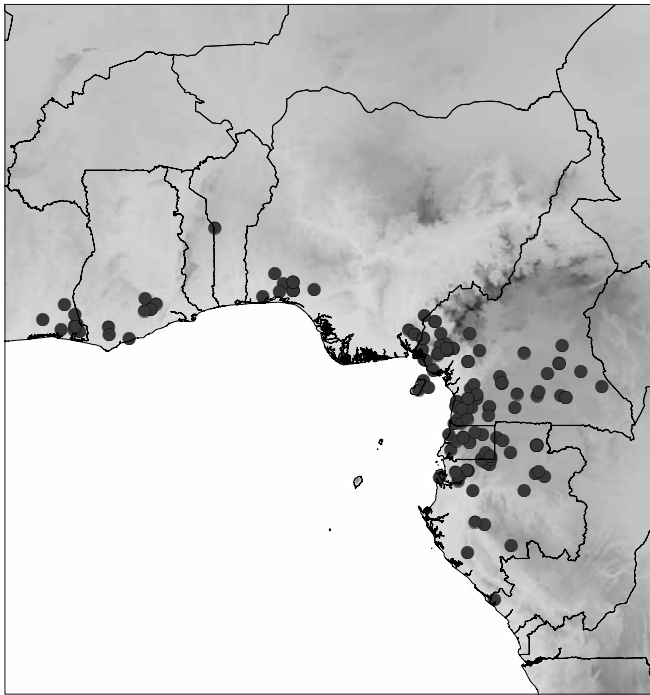
The genus *Paracostus* is in Africa represented by only one species: *P. englerianus*. The second species, *P. paradoxus* (K.Schum.) C.D.Specht, occurs in Asia (Borneo).

1. *Paracostus englerianus* (K.Schum.) C.D.Specht — Plate 1e; Map 15

Paracostus englerianus (K.Schum.) C.D.Specht in Specht & Stevenson (2006) 162. — *Costus englerianus* K.Schum. (1892) 419, t. 13 (2 Aug. 1892); (1904) 424. — Type: *Preuss 461* (holo B destroyed), Cameroon, W of Barombi-ba-Mbu, 2 Sept. 1890. As the holotype in B has been destroyed, the illustration accompanying the protologue (*K. Schumann 1892: Tafel 13*), which is the only remaining original material, is here designated as the lectotype.

Costus unifolius N.E.Br. (1892) 696 (10 Dec. 1892), syn. nov. — Type: *Cultivated in Kew Gardens in 1892 from material received from Sander & Co.*, who collected it in 1891 in Ghana ('Gold Coast') (holo K).

Terrestrial, prostrate herb 0.2–0.3 m tall; rhizomes > 20 cm long, repeatedly branched, horizontally creeping, 1.5–7 mm diam, shoots reddish, provided with brown membranous sheaths 1.2–1.9 by 0.5–0.8 cm and roots with side roots to c. 10 cm long. *Leaves* 1 per shoot; description of sheaths see under inflorescence; ligule and petiole absent; lamina green to shiny dark green above, paler green to whitish green below, elliptic to obovate or broadly so, 8–19 by 5–13 cm, 3–4-plicate, glabrous on both sides, base attenuate, extreme base of leaf fleshy, 10–20 mm long, at an angle of 45° with the lamina, surrounding the inflorescence, apex obtuse, minutely apiculate. *Inflorescence* axillary, 1–7-flowered, 0.5–1.3 cm long, the lower portion enclosed by the more or less overlapping margins of the base of the lamina and by the uppermost 1–3 sheathing leaf bases; sheaths to c. 6 by 1.3 cm, apex acute to obtuse; bracts, bracteoles and calyx rather densely covered with soft, erect hairs c. 1 mm long, ovary glabrous; bracts reddish brown, green, or yellow, membranous, broadly to depressed ovate, 0.7–1.5 by 1–1.3 cm, callus absent; appendages absent; bracteole pale brown to green, boat-shaped, 12–13 mm long, callus absent; calyx pale brown to green, 9–20 mm long, lobes (broadly) triangular, 1–4 mm long, callus absent; corolla white to pale green, 28–35 mm long, glabrous, tube 10–15 mm long, lobes erect, narrowly ovate-triangular, 18–20 mm long; labellum white to slightly pink, inner side with yellow or orange nectar guide in the throat, horizontally flattened, (broadly) obovate when spread out, 20–50 by 12–30 mm, margin crenate; stamen white, 15–35 by (1.5–)3–4 mm, apex yellow, anther 2–3 mm long; stigma is composed of a funnel-shaped upper part and a reflexed lamellate part; appendage absent. *Fruit* and *seeds* not seen.



Map 15 Distribution of *Paracostus englerianus* (K.Schum.) C.D.Specht.

Distribution — West Africa (Benin, Ghana, Ivory Coast, Nigeria); Central Africa (Cameroon, Congo Brazzaville, Equatorial Guinea, Gabon).

Habitat & Ecology — Understorey of lowland rainforest, often forming dense patches and growing on rocks. At elevations of 0–1100 m. Flowering and fruiting: all year through.

IUCN Conservation Status — *Paracostus englerianus* with around 50 locations of which 14 have a protected status and an AOO of 484 km² is assessed by us as Least Concern (LC). However, we need to note that nearly the entire distribution in Upper Guinea (West of the Dahomey Gap) is present in unprotected areas (only the locality in the Atewa Range has some protection, but see Hoekstra et al. 2016), while this area is seriously facing habitat destruction. If this somewhat isolated part of the species would prove to possess unique genetic (or morphological) features, these populations should get some attention and might need to be assessed separately.

Note — *Paracostus englerianus* is distinguished from other African *Costaceae* by its prostrate and often lithophilic habit, 1 solitary leaf per shoot, few-flowered inflorescence with inconspicuous bracts and relatively small whitish flowers. The inflorescence of *P. englerianus* is axillary. According to Specht & Stevenson (2006) the inflorescence emerges from the axil of the leaf and appears terminal due to secondary displacement along with lack of continued growth of the shoot apical meristem.

INSUFFICIENTLY KNOWN NAMES

Costus adolphi-friderici Loes. (1910) 66 (as '*Adolphi Friderici*'). — Type: *Mildbraed 2378* (holo B destroyed), Congo Kinshasa, Nord-Kivu, Beni, 'Im Urwald bei Muera, nordwestlich von Beni, Januar 1908'.

Costus auriculatus K.Schum. (1904) 396, nom nud.

Costus bicolor J.Braun & K.Schum. (1889) 152. — Type: *Braun 91* (holo B destroyed), Cameroon, 'in Müha, bei Malimba auf dicken Bäumen in Inundationsgebiet des Sannaga flusses'. This epiphytic species is insufficiently understood because the type (and only material) in B has been destroyed

Costus dendrophilus K.Schum. (1904) 416. — Type: *Dinklage 1138* (holo B destroyed), Cameroon, South Province, Batanga, 16 Feb. 1891. This species has been described as being an epiphyte by Schumann.

Costus ledermannii Loes. (1909) 391. — Type: *Ledermann 344* (holo B destroyed), Cameroon, South Province, Bodje.

Costus mosaicus W.Bull (1887) 10, 'Congo', nom. dub. This might be a variegated form of an African species of *Costus*.

Costus schlechteri H.J.P.Winkl. (1908) 275. — Type: *Winkler 25a* (holo B destroyed), Cameroon, South-West Province, Victoria, 'Urwald hinter dem Kirchhof', May 1904.

Costus ulugurensis K.Schum. (1904) 396. — Type: *Stuhlmann 8709* (holo B destroyed), Tanzania, N'glewenu, Mochuba, 350 m, 17 Oct. 1894.

Costus zechii K.Schum. (1904) 409. — Type: *Zech auf Neuhofen 273c* (holo B destroyed), Ghana, Kete Krachi ('bei Kete Kratschi').

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Note: initials are only added when there is more than one person with that surname as main collector in Africa.

acu = <i>Costus acutissimus</i>	gab = <i>Costus gabonensis</i>	lou = <i>Costus louisii</i>
afe = <i>Costus afer</i>	gig = <i>Costus giganteus</i>	luc = <i>Costus lucanusianus</i>
alb = <i>Costus albifolius</i>	gra = <i>Costus gracillimus</i>	mab = <i>Costus maboumiensis</i>
aur = <i>Costus aureus</i>	kup = <i>Costus kupensis</i>	mac = <i>Costus macranthus</i>
din = <i>Costus dinklagei</i>	lat = <i>Costus lateriflorus</i>	nim = <i>Costus nimba</i>
dub = <i>Costus dubius</i>	lig = <i>Costus ligularis</i>	phy = <i>Costus phyllocephalus</i>
eng = <i>Paracostus englerianus</i>	lil = <i>Costus lilaceus</i>	spe = <i>Costus spectabilis</i>
fen = <i>Costus fenestralis</i>	loa = <i>Costus loangensis</i>	tal = <i>Costus talbotii</i>
		tap = <i>Costus tappenbeckianus</i>

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