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THE CANNACEAE OF THE WORLD

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SUMMARY

This taxonomic treatment includes all Cannaceae of the world. Emphasis is on the 10 species growing in the wild in the Neotropics. Included are chapters on the history of the taxonomy of the family and genera, and on relationships of higher level taxa. Data are provided on vegetative morphology as well as on floral morphology and floral biology.

Structure of the inflorescence, the ovary and ovules, fruit and seeds, germination and seedlings are treated in detail. Finally a chapter on uses and vernacular names, a bibliography, and a list of over 200 names ever used in *Canna* are added.

Key words: Cannaceae, anatomy, floral biology, history, uses, taxonomy worldwide, vernacular names.

INTRODUCTION

In 1970 P.J.M. Maas and his graduate student W. Segeren started studying the genus *Canna* making a first attempt at a revision of the species in northern South America. The monograph of Kraenzlin of 1912 was outdated and difficult to use because it had been written in Latin. The publication of Segeren & Maas (1971) comprised 10 species of *Canna* in 2 subgenera (*Distemon* and *Canna*).

A few years later, when a second graduate student J. van Duuren joined the team, a worldwide monograph of the family Cannaceae was started.

Mainly because of the taxonomic and nomenclatural complexity of *Canna indica*, the work could not be completed earlier. However, some treatments of the family Cannaceae for the local Flora of the Lesser Antilles (Maas 1979), the Guianas (Maas 1985), and Ecuador (Maas & Maas 1988) were published. Work on the nomenclatural problems resulted in a typification in 'A list of Linnaean generic names and their types' (Maas 1993).

In 2001 the Japanese botanist Nobuyuki Tanaka published his 'Taxonomic revision of the family Cannaceae in the New World and Asia', stating that the genus has been "early introduced into the Old World", but has "naturalized in the Old World tropics and subtropics" (page 1–2).

Finally the first author, H. Maas-van de Kamer, took over the heritage of many years of study and data collecting. This publication is a compilation of all knowledge up to now about the family Cannaceae worldwide with emphasis on the taxa occurring in the wild. Little attention has been given to all kinds of cultivated forms, including hybrids.

This article has been preceded by proposals to conserve versus reject several species names (Maas-van de Kamer 2004, 2006).

MATERIAL AND METHODS

This study was based on several thousands of herbarium specimens of the following herbaria: A, AAU, B, BBS, BM, BR, C, CAY, CGE, COL, CUZ, DAV, DUKE, E, EAP, ECON, F, FI, G, GB, GH, GOET, HBG, IAN, IJ, INPA, K, KIEL, L, LAM, LE, LINN-SM, LIV, M, MG, MICH, MO, MY, NA, NY, OXF, P, PR, QCA, R, RB, S, SP, TRIN, U, UC, US, VALLE, VEN, W, WAG, WIS, and Z. Travelling through many countries in the Neotropics, the Maas's were able to study the family in the field, take photographs, and collect flowers in spirit. Thanks to the assistance of many local botanists, 8 species have been available for study at the greenhouse 'Sandwijck' of the Utrecht University, the Netherlands.

HISTORICAL SURVEY OF TAXONOMY OF GENERA AND LOWER LEVEL TAXA

The plate in Leonhart Fuchs's unpublished book 'The Vienna Codex' (compiled between 1536 and 1566) representing *Canna indica* may well be the first illustration of the genus in botanical literature. The plate is annotated as '*Gladiolus indicus* or Indischer Schwertel', and numbered 'Cod. 11122, p. 321'. This plate has been reproduced in 2001 in the book on Botanical Illustration by Lack (see also Meyer et al. 1999).

In his 'Plantarum seu stirpium historia' published at Antwerp in 1576 De Lobel described and illustrated a plant cultivated in Belgium as 'Indica florida', the seeds of which he had received from friends from the West Indies ('Indiae Occiduae'). According to him the species was very rare, but already in cultivation in France, England, Italy, and Portugal. He did not know any use made of it, and described it as resembling to *Acorus* and *Canna* (then the names used for all sorts of reeds).

Clusius writes in his famous herbal of 1601 that a plant named 'Canna indica or Flos Cancri' (because the closed flowers resemble the claw of a lobster) had already been cultivated for a long time in cloister gardens in Portugal where it may well have arrived with the early discoverers of the New World like Columbus (1492). Clusius also tells us the plant was at that time generally cultivated in pots by 'rei herbariae studiosis' (people interested in botany), that it had been cultivated for many years in Austria and in Belgium, and that it had to be sheltered in a warm place for the European winter. As an illustration he uses the same woodcut as published by De Lobel.

In 1648 a book on medicinal plants of Brazil was published by Willem Piso, physician of the Dutch settlement in Recife (Brazil), then Dutch property and governed by Johan Maurits van Nassau. He provided the first description and illustration of both the wild *Canna indica* (as 'Meeru, sive *Canna Indica'*) and *C. glauca* (as 'Albara, aliis Paçivira').

In 1671 Bauhin published the second editions of both his 'Prodromus Theatri Botanici' and 'Pinax'. In these books *Canna* is still placed in one group with *Arundo inodora* (*Phragmites*), *Arundo odorata* (*Calamus*), and *Arundo indica* (comprising bamboo, sugar cane, and *Canna*).

Between 1678 and 1693 Van Rheede tot Draakestein published 'Hortus Indicus Malabaricus', a book on the medicinal plants of a Dutch colony in SE India. As was customary in this period, people were much interested in local medicines to help keeping the inhabitants of the new colony healthy, and especially for the long journey back home. In volume 11 of 1692 we find *Canna indica* listed as 'Katu bala' which means wild *Musa*. On t. 43 Van Rheede tot Draakestein mentions that the plant is called 'figueira de mato' by the Portuguese (meaning 'fig tree from the woods'), but because he also added that several of 'these species' were cultivated in Holland, it is doubtful whether this concerns a wild plant.

Rumphius treating *Canna* in the fifth volume of his Herbarium Amboinense (1747: 177) recalls encountering rosaries made of the seeds of *Canna* found in the possession of an Arabian (?) prisoner taken into custody at Ambon (Indonesia) in 1685.

In 1700 De Tournefort gives the first detailed illustration of the floral parts of a flower and fruit of *Canna* (as Cannacorus or 'Balisier'), mentioning 6 species. He illustrates 3 sepals and 1 petal which is divided into 6 lobes: 1 of these lobes bears both anther and stigma.

In 1732 Dillenius made a list of the plants cultivated in 'Hortus Elthamensis', the garden of J. Sherard in Eltham (now in Southeast London) in England, in which he described and illustrated *Canna flaccida*, originating from South Carolina, USA. He did not realize his 'Cannacorus glaucophyllos, ampliore flore, iridis palustris facie' was the third species of *Canna* then known to exist (cf. typification of *C. glauca*).

In 1737 Linnaeus published 'Hortus Cliffortianus', a list of the plants cultivated in the garden of G. Clifford in the Netherlands, and 'Viridiarum Cliffortianum', an abbreviated version of the former book. He noticed 2 'kinds' of plants from this garden:

1. Canna spathulis bifloris (= *Canna indica*) originating from the warm parts of America, Asia, and Africa, and cultivated in the wild form and in 3 'Varietates obviae':
   – *Naturalis allegata planta*, *flore luteo est*
   – *Cannacorus flore luteo punctato* Tournef.
   – *Cannacorus amplissimo folio*, *flore rutilo* Tournef.
   – *Cannacorus flore coccineo splendente* Tournef.
2. Canna foliis lanceolatis petiolatis (= *Canna glauca*) from very hot and wet places in America.

In this way Linnaeus arranged the descriptive sentences then commonly used by botanists to 'name' plants in 2 groups: the 2 species of *Canna* he would later discern as *C. indica* and *C. glauca*.

Following the international rules of botanical nomenclature, the official taxonomy of Cannaceae starts in 1753 when Linnaeus published 'Species Plantarum'. In this book Linnaeus arranged the plants according to his new binominal system. Because 'Species Plantarum' starts with Classis I, Monandria (flowers with 1 stamen), Monogynia (flowers with 1 ovary), the first genus on page 1 is *Canna* L. comprising 3 species:

– *C. indica*,
– *C. angustifolia* (now in the synonymy of *C. glauca*), and
– *C. glauca*.

One year later, in 1754, Miller still uses the generic name *Cannacorus* in the abbreviated 4th edition of his Gardeners Dictionary. The genus comprises 6 species, described by more than 2 Latin words, the first being '*C. latifolius vulgaris*. Tourn.' (= *Canna indica*). In the 8th edition of 'The Gardeners Dictionary' of 1768 Miller recognizes the genus *Canna* containing besides *C. indica* and *C. glauca* 3 new species: *C. latifolia* (now in the synonymy of *C. tuerckheimii*), and 2 'colour forms' now belonging to *C. indica*: *C. coccinea* (deep red flowers) and *C. lutea* (golden yellow flowers).

In 1789 the first list of plants cultivated in the Royal Botanic Gardens at Kew, 'Hortus kewensis', was compiled by W. Aiton. It comprises *C. glauca* and *C. indica*. Aiton recognizes 4 varieties of *C. indica* based on flower colour, flower parts being erect or reflexed, and shape of the leaves: *Canna indica* α *rubra* Aiton, *C. indica* β *lutea* Aiton, *C. indica* γ *coccinea* Aiton, and *C. indica* δ *patens* Aiton.

Also in 1789 the family Cannaceae was created by A.L. de Jussieu. His 'Ordo II. Cannae' or in French 'Les Balisiers' has been conserved as a family name, and comprised besides the genus *Canna* 10 more monocotyledonous genera belonging to the Costaceae, Zingiberaceae, and Marantaceae.

The third species of *Canna*, *C. flaccida*, has been described and illustrated by Salisbury in 1791 from a plant originally collected by J. Bartram in South Carolina, USA, and at the time generally cultivated in gardens in England (cf. typification of *C. glauca*).

In their 'Flora Peruviana' of 1798 Ruiz & Pavón listed 3 species of *Canna*. Apart from *C. indica* they described 2 new species: *C. paniculata* and *C. iridiflora*, both based on Peruvian material.

In 1807 Roscoe published his 'New Arrangement of the Plants of the Monandrian Class usually called Scitamineae'. He states that due to the fact that more and more tropical plants could be cultivated in greenhouses he feels the need to propose a new arrangement, "which may contribute in some degree to remove the inconveniences of which there has hitherto been but too much reason to complain, and which are the more regretted, as they present themselves to the student on the very opening of the Linnaean system". He considers the construction of the stamen to be the main discerning character illustrating this by a 'synoptical table' (his t. 20). In his option Monogynia are composed of Scitamineae and Cannae. He characterized the Cannae, comprising the genera *Canna*, *Maranta*, *Thalia*, *Phrynium*, and *Myrosma* by 'anthera simplex, stylus erectus, liber'. The genus *Canna* he characterized by 'stylus claviformis; stigma obtusum'. It included *C. indica* (followed by 3 synonyms), *C. glauca*, and *C. flaccida*.

In 1808 Willdenow published *Canna chinensis* based on plants cultivated from seed he got from China. This is the first species name of a *Canna* originating from outside the Neotropics. This name is now included in *C. indica*.

In 1822 Sims published *Canna pedunculata* in Curtis's Botanical Magazine, bringing the number of species up to 6. His t. 2323 depicted from a cultivated plant of unknown origin has been chosen as neotype of this species.

Between 1824 and 1828 Roscoe published his monumental Monandrian Plants, a book in 15 parts containing over a hundred coloured plates chiefly drawn from living specimens in the Botanic Garden at Liverpool. Many of these plates have been chosen as lectotypes of the cultivated plants they represent. For publication dates of the plates of this work, see Cullen (1973).

Between 1833 and 1845 Bouché, 'Institutsgärtner zu Neu-Schöneberg bei Berlin', published 4 articles in which he described many species of *Canna*, most of which he had in cultivation in his garden (Bouché 1833, 1837, 1838, 1845). At last he recognized 3 genera, *Canna*, *Eurystylus*, and *Distemon*, with in total 71 species. He subdivides C*anna* on characters like length of floral tube, orientation of the style, shape of petioles in cross section, shape and orientation of staminodes, orientation of petals (reflexed/patent), staminodes flat or caniculate, colour of staminodes, and direction of labellum turned sideways or towards the axis. Between his first (1833) and his last (1845) publication, Bouché's interpretation of the floral parts of Cannaceae switched from a flower with 1 stamen and 2 whorls of petals (outer and inner limb of corolla), to a flower with 2 whorls of petaloid anthers, one of which is fertile.

In 1855 Planchon validly published the 7th species of *Canna: C. liliiflora*. This large white-flowered species had recently been brought to Europe from South America by Von Warszewicz, and was in cultivation by the famous Belgian grower Van Houtte.

In 1862 Horaninow divided the genus *Canna* into 4 separate genera: *Achirida*, *Canna*, *Distemon*, and *Eurystylus*. He also recognized the maximum total number of species ever: exactly 100 species.

In 1890 Petersen, revising the family for Martius's Flora Brasiliensis, treats the 4 genera of Horaninow as sections of *Canna* (sect. *Achirida*, sect. *Eucanna*, sect. *Distemon*, and sect. *Eurystylus*). He also states that the genus only inhabits tropical and subtropical America, and that most of the species of Bouché in his opinion should be put in the synonymy of *C. indica*.

In 1912 Kraenzlin revised the Cannaceae for 'Das Pflanzenreich'. He recognized 2 subgenera within *Canna*: subg. *Distemon* and subg. *Eucanna*, the latter with 2 sections: sect. *Bialatae* and sect. *Trialatae*, based on the number of staminodes (referred to as 'alae' or 'Flügel' meaning 'wings'). The latter section he subdivided into 4 subsections (subsect. *Glaucae*, subsect. *Coccineae* v(el) *Indicae*, subsect. *Elatae*, and subsect. *Achirida*). In his monograph of 1912 Kraenzlin added 2 new species to the 7 already known: *C. bangii*, a high-Andean species from Bolivia and Peru, and *C. tuerckheimii* from high altitudes in Central America.

Finally, in 1917 Urban in his account of a plant collection from Haïti (Sertum Antillanum) described the 10th (and last) species recognized in the current treatment: *Canna jaegeriana*.

When Maas and his student Segeren in 1970 started to study the Cannaceae after a period of taxonomic silence, they decided to distinguish 2 subgenera within *Canna*: subg. *Canna* with more than 1 staminode and subg. *Distemon* with only 1 staminode. They emphasized the importance of the number of staminodes as an important character, but in their opinion the discerning factor is not the difference between 2, 3, or more staminodes, but that between flowers with only 1 or more than 1 staminode. In 1988 Maas and H. Maas-van de Kamer, contributing the Cannaceae for the Flora of Ecuador, refrained from using subgeneric taxa: *Distemon*, *Eurystylus*, as well as *Achirida* were placed in the synonymy of *Canna*.

In 2001 a 'Taxonomic Revision of the Cannaceae in the New World and Asia' was published by Tanaka, including an infrageneric classification based on morphological, cytogenetical, pollen morphological, and molecular studies. He recognized 19 species, re-establishing several species and varieties to accommodate the Asian plants, which,

in his opinion, have been imported very long ago from the Neotropics, and which he considers to be naturalized in Asia. Many of his taxa occur in the Neotropics as well as in Asia.

In 2001 Prince, a student of Kress, showed the first results of molecular research based on nuclear ITS DNA sequence data. She could not find support for separating species within the *Canna indica*-complex, some evidence for subspecific structure, and no evidence for some of Bouché's genera based on staminode number.

Concluding, the Cannaceae is a monogeneric family with a problem-free circumscription, in contrast with its internal taxonomic and nomenclatural disarray (Rogers 1984). The treatment of the family presented here comprises 10 species of *Canna*, including one huge *C. indica*-complex.

HISTORY OF THE FAMILY AND RELATIONSHIPS OF HIGHER LEVEL TAXA

The family Cannaceae, comprising only the genus *Canna*, was placed on page 1 of 'Species Plantarum' by Linnaeus (1753) because the flowers had just 1 stamen and 1 style and therefore belonged in his Monandria, Monogynia.

In 1789 A.L. de Jussieu created the family of Cannaceae (as 'Cannae') then comprising 10 genera, 9 of which now belong to the Costaceae, Marantaceae, and Zingiberaceae.

In 1807 Roscoe split Linnaeus's group of plants with 1 stamen and 1 style in the Cannae and the Scitamineae. The Cannae he characterized by an anther with 1 theca and a free and erect style, versus an anther with 2 thecae and a style embedded in a groove between these thecae in the Scitamineae. His Cannae comprise, besides the genus *Canna*, 4 genera of the Marantaceae: *Maranta*, *Myrosma*, *Phrynium*, and *Thalia*.

In 1853 Lindley placed the family Marantaceae including the Cannaceae in the order Anomales (i.e. plants "with unsymmetrical flowers") in the class Endogens, characterized by "leaves parallel-veined, permanent; wood of the stem always confused".

In 1883 in Genera Plantarum Bentham & Hooker treated the Canneae together with the Maranteae, Museae, and Zingibereae as tribes of the Scitamineae (in German: Gewürzröhre, meaning: spicy canes).

In 1888 Petersen revised the Cannaceae for Engler & Prantl's 'Die natürlichen Pfanzenfamilien'. In the 'Nachträge' (Appendices) of this book series, Engler (1897: 334) gave a survey of all higher plants and placed the Cannaceae in the order ('Reihe') Scitamineae, along with the Marantaceae, Musaceae, and Zingiberaceae (then still including Costaceae). These 4 families have been grouped together by many authors, first in the Scitamineae, later on in the order of Zingiberales, also including Lowiaceae and Strelitziaceae. Following this, Cronquist in his final classification of 1981, placed the Cannaceae (together with the Costaceae, Heliconiaceae, Lowiaceae, Marantaceae, Musaceae, Streliziaceae, and Zingiberaceae) in the order Zingiberales. This order he placed in subclass Zingiberidae, class Liliopsida (Monocotyledones). Thorne (1968) placed the order Zingiberales (including the Cannaceae) in the monocotyledonous superorder Commeliniflorae. Dahlgren et al. (1985) considered the order of the Zingiberales to be the only order of the superorder Zingiberiflorae.

The Russian botanist Takhtajan at first also followed this pattern in 1959; in his final classification of the flowering plants of 1997, however, he created the order Cannales to accommodate the families Cannaceae and Marantaceae. This order he placed together with the orders of the Lowiales, Musales, and Zingiberales in the superorder Zingiberanae, within the subclass Commelinidae in the class Liliopsida.

In 1983 Dahlgren & Rasmussen published an article on monocotyledon evolution. They compiled as many morphological characters as possible, using these in a phylogenetic analysis. The Cannaceae and Marantaceae proved to be a sister group pair united by the strong androecial reduction and the specialized staminodes which are unique for this group. Together with the sister group formed by the Costaceae and Zingiberaceae, this 'ginger group' of 4 families constitutes a well-corrobated clade within the order of the Zingiberales.

In 1990 Kress proposed a new phylogenetic classification of the order of the Zingiberales based on a cladogram resulting from the analysis of morphological characters. The order comprised 5 suborders. One of these suborders, the Zingiberineae contained 2 superfamilies: the Zingiberariae (Costaceae and Zingiberaceae) and Cannariae (Cannaceae and Musaceae). He illustrated this classification with a 'rhizogram'. In 1995 he published again on the phylogeny of the superorder Zingiberanae. This time he combined morphological and molecular data of DNA sequences from the chloroplast-encoded rbcL gene. Again the Cannaceae and Marantaceae came out as sister families characterized by the following apomorphies: asymmetric flower shape, bisporangiate anther, and modified (petaloid) style. To conclude, the superorder Zingiberanae (Lindley) Reveal contains the sole order Zingiberales Grisebach (1854) which is composed of 5 suborders. The suborder Zingiberineae Kress is composed of 2 superfamilies. The superfamily Cannariae Kress comprises the Cannaceae and the Marantaceae.

The Angiosperm Phylogeny Group (APG) published in 1998 an ordinal classification for the families of flowering plants based on the compilation of cladistic analyses then available. In the resulting suprafamilial classification the Cannaceae together with the above cited 7 families constitute the order of the Zingiberales. The Zingiberales, Poales, Commelinales, and Arecales (and some families without assignment to order) altogether form the 'Commelinoids'. The 'Commelinoids' as well as the 'Monocots' are in their opinion monophyletic informal higher groups within the flowering plants. The Angiosperm Phylogeny Website up till now gives the same data (Stevens 2006).

VEGETATIVE MORPHOLOGY

The species of *Canna* are sturdy herbs to 6 m tall. They are devoid of hairs, but often the leaves, sheaths, inflorescence, bracts, and sepals are described as glaucous or woolly, scurfy, lanuginose, or waxy. This aspect is caused by an epicuticular wax layer. When most prominent this layer is made up of relatively long (2 μm) rodlets of wax composed of massive subunits intermingled with miniature random orientated scales. The waxy layer of Cannaceae belongs to the 'Strelitzia-type' which is characteristic for Zingiberidae and Commelinidae (Fröhlich & Barthlott 1988).

In this manuscript 'lanuginose' is used when a plant is covered with a waxy layer composed of relatively long rodlets creating a 'woolly' appearance. The term glaucous is used to describe a waxy layer composed of minute components creating a bluish

green appearance, as if covered with a bloom. This last aspect is most prominent in *Canna glauca* which is a completely glaucous plant. In many species the lower side of the leaves is more or less lanuginose, except in *C. flaccida*, *C. glauca*, *C. indica*, and *C. pedunculata*. In all species parts of the inflorescence are more or less glaucous, but sometimes also more or less lanuginose as in *C. bangii*, *C. iridiflora*, *C. jaegeriana*, and *C. paniculata*.

The rhizome (subterranean stem) is fleshy, horizontal, and sympodially branched. It is either long-creeping and growing in wet habitats as in *C. flaccida*, *C. glauca*, and *C. pedunculata*, or short, tuberous, and starch-rich as in the remaining species. Tanaka (2001: 14) recognizes 4 morphological types of rhizomes mainly characterized by the length of the internodes. The rhizome is divided into segments by nodes with distichously arranged scale-like leaves (Tomlinson 1961). In the axil of each of these cataphylls we find some small cylindrical adventitious roots (Winkler 1930), and either an erect aerial shoot or a horizontal side branch of the rhizome. Gade (1966) studying plants of *C. edulis* (= *C. indica*) cultivated in Peru, reports that a single rhizome may become 60 cm long containing 12 segments representing 5 generations.

The well-developed aerial stems are composed of nodes and internodes, and basally covered by bladeless sheaths (Tomlinson 1969). *Canna*'s are hapaxanthic plants of which the aerial parts live only for a few months, flower, and then die off (Kraenzlin 1912). Each stem bears up to 10 leaves, varying in size between 20–120 by 1.5–45 cm. They are generally narrowly ovate-elliptic in shape. Because the leaf base tapers more or less gradually into the sheath, in the descriptions no petiole length is given. In *C. paniculata* the lamina is basally provided with a kind of pulvinus as in the Marantaceae.

The sheath is open and tubular. The lamina is provided with a primary vein which in young leaves is apically prolonged into a filiform thread. It is divided by the primary vein into 2 more or less unequal parts (Roscoe 1824), the largest defined by Stearn (1973) as the right hand part (looking at the adaxial side of the leaf: 'e centro visus': Fig. 1a). In bud one leaf is completely rolled up inside the other (convolute vernation). The ptyxis of each separate leaf is supervolute (Cullen 1978), i.e. the lamina is rolled vertically and parallel to its primary vein into a narrow tapering point. Rolling starts from the right hand margin and ends at the left margin (Fig. 1b, c). Thus the smaller/left hand half completely covers the larger/right hand one (Schachner 1924). The margin of the sheath corresponding with the smaller half also partly covers the other margin. The leaves unroll in the dark (Skutch 1930). According to Eichler (1873) the young leaves are arranged in a 1/2 spiral winding to the right hand along the stem 'e centro visus'. In fully developed stems, however, the leaves can be found in a 1/3 spiral. In literature there has been much confusion whether the arrangement of the leaves in *Canna* is either distichous or spirally. According to Kubitzki (1998) the latter condition may be secondary due to torsion of the internodes. The primary vein is prominent on the lower side of the lamina, as in many Monocotyledones. The many secondary veins are pinnately arranged and follow a more or less sigmoid course, passing acutely from the primary vein region and approaching the leaf margin almost asymptotically. As in other large-leaved Zingiberales, prominent secondary veins are separated by 3–5 less prominent ones creating a slightly undulate appearance of the lamina. In the middle

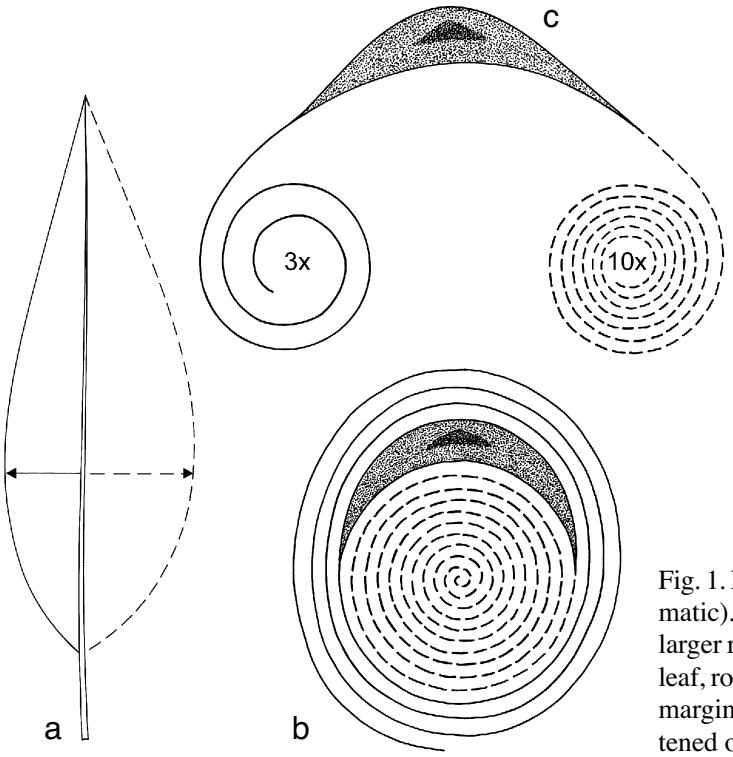


Fig. 1. Leaf morphology of *Canna* (schematic). a. Adaxial side of leaf, showing larger right hand part; b. cross section of leaf, rolled vertically from the right hand margin to the left hand margin; c. flattened out leaf in cross section.

part of their course, the secondary veins are parallel with each other and connected by weak commissures (Tomlinson 1961).

The large lamina of the leaves often shows many incisions of varying length running parallel to the secondary veins (foramina) as seen in the leaves of other large Monocotyledones (e.g. *Heliconia chartacea* and *Musa*).

FLORAL MORPHOLOGY

The flowers of *Canna* are red, purple, orange, yellow, or white. This colour is mainly brought about by the petaloid staminodes, style, and stamen, and to a lesser extent also by the corolla. For a floral diagram see Fig. 2a. The length of the flowers of *Canna* is measured here from the apex of the ovary up to the tip of the largest floral part, thus ovary excluded. Therefore, in flowers in which the petals are reflexed or shorter than the staminodes, the length of the flower is the same as the length of the staminodes as in *C. flaccida*, *C. indica*, *C. liliiflora*, and *C. pedunculata* (Fig. 2b). In *C. paniculata* the single staminode is shorter than the petals which in this species determine the length of the flower. When the petals are erect they are as long as or somewhat shorter than the staminodes. According to Kirchoff (1983b) studying allometric growth in the Cannaceae, the sepals and all succeeding floral parts lie on the same ontogenetic spiral. The originally asymmetric flower turns into a more or less 2-labiate zygomorphic one by lengthening and changing of position of the floral parts (Kunze 1984; see also chapter on pollination).

The 3 free sepals are slightly unequal, mostly glaucous green, erect, narrowly obovate to narrowly triangular, acute to obtuse, and persistent. They are imbricate, i.e. 1 sepal

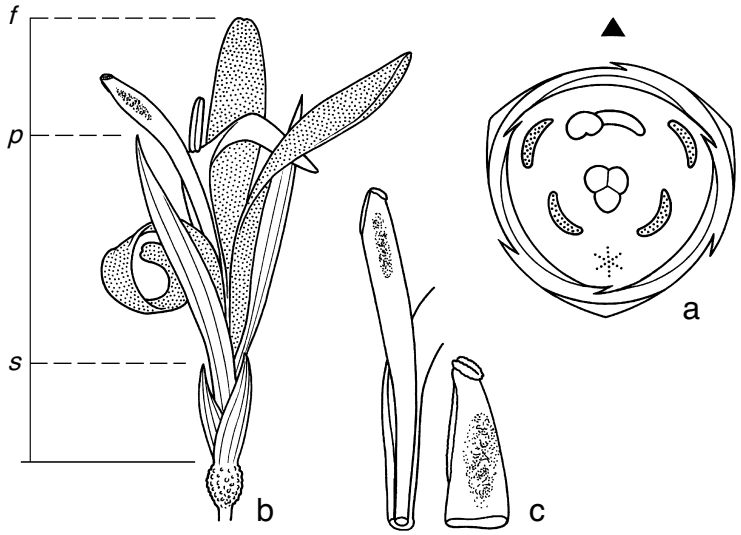


Fig. 2. Flowers of *Canna* (f = length of flower; p = length of petals; s = length of sepals). a. Floral diagram: androecium composed of 2 staminodes and 1 stamen in inner whorl, and 2 staminodes in outer whorl (star represents missing staminode); b. flower of *C. indica* showing 2 of the 3 calyx lobes, 2 of the 3 petals, 3 staminodes, 1 stamen with petaloid part and theca, and style with stigmatic areas on the top and a patch of pollen aside; c. details of style showing stigmatic areas and patch of pollen deposited on surface (a: Kress 1990, f. 1; b: Eichler 1873, t. 2, f. 1; c: Idem, t. 2, f. 3–4).

is placed completely outside the others, 1 completely inside, and 1 half inside and half outside the other 2 (Eichler 1875).

The 3 petals are mostly erect, but reflexed in *C. flaccida*, *C. liliiflora*, and *C. pedunculata*. They generally do reflex with maturity in the flowers of all species (Roscoe 1826: 40). Their shape is narrowly ovate-triangular with a cucullate, acute to acuminate apex. They are basally connate and unequal, one being always smaller than the other 2, and they are inserted at different levels in the floral tube (the 2 larger ones below the smaller one). They alternate with the sepals and their aestivation is imbricate like that of the sepals.

The androecium is composed of 2 essentially 3-merous whorls, the outer whorl being episepalous, and the inner one epipetalous (Fig. 2a). Members of the inner whorl are the petaloid stamen, the staminode previously called 'labellum', and a second inner staminode. The outer whorl is occupied by a number of staminodes varying from none to 2. The third position of the outer androecial whorl diametrically opposite the functional stamen is always vacant (Kirchoff 1983a, Kress 1990).

In 1842 Lestiboudois supposed that all floral parts inside sepals and corolla (style excepted) were of androecial origin. Eichler (1873) also stated the labellum of *Canna* flowers to be of staminodial origin because he rarely found it bearing 1 or 2 thecae. In the present publication the so-called labellum is considered to be a staminode. Therefore its measurements and those of the other staminodes are summarized in the descriptions. The number of staminodes is used here as a key character. It varies from 1–4(–5) per flower. The staminodes are petaloid, narrowly obovate to narrowly triangular, sometimes broadly so, or narrower to linear. Their apex can be entire and is generally obtuse or emarginate. The free part of all staminodes can be erect (*C. jaegeriana*) or patent (*C. tuerckheimii*). In the flowers of *C. indica* the free part of one of the staminodes is

always reflexed. The number of staminodes has been an important discerning character in the taxonomical history of *Canna* (see chapter on history).

The stamen consists of a petaloid part and 1 theca which is connate for up to half of its length to the margin of the petaloid part, well below its apex. In bud the stamen is conduplicate, enfolding the style (Yeo 1993). It is part of the inner androecial epipetalous whorl. The theca is 1-locular and 2-sporangiate. According to Dahlgren & Clifford (1982), anther wall formation follows the Monocotyledonous type, the cells forming the endothecium being provided with thickenings of the spiral type. The tapetum probably represents the invasive type as described by Furness & Rudall (1999), and microsporogenesis is successive. The pollen is globose, 45–77 μm diameter, and inaperturate (Kress & Stone 1982: f. 1A–C) when shed in monads. It is 2-celled (Dahlgren et al. 1985), or 3-celled (Goldberg 1989). The sporoderm is composed of 2 layers: intine and exine. The first is acid-degradable and 2-layered (exintine and endintine). The exine is acetolysis-resistant, ectexinous, and composed of conical spinules with a basal diameter as large as their length of 2–4 μm. They are distributed spirally and vary in number per surface area (Tanaka 2001). The sporoderm is relatively thick: 4–8 μm.

The style is petaloid, firm and fleshy, and for most of its length connate with the stamen. The stylar canal forms a 3-pointed star in cross section (Kunze 1984: 304). Apically there are 2 stigmatic areas shaped as callose strips along the edges of the asymmetrically truncate top of the style, whereas the third stigmatic area is formed by a vertical row of papils directed downwards along the side of the style (Fig. 2c, after Eichler (1873) t. 2, f. 3, 4). This refers to the 3 carpels forming the ovary. The stigmatic areas generally are papillate and have a wet surface at anthesis (Dahlgren et al. 1985).

For morphology and development of the ovary, ovules, fruit, seeds, and their germination, see special chapter on this subject.

Most floral parts (petals, staminodes, stamen, and style) are more or less connate, together forming a floral tube of variable length. The petals are only basally connate, the staminodes together form a longer tube, and stamen and style are connate even higher. For practical reasons it was decided to first give the total length (excluding ovary) of each floral part, followed by the length, apex, and shape of their free part (Fig. 2b). The floral parts that are forming the tube are placed in a spiral from base to apex in the following order: the 2 largest petals, the smaller third petal, and the staminodes (on 2 different levels). Apically the stamen and style are only incompletely connate. The length and width of the tube are related to the pollinators of the flower. The incomplete apical part of the tube formed by stamen and style forms the entrance to the tube. After anthesis the whole connate petals-staminodes-stamen-style complex falls off in one piece.

Much variation has been recorded in the morphology of the flowers of *Canna*. Especially the colour of the flowers and the number of staminodes per flower are extremely variable. According to Kraenzlin (1912: 22) flowers of the same plant can have a different colour from year to year! Eichler (1873: 183–184) states that flowers with 2 or 3 'Flügel' are common. He also reports to have found a 'Labellum' provided with 1 or 2 thecae. Segeren & Maas (1971) regularly found flowers provided with 2 and 3 staminodes on a single cultivated specimen. They also report to have very often found

rudimentary staminodes at the base of well-developed ones. The apex of the staminodes varies between emarginate and entire. Rogers (1984) mentions the varying number of flowers per cincinnus: generally 1, but sometimes 2, and rarely 3.

INFLORESCENCE

The inflorescence of *Canna* is terminal, sympodially branched, and lax or congested (Fig. 3). The flowers are placed in 1- or 2-flowered cincinni. The inflorescence varies in length from 10 cm up to 100 cm in *C. paniculata*. Each branching node of the inflorescence is enclosed by 1 primary bract. From this bract arise 2 axes: the flowering one already present (the former primary rachis) and a new secondary rachis which is basally provided with 2 branch bracts. At the next node this new rachis again transforms into a flowering branch, and a tertiary rachis is produced again basally provided with 2 branch bracts. The subsequent flowering branches are spirally arranged. The cincinni too are spirally arranged in 3 rows on the flowering branches which are triangular in cross section (1/3 spiral, Eichler 1873). Flowering starts at the base of the inflorescence (at the first flowering branch).

The inflorescence is thus provided with different kinds of bracts, i.e. primary bracts, branch bracts, floral bracts, and bracteoles:

1. The primary bracts are placed on the rachis at each node. They are 7–40 cm long, basally completely enclosing the sympodial rachis (Fig. 3a), and apically acute,

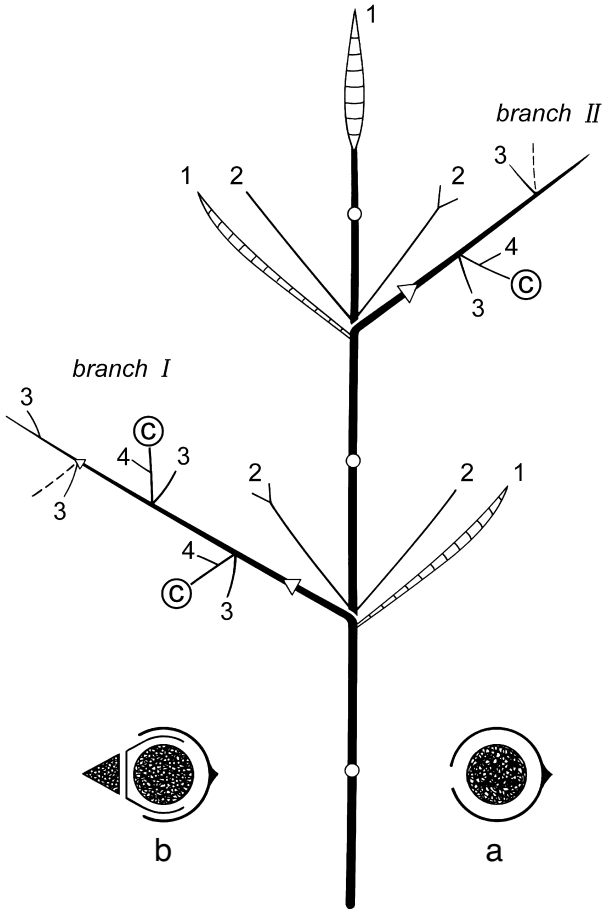


Fig. 3. Scheme of inflorescence of *Canna*, showing positioning of bracts and bracteoles (1 = primary bract; 2 = branch bract; 3 = floral bract; 4 = bracteole; c = 1- or 2-flowered cincinnus). a. Detail of primary bract enclosing the primary rachis; b. detail of 2 branch bracts: the left one 2-keeled and placed between the new secondary rachis and the former primary rachis.

obtuse or sometimes acuminate, or ending in a filiform thread. This large bract envelopes the whole developing inflorescence.

2. Two branch bracts are placed at the base of the new rachis at each branching point. They are 1–20 cm long. Basally they both partially enclose the new rachis (Fig. 3b). One is placed in the narrow space between the rachis and the branch, which explains why it is 2-keeled; the keels are directed towards the oldest rachis. This bract is often referred to as prophyll. Apically both branch bracts are generally acute, and sometimes ending in a filiform thread.
3. The floral bracts are each subtending a cincinnus. They are 0.2–4.1 cm long, their shape ranges from depressed ovate to triangular, with obtuse or acute apex. They can be either caducous or persistent.
4. The bracteoles are placed on the pedicel, each subtending a flower. They are 0.2–4 cm long, broadly ovate-triangular to linear in shape, and acute or obtuse.

The flowers are pedicellate and the pedicel is lengthening in fruit. In *C. bangii* the pedicel is partly covered by the same kind of tubercles as the fruit. The latter character is used in the key. The flowers are erect, except in *C. iridiflora* where they are pendent. They are developing one after the other, thus the basal flower of each cincinnus flowers first, eventually followed by the second one. The flowers of a 'pair' are not mirror images of one another as in the Marantaceae. They are placed as if the second flower was rotated approximately 70° counterclockwise with respect to the first one (Kirchoff 1983a).

OVARY AND OVULES, FRUIT AND SEEDS, GERMINATION AND SEEDLINGS

The ovary in *Canna* is inferior and 3-locular with axillary placentation, each locule containing 2 alternating rows of ovules; 3 septal nectaries are filling the upper part of the ovary and opening at the top, the lower part of the ovary being the fertile part (Vogel 1969: f. 29d–g). The outer side of the wall of the ovary is covered by soft, juicy, often reddish, conical tubercles of 1–2 mm long.

According to Grootjen & Bouman (1988) the ovules are anatropous, 2-tegmic, and crassinucellate. The nucellar tissue which at first is nuclear transforms to cellular endosperm, resulting in a single layer of endosperm cells around the embryo. Storage tissue (the perisperm) is largely formed by the chalazal part of the nucellus and is hard and white containing abundant starch. Embryo sac development is according to the Polygonum type. Embryogeny follows the Asterad type.

The mature fruit of *Canna* is a dry capsule crowned by the persistent sepals. Dehiscence is by 3 loculicidal slits, starting apically and often only partly realized, or the seeds are released by the final breakdown of the pericarp. This wall becomes glabrous by shedding of the dried brown tubercles, leaving a reticulate, translucent, scarious, and glabrous surface (Fig. 4a). When the wall between the reticulate veins has also disappeared, the fruit finally looks like a 'net-bag' containing the seeds (Fig. 9f: *C. tuerckheimii*).

Mature seeds of *Canna* are numerous, shiny brown to black, and globose to narrowly ellipsoid. They measure 3.5–10 by 2–8 mm. The weight of the seeds of *C. glauca*

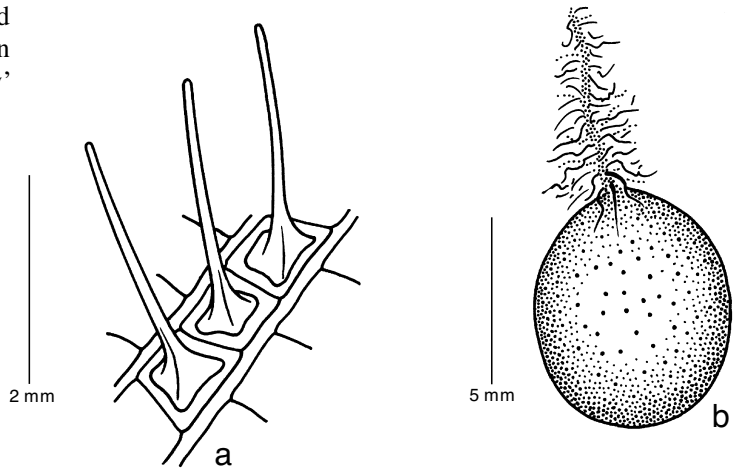


Fig. 4. Details of capsule wall and seed of *Canna*. a. Old tubercles on capsule wall; b. seed with 'hairy' funicle.

(Grootjen & Bouman 1988) is about 300 mg. The seeds lack an aril but the funicle is densely covered with a tangle of simple, curly, to 3 mm long emergences (Fig. 4b). When the seeds are shed this 'hairy, aril-like' funicle remains on the placenta, and thus does not function as a true aril which is attached to the diaspore to be dispersed. The embryo is linear and consists of one large cotyledon and a tiny very young sprout and rootlet. Dispersal is probably semachorous, the seeds being strewn out of the capsule when moved by the wind or touched by passing animals.

The seeds are pachychalazal, containing a massif chalaza, and surrounded by an extremely hard seed coat. This seed coat is not only hard but also completely impermeable, so one can speak of 'seed coat imposed dormancy' because no germination is possible even if circumstances seem to be favourable. Intact seeds do not imbibe water, do not swell, and remain hard accounting for the extreme longevity of *Canna* seeds. In horticulture, part of the seed coat (preferably the imbibition lid – see below) is filed away to make germination possible. A seed approximately 550 years old rediscovered from an Argentinian tomb, grew into a flowering individual of *C. indica*! Each of the seeds had been placed inside a *Juglans* nut, together forming a rattling necklace (Sivori et al. 1968).

The seed coat consists of 4 layers and is apart from the epidermis largely formed by chalazal tissue (c), partly also by integumentary (i) and raphal (r) tissue.

Chalazal tissue: The 4 layers (c1–c4) forming the chalazal part of the seed coat are:

c1. Epidermis composed of Malpighian cells, also known as the palisade layer. The cells are long and narrow, with thickened walls almost filling the lumen. In each cell the upper hydrophobic part contains silica, callose, and lignin, and the lower hydrophilous part consists of cellulose (Graven et al. 1996). There is a continuous light line at c. 2/3 of the height of the Malpighian cells. The stomata placed at a distance of 0.1–0.8 mm from each other between these cells do not play any role in the imbibition of water. The epidermis forms the exotesta in Cannaceae.

The endotesta consists of 3 layers of chalazal origin (c2–c4):

c2. Subepidermal layer.

c3. Vascularized layer.

c4. Tanniniferous layer containing vegetable polyphenols, providing for a secondary dormancy after shedding of the imbibition lid (Graven et al. 1997).

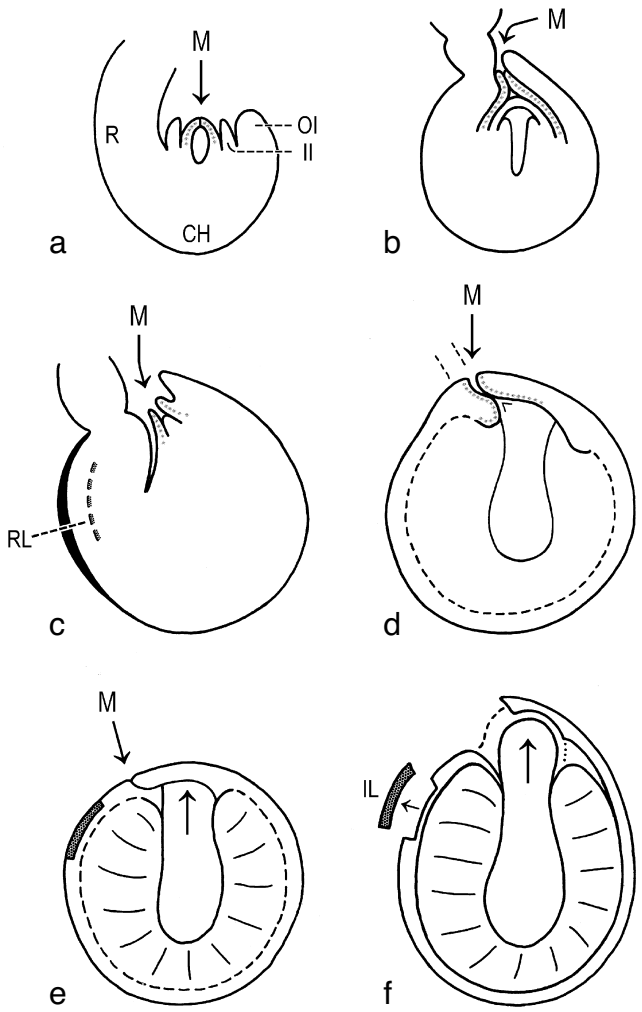


Fig. 5. Details of developing ovule and seed (CH = chalazal tissue; II = inner integument; IL = imbibition lid; M = micropyle; OI = outer integument; R = raphal tissue; RL = rupture layer). a. Longitudinal section of developing ovule, showing integuments and anatropous curvature; b. longitudinal section of mature ovule, showing pachychalazal development; c. longitudinal section of developing seed, showing rupture layer, i.e. the early differentiation of the imbibition lid; d. longitudinal section of developing seed, showing vestigial micropylar collar; e. longitudinal section of mature seed, showing imbibition lid; f. longitudinal section of germinating seed, after shedding of imbibition lid showing emerging embryo and ruptured seed coat (After Grootjen & Bouman 1988; a: f. 1F; b: f. 1I; c: f. 3A–C; d: f. 1J; e: f. 1K; f: f. 3F).

Integumentary tissue: Only about 1/15th part of the surface of the seed coat around the micropyle is of integumentary origin. The micropyle itself is formed by the inner integument (Fig. 5a–c). The integumentary seed coat is similarly composed of 4 layers (i1–i4):

i1. Palisade layer, in this case without any stomata.
i2. Subepidermal layer grown inwards around the apex of the embryonal root to form a small micropylar collar (Fig. 5d).
i3. Vascularized layer.
i4. Tanniniferous layer.

Raphal tissue: The seed coat of the raphal part of the seed forms an 'imbibition lid' of 1.5–3 mm diameter. At first there is only an elevated area devoid of stomata visible close to the hilar-micropylar slit. Later on, the margins of a more or less circular area loosen from the surrounding tissue by a preformed rupture layer (Fig. 5c). The lid itself is composed of only the 2 outer layers of the seed coat, i.e. the epidermis (r1) and the multi-layered subepidermal layer (r2). The lowermost layer of the last one is forming the rupture layer. During imbibition a difference in pressure between the hydrophylic parts and the hydrophobic parts of the Malpighian cells in the epidermis builds up. This induces shedding of the imbibition lid along the rupture layer (Fig. 5e, f). Graven et al. (1997) found that circumstances activating the opening of the imbibition lid are a raised incubation temperature of 50 °C during 24 hours in wet surroundings. In nature, this raise in temperature may be due to solar radiation. Chodat & Hassler (1903) noted germination of seeds of *C. indica* in places where fire had been made, 8–15 days after that. Following shedding of the lid, imbibition of water is possible, especially by the vascularized layer of the integumentary part of the seed coat (i3). This hydration induces germination. As a result, the integumentary part of the seed coat softens, making it possible for the germinal root to emerge from the seed (Fig. 5f).

This water regulating mechanism, combining an impermeable palisade layer and an imbibition lid, is a unique feature of the Cannaceae. The seed coat is mainly of chalazal origin, and the main mechanical layer is formed by the exotesta. Other families of the Zingiberales, in contrast, open by an operculum formed by all seed coat layers. Moreover, the seed coat in those families is of integumentary origin, and the main mechanical layer is formed by the exo- and/or endotesta (Liao & Wu 2000).

Germination starts with the rootlet protruding from the seed. The middle part of the cotyledon lengthens, forming the connection between seedling and seed, while the haustorial part of the cotyledon which has a suctorial function stays inside the seed (Fig. 6a).

Canna seedlings are composed of the following elements (Tillich 1959): cotyledon represented by haustorium and tubular cotyledonary sheath; primary leaves; hypocotyl with endogenously shoot-borne roots; collar with many collar roots (endogenous), and exogenously initiated primary root with velvety root hairs (Fig. 6b). According to Tillich seedlings of Cannaceae and Streliziaceae show the most basal character states in Zingiberales: they are relatively unspecialized.

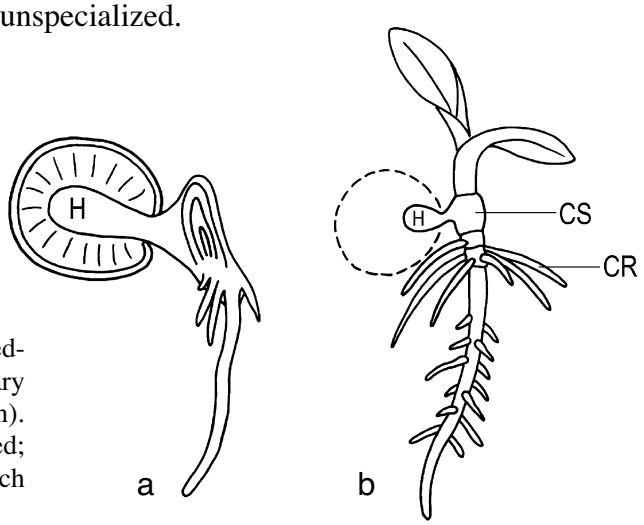


Fig. 6. Details of germinating seed and seedling (CR = collar roots; CS = cotyledonary sheath; H = haustorial part of cotyledon). a. Longitudinal section of germinating seed; b. seedling (a: Gatin 1908, f. 1–5; b: Tillich 1959, f. 16).

FLORAL BIOLOGY (POLLINATION AND DISPERSAL)

The flower buds of *Canna* are protected by 1 whorl of sepals and 1 whorl of petals. The flowers are erect, pendent, or the entrance to the flower is horizontal (in this case the floral tube is curved). The tube is cylindrical at the base and apically funnel-shaped.

Flowering time can be very different: from ephemeral flowers opening at dusk and withering the following day (*C. flaccida*) to long-lasting flowers that are at anthesis for several days (*C. indica*). According to Lopriore (1928), the flowers of *Canna* are protandrous.

The 'advertising' function of the flower is generally performed by the staminodes which are petaloid, in most species longer than the petals, and colourful. Colours range from white, yellow, orange and red, to purple. The stamen and style are petaloid as well, and are adding to the floral display. If the petals are erect, they also add to the display of the flower, being as long as or somewhat shorter than the staminodes. Sometimes the staminodes (especially the recurved staminode) and the petaloid parts of stamen and style are provided with dots or streaks functioning as a guide mark.

Kunze (1984), studying the ontogeny of flowers of *C. indica*, found that the originally asymmetric flowers (his f. 3a) reshape later in their development into a 2-labiate more or less zygomorphic pattern (his f. 3b). His figures show the upper lip being formed by style, stamen, and 2 staminodes, while the third staminode ('labellum') constitutes the lower lip. In his floral diagram Kress (1990) depicts 1 extra staminode placed at the abaxial side of the flower. Vogel (1969), observing living flowers of *C. liliiflora* at anthesis, describes besides an upper and lower lip, another floral part placed at the supposed left side of the pollinator. In *C. glauca* the stamen resp. style are placed at the left resp. right side of the pollinator.

All species of *Canna* show secondary pollen presentation as already described by Delpino (1867). In bud the single stamen is wrapped around the petaloid style in a conduplicate position. The theca opens in bud stage before anthesis, and deposits all of its pollen in one large patch on the style, where it is easily accessible to possible pollinators (Yeo 1993: f. 54C). The pollen is loosely deposited on the downward facing side of the style, and it is lightly coherent (see Fig. 2b, c). This represents the male phase of anthesis. After this, the empty stamen shrivels somewhat and its distal part bends away from the style. Ultimately it is rolled up backwards from the top towards the base.

Septal nectaries secrete nectar into the base of the floral tube, representing the reward for possible pollinators.

Most species are not known to produce scent to attract pollinators. Fragrant flowers are only reported for *C. liliiflora* with large, whitish flowers, and for *C. flaccida* with large, yellow flowers.

Bouché (1833) divided the *Canna* species into 2 groups, based on the place of deposition of the pollen on the style:

1. the group characterized by 'foecundatio directa': the pollen is deposited directly on the stigmatic part of the style resulting in self pollination;
2. the group characterized by 'foecundatio indirecta': the pollen is deposited just below the stigmatic part of the style. The plants belonging here had to wait for a pollinator to be cross-pollinated. Eventually self pollination could be the final possibility.

The presenting of the pollen in the way as shown by flowers of *Canna* is according to Yeo (1993) an ornithophilous syndrome, providing for the receipt and donation of pollen during the same pollinator visit. However, pollinators have not often been observed or recorded. Moreover, all species of *Canna* are presumed to be self-compatible (Yeo 1993). The fact that all *Canna* species exhibit secondary pollen presentation, while cases of chiropterophily, ornithophily, and sphingophily are reported, causes Yeo to suppose this might be a case of "residual secondary pollen presentation", originally developed as adaptation to melittophily as in the closely related Marantaceae. With the adoption of different pollination syndromes, this mode of presentation would have become unnecessary but not disadvantageous.

Following is summarized what is (supposedly) known of pollination in *Canna*:

C. bangii: no data.

C. flaccida: Rogers (1984) describes the flowers of this species as fragrant, nocturnal, and ephemeral, flowering during 1 night and therefore being flaccid the next morning. Kress & Beach (1994) did not report any scent. Most probably this species is moth-pollinated. In a specimen cultivated in Sandwijck (Utrecht) the flower started opening at 17.30 o'clock and was completely open and already withering showing pollen shed on the style at 22.45 o'clock.

C. glauca: there is unconfirmed evidence of pollination by hummingbirds.

C. indica: Vogel (1969) supposes pollination by birds because of the short tube, small nectaries, and lack of scent. There is no confirmed evidence that this is indeed the case. Rechinger (1910) reported from the island of Samoa visits by the bird *Myzomela nigriventris* (Meliphagidae) with a somewhat curved beak, and of the butterfly *Danais archippus*. Vogel (1954) noted birds of the genus *Nectarina* on the flowers of *C. indica* in South Africa. *Canna indica* is predominantly hummingbird-pollinated according to Kress (pers. comm. in Kirchoff 1983b: 117).

C. iridiflora: Yeo (1993) suggests the pendent flowers of this species to be pollinated by a large hawkmoth.

C. jaegeriana: no data.

C. liliiflora: According to Vogel (1969), who studied this species in the field (as *C. brittonii*), the flowers are pollinated by bats. The inflorescence reaches well above the leaves. The flowers are erect, whitish and funnel-shaped, the floral tube is basally thick-walled and curved so that the entrance to the flower is horizontal. Two staminodes form the 'upper lip' of the flower, the third one along with the petaloid stamen suggests the 'lower lip', while the 4th staminode and the stigma are positioned at the left side of an eventual pollinator. In bud the pollen has already been deposited on the style (secondary pollen presentation). Upon entering the flower, the pollen is transferred from the style to the left side of the pollinator (antero-laterally). Septal nectaries secrete a considerable amount of nectar into the base of the floral tube and constitute a reward for the pollinating bats, which are attracted by a herbaceous-soapy scent to visit the flower.

C. paniculata: Vogel (1969) supposes pollination by birds because of the short tube, small nectaries, and lack of scent.

C. pedunculata: no data.

C. tuerckheimii: Kress & Beach (1994) report pollination by hummingbirds for this species. The tubular base of the flower opens by a 1-sided slit in such a way, that

a bird probing for nectar will touch the pollen-covered style with the top of its head (personal observation in flower of cultivated plant in greenhouse of Leipzig, Germany).

Dispersal is probably semachorous, the seeds being strewn out of the capsule moved by the wind or touched by passing animals (Grootjen & Bouwman 1988).

DISTRIBUTION

The family Cannaceae is distributed all over the Neotropics, from Virginia in the USA (*C. flaccida*) to the West Indies and northern Argentina (*C. indica* and *C. glauca*). The family covers a large altitudinal range as well: from sea level to up to almost 3000 m in the Andes of Peru and Bolivia (*C. bangii*, *C. iridiflora*, *C. jaegeriana*, and *C. liliiflora*). The habitat preference is very diverse as well: some species grow in low, open and wet vegetation (*C. flaccida*, *C. glauca*), others prefer forested areas. Several species thrive well in secondary vegetation, along roads, in coffee plantations, and as weed in cultivated areas.

In our opinion the Cannaceae are from Neotropical origin. Therefore all species from Africa as well as from Asia have been derived from plants, rhizomes or seeds that have been imported from the Neotropics. Many of these plants have been naturalized so long ago that they behave like indigenous taxa. They even can form a serious threat, turning into an invasive, and thereby crowding out other plants. Almost all the Asian and African species are here included in the synonymy of *C. indica*. It was impossible to find differences in characters that are invariable enough to create different species within the *C. indica*-complex.

Simple distribution maps of the species are provided.

USES AND VERNACULAR NAMES

For a very long time *Canna*'s have been used for several purposes. The extensive use of the rhizome and the seeds may well have contributed to the distribution of the genus by man to places all over the world, where they often escaped from cultivation and (semi-)naturalized. In the case of the seeds, the distribution has been facilitated by their extreme longevity (see above). The oldest record is from Peru where dried rhizomes and leaves of *C. indica* have been excavated from the desert coastal area dating from 2500 BC, suggesting the plant must have been important for the people who lived then and there. Also moulded pottery resembling *Canna* rhizomes ('corms') has been found (Gade 1966).

Almost all species have locally been used for medical purposes. Data about this are listed under the species concerned. The 3 main purposes of cultivation are briefly discussed below:

1. The rhizomes have been cultivated extensively for food in the West Indies and in South America to Argentina in the south. The cultivated rhizomes are larger than those of the wild forms (up to 0.6 m long), and can be stored for several months in a dry place. Domestication is from South American origin where the presumed centre is situated in Colombia. From there the rhizomes are spread by Indian people to the S and SE on both sides of the Andes, and thirdly to the NE

to the West Indian Islands. Rhizomes are planted casually around the houses, and dug out and boiled when mature after about 8 months (Purseglove 1972). Also in Australia, Africa, and Asia, *Canna* has been cultivated for its edible starch and stock food (Ong & Siemonsma 1996). In the beginning of the 20th century, *C. indica* has again been promoted as a promising crop in (the former) Rhodesia and in Hawaii for pig-raising, dairying, or fattening of steers feeding them both stems and starchy rhizomes (Howes 1929). In tropical America, nowadays locally in Peru (Apurimac Valley, Dep. Cuzco, 2350–2550 m) this crop is still commonly cultivated in connection with folklore: the baked rhizomes are used to make cakes which are sold at the market of Cuzco for the celebration of the festival of Corpus Christi (Gade 1966). The rhizomes are also reported to be eaten in Colombian Amazonia (La Rotta 1988: 268).

The rhizomes contain almost pure starch and can not compete with *Manihot esculenta* or *Zea mais* which are more nutritious, palatable, or have higher yielding crops. They can, however, be cultivated at higher altitudes. The starch is composed of exceptionally large grains with a glossy appearance. When cooked it forms a semi-translucent, fibrous and somewhat mucilaginous mass with a sweet taste. Small tubers have the consistency and taste of potatoes, older ones soon become too fibrous and need to be cooked for a long time.

2. The seeds have been used as beads for rosaries by both Christian as well as Muslim people all over the world (see Plate 4b). Seeds have also been used in musical rattles, and (after softening by cooking) to make necklaces and bracelets.
3. The third and perhaps most commonly known use mankind has made of the genus *Canna* is the creation of innumerable cultivars for horticultural purpose. Except for hybrids or new forms selected by growers, many names have been described based on plants cultivated in Europe from seeds which were send from the Neotropics by local collectors. As a result there have been created many names to identify all these 'new' *Canna*'s. This took mainly place in Europe, where descriptions were at first published in herbals and garden catalogues (see chapter on 'Historical survey of taxonomy of genera and lower level taxa').

From the beginning until the end of the 19th century many publications describing new cultivated forms of *Canna* have been published in famous garden magazines and books. The following list is far from complete:

Botanical Cabinet (Loddiges 1821, 1822a–d, 1823a–b, 1824);
Botanical Magazin (Curtis 1799);
Botanical Register (Ker Gawler 1817, 1820, 1822, 1824a–e);
Curtis's Botanical Magazin (Hooker 1835, 1855; Sims 1818, 1819, 1822a–d, 1824);
Edwards's Botanical Register (Lindley 1829a–b, 1830a–b, 1837);
Exotic Flora (Hooker 1823, 1827);
Flore des Serres et des Jardins de l'Europe (Planchon 1855);
Gardeners Chronicle (Baker 1893);
Revue Horticole (Paris) (André 1861a–c, 1862, 1884, 1896).

These descriptions and illustrations are not always of a high scientific quality. Many forms described as new species ended up in the synonymy of mainly *C. indica*.

Canna indica and *C. glauca* belong to the principal progenitors of the multiple lineages of cultivated *Canna*'s. Growers have also used *C. flaccida*, *C. iridiflora*, and *C. lilii-*

flora many times to create new forms with larger flowers. *Canna warszewiczii* and *C. discolor* (both now in the synonymy of *C. indica*), plants with purplish or brown-purple stems and leaves, have often been incorporated too. The most famous grower has been the Frenchman Mr. Crozy, who around 1900 created about 200 hybrids, specializing in small plants with showy flowers to better stand rain and other adverse weather conditions. This so-called Crozy *Canna*'s have been crossed with *C. flaccida* creating the orchid-flowered *Canna*'s with even showier flowers (to over 20 cm diameter). Rogers (1984) estimates there are probably over 1000 horticultural varieties in a rich array of colours, mostly reddish and yellowish hues, sometimes pastels or white, with the staminodes often spotted, streaked, and bordered, and foliage and stems bronzed in some.

In 1923, Bailey made an attempt to provide a binomial for cultivated *Canna*'s, describing '*Canna generalis*, cultg. nov.'. Published as a 'cultigen novum', however, this can not be a valid species name in *Canna*. It neither is a valid hybrid name, because the parent species are not mentioned (McNeill et al. 2006: 119, Art. H. 3). The same holds true for '*Canna orchiodes*, cultg. nov.' described on the same page. Bailey characterized '*C. generalis'* by erect petals and a short floral tube and '*C. orchiodes'* by reflexed petals and a long floral tube.

In 1930 Bailey & Bailey validly published *C. generalis* and *C. orchiodes* in a dictionary of garden plants. Below these names are included in the synonymy of *C. indica*, because the fact that Bailey & Bailey added to their description "Of garden origin" does not necessarily mean these names do only refer to garden plants. According to these authors, *C. generalis* includes the original Crozy or French *Canna*'s, while *C. orchiodes* comprises varieties as 'Italia' and 'Austria'. Standley & Steyermark (1952) did incorporate *C. generalis* Bailey as a regular species recorded for Guatemala, citing Bailey & Bailey (1930) as a reference.

The enormous number of new taxa, made possible by the genetic intercompatibility of the species, has been a considerable source of taxonomic confusion in defining species.

Like all plants that have been used in many ways, *Canna*'s are known by many vernacular names. A list of these names is included. Several names are common for the genus, like: achira(s)/hachira in South America, arrow-root/araruta for the starch containing rhizomes, bananeir(inh)a or platanillo because the plant looks vaguely banana-like in its habit, bandana in Spanish (flag), balisier in French in the West Indies (indicating the use of the plants as a fence or in hedges), caité/caeté/caaeté/caetê in Brazil, canna or Indian Reed because the plant reminds of a reed, inbiri/imbiry/embiri in Brazil, weglopers hagel (Dutch) or indian shot by English speaking people, maraca(s) or musical rattles in the West Indies, Panama, and Brazil, and tous les mois/tulema for rhizomes one can harvest all year.

Several uses can be recognized in the alphabetical list of vernacular names e.g.: caité-conta-de-rosário (*C. paniculata*)/chapelet (*C. indica*)/cuentas (*C. indica*) for rosary beads, chumbo de indio (*C. indica*)/indian shot because one can use the seeds for shooting, herva dos feridos (*C. glauca*, *C. tuerckheimii*) to cure fever, shack-shack (*C. indica*) for seeds used in musical rattles, Backblätter (*C. paniculata*) by the german colonists of Rio Grande do Sul in Brazil for leaves used to wrap around something to be cooked.

CANNACEAE

Cannaceae Juss. (1789) 62 (as 'Cannae'), nom. cons.; Petersen (1890) 63; Kraenzl. (1912) 1; Maas & H.Maas (1988) 3. — Type: *Canna* L.

Perennial, rhizomatous, glabrous herbs; aerial shoots unbranched, with green leaves. *Leaves* distichously to spirally arranged along the stem, composed of an open sheath and an entire lamina with closely set, pinnately arranged, parallel, secondary veins, lower side often glaucous or lanuginose; lamina supervolute in bud. *Inflorescence* terminal, bracteate, sympodially branched or simple, with 1- or 2-flowered cincinni. *Flowers* asymmetric, perfect, epigynous, pentacyclic, 3-merous; sepals composed of 3, free, slightly unequal, imbricate sepals; corolla composed of 3, unequal, imbricate petals, basally connate into a tube; androecium essentially composed of two 3-merous whorls, the inner whorl composed of 1 petaloid stamen, the staminode previously called 'labellum', and often a second inner staminode, the outer whorl composed of 0–2 staminodes; staminodes petaloid, varying in number; stamen with a solitary monothecal, 2-sporangiate, marginal anther; style petaloid, stigmatic areas terminal and marginal; floral tube formed by the connate parts of petals, staminodes, stamen, and style; ovary inferior, 3-locular, with numerous, anatropous ovules arranged on axile placentae in 2 alternating rows per locule, septal nectaries 3, opening by holes into the base of the floral tube. *Fruit* a capsule, crowned by the persistent sepals, loculicidally dehiscent or seeds released by the breakdown of the capsule wall, wall tuberculate. *Seeds* numerous, exarillate, with imbibition lid, copious perisperm, and straight embryo.

Distribution — Originally Neotropical family with the single genus *Canna*. Widely cultivated all over the Tropics and Subtropics, and often escaped and naturalized.

CANNA

Canna L. (1753) 1; Bouché (1833) 144; Petersen (1890) 65; Kraenzl. (1912) 27; Segeren & Maas (1971) 670; Maas & H.Maas (1988) 4. — Lectotype: *Canna indica* L., vide Britton (1918) 86.
Cannacorus Mill. (1754) ≡ *Canna* L.
Katubala Adans. (1763) 67, 534 ≡ *Canna* L.
Xyphostylis Raf. (1838) 52 ≡ *Canna* L.
Eurystylus Bouché (1845) 485. — Type not chosen.
Distemon Bouché (1845) 494. — Type not chosen.
Achirida Horan. (1862) 18. — Type: *Achirida iridiflora* (Ruiz & Pav.) Horan. (*Canna iridiflora* Ruiz & Pav.).

Rhizomatous, glabrous, large herbs; rhizome either short and tuberous or long-creeping, fleshy, subterranean, horizontal, sympodially branched, with distichous, membranous scales, and cylindrical roots, especially at the base of the shoots, rhizome scales to c. 1.5 cm long. *Leaves*: lamina large, ovate-elliptic, slightly asymmetric, petiole indistinct, base narrowed into the sheath to rounded, apex obtuse to acute, often shortly acuminate and/or ending in a filiform thread. *Inflorescence* sympodially branched or simple, with 1- or 2-flowered cincinni; primary bracts placed on the rachis at each node, basally completely enclosing the rachis, apically often ending in a filiform thread; branch bracts 2 at each branching point, placed at the base of the secondary rachis and both basally partially enclosing that rachis: one 2-keeled and placed between the rachis and the

branch, apex sometimes ending in a short filiform thread; floral bracts spirally arranged on the branches, each subtending a cincinnus; bracteoles placed on the pedicel, each subtending one flower. *Flowers* red, orange, yellow, purple, or white, generally erect; sepals erect, narrowly triangular to narrowly obovate, acute to obtuse, persistent; petals mostly erect, narrowly ovate-triangular, cucullate, acute to acuminate; staminodes 1–4(–5), petaloid, sometimes 1 recurved, obovate to narrowly triangular, apex obtuse, acute, acuminate, or emarginate; stamen with 1 theca, connate for up to half of its length with the petaloid part of the stamen; pollen spherical, 55–77 μm diameter, inaperturate, wall provided with spinules; style firm and fleshy, connate for most of its length with the stamen, stigmatic areas 3, shaped as 2 callose strips along the edges of the apical part and 1 vertical row of papils, apex asymmetrically truncate. *Fruit* generally green, maturing brown, ellipsoid to obovoid, more or less trigonous; wall covered by soft tubercles; tubercles 1–2 mm long, maturing woody and shed with age. *Seeds* black to dark brown, globose to ellipsoid, very hard.

Distribution — All over the Neotropics, from Virginia in the USA to northern Argentina.

Habitat & Ecology — At elevations between sea level and 3000 m; in shady, often wet places in forest, along rivers, or roadsides, also in secondary vegetation.

Etymology — According to Hooker (1835 ad t. 3437) the name *Canna* is derived "from Can, or Cana, a reed, in Celtic, and that from Cana, a watery place, in the same language".

Uses — See under each species.

KEY TO THE SPECIES OF CANNA

1a. Staminode 1; flower composed of 6 coloured parts (3 petals, 1 style, 1 stamen, 1 staminode); leaves basally provided with a pulvinus, lower side mostly lanuginose. — S Mexico and tropical South America except for the Amazon Basin. . . . . **8. C. paniculata**

b. Staminodes 2 or more; flower composed of 7 or 8 or more coloured parts; leaves without a pulvinus 2

2a. Petals reflexed; flowers greenish to purplish white, or yellow 3

b. Petals not reflexed; flowers red, orange, or yellow 5

3a. Flowers greenish to purplish white; capsule 5–10.5 cm long, seeds 8–10 mm long. — Bolivia and Peru, 2000–2800 m. . . . . **7. C. liliiflora**

b. Flowers yellow; capsule 3–6 cm long, seeds 5–7 mm diameter 4

4a. Flowers 10–14 cm long; staminodes 1.5–6.5 cm wide; sepals acute. — SE USA . . . . . **2. C. flaccida**

b. Flowers 3–4 cm long; staminodes 0.5–1 cm wide; sepals obtuse. — SE Brazil . . . . . **9. C. pedunculata**

5a. Flowers pendent, reddish purple, 10–14 cm long; leaves often lanuginose below. — Peru, 1800–2850 m . . . . . **5. C. iridiflora**

b. Flowers erect 6

6a. Leaves glaucous, narrowly ovate to narrowly elliptic, apex very gradually narrowed; flowers generally yellow; rhizomes long-creeping; plants bordering streams. — All over the Neotropics . . . . . **3. C. glauca**

b. Leaves not glaucous, generally ovate to elliptic, apex acute to obtuse, often acuminate; flowers never purely yellow, but of all kinds of colours between red and yellow; rhizomes short, tuberous 7
7a. Pedicels below the ovary densely tuberculate, 0.5–1 cm long, to 2 cm in fruit; lower side of leaves more or less lanuginose. — Peru and Bolivia, 1400–2800 m . . . . . **1. C. bangii**
b. Pedicels smooth, never tuberculate 8
8a. Lower side of leaves glabrous; free part of one of the staminodes recurved. — Throughout the Neotropics . . . . . **4. C. indica**
b. Lower side of leaves more or less lanuginose; free part of all staminodes erect or patent 9
9a. Pedicels 0–0.5 cm long, to 1 cm in fruit; flowers orange, 4–7.5 cm long; floral tube curved, free part of staminodes erect; seeds (narrowly) ellipsoid. — Northern and western South America and Greater Antilles, 750–2000 m **6. C. jaegeriana**
b. Pedicels 0.5–3 cm long, to 5 cm in fruit; flowers orange to red, 5.5–9 cm long; floral tube straight, free part of staminodes apically patent; seeds subglobose. — Andean South America, and Central America including Mexico, 500–2000 m . . . . . **10. C. tuerckheimii**

1. Canna bangii Kraenzl. — Map 1; Plate 1a–c

Canna bangii Kraenzl. (1912) 38. — Type: *Bang 2413* (holo B, destroyed; lecto BM, chosen by Tanaka (2001: 44); isolecto F, G, GH, K, LE, M, MO, NY, US, WU), Bolivia, La Paz, Yungas, Coripati.

Plants to 4 m tall. Rhizome short, tuberous, diameter unknown. *Leaves*: sheaths more or less lanuginose, with blackish margins; lamina narrowly elliptic-ovate to elliptic-ovate, 25–65 by 8–25 cm, base narrowly cuneate, apex acute or sometimes shortly acuminate, upper side dark dull green, lower side more or less lanuginose. *Inflorescence* repeatedly branched, with 2-flowered cincinni; pedicels 0.5–1 cm long, to 2 cm in fruit, densely tuberculate below the ovary; primary bracts 12.5–16 cm long, obtuse, acute, or acuminate; branch bracts 4.5–14 cm long, acute; floral bracts broadly (ob)ovate to (ob)ovate, 0.5–2.5 cm long, obtuse to acute, persistent; bracteoles narrowly triangular to triangular-ovate, 1–2.5 cm long, acute; rachis, bracts, bracteoles, and sepals generally glaucous and more or less lanuginose. *Flowers* orange-red (to pale orange-yellow or red), erect, 4–7 cm long; sepals pale green to reddish pink, narrowly ovate-triangular, 1–1.5 by 0.3–0.5 cm, acute to acuminate; corolla orange-red, 3.5–6.5 cm long, petals erect, narrowly ovate-triangular, 3–5 by 0.4–0.6 cm, acute; staminodes 3 or 4, orange-red, 5–7 cm long, free parts narrowly obovate to narrowly ovate-elliptic, 2.5–3.5 by 0.2–0.6 cm, erect, 1 slightly recurved; stamen orange-red, free part narrowly obovate, 2–2.5 by 0.4–0.8 cm, theca 0.5–0.7 cm long; style orange-red, free part narrowly elliptic, 1.5–3.5 by 0.3–0.4 cm. *Fruit* greenish, covered by purple to wine red-tipped tubercles, ellipsoid to obovoid, 2.5–4.5 by 2–2.5 cm. *Seeds* subglobose to broadly ellipsoid, 5–9 by 4–7 mm.

Distribution — Peru (Ayacucho, Cajamarca, Cuzco, Huánuco, Puno) and Bolivia (La Paz, Santa Cruz).

Habitat & Ecology — At elevations of 1400–2800 m; in shady, wet places in forest, along rivers, on forested slopes or roadsides, also in secondary vegetation.

Map 1. Distribution of *Canna bangii* Kraenzl.

Etymology — *Canna bangii* has been named after Miguel Bang, the collector of the holotype of this species.

Uses — This species has been found cultivated as an ornamental in Bolivia, La Paz.

Notes — 1. *Canna bangii* can be recognized by having erect, orange-red flowers with erect petals, inflorescences with persistent floral bracts, and pedicels densely tuberculate just below the ovary or fruit.

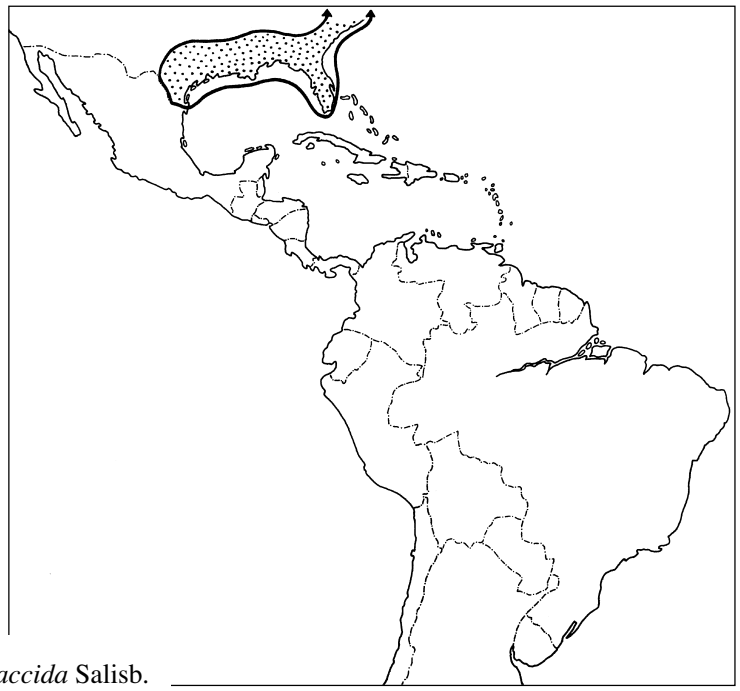
2. This species looks quite similar to *C. indica*, but differs by the persistence of its floral bracts, its somewhat longer, tuberculate pedicels (especially in fruit), and its preference for high altitudes.

2. Canna flaccida Salisb. — Map 2; Plate 2a–d

Canna flaccida Salisb. (1791) 3, t. 2; Roscoe (1824) 25, t. 6; Bouché (1833) 159; Petersen (1890) 74, t. 17, f. 2; Kraenzl. (1912) 49, f. 9; Segeren & Maas (1971) 675; G.K.Rogers (1984) 29. — *Canna glauca* L. var. *flaccida* (Salisb.) Willd. (1797) 4 (as '*β flaccida*'). — *Xyphostylis lutea* Raf. (1838) 52, nom. illeg. — *Eurystylus flaccidus* (Salisb.) Bouché (1845) 485 (as '*flaccida*'). — Type (here chosen): Herb. J.E. Smith No. 0001.31 (neo LINN), USA, South Carolina, Lee's Stove. Photograph in U.

Canna reevesii Lindl. (1837) ad t. 2004; Bouché (1838) 145; Kraenzl. (1912) 50, f. 10A–C. — *Eurystylus reevesii* (Lindl.) Bouché (1845) 485 (as '*reewesii*'). — Type (here chosen): [icon, neo] Lindley (1837) t. 2004.

Plants to 2 m tall. Rhizome long-creeping, 0.2–0.5 cm diameter. *Leaves*: sheaths more or less lanuginose; lamina narrowly elliptic to narrowly (ob)ovate, 20–55 by 5–18 cm, base gradually and continuously narrowed into the sheath, apex acute or sometimes shortly acuminate, lower side more or less glaucous. *Inflorescence* unbranched, with 1- (or 2-)flowered cincinni; pedicels up to 0.2 cm long, not lengthened in fruit;



Map 2. Distribution of *Canna flaccida* Salisb.

primary bracts 10–20 cm long, acute; branch bracts 11–14.5 cm long, acute; floral bracts depressed ovate to ovate-triangular, 0.2–0.5(–1) cm long, obtuse to acute, persistent; bracteoles narrowly triangular, 0.4–3 cm long, acute; bracts, bracteoles, and sepals glaucous. *Flowers* yellow, erect, 10–14 cm long; sepals pale yellow, narrowly ovate-elliptic, 2–3.5 by 0.4–0.8 cm, acute; corolla green, 10–13 cm long, petals reflexed, narrowly ovate-triangular, 4–6.5 by 0.3–1.8 cm, acute; staminodes 4, yellow, 9–14 cm long, free part obovate to broadly obovate, 6–7 by 1.5–6.5 cm, erect, showy, thin and flaccid, margins undulate; stamen yellow, free part obovate, 5.5–7 by 2.5–3.5 cm, theca 1.5–2 cm long; style yellow, free part narrowly obovate, 2.5–4 by 0.8–1.2 cm. *Fruit* green, maturing dark brown, very densely covered by tubercles, ellipsoid, 3–6 by 2–3.5 cm. *Seeds* globose, 5–7 mm diameter.

Distribution — SE USA, the Coastal Plain from Virginia to Texas.

Habitat & Ecology — At sea level; forming dense stands in wet vegetations like marshes, swamps, hammocks, swampy woodland, often growing along ditches, and in pine savannahs.

Etymology — The adjective 'flaccid' meaning 'withered and limp' and translated into Latin as '*flaccida*' has been used as epitheton of this species of *Canna*, probably because most flowers are collected by daylight when they are already withering after having flowered the night before.

Uses — This species has been used many times in hybridization. The species itself has been cultivated as an ornamental at least since 1732 as mentioned by Dillenius.

Vernacular names — See list.

Pollination — The fragrant flowers of *C. flaccida* open at dusk and flower for one night only. Rogers (1984) describes the flowers of this species as fragrant, nocturnal, and ephemeral, flowering during one night and therefore being flaccid the next morning. Most probably this species is moth-pollinated.

Dispersal — No data.

Notes — 1. *Canna flaccida* is characterized by relatively large yellow almost sessile flowers (10–14 cm long) with reflexed petals and 4 showy flaccid staminodes (1.5–6.5 cm wide).

2. *Canna flaccida* has often been confused with *C. glauca*. It clearly differs from that species, however, by having reflexed petals and much larger and wider free parts of staminodes.

3. Canna glauca L. — Map 3; Plate 3a–d

Canna glauca L. (1753) 1; Roscoe (1828) 27, t. 7; Bouché (1833) 158; (1845) 487; Petersen (1890) 72, t. 16; Kraenzl. (1912) 54, f. 11C–D; Segeren & Maas (1971) 674; Maas & H.Maas (1988) 5. — Type: Herb. A. van Royen No. 912.356.404 (lecto L), origin unknown (see note 2).

Canna angustifolia L. (1753) 1; Bouché (1845) 493. — *Xyphostylis angustifolia* (L.) Raf. (1838) 52. — Type (here chosen): [icon, lecto] Morison (1699) t. 14, f. 6 (see note 3).

Canna glauca L. var. *rufa* Sims (1822a) ad t. 2302 (as '*ß. rufa*'); Petersen (1890) 72 (as '*γ. rufa*'). — Type (here chosen): [icon, neo] Sims (1822a) t. 2302.

Canna pedicellata C.Presl (1827) 106; Bouché (1845) 494; Kraenzl. (1912) 72. — Type: *Haenke s.n.* (holo PR), 'Chile'. According to Stearn (1938: 153) the localities of Haenke's plants are not always correct. It is unlikely that the specimen has been found in Chile.

Canna mexicana A.Dietr. (1831) 11. — Type not chosen.

Canna stolonifera A.Dietr. (1831) 11; Bouché (1833) 159; (1845) 487. — Type: *Sellow s.n.* (lecto or neo, K), Brazil (see note 4). Photograph in U.

Canna liturata A.Dietr. (1831) 12; Bouché (1845) 494. — Type not chosen.

Canna glauca L. var. *rubro-lutea* Hook. (1835) ad t. 3437 (as '*γ, rubro-lutea*'); Petersen (1890) 72 (as '*ß rubro-lutea*'); Kraenzl. (1912) 54. — Type (here chosen): [icon, neo] Hooker (1835) t. 3437.

Canna stricta Bouché (1838) 144; (1845) 487. — Type not chosen.

Canna longifolia Bouché (1845) 487; Kraenzl. (1912) 56, f. 11A–B. — Type (here chosen): [icon, neo] Kraenzlin (1912) f. 11A–B.

Canna schlechtendaliana Bouché (1845) 487. — Type not chosen.

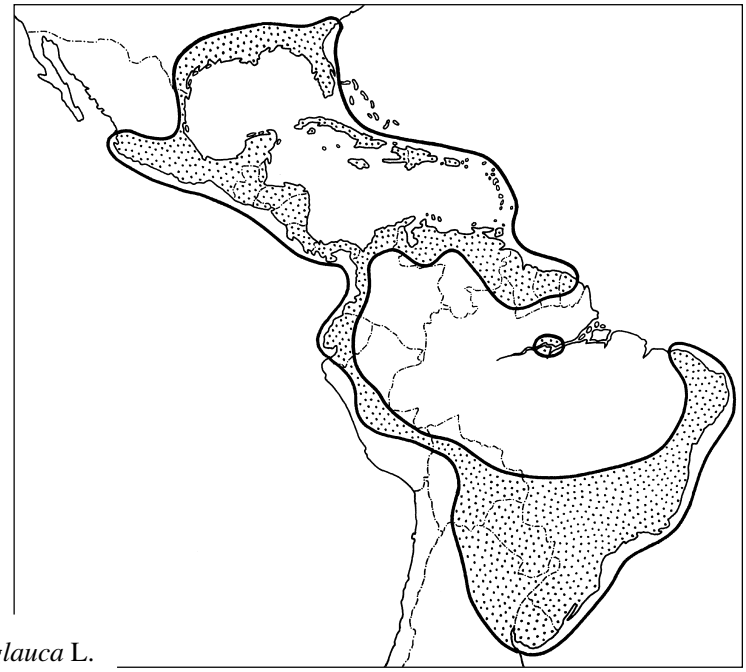
Canna annaei André (1861c) 471, f. 111–112; Petersen (1890) 72. — *Canna glauca* L. var. *annaei* (André) Regel (1867) 84 (as '*δ. annaei*'). — *Canna schlechtendaliana* Bouché var. *annaei* (André) Kraenzl. (1912) 54. — Type (here chosen): [icon, neo] André (1861) f. 112.

Canna siamensis Kraenzl. (1912) 55. — *Canna glauca* L. var. *siamensis* (Kraenzl.) Nob.Tanaka (2001) 56. — Type: *Zimmerman 141* (holo B, destroyed; lecto K, chosen by Tanaka (2001: 56) as 'holotype'; isolecto G, M, US), Thailand, near Bangkok.

Canna hassleriana Kraenzl. (1916) 296. — Type: *Hassler 7883* (holo G), Paraguay, Amambay, Upper Río Apa, Nov. 1901.

Canna glauca L. var. *angusta* J.W. Richardson & L.B. Sm. (1972) 24, t. 6, f. E. — Type: *E. Meyer 10939* (holo F), Argentina, Entre Ríos, Concordia, between Gómez and Yuquerí Chico.

Plants to 2 m tall, completely glaucous. Rhizome long-creeping, 0.5–1.5 cm diameter. *Leaves*: sheaths sometimes lanuginose; lamina bluish green, narrowly ovate to narrowly elliptic, 28–70 by 1.5–14(–17) cm, base and apex very gradually narrowed, acute. *Inflorescence* generally unbranched, with 1- or 2-flowered cincinni; pedicels 0–0.5 cm long, to 1.5 cm in fruit; primary bracts 10–30 cm long, acute; branch bracts 5–20 cm long, acute; floral bracts (broadly) ovate-triangular, 0.7–2.5 cm long, acute to obtuse, persistent; bracteoles (broadly) ovate-triangular, 0.3–2 cm long, acute to obtuse. *Flowers* (pale) yellow, erect, 7–10 cm long; sepals pale yellow, narrowly elliptic-triangular, 1–2.5 by 0.3–0.7 cm, acute; corolla yellow, 5–9 cm long, petals erect, narrowly ovate to subulate, 4–7 by 0.7–1.3 cm, acute to acuminate; staminodes 4, yellow, 7–10 cm long,



Map 3. Distribution of *Canna glauca* L.

free part narrowly obovate to linear, 5–9 by 0.7–2.3 cm, erect, 1 strongly recurved; stamen yellow, free part narrowly obovate, 3.5–4.5 by 0.3–0.5 cm, theca 0.5–2 cm long; style yellow, free part linear to narrowly obovate, 4–5.5 by 0.1–0.3 cm. *Fruit* green, covered by glaucous green tubercles, obovoid to ellipsoid, (1–)2–5(–6) by 2–4 cm. *Seeds* broadly ellipsoid to globose, 6–9 by 4–6 mm.

Distribution — All over the Neotropics, except in the Amazon Basin: in the southern states of the USA (Louisiana, South Carolina, and Texas), Mexico, Central America, the Greater and Lesser Antilles, and southwards to northern Argentina and Paraguay.

Habitat & Ecology — Mostly at low elevations, but occasionally up to 1100(–2000) m; in wet vegetations like wet savannahs, marshes, swamps, and along margins of lakes, ditches, or streams.

Etymology — The epithet '*glauca*' has the same meaning as the English 'glaucous', i.e. dull green to greyish blue.

Uses — The rhizomes of *C. glauca* are said to be eaten by the poor; they are also used to cure tumours, as diuretic, as febrifuge, and are recommended to treat venereal diseases and kidney stones. The powdered rhizome is used in tooth-paste (Brazil). In the West Indies the flour made of the rhizomes of this species is often used as a(n illegal) replacement for the real Araruta made of the rhizomes of *Maranta arundinacea*. The leaves are used to wrap food. Bruised fresh leaves are supposedly anti-rheumatic and used as compress to treat tumours, wounds, and ulcers (Brazil). The juice of the plant is used as a gargle and is reported to calm down uncontrollable saliva (Brazil). The juice of the fruits is used against inflammation of the ear (Brazil). The seeds are used as rosary beads and they are eaten by domestic ducks.

The species has been used in hybridization and has been cultivated as an ornamental.

Vernacular names — See list.

Pollination — The flower at anthesis shows a zygomorphic pattern: 3 erect staminodes forming the upper lip and the recurved staminode forming the lower lip (functioning

as a hold for the pollinator?); at the right side of the pollinator is the style carrying the pollen, at its left side the stamen. The petaloid part of the stamen is apically curved back, the empty anther is erect. There is unconfirmed evidence of pollination by hummingbirds.

Dispersal — Seeds have been reported to be eaten by 'palmipedes silvestres' (web-footed birds) in Brazil.

Notes — 1. *Canna glauca* is very well marked by its glaucous narrow leaves and yellow flowers with erect petals.

2. When Linnaeus published *C. glauca* in Species Plantarum (1753), he gave as phrase-name *Canna foliis lanceolatis petiolatis enervibus*. Roy. lugdb. 11.

As synonyms he added:

- *Canna foliis enervibus*. Virid. cliff. 104.
- *Cannoides*. Hort. cliff. 488.
- *CannaAcorus glaucophyllus*, *ampliore flore*, *iridis palustris facie*. Dill. elth. 69. t. 59. f. 69.

Furthermore he added 'Habitat in Carolina? perennial'.

Searching for type material corresponding with the phrase-name we found in the Van Royen herbarium at Leiden (L) a specimen consisting of only 2 leaves (sheet number 912.356.404). On the sheet essentially the same phrase-name and synonyms are written as given by Linnaeus:

- *Canna foliis lanceolatis petiolatis enerviis*. Roij. prodr. 11.
- *Canna foliis enerviis*. Linn. Vir. 104.
- *Cannoides*. Linn. cliff. 488.
- *Cannacorus glaucophyllos*, *ampliore flore*, *iridis palustris facie*. Dill. elth. 69. t. 59. f. 69.

Dillenius's polynomial (3) should be excluded. This is the current *C. flaccida* Salisb., as is unmistakably shown by the illustration on t. 59, f. 69 of Hortus Elthamensis depicting flowers with broad staminodes and reflexed petals. Dillenius adds to his description of the species as note about its distribution: 'fructus e Carolina, ubi sponte nascitur'. This remark was later referred to in Species Plantarum by Linnaeus as 'Habitat in Carolina?' with a question-mark indicating that he was not sure if *Cannacorus glaucophyllus* should be included in the synonymy of his *C. glauca*.

To conclude, there is only one candidate for lectotypification: Van Royen's specimen mentioned above. This specimen, although consisting of 2 leaves only, illustrates without any doubt the typical form of the leaves of *C. glauca*, and is therefore here designated as lectotype.

The lectotype chosen by Tanaka (2001: 53): "Hort Chelsea, unknown collector 2005 (BM, K)" is not valid, because it did not belong to the original material studied by Linnaeus when describing *C. glauca*.

3. When Linnaeus (1753) published *C. angustifolia*, he gave the phrase-name *Canna foliis lanceolatis petiolatis nervosis*. He included 2 polynomials in its synonymy:

- *Canna foliis lanceolatis petiolatis*. Hort. cliff. 1'.
- *Arundo indica florida angustifolia*. Moris. hist. 3. p. 250. s(ectionis) 8. t. 14. f. 6.

He also added: "Habitat inter tropicos Americae: Umbrosis spongiosis. perennial". We have tried to locate original type material. In the Hortus Siccus Cliffortianus at the British Museum, however, no material associated with the above-mentioned phrase-

name could be traced. Morison's polynomial is illustrated with a plate carrying as superscription the legend: Arundo Indica florida angustifolia, Albara et Paçivira Brasiliensium Pisonis. This illustration is an elaborate copy of Piso's plate in De Medicina brasiliensium 4 (1648) 117 and 213, and clearly illustrates this species. Therefore Morison's plate is here designated as lectotype of *C. angustifolia*.

Canna angustifolia and *C. glauca* are synonyms. They are both published by Linneaus in Species Plantarum on page 1, as '*Canna* species 2' and '*Canna* species 3', respectively. The name *C. angustifolia* has rarely been applied. The name *C. glauca*, on the contrary, has been and is commonly used for this species. The first author to combine both species was Baker (1893: 70), who mentioned *C. angustifolia* as a synonym of *C. glauca*. Therefore the latter name must be retained for this species.

4. The specimen in K is annotated as originating from Brazil and collected by Sellow. It has a label with "Herb. Reg. Berolinense 1840" and "Canna stolonifera Hort. Berol.". Sellow died in Brazil in 1831; the faintly written '1840' might have caused Tanaka (2001: 54) to suppose this is a Sellow number '840'. It is doubtful if this specimen, inserted in the Berlin Herbarium in 1840, was seen by A. Dietrich; it probably was grown from a seed, collected by Sellow.

5. The flowers of this species are predominantly unicoloured and (pale) yellow throughout the distribution area of the species. Rarely the recurved staminode and stamen are spotted with pink, also the flowers may turn somewhat darker after anthesis.

In the marginal parts of the distribution area, in the north as well as in the south, plants with more or less reddish flowers have been found. *Canna glauca* with reddish flowers has been collected in the northern part of the area in some Caribbean Islands (St. Vincent, Jamaica), northern Venezuela (Caracas), and especially in Mexico and the southern part of the USA (South Carolina, Louisiana). In 1788 Walter described 3 species of *Canna* in his Flora of Carolina. He had the same 3 binomials that Linnaeus had in 1753, with the same descriptions, except that he added the colour of the flowers. He should thus not be considered to have described new species. According to Walter *C. glauca* had red flowers and *C. angustifolia* yellow flowers: so he recognized the 2 forms of *C. glauca* with different flower colour.

Many names of plants with reddish flowers originating from the marginal regions of the distribution area of *C. glauca* have been included here in its synonymy:

- *Canna annaei* André – reddish – origin unknown
- *Canna glauca* L. var. *angusta* J.W. Richardson & L.B. Sm. – orange – Argentina
- *Canna glauca* L. var. *rubro-lutea* Hook. – red-yellow – Jamaica
- *Canna glauca* L. var. *rufa* Sims – reddish – Caracas and St. Vincent
- *Canna hassleriana* Kraenzl. – red – Paraguay
- *Canna liturata* A.Dietr. – dark yellow with reddish marking – Panama
- *Canna longifolia* Bouché – reddish – Mexico
- *Canna mexicana* A.Dietr. – reddish – Mexico
- *Canna schlechtendaliana* Bouché – red – origin unknown
- *Canna stricta* Bouché – reddish yellow – origin unknown.
- *Xyphostylis angustifolia* Raf. – red – Florida to Louisiana

These more or less red-flowered forms of *C. glauca* are different from *C. indica* by their definitely narrower and glaucous green leaves. They differ from *C. paniculata* by the number of staminodes (1 in *C. paniculata* versus 4 in *C. glauca*).

In northern Argentina (Corrientes, Chaco, and Formosa), plants have been found with more or less reddish or reddish punctate flowers. Their leaves are narrow and glaucous as in *C. glauca*, or wider and green as in *C. indica*. These specimens (hybrids?) were reported to grow next to pure *C. glauca* and/or *C. indica* stands.

Some species, like *C. fintelmannii*, *C. jacobiniflora*, and *C. stenantha* have been placed under 'Doubtful and excluded species' but could belong in the above list, because they combine characters of both *C. indica* and *C. glauca*.

4. **Canna indica** L. — Fig. 7; Map 4; Plate 4a–d

Canna indica L. (1753) 1; Roscoe (1825) 14, t. 1; Bouché (1833) 155; (1845) 490; Petersen (1890) 67; Kraenzl. (1912) 59, f. 8A–C; Segeren & Maas (1971) 676, t. 3; Maas & H.Maas (1988) 6. — *Cannacorus ovatus* Moench (1794) 526, nom. illeg. — *Canna variabilis* Willd. (1808) 169; Bouché (1845) 491; Kraenzl. (1912) 41, nom. illeg. (see note 5) — *Canna ellipticifolia* Stokes (1812) 2, nom. illeg. — *Canna elegans* Raf. (1817) 143; Horan. (1862) 18, nom. illeg. — Type: Herb. A. van Royen No. 912.356.390 (lecto L, chosen by Maas (1993: 29)), origin unknown.

Canna coccinea Mill. (1768) *Canna* no. 3; Roscoe (1826) 35, t. 11; Bouché (1845) 490; Petersen (1890) 68, t. 15; Kraenzl. (1912) 60. — *Canna indica* L. var. *coccinea* (Mill.) Aiton (1789) 1 (as 'γ *coccinea*'). — *Canna rubra* Willd. (1808) 169, nom. illeg. — *Canna ellipticifolia* Stokes var. *coccinea* (Mill.) Stokes (1812) 2 (as 'γ *coccinea*'). — *Canna speciosa* Hegetschw. (1813) 5, t. 1, f. 7, nom. illeg. — *Canna indica* L. var. *speciosa* Baker (1892) 261, nom. illeg. — Type: *Anonymus 1660*, 'Plant from Chelsea Physick Garden' (lecto BM, chosen by Tanaka (2001: 45)), origin unknown.

Canna lutea Mill. (1768) *Canna* no. 4; Roscoe (1826) 51, t. 18; Bouché (1833) 147; (1845) 489; Petersen (1890) 71; Kraenzl. (1912) 39, f. 3; Segeren & Maas (1971) 672, t. 3. — *Canna indica* L. var. *lutea* (Mill.) Aiton (1789) 1 (as 'β *lutea*'). — *Canna ellipticifolia* Stokes var. *lutea* (Mill.) Stokes (1812) 2 (as 'β *lutea*'). — Type (here chosen): Liverpool Botanic Garden No. 1909. LBG. 2072 (neo LIV), origin South America (?). Photograph in U.

Canna indica L. var. *patens* Aiton (1789) 1 (as 'δ *patens*'). — *Canna patens* (Aiton) Roscoe (1807) 338; Roscoe (1825) 18, t. 3; Bouché (1833) 160; (1845) 488. — *Canna ellipticifolia* Stokes var. *patens* (Aiton) Stokes (1812) 3 (as 'δ *patens*'). — *Canna chinensis* Willd. (1808) 170; Bouché (1833) 146; Kraenzl. (1912) 46, nom. illeg. — *Canna thyrsiflora* Hegetschw. (1813) 5, t. 1, f. 8, nom. illeg. — *Canna orientalis* Roscoe (1826) 37, t. 12, nom. illeg. — *Canna indica* L. var. *orientalis* Baker (1892) 260, nom. illeg. — Type: [icon, neo] Hooker (1827) t. 228, chosen by Tanaka (2001: 60) as 'lectotype'. According to Roscoe, from seeds that had been received from the Island of St. Helena.

Canna indica L. var. *rubra* Aiton (1789) 1 (as 'α *rubra*'). — *Canna ellipticifolia* Stokes var. *rubra* (Aiton) Stokes (1812) 2 (as 'α *rubra*'). — Type (here chosen): [icon, neo] Roscoe (1825) t. 1.

Canna crocea Roem. & Schult. (1817) 11. — Type not chosen.

Canna lambertii Lindl. ex Ker Gawl. (1820) ad t. 470 (as '*Canna lamberti*'); Roscoe (1828) 16, t. 2; Bouché (1833) 156; (1845) 492; Petersen (1890) 71; Kraenzl. (1912) 68, f. 15A–C. — Type (here chosen): [icon, neo] Ker Gawler (1820) t. 470.

Canna aureovittata Roscoe ex Lodd. (1821) ad t. 449 (as '*aura-vittata*' and '*auravittata*'). — *Canna limbata* Ker Gawl. (1824a) ad t. 771; Roscoe (1827) 31, t. 9, nom. illeg. — *Canna coccinea* Mill. var. *limbata* Regel (1867) 85 (as 'γ. *limbata*'), nom. illeg. — *Canna indica* L. var. *limbata* Petersen (1890) 68 (as 'γ *limbata*'), nom. illeg. — *Canna patens* (Aiton) Roscoe var. *limbata* Baker (1893) 43, nom. illeg. — Type (here chosen): [icon, neo] Loddiges (1821) t. 449.

Canna rubricaulis Link (1821) 1. — Type not chosen.

Canna speciosa Roscoe ex Sims (1822c) ad t. 2317 (non Hegetschw. 1813); Roscoe (1826) 49, t. 17; Kraenzl. (1912) 44. — Type (here chosen): [icon, neo] Sims (1822c) t. 2317.

Canna platyphylla Nees & Mart. (1822) 66a; (1823) 22; Bouché (1833) 167. — Type not chosen.

Canna indica L. var. *maculata* Hook. (1823) ad t. 53. — *Canna maculata* (Hook.) Link (1829) 227; Bouché (1833) 148; (1845) 489. — *Canna roscoeana* Bouché (1833) 146; (1845) 489, nom. illeg.

— *Canna lutea* Mill. var. *maculata* (Hook.) Regel (1867) 87 (as '*γ. maculata*'); Petersen (1890) 71 (as '*γ maculata*'). — Type (here chosen): [icon, neo] Hooker (1823) t. 53.

Canna occidentalis Ker Gawl. (1824b) ad t. 772; Bouché (1833) 145; (1845) 490; Kraenzl. (1912) 34. — Type (here chosen): Herb. J.E. Smith No. 0001.32 (neo LINN), Liverpool Botanic Garden, origin West Indies(?). Photograph U.

Canna edulis Ker Gawl. (1824d) ad t. 775; Roscoe (1826) 22, t. 5; Bouché (1833) 157; (1845) 492; Petersen (1890) 69; Kraenzl. (1912) 64; not sensu Woodson & Schery (1945) 78, t. 43; nor Standl. & Steyerm. (1952) 204. — Type (here chosen): [icon, neo] Ker Gawler (1824d) t. 775.

Canna compacta Roscoe (1824) 59, t. 22; Bouché (1833) 154; (1845) 492; Petersen (1890) 69; Kraenzl. (1912) 34. — Type (here chosen): [icon, neo] Roscoe (1824) t. 22.

Canna pruinosa Hoffmanns. (1824) 79. —Type not chosen.

Canna pallida Roscoe (1825) 53, t. 19; Bouché (1833) 148; (1845) 489; Kraenzl. (1912) 37. — *Canna lutea* Mill. var. *pallida* (Roscoe) Regel (1867) 87 (as '*β. pallida*'); Petersen (1890) 71 (as '*β pallida*'). — Type (here chosen): Liverpool Botanic Garden No. 1909.LBG.2047 (lecto LIV), origin Barbados. Photograph in U.

Canna orientalis Roscoe var. *flava* Roscoe (1826) 40, t. 13. — *Canna flavescens* Link (1829) 226; Bouché (1833) 149; (1845) 489 — *Canna indica* L. var. *flava* (Roscoe) Baker (1892) 261. — *Canna orientalis* Roscoe var. *flavescens* Baker (1893) 43, nom. illeg. — Type (here chosen): [icon, neo] Roscoe (1826) t. 13, chosen by Tanaka (2001: 40) as 'lectotype'.

Canna carnea Roscoe (1826) 45, t. 15; Bouché (1833) 156; Petersen (1890) 68. — Type (here chosen): [icon, neo] Roscoe (1826) t. 15.

Canna aurantiaca Roscoe (1826) 57, t. 21; Bouché (1833) 153; (1845) 491. — *Canna lutea* Mill. var. *aurantiaca* (Roscoe) Regel (1867) 87 (as '*δ. aurantiaca*'); Petersen (1890) 71 (as '*δ aurantiaca*'). — Type (here chosen): Liverpool Botanic Garden No. 1909.LBG.2066 (lecto LIV), origin Brazil. Photograph in U.

Canna montana Blume (1827) 35; Bouché (1845) 494. — Type not chosen.

Canna lanuginosa Roscoe (1827) 47, t. 16; Bouché (1833) 154; (1845) 492; Petersen (1890) 70; Kraenzl. (1912) 35, f. 6C–D. — Type (here chosen): Specimen annotated 'Hort. bot. Berol., 9. 41, in Herb. Auerswald' (neo BM), origin 'Indiae Orientalis'. Photograph in U.

Canna discolor Lindl. (1829a) ad t. 1231; Bouché (1833) 157; (1845) 492; Petersen (1890) 73; Kraenzl. (1912) 38. — Type (here chosen): [icon, neo] Lindley (1829a) t. 1231.

Canna lagunensis Lindl. (1830a) ad t. 1311; Bouché (1833) 149; (1845) 489; Kraenzl. (1912) 37. — Type (here chosen): Specimen annotated 'Hort. Reg. bot. Berol., in Herb. Auerswald' (neo BM), origin Mexico. Photograph in U.

Canna achiras Gillies ex Lindl. (1830b) ad t. 1358; Bouché (1845) 491. — Type (here chosen): [icon, neo] Lindley (1830b) t. 1358.

Canna tenuiflora Bouché ex A.Dietr. (1831) 13; Bouché (1833) 150; (1845) 490. — Type (here chosen): Imperial Botanical Garden St. Petersburg No. 337 (neo LE), origin West Indies.

Canna commutata Bouché (1833) 147; Kraenzl. (1912) 39. — Type (here chosen): Specimen collected by Martens in Berlin Botanic Garden in 1839 (neo BR), origin South America. Photograph in U.

Canna ehrenbergii Bouché (1833) 150; (1845) 490. — Type not chosen.

Canna polymorpha Bouché (1833) 151; (1845) 491. — Type (here chosen): Liverpool Botanic Garden No. 1909.LBG.2075 (neo LIV), origin unknown. Photograph in U.

Canna leptochila Bouché (1833) 152; (1845) 491. — Type (here chosen): Berlin Botanic Garden, in Herb. Auerswald (neo BM), origin unknown.

Canna humilis Bouché (1833) 153; (1845) 491; Kraenzl. (1912) 43. — Type not chosen.

Canna nepalensis Bouché (1833) 158; (1845) 487. — *Canna indica* L. var. *nepalensis* (Bouché) Baker (1892) 261. — Type (here chosen): Specimen with copy of fragment of Wallich (1832) Num. List No. 6622 (neo K), origin Asia.

Canna sellowii Bouché (1833) 162 (as '*sellowi*'); (1845) 489; Kraenzl. (1912) 65 (as '*selloi*'). — Type (here chosen): Specimen annotated 'Canna Selloi Hort. Berol. Weinmann 1838' (neo LE), origin Brazil. Photograph in U.

Canna xalapensis Bouché (1833) 163; (1845) 493. — *Canna heliconiifolia* Bouché var. *xalapensis* (Bouché) Kraenzl. (1912) 67. — Type not chosen.

Canna heliconiifolia Bouché (1833) 164 (as '*heliconiaefolia*'); (1845) 493; Kraenzl. (1912) 67, f. 15D–F; Segeren & Maas (1971) 679, t. 3. — Type: *Fendler 1492* (neo K, chosen by Tanaka (2001: 35) as 'lectotype'), Venezuela, Aragua, Colonia Tovar.

Canna altensteinii Bouché (1837) 326; (1845) 493. — Type not chosen.

Canna poeppigii Bouché (1838) 143; (1845) 491. — Type not chosen.

Canna portoricensis Bouché (1838) 147; (1845) 492; Kraenzl. (1912) 62. — Type not chosen.

Canna pulchra Hassk. (1842) 154. — Type not chosen.

Canna spectabilis Bouché (1845) 487. — Type (here chosen): Specimen annotated 'Hort. bot. Berol., 9. 41, in Herb. Auerswald' (neo BM), origin unknown. Photograph in U.

Canna recurvata Bouché (1845) 488. — Type (here chosen): Specimen annotated 'Hort. Bot. Berol., 9. 41, in Herb. Auerswald' (neo BM), origin unknown. Photograph in U.

Canna variegata Bouché (1845) 488, non Besser 1810. — *Canna indica* L. var. *variegata* Regel (1867) 83 (as '*ε. variegata*'). — Type not chosen.

Canna ventricosa Bouché (1845) 488. — Type not chosen.

Canna densifolia Bouché (1845) 489. — Type not chosen. This name has been misspelled as '*densiflora*' a.o. by Woodson & Schery (1945).

Canna floribunda Bouché (1845) 489. — *Canna coccinea* Mill. var. *floribunda* (Bouché) Regel (1867) 85 (as '*ε. floribunda*'). — Type (here chosen): Specimen collected by Martens in Berlin Botanic Garden in 1895 (neo BR), origin unknown. Photograph in U.

Canna laeta Bouché (1845) 489. — Type (here chosen): Specimen annotated 'h. b. Lov 1858' (neo BR), origin unknown. Photograph in U.

Canna cinnabarina Bouché (1845) 490; Kraenzl. (1912) 43. — Type not chosen.

Canna exigua Bouché (1845) 490. — Type: Specimen annotated 'Hort. Berol., 9. 41, in Herb. Auerswald' (neo BM, chosen by Tanaka (2001: 35) as 'lectotype K'), origin Nepal.

Canna fulgida Bouché (1845) 490. — Type not chosen.

Canna concinna Bouché (1845) 491; Kraenzl. (1912) 39. — Type not chosen.

Canna formosa Bouché (1845) 491; Kraenzl. (1912) 61; Segeren & Maas (1971) 675. — Type (here chosen): *Allart 403* (neo VEN, isoneo US), Venezuela, Aragua, Colonia Tovar.

Canna surinamensis Bouché (1845) 491. — Type not chosen.

Canna moritziana Bouché (1845) 492. — Type (here chosen): Specimen annotated 'Herb. Fischer, Jan 1848' (neo LE), origin Venezuela, Caracas. Photograph in U.

Canna warszewiczii A.Dietr. (1851) 290; Hook. (1855) t. 4854; Petersen (1890) 73; Kraenzl. (1912) 64. — *Canna indica* L. var. *warszewiczii* (A.Dietr.) Nob.Tanaka (2001) 42. — Type (here chosen): [icon, neo] Hooker (1855) t. 4854, chosen by Tanaka (2001: 42) as 'lectotype'.

Canna saturate-rubra Bouché ex K.Koch (1858) 386. — *Canna indica* L. var. *saturate-rubra* (Bouché ex K.Koch) Regel (1867) 83 (as '*γ. saturate-rubra*'). — Type not chosen.

Canna bidentata Bertol. (1859) 33, t. 5; Kraenzl. (1912) 46. — Type: Specimen with 2 watercolours (holo BOLO), origin Mozambique.

Canna eximia Bouché ex Horan. (1862) 18; Kraenzl. (1912) 41. — Type not chosen.

Canna schubertii Horan. (1862) 18. — Type (here chosen): Specimen collected by Martens in Berlin Botanic Garden in 1855 (neo BR), origin Venezuela, Caracas. Photograph in U.

Canna polyclada Wawra (1863) 7; (1866) 143, t. 22; (1883) 88; Petersen (1890) 69; Kraenzl. (1912) 41, f. 7. — Type: *Wawra & Maly 495* (holo W, destroyed), Brazil, Rio de Janeiro, Corcovado.

Canna indica L. var. *edwardsii* Regel (1867) 83 (as '*ß. edwardsii*'). — Type (here chosen): [icon, neo] Ker Gawler (1824e) t. 776 ('*Canna indica*').

Canna indica L. var. *karsteniana* Regel (1867) 83 (as '*δ. karsteniana*'). — Type not chosen.

Canna coccinea Mill. var. *concolor* Regel (1867) 85 (as '*δ. concolor*'). — Type not chosen.

Canna texensis Bouché ex Regel (1867) 86. — Type (here chosen): Specimen collected by Martens in Berlin Botanic Garden in 1857 (neo BR), origin USA, Texas (?). Photograph in U.

Canna cearensis Huber (1901) 297. — Type: *Huber 289* (holo MG), Brazil, Ceará, Guaramiranga (= Conceição), Serra de Baturité, 700 m.

Canna coccinea Mill. forma *flaviflora* Chodat & Hassl. (1903) 1108. — Type: *Hassler 3194* (holo G; iso GH, K, NY, S, UC), Paraguay, Apa R., near Guardia de Francia.

Canna warszewiczii A.Dietr. var. *flameus* Ram.Goyena (1911) 806. — Type not chosen.

Canna sanctae-rosae Kraenzl. (1912) 40, f. 4C–E (as '*sanctae rosae*'). — *Canna indica* L. var. *sanctae-rosae* (Kraenzl.) Nob.Tanaka (2001) 43. — Type: *Heyde & Lux 4290* (holo K), Guatemala, Prov. Santa Rosa, Santa Rosa, 1000 m. Photograph in U.

Canna seleriana Kraenzl. (1912) 56. — Type: *C. & E. Seler 2209* (holo B, destroyed), Mexico, Chiapas, between Ococinga and San Martin.

Canna coccinea Mill. var. *bicolor* Kraenzl. (1912) 61. — Type: *Lehmann 5735* (lecto K, 2 sheets, chosen by Tanaka (2001: 35; isolecto BM), Colombia, Cauca, Popayán. Photograph in U.

Canna generalis L.H.Bailey & E.Z.Bailey (1930) 118; Standl. & Steyerm. (1952) 204. — Type: Specimen named *'Cheerfulness'* (holo BH), origin cultivation.

Canna orchiodes L.H.Bailey & E.Z.Bailey (1930) 119. — Type: Specimen named *'Italia'* (holo BH), origin cultivation.

Canna variegatifolia Ciciar. (1995) 334, f. 1–3. — Type: *Ciciarelli 4* (holo LP), Argentina, Santa Fé, La Capital.

Canna plurituberosa T.Koyama & Nob.Tanaka (2000a) 89, f. 1A, 2. — Type: *Koyama 15858* (holo MAK; iso TNS), Argentina, Jujuy: tributary of Alto Río Grande, Road to Termes de Reyes, 20 km NW of Jujuy, 1750 m.

Canna amabilis T.Koyama & Nob.Tanaka (2000b) 11. — Type: *Koyama 15865* (holo TNS; iso MAK), Argentina, Chaco.

Canna discolor Lindl. var. *rubripunctata* Nob.Tanaka (2001) 31 (as '*rubripuncutata*'). — Type: *Tanaka 1454* (holo MAK; iso MBK), China, Yunnan, Me Lei. See note 6.

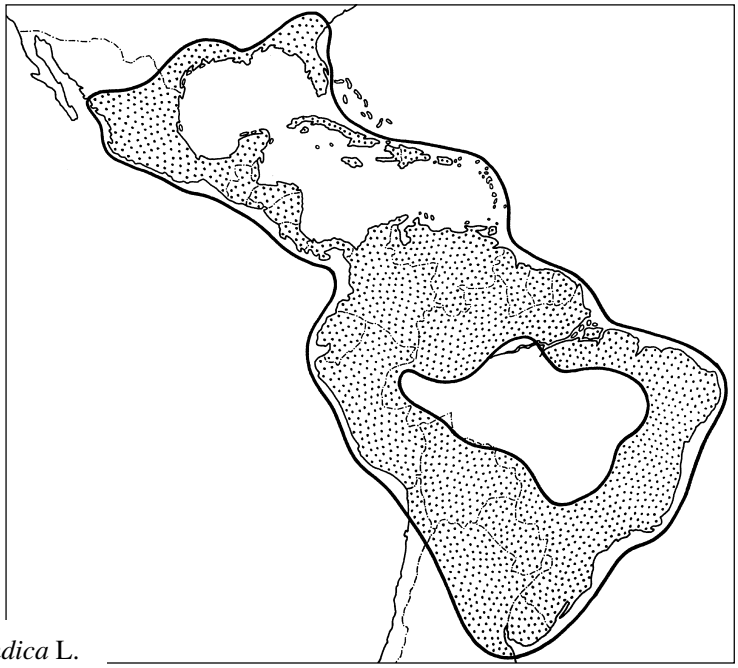
Canna discolor Lindl. var. *viridifolia* Nob.Tanaka (2001) 31. — Type. *Koyama s.n.* (holo NY), Taiwan, Prov. Nantou, Chushan Co., c. 500 m above Chushan village, 1200 m.

Plants to 3 m tall. Rhizome short, tuberous, 2.5–3.5 cm diameter. *Leaves*: sheaths sometimes lanuginose or glaucous; lamina sometimes pluriplicate, (narrowly) ovate to (narrowly) elliptic, 20–35(–50) by (7–)15–25 cm, base obtuse to narrowly cuneate, apex acute and shortly acuminate. *Inflorescence* often branched, with (1- or) 2-flowered cincinni; pedicels up to 1 cm long, to 1.5 cm in fruit; primary bracts 7–15 cm long, acute; branch bracts 3–6 cm long, obtuse to acute; floral bracts (broadly) obovate-elliptic, 0.8–2.5 cm long, obtuse to irregularly truncate, persistent; bracteoles narrowly (ovate-) triangular, (0.5–)1.2–1.5(–2) cm long, acute; bracts, bracteoles, and sepals generally glaucous. *Flowers* deep red to yellow, erect, 3.5–6.5(–7.5) cm long; sepals whitish green to red or purple, narrowly ovate-triangular, 0.8–2 by 0.3–0.5 cm, acute; corolla red to yellow, (3–)4–5.5(–6.5) cm long, petals erect, narrowly triangular, 2.5–4.5(–5) by 0.3–0.7 cm, acute; staminodes 3 or 4, red to yellow, 4.5–5.5(–7.5) cm long, free part narrowly obovate to narrowly triangular, 2.5–4.5(–5) by 0.3–0.8(–1) cm, erect, 1 recurved and sometimes dotted or striped; stamen red to yellow, free part narrowly elliptic, 1.5–2.5(–4) by 0.2–0.6 cm, theca 0.5–1.2 cm long; style red to yellow, free part linear to club-shaped, 1.5–4.5 by 0.1–0.3 cm. *Fruit* bright green, covered by green to purple tubercles, ellipsoid to subglobose or obovoid, 1.5–4(–5.5) by 1.5–2(–3.5) cm. *Seeds* subglobose, 4–8 mm diameter.

Distribution — Throughout the Neotropics, from the southern states of the USA to northern Argentina, and on the West Indian Islands, but not in the Central Amazon Basin.

Habitat & Ecology — At elevations between sea level and 2000(–2700) m; in shady, often wet places in forest and savannahs, in swampy areas, along rivers, or roadsides, also in secondary vegetation, and often in coffee plantations.

Etymology — In 1576, De Lobel gave the first description of a *Canna* as 'Indica florida', a plant raised from seeds originating from 'Indiae Occiduae'. This could very well explain the origin of the epithet '*indica*'.



Map 4. Distribution of *Canna indica* L.

Uses — Cultivation of *Canna*'s has resulted in larger plants provided with larger rhizomes and larger leaves. Names like *C. maxima* and *C. macrophylla* have been used for large-leaved plants especially in cultivation, without (proper) description and without typification. It is not clear if all these plants belong to *C. indica*.

Hybridization has mainly been performed to create plants with larger flowers. *Canna indica* has been extensively cultivated for decoration and as an ornamental, and it even became a weed in gardens in tropical America. The species has also been used in hybridization (cf. chapter on uses and vernacular names).

The rhizomes have been cultivated for their edible starch, originally in tropical America and later on all over the World. The flour is often used in soups for children and the sickly (Peru, French Guiana), and as a(n illegal) replacement for araruta (flour made of the rhizomes of *Maranta arundinacea*). The rhizomes contain ethereal oils, waxes, and a diuretic (diuresin; Brazil, Panama). They are used as a febrifuge (diaphoresin; Brazil), against dropsy (hydropsia; Brazil, Peru), against fever (Brazil, Peru), in softening compresses (Brazil, Panama), in tandpowder (Brazil), and as stimulant (estimulantes; Brazil). A decoction of the rhizome is used to treat gonorrhoea (antiblennorrhagia; Brazil) and cold of the bladder (Brazil). A decoction of the stems is used as a drink or bath to regain energy (Peru). The leaves are used for wrapping up parcels in Asia (Ridley 1924) as well as in Panama, and to wrap around tamales (pastries made of corn filled with beans, meat, and pepper; Mexico, Belize), they are fed to animals, and have sometimes been eaten as legume by the poor (Brazil). Smoke of burned leaves can be used as insecticide (Kraenzlin 1912: 15; greenhouse America). Freshly squashed leaves are used in baths against rheumatic pains and arthritis (Brazil), and are applied to ulcers (Brazil). Juice of leaves is used against mercurialism (Brazil), as a diuretic (Brazil, Panama, Peru), and in compresses (Brazil, Panama). Leaf extracts have shown molluscicidal activity (to kill snails, Rogers 1984). The juice of unripe fruit is used against inflammation of the ear (Brazil). The fruit can be used to treat constipation

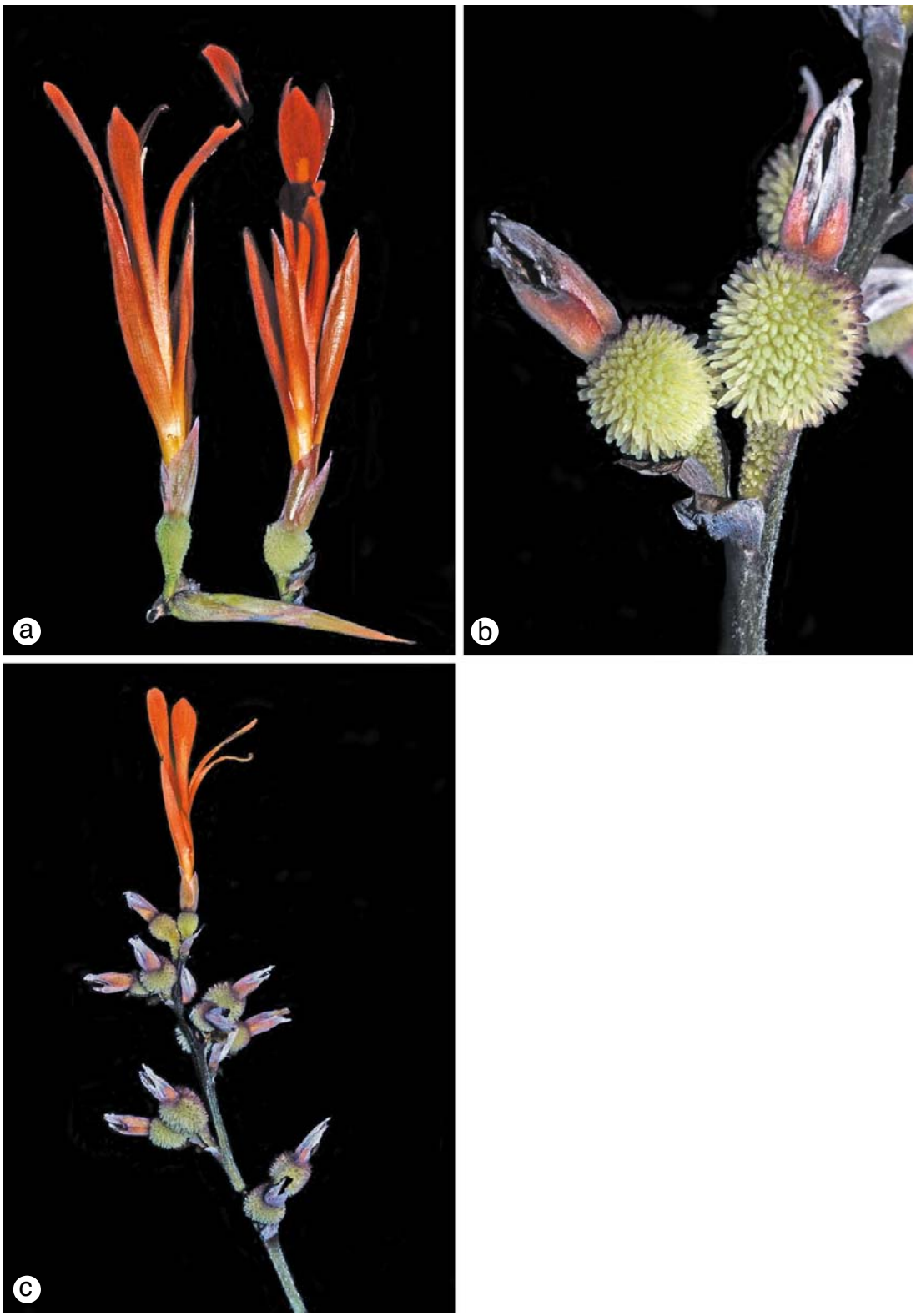


Plate 1. *Canna bangii* Kraenzl. a. Flowers; b. fruits; c. inflorescence (all: *Plowman s.n.* cult. at Utrecht as number 75GR00069). — Photos by P. Maas.

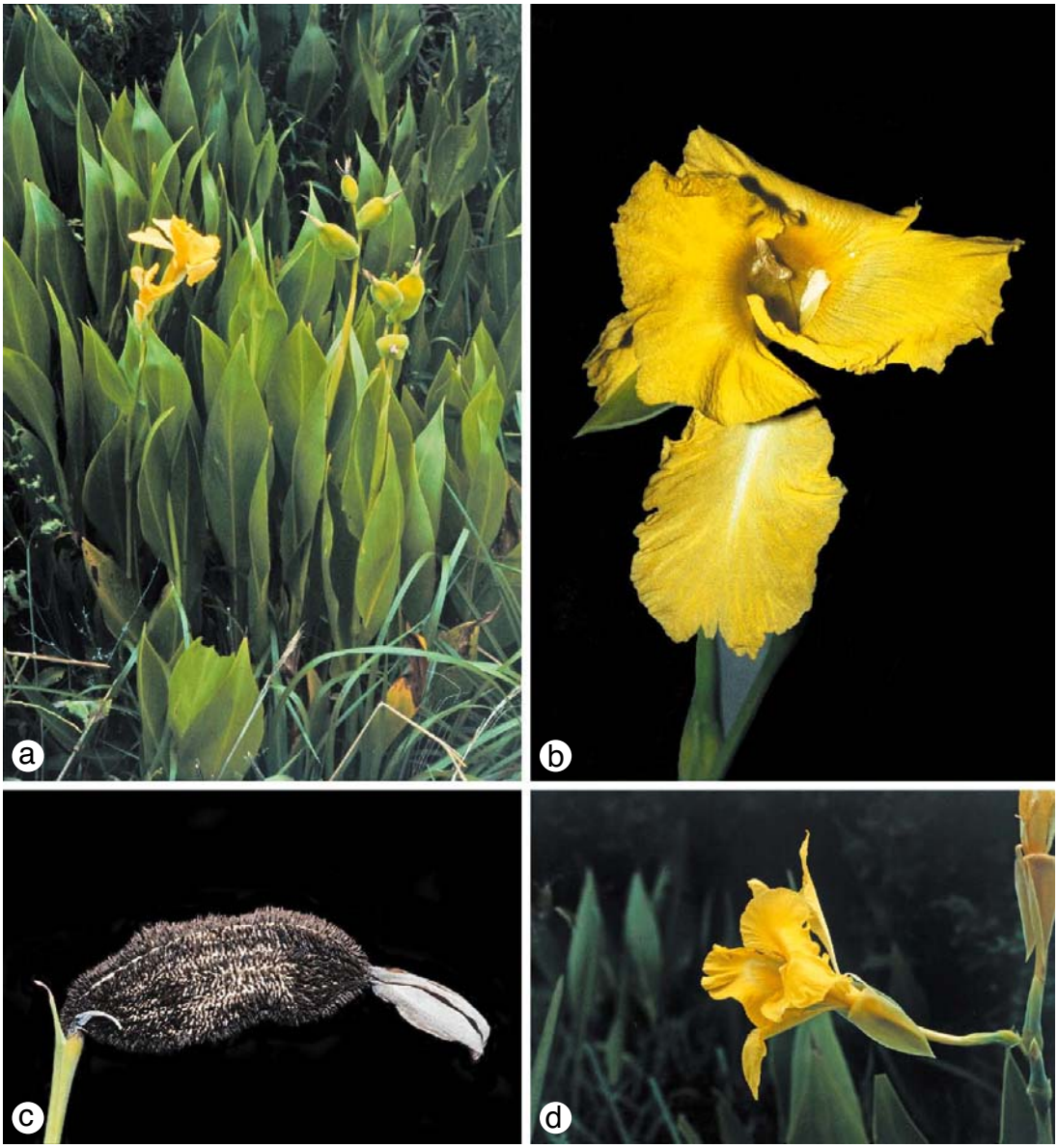


Plate 2. *Canna flaccida* Salisb. a. Habit; b. flower seen from above; c. fruit; d. flower (a, b: South Florida; c, d: cult. at Utrecht as number 68GR00977). — Photos: a, b by T. Plowman; c, d by P. Maas.

of children (obradera; Panama), and they yield a purple dye which is not permanent (Brazil). The seeds are used as ammunition for blowpipes (serbatanas; Mexico), in musical rattles (maracas; Panama, Brazil, West Indies), as beads for making rosaries (Indonesia, India, West Indies), as beads to make necklaces and bracelets after boiling (Bolivia, Brazil, French Guiana), as toys, as ammunition for children's shotguns (St. Helena), or as a substitute for lead in hunting (Brazil). They also have been used as an ingredient or a substitute for coffee (Brazil, Europe). For extensive medical applications see Hegnauer (1963).

Vernacular names — See list.

Pollination — Vogel (1969) supposes pollination of *C. indica* by birds because of the short tube, small nectaries, and lack of scent. There is unconfirmed evidence that

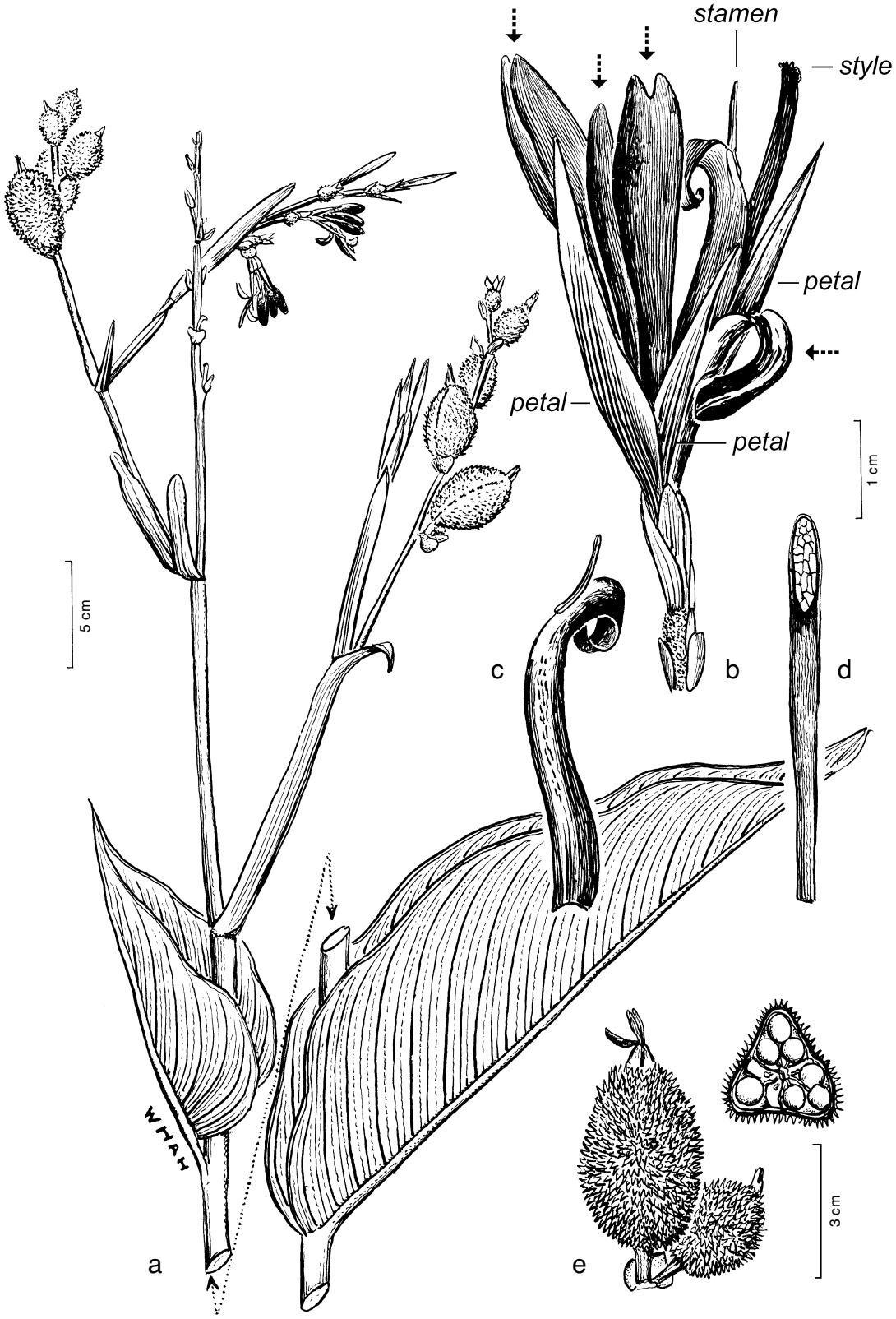


Fig. 7. *Canna indica* L. a. Inflorescence with leaves; b. detail of flower showing sepals, petals, 4 staminodes (marked with arrows), stamen and style; c. detail of stamen (petaloid part and anther); d. detail of style (petaloid part covered with pollen); e. fruit and cross section of fruit showing seeds (all: drawn by W.H.A. Hekking in Surinam from fresh material).

this is indeed the case. Rechinger (1910) reported from the island of Samoa visits by the bird *Myzomela nigriventris* (Meliphagidae) with a somewhat curved beak, and of the butterfly *Danais archippus*. Vogel (1954) saw birds of the genus *Nectarina* on the flowers of *C. indica* in South Africa.

Dispersal — No data.

Notes — 1. *Canna indica* is a very variable species. The above description is intended to be based on measurements of wild specimens. In our opinion the true wild *C. indica* is a plant from low to middle elevation, with middle-sized green leaves (20–35 by 15–25 cm), persistent floral bracts, red to yellow flowers with a straight floral tube, several staminodes with erect free parts, one with recurved free part, and subglobose seeds. The inflorescence is generally glaucous and the lower side of the leaves is not lanuginose.

2. *Canna indica* is different from *C. jaegeriana*. The latter occurs at high altitudes and has larger leaves than *C. indica*. *Canna jaegeriana* has orange flowers with a curved tube, all staminodes with erect free parts, ellipsoid seeds, and caducous bracts. Moreover, in *C. jaegeriana* the lower side of the leaves, the sheaths, and parts of the inflorescence are always lanuginose.

3. *Canna indica* is different from *C. tuerckheimii*. The latter occurs also at high altitudes and has also larger leaves than *C. indica*. *Canna tuerckheimii* is characterized by orange-red flowers with a straight floral tube, staminodes with patent free parts, subglobose seeds, caducous bracts, and a more or less lanuginose lower side of the leaves, as well as a glaucous inflorescence.

4. Specimens of *C. indica* with red or yellow flowers have been found growing next to each other in the Antilles, in Mexico, in Peru, in El Salvador, as well as in Uruguay. This seems to be a not too rare phenomenon.

5. *Canna variabilis* Willd. was published as the name of one of the three species into which *C. indica* was split up. The other two must be treated as homotypic synonyms of *C. coccinea* Mill. and *C. patens* (Aiton) Roscoe, respectively. This leaves us with *C. variabilis* as a homotypic synonym of *C. indica*, despite the fact that *C. indica* var. *rubra* was mentioned as its synonym.

6. The spelling '*rubripunctata*' only occurs on p. 23, in the dendrogram.

7. *Canna pallida* Roscoe var. [without epithet] (1825) 55, t. 20 belongs to *C. indica*.

In northern Argentina (Corrientes, Chaco, and Formosa) also plants have been found with more or less reddish or reddish punctate flowers. Their leaves are narrow and glaucous as in *C. glauca*, or wider and green as in *C. indica*. These specimens were reported to grow next to pure *C. glauca* and/or *C. indica* stands. See also under *C. glauca* note 5.

5. Canna iridiflora Ruiz & Pav. — Map 5; Plate 5a, b

Canna iridiflora Ruiz & Pav. (1798) 1; Roscoe (1825) 42, t. 14; Bouché (1833) 164; (1845) 493; Petersen (1890) 75; Kraenzl. (1912) 68. — *Achirida iridiflora* (Ruiz & Pav.) Horan. (1862) 18, t. 2. — Type: *Ruiz & Pavón 642* (holo MA, only photograph seen; iso BM, F, K, U), Peru, Huánuco, Pillao, anno 1787.

Plants to 5 m tall. Rhizome tuberous, diameter unknown. *Leaves*: sheaths mostly densely lanuginose; lamina pluriplicate, narrowly ovate, (20–)40–80 by 15–45 cm, base

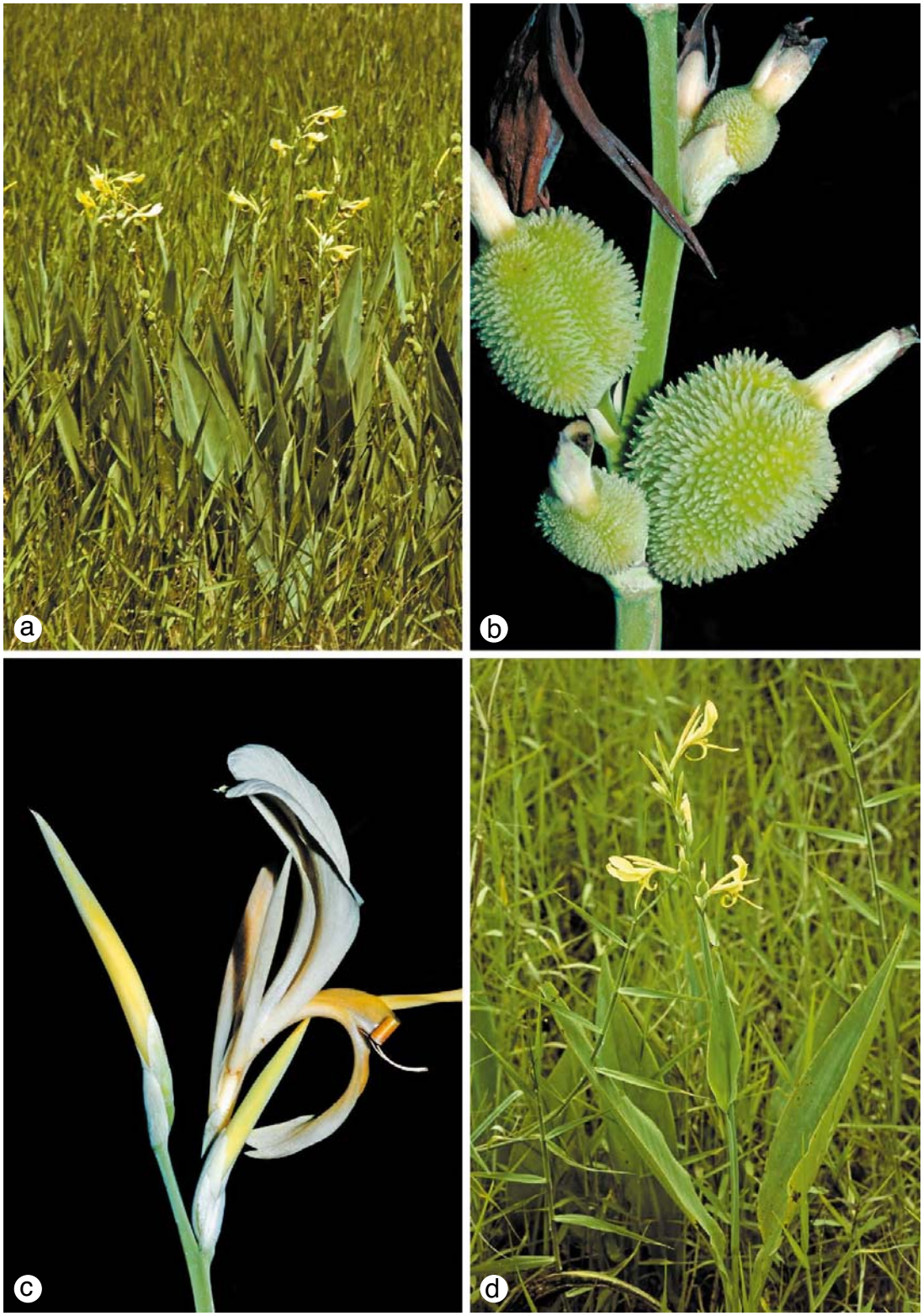


Plate 3. *Canna glauca* L. a. Plants in wet grassy vegetation; b. infructescence; c. flower; d. habit (a, d: *Maas et al. 2158*; b, c: Guyana). — Photos by P. Maas.

Plate 4. *Canna indica* L. a. Habit; b. rosary made of seeds of *Canna* mounted as herbarium specimen; c. flower; d. girl holding flowers and fruits (a, c: cult. at Utrecht; b: *A. Aziz s.n.* (MO); d: Guyana). — Photos: a, c after L. Westra; b by P. Maas; d by T. van Andel.

Map 5. Distribution of *Canna iridiflora* Ruiz & Pav.

cuneate, apex acute, sometimes shortly acuminate, lower side often densely lanuginose. *Inflorescence* branched, with 1- (or 2-)flowered cincinni; pedicels 0.5–2 cm long, to 3 cm in fruit, densely tuberculate just below the ovary; primary bracts 20–40 cm long, acute; branch bracts 3–11 cm long, acute to obtuse; floral bracts (narrowly) ovate-triangular to broadly obovate, 0.3–1.5 cm long, obtuse to acute, persistent; bracteoles linear, 1–4 cm long, acute, far exceeding the floral bracts; bracts, bracteoles, and sepals glaucous, sometimes lanuginose. *Flowers* carmine-red to purple, pendent, 10–14 cm long; sepals deep red to dark purple, narrowly ovate-triangular, 2.3–4.5 by 0.4–0.8 cm, acuminate to acute; corolla carmine-red to purple, 8–12.5 cm long, petals erect, narrowly ovate-triangular, 3.5–7 by 0.6–1.5 cm, acute; staminodes 4, carmine-red to purple, inner ones sometimes spotted with white, 11–14 cm long, free part narrowly obovate to narrowly elliptic, 4.5–6 by 1–2.5 cm, apically more or less patent; stamen carmine-red to purple, free part narrowly elliptic, 3–4.3 by 0.5–1 cm, theca 1–1.5 cm long; style carmine-red to purple, free part narrowly obovate to narrowly elliptic, 3–4 by c. 0.5 cm. *Fruit* yellowish green, covered by dark purplish tubercles, ellipsoid, 5.5–10 by 3.7–4.5 cm. *Seeds* broadly ellipsoid, 8–10 by 5–8 mm.

Distribution — Peru (Ayacucho, Cuzco, Huánuco, Junín, Puno, and San Martín).

Habitat & Ecology — At elevations of 1800–2850 m; in shady, often wet places on steep forested slopes, in open woods, or along roadsides.

Etymology — In their description of this species, Ruiz & Pavón mentioned the 3 inner lobes of the corolla to be the larger ones ("laciniis tribus corollae interioribus majoribus"). The flower of the genus *Iris* is in the same way characterized by 3 large stigma lobes inside the petals.

Uses — This species has been cultivated as an ornamental and has been used in hybridization.

Pollination — No data.

Dispersal — No data.

Notes — 1. *Canna iridiflora* can be recognized by large, pendent, carmine red to purple flowers with a long tubular part, compared to flowers of other species. The leaves have a lanuginose lower side.

2. Sims (1818) t. 1968 published the first plate of *C. iridiflora*. In the accompanying text he stated the depicted specimen was raised from seeds by A.B. Lambert in his hothouse at Boyton from seeds received in 1816 from the celebrated Don J. Pavón, who had collected them in his travels through Peru and Chile a long time ago (i.e. between 1778 and 1788).

6. Canna jaegeriana Urb. — Fig. 8; Map 6; Plate 5c, d

Canna jaegeriana Urb. (1917) 102, nom. cons.; Maas & H.Maas (1988) 7. — Type: *Jaeger 165* (holo K; iso LE, MO), Haïti, in wet forests of Black Mountain, 'Le grand fond et Sourçailla', 300–1200 m. Photograph in U.

Canna leucocarpa Bouché (1845) 493, nom. rej.; Kraenzl. (1912) 56, f. 11E; Segeren & Maas (1971) 672. — Type: [icon, neo] Kraenzlin (1912) f. 11E, chosen by Maas-van de Kamer (2004: 835) (see note 6).

Canna pertusa Urb. (1917) 101. — Type (here chosen): *Sintenis 6494* (holo B, destroyed; lecto L, cited by Tanaka (2001: 46) as 'holotype'; isolecto G), Puerto Rico, near Utuado in the surroundings of Isabon at the margin of a small river.

Canna domingensis Urb. (1917) 102. — Type: *Von Tuerckheim 3231* (holo BR), Dominican Republic, near Constanza, 1300 m.

Plants to 5 m tall. Rhizome short, tuberous, diameter unknown. *Leaves*: sheaths more or less lanuginose; lamina pluriplicate, narrowly elliptic-ovate to elliptic-ovate, 40–100 by 15–40 cm, base cuneate, apex acute, sometimes shortly acuminate, lower side more or less lanuginose, upper side often darker green, thus creating a 2-coloured appearance of the leaves. *Inflorescence* branched or unbranched, lax or congested, with 1- or 2-flowered cincinni; pedicels up to 0.5 cm long, to 1(–3) cm in fruit, rarely tuberculate just below the ovary; primary bracts 10–31 cm long, obtuse to acute; branch bracts 2.5–13 cm long, acute; floral bracts (ob)ovate to triangular, 0.3–3.5 cm long, acute to obtuse, mostly caducous; bracteoles narrowly triangular to obovate, 0.2–2 cm long, acute to obtuse; rachis, primary bracts, and branch bracts more or less lanuginose. *Flowers* orange (sometimes to yellow or scarlet red, or with darker dots), erect, 4–7.5 cm long; floral tube more or less curved around the middle resulting in a horizontally orientated entrance to the flower; sepals pale green, pink, or red, narrowly triangular to narrowly ovate, 0.6–2.2 by 0.2–1 cm, acute; corolla orange to red, 3–5.5 cm long, generally about as long as the staminodes, petals erect, narrowly triangular, 2–3(–4.5) by 0.5–1(–1.4) cm, acute; staminodes (3 or) 4 or 5, orange sometimes with darker dots, 4–6(–7.5) cm long, free part (narrowly) obovate-elliptic, 1.4–2(–4) by (0.4–)0.7–1(–1.5) cm, erect, sometimes 1 recurved; stamen orange, free part narrowly elliptic-obovate, 1.2–3 by 0.4–1.1 cm, theca 0.7–1.2 cm long; style orange to red, free part narrowly elliptic, 1.3–2.5 by 0.3–0.6 cm. *Fruit* light yellowish green turning green, covered by pinkish, reddish, or purplish tubercles, ellipsoid to (narrowly) obovoid, 3–9 by 1.5–4 cm. *Seeds* (narrowly) ellipsoid, 4–7 by 2–4.5 mm.

Distribution — Greater Antilles and North and West tropical South America (Venezuela, Colombia, Ecuador, Peru, and Bolivia).

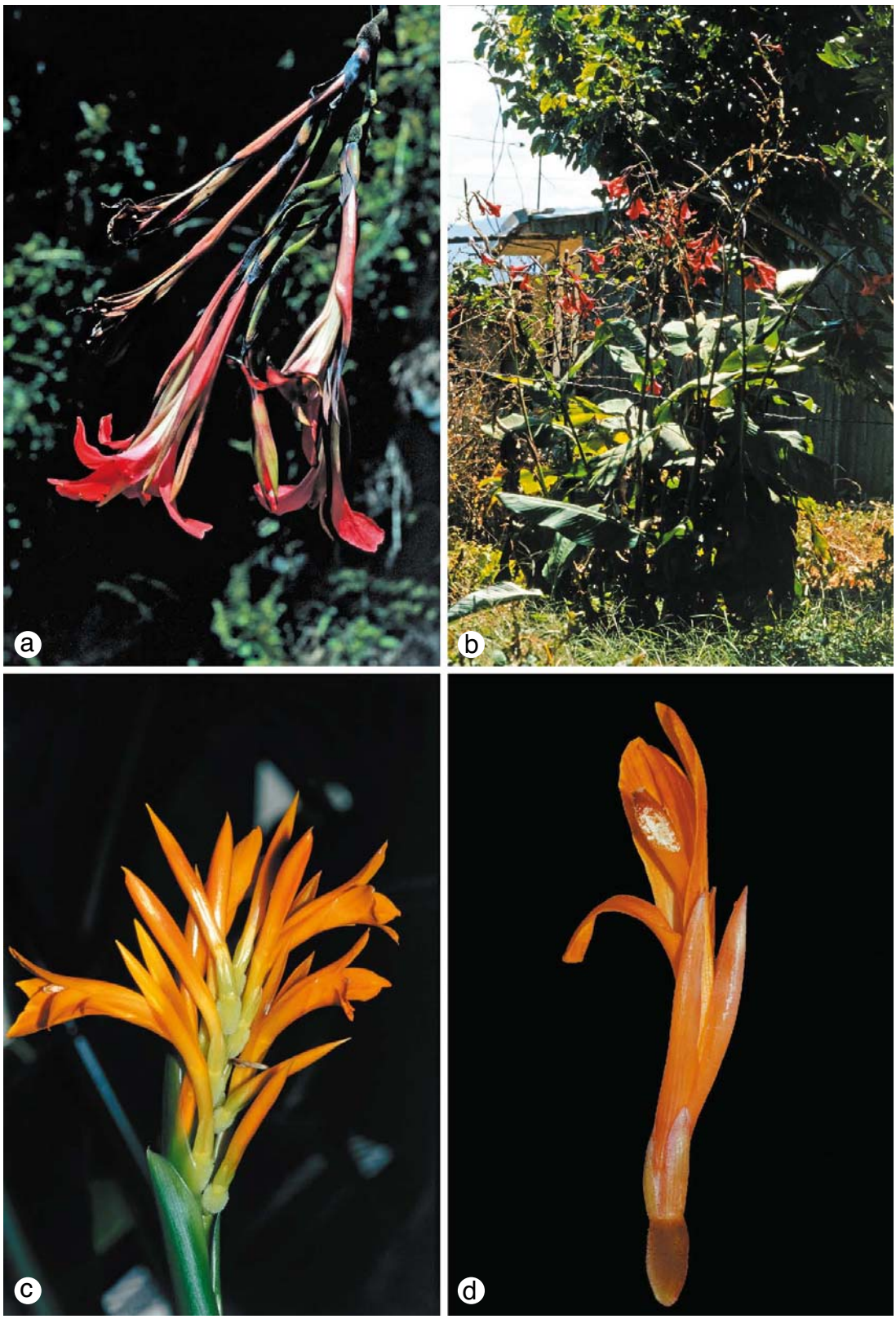


Plate 5. a, b. *Canna iridiflora* Ruiz & Pav. a. Inflorescence; b. habit. — c, d. *C. jaegeriana* Urb. c. Inflorescence; d. flower (a: *Maas et al. 6050*; b: cult. in Costa Rica; c: cult. at NYBG; d: *Maas et al. 6439*). Photos by P. Maas.

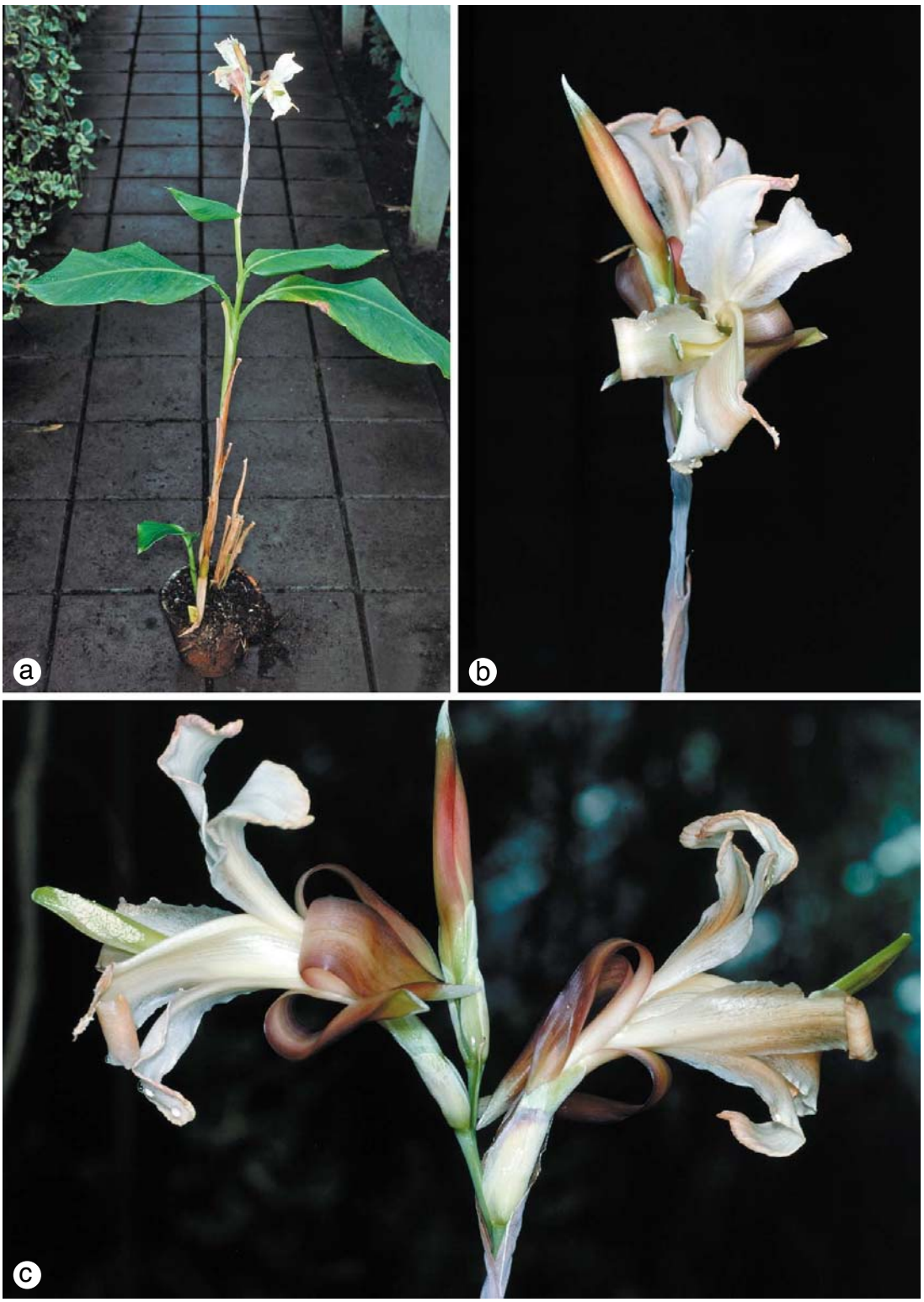
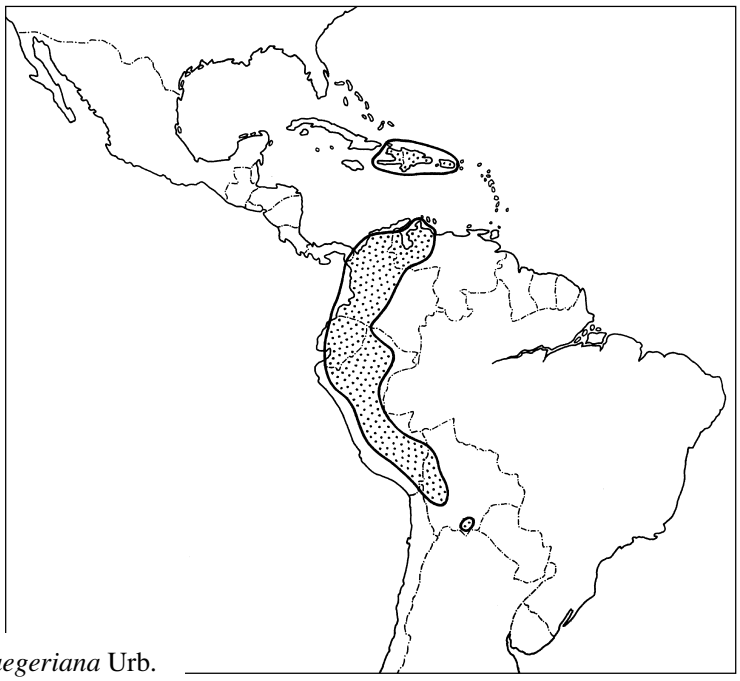


Plate 6. *Canna liliiflora* Warsz. ex Planch. a. Habit; b, c. inflorescence (all: *Plowman 5189* cult. at Utrecht as number 75GR00068). — Photos by L. Westra.



Map 6. Distribution of *Canna jaegeriana* Urb.

Habitat & Ecology — At elevations of (200–)750–2000(–2800) m; on forested slopes or ravines, forest edges, or in open places along streams.

Etymology — *Canna jaegeriana* is named by Urban after B. Jaeger, the collector of the type specimen. He was a plant collector for the Botanical Garden of St. Petersburg, collecting in Haïti in 1827–1828.

Uses — This species has been much cultivated in Colombia, Ecuador, and Peru for its edible rhizomes (often erroneously named *C. edulis* which is now placed in synonymy with *C. indica*). It also has been cultivated for its leaves as wrappers and for its seeds to make necklaces.

Vernacular names — See list.

Pollination — The tube of the flower of *C. jaegeriana* is formed by staminodes, stamen and style being more or less curved around the middle, resulting in a horizontally orientated entrance to the flower, with the stigma mostly at the left side of the entrance. The firm texture and bright orange colour of the floral parts suggest pollination by hummingbirds.

Dispersal — No data.

Notes — 1. *Canna jaegeriana* can be recognized by the combination of the following characters: generally curved, orange, small (4–7.5 cm long) flowers with free part of staminodes erect, floral bracts mostly caducous, and upper side of leaves often dark brown to black in herbarium material. Besides, the seeds are ellipsoid and relatively small (4–7 by 2–4.5 mm). The plants are generally growing at high altitudes.

2. By the above-mentioned characters *C. jaegeriana* differs from *C. tuerckheimii* which has orange-red, straight flowers with free part of staminodes patent, subglobose seeds, and which occurs in Central and western South America, also at high altitudes. Both species have a more or less lanuginose lower side of the leaves.

3. Some specimens from high places in South America are difficult to identify. Because of cultivation, plants may be larger and may have larger leaves suggesting

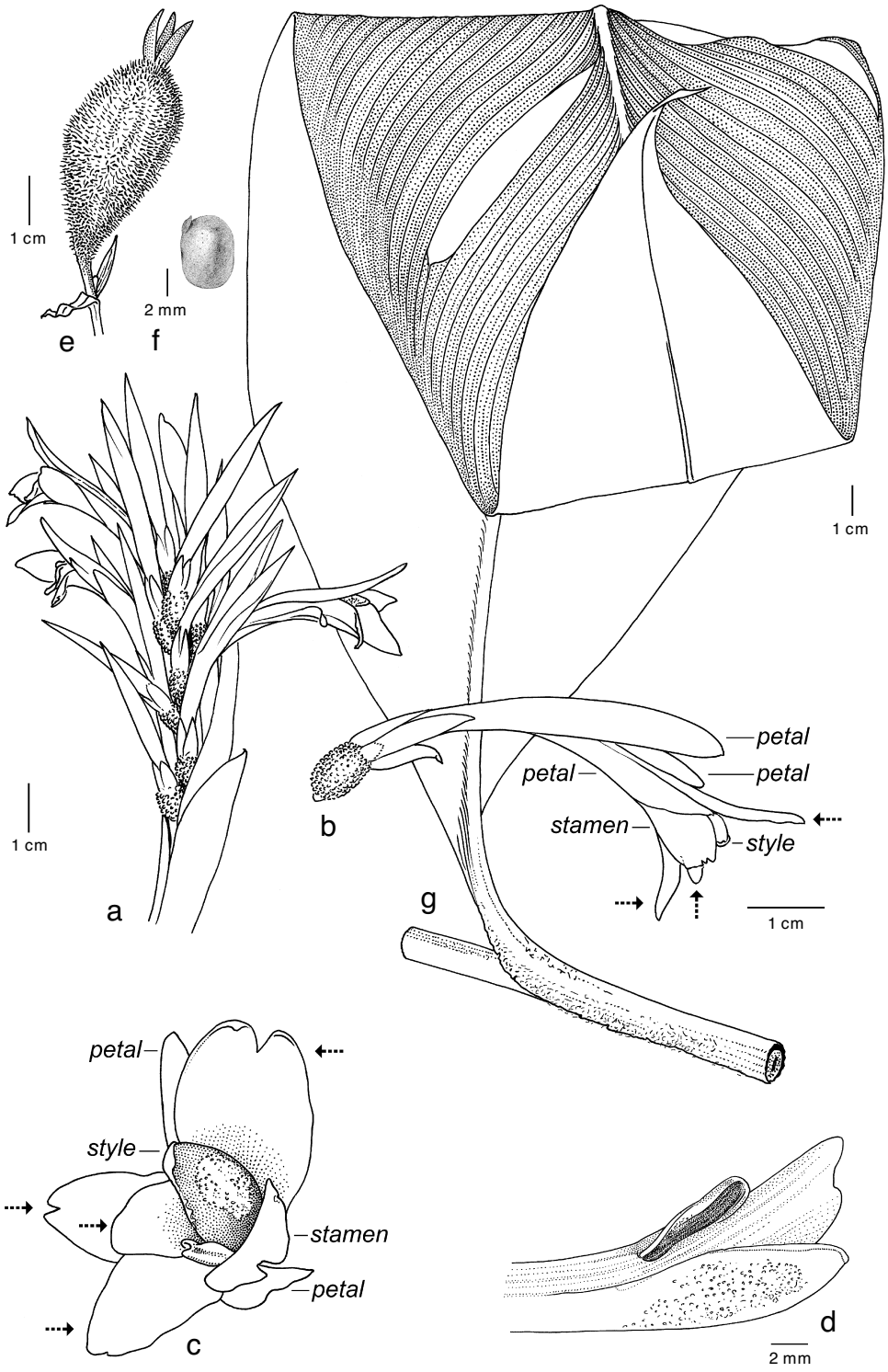


Fig. 8. *Canna jaegeriana* Urb. a. Inflorescence; b. flower seen from the side showing sepals, petals, staminodes (marked by arrows), stamen, and style; c. flower seen from the front; d. detail of stamen (petaloid part with empty anther) and style (petaloid part covered with pollen and marginal stigmatic area); e. fruit; f. seed showing opened imbibition lid; g. leaf (a: drawn from a colour slide of a plant growing in the New York Botanical Garden; b–d: drawn from a colour slide of a plant growing in the Botanic Gardens of Utrecht (75GR00053), cultivated from seed collected by *Plowman 5123* in Peru; e, f: *Zanoni et al. 20254*; g: *Betancur et al. 5954).*

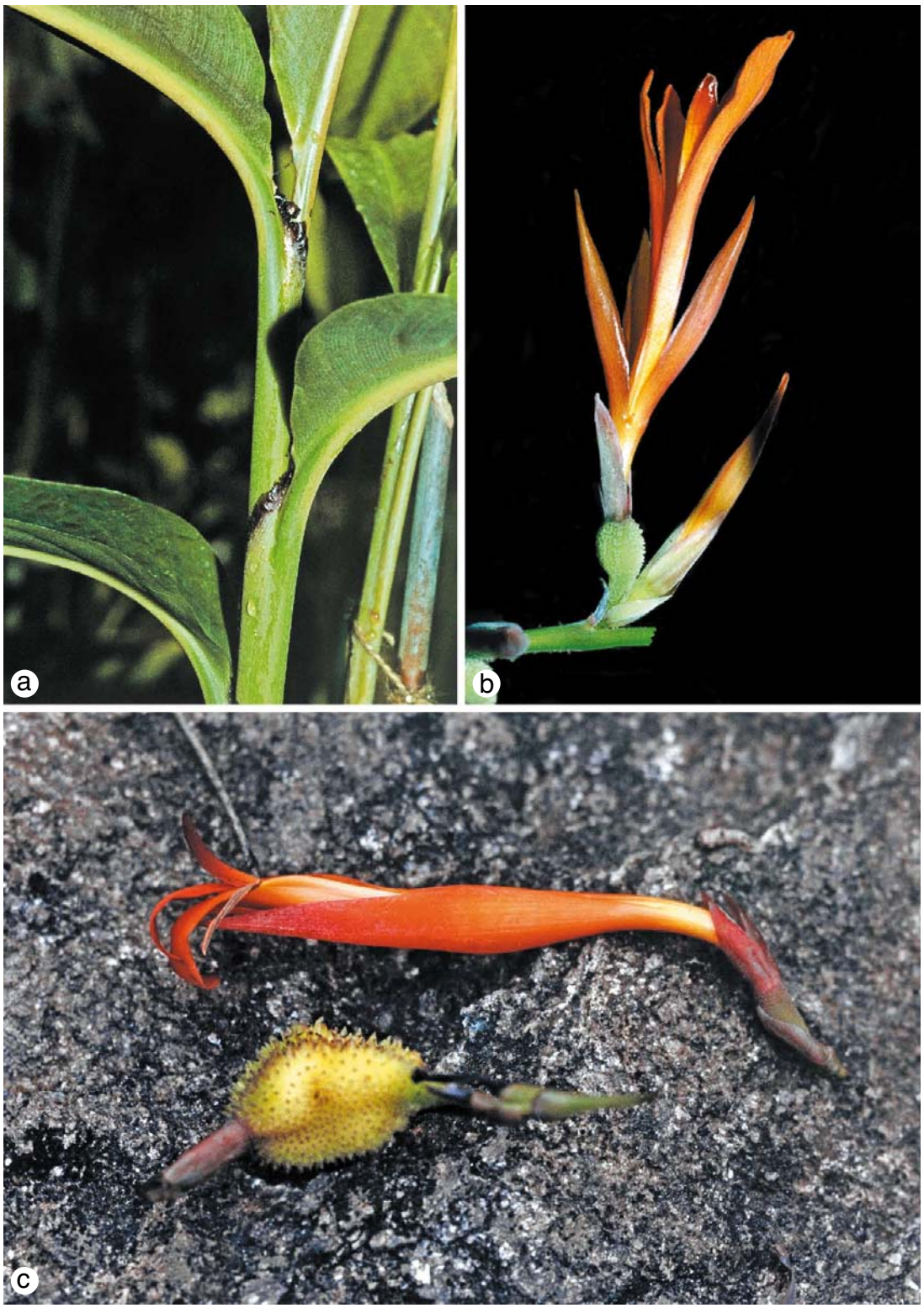


Plate 7. *Canna paniculata* Ruiz & Pav. a. Leaves with pulvinus; b. flower; c. flower and young fruit (a, b: *Plowman & Kennedy 5700* cult. at Utrecht as number 76GR00106; c: *Maas et al. 3305*). Photos by P. Maas.

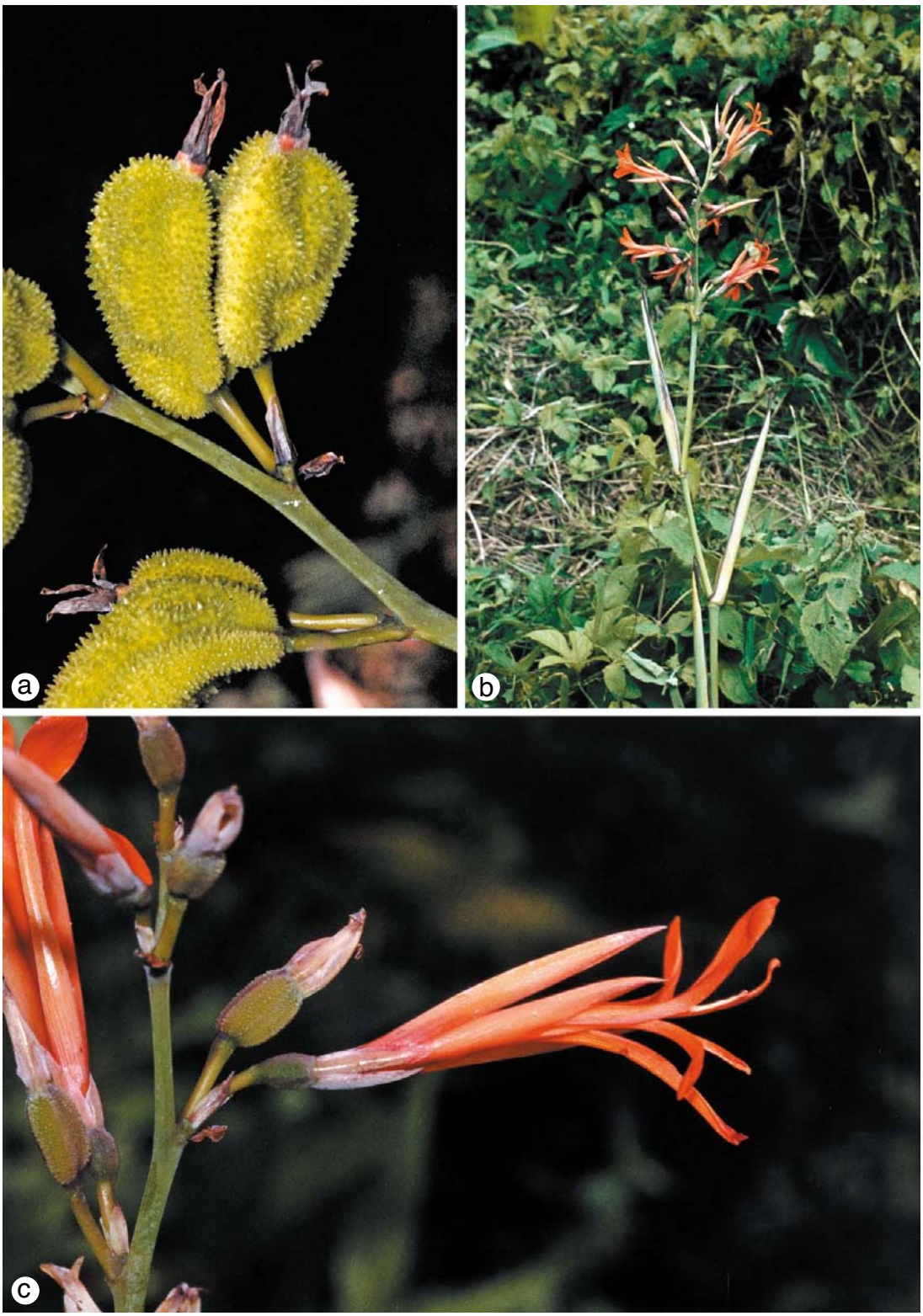


Plate 8. *Canna tuerckheimii* Kraenzl. a. Infructescence; b. habit; c. flower (a, c: *Maas et al. 4707*; b: *Maas et al. 1614*). Photos by P. Maas.

C. jaegeriana, while the flowers are like those of *C. indica*. There could also be hybrids involved.

4. Some specimens are aberrant by having large, subglobose seeds of 9–10 by 8–9 mm. It concerns specimens from high altitudes in Ecuador (Pichincha and Cotopaxi) and Bolivia (Tarija).

5. Part of the specimens from Puerto Rico, Haïti, and the Dominican Republic is slightly different by small and caducous floral bracts, small sepals (c. 0.5 cm long), and red flowers with petals shorter than the staminodes (see *C. pertusa* and *C. domingensis*).

6. Kraenzlin (1912: 58) wrote that his illustration was based on a specimen in the Berlin Botanic Garden, originating from seeds that had been received from Richard Schomburgk from Guyana, and already in 1843 and 1844 producing flowering plants in Berlin. Richard Schomburgk, however, did not visit Guyana before 1843. His brother, Robert Schomburgk, visited Puerto Rico around 1830, and the Berlin specimens might be originating from this island.

7. Canna liliiflora Warsz. ex Planch. — Map 7; Plate 6a–c

Canna liliiflora Warsz. ex Planch. (1855) 211, t. 1055–1056; Petersen (1890) 76; Kraenzl. (1912) 70. — Type: [icon, neo] Planchon (1855) t. 1055–1056, chosen by Tanaka (2001: 50) as 'holotype' (see note 2).

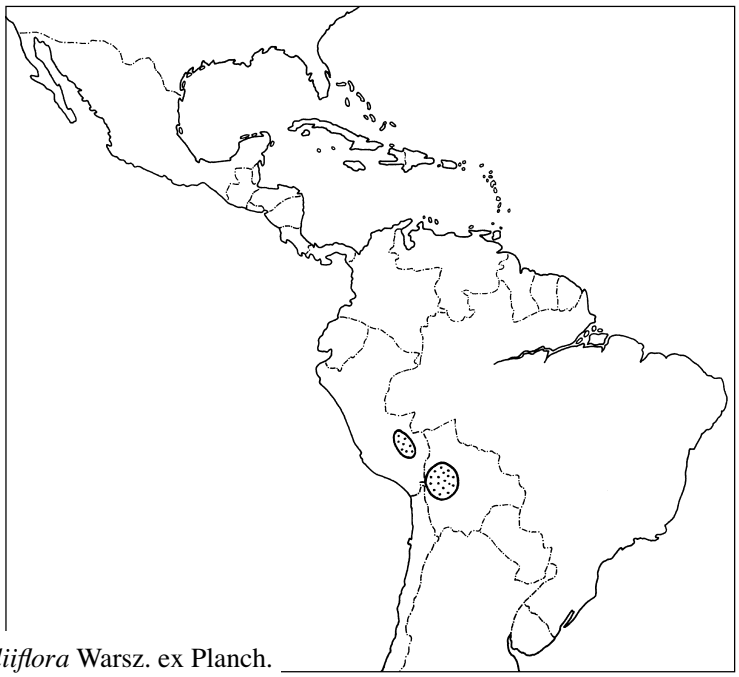
Canna brittonii Rusby (1902) 695 (as '*brittoni*'); Kraenzl. (1912) 72. — Type: *Rusby 2857* (holo NY), Bolivia, La Paz, Yungas, c. 2000 m.

Plants 3–6 m tall. Rhizome composed of subglobose tubers, to 6 cm diameter. *Leaves*: sheaths more or less lanuginose; lamina narrowly to broadly ovate-elliptic, 35–120 by 20–45 cm, base rounded, apex obtuse to acute, sometimes shortly acuminate, lower side more or less lanuginose. *Inflorescence* generally unbranched, flowers solitary, sessile; primary bracts 11–39 cm long, obtuse, sometimes mucronate; branch bracts 4–18 cm long, acute; floral bracts broadly ovate to broadly elliptic, 1.8–4.1 cm long, obtuse, persistent; bracteoles ovate-triangular, 2.3–4 cm long, obtuse; rhachis, bracts, bracteoles, and sepals glaucous. *Flowers* greenish white, yellowish white, or purplish white, erect, 9–13 cm long; floral tube slightly curved around the middle, resulting in a horizontally orientated entrance to the flower; sepals whitish green, narrowly elliptic to narrowly ovate, 2.2–4.5 by 0.6–1.6 cm, obtuse or acute; corolla purplish, 7–12.5 cm long, petals reflexed, narrowly triangular, 6–10.5 by 1–2 cm, acute; staminodes 4, (greenish) white or yellowish, 9–13 cm long, free part narrowly obovate, 4–6 by 1–2 cm, apically more or less patent; stamen greenish yellow to whitish, free part narrowly obovate-elliptic, 3–5 by 1–1.7 cm, theca 2–4 cm long; style yellowish green, free part linear to narrowly elliptic, 3.5–5.5 by 0.5–0.8 cm. *Fruit* maturing brown, narrowly ellipsoid to ovoid, 5–10.5 by 2.5–5 cm. *Seeds* subglobose to broadly ellipsoid, 8–10 by 6–7 mm.

Distribution — Bolivia (Cochabamba and La Paz) and Peru (Cuzco).

Habitat & Ecology — At elevations of 2000–2800 m; in shady, often wet places in forest, in cloud forest, on steep slopes, along rivers, or roadsides, also in secondary vegetation.

Etymology — The epithet *liliiflora* has been chosen by Planchon because "la nouvelle venue est à bon droit comparée aux lis". In his opinion the flower of this species looked like a flower of the genus *Iris* ('lis' in French).



Map 7. Distribution of *Canna liliiflora* Warsz. ex Planch.

Uses — *Canna liliiflora* has been cultivated as an ornamental, and has been used in hybridization. The seeds have been used to weigh gold in Bolivia (Rusby 1902).

Vernacular names — See list.

Pollination — According to Vogel (1969) who studied this species in the field (as *C. brittonii*) it is pollinated by bats. The flowers are erect, whitish and funnel-shaped, the floral tube is basally thick-walled and curved so that the entrance to the flower is horizontal. Two staminodes together form the 'upper lip' of the flower, the third one together with the petaloid stamen suggests the 'lower lip', while the 4th staminode and the stigma are positioned at the left side of an eventual pollinator. In bud the pollen has been deposited on the style (secondary pollen presentation). Upon entering the flower, the pollen is transferred from the style to the left side of the pollinator (antero-laterally). The septal nectaries of c. 7 mm long, filling the apical part of the ovary, do open by oval pores into the base of the floral tube. They secrete a considerable amount of nectar and constitute a reward for the pollinating bats, which are attracted by a herbaceous-soapy scent to visit the flower. According to the label of *Wood 9893* (K), the flowers are open in the evening.

Dispersal — No data.

Notes — 1. *Canna liliiflora* can be recognized by its large (9–13 cm long), whitish flowers and/or large (5–10 cm long) capsules. It grows at altitudes over 2000 m.

2. According to Planchon, the plant had been recently collected by Warszewicz in the state of Veraguas in Central America ('Veragua'). It is, however, highly improbable that the type collection is from Veraguas in Panama where elevations over 2000 m are not reached. Probably Warszewicz collected the specimen when travelling in South America between 1851 and 1853 when he visited Bolivia and Peru, see Regel (1852) and (1853).

8. Canna paniculata Ruiz & Pav. — Map 8; Plate 7a–c

Canna paniculata Ruiz & Pav. (1798) 1, t. 1, f. a; Bouché (1833) 167; (1845) 493; Petersen (1890) 75; Kraenzl. (1912) 28; Maas & H.Maas (1988) 4. — Type: *Ruiz & Pavón 643/s.n.* (holo MA; iso BM, F, K), Peru, Huánuco, near Chinchao.

Canna excelsa Lodd. (1823b) ad t. 743; Bouché (1845) 494. — Type (here chosen): [icon, neo] Loddiges (1823b) t. 743.

Canna denudata Roscoe (1825) 61, t. 23; Bouché (1833) 165; Petersen (1890) 74, t. 17, f. 1; Kraenzl. (1912) 32. — *Distemon roscoeanus* Bouché (1845) 495 (as '*roscoeanum*') — Type (here chosen): Herb. J.E. Smith No. 0001.11 (neo LINN). Photograph in U.

Canna brasiliensis Roscoe ex Spreng. (1827) 5; Bouché (1833) 165. — *Canna denudata* Roscoe var. [without epithet] (1825) 63, t. 24. — *Distemon brasiliensis* (Roscoe ex Spreng.) Bouché (1845) 495. — *Distemon grandis* Horan. (1862) 14 (as '*grande*'), nom. illeg. — *Canna denudata* Roscoe var. *grandis* Petersen (1890) 75. — Type (here chosen): Liverpool Botanic Garden No. 1909. LBG. 2067 (neo LIV), origin Brazil. Photograph in U.

Canna miniata Bouché (1833) 165. — *Distemon miniatus* (Bouché) Bouché (1845) 495 (as '*miniatum*'). — Type not chosen.

Canna linkii Bouché (1833) 166; Kraenzl. (1912) 30. — *Distemon linkii* (Bouché) Bouché (1845) 495. — Type not chosen.

Canna jacquinii Bouché (1838) 148 (as '*jacquini*'); Kraenzl. (1912) 28, f. 4A. — *Distemon jacquinii* (Bouché) Bouché (1845) 495. — Type (here chosen): [icon, neo] Kraenzlin (1912) 28, f. 4A.

Distemon ottonis Bouché (1845) 494. — *Canna ottonis* (Bouché) Kraenzl. (1912) 32; Segeren & Maas (1971) 671, t. 3. — Type (here chosen): *Otto 564* (B, destroyed) from Venezuela may have been the holotype; *Steyermark 91627* (neo VEN), Venezuela, Miranda, between Petare and Guarenas.

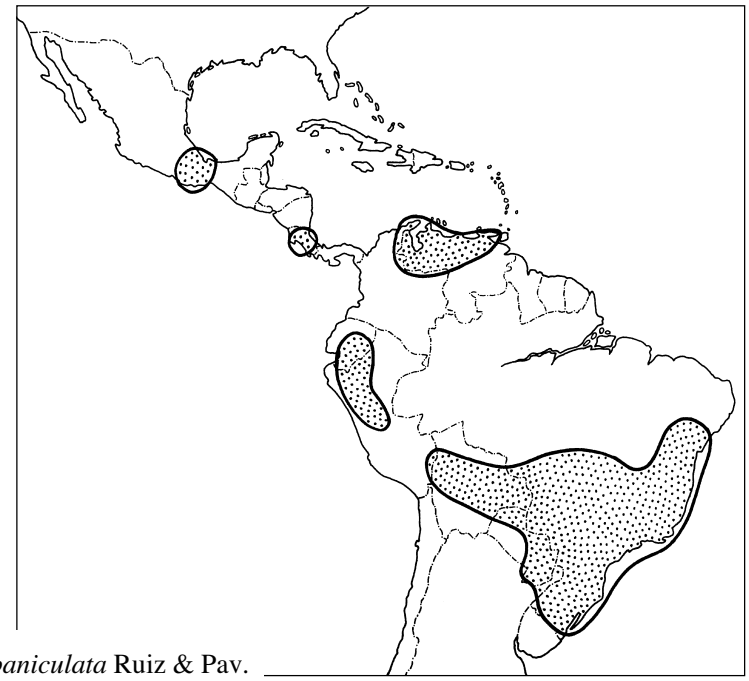
Distemon kunzei Bouché (1845) 495 (as '*kunzii*'). — *Canna kunzei* (Bouché) Kraenzl. (1912) 28. — Type not chosen.

Canna paniculata Ruiz & Pav. var. *glabra* Regel (1867) 87 (as '*β glabra*'). — Type not chosen.

Canna meridensis Kraenzl. (1912) 30, f. 4B–B', f. 5B–D. — Type (here chosen): *Moritz* 1286 (B and W destroyed; lecto BM; isolecto P), Venezuela, Merida (see note 2). Photographs in U.

Canna amambayensis Kraenzl. (1916) 297. — Type: *Hassler & Rojas 10422* (holo G, 5 sheets; iso BM, CAY, K, NY, P), Paraguay, Amambay, Sierra de Amambay.

Plants to 5 m tall. Rhizome tuberous, diameter unknown. *Leaves*: petiole provided with a kind of pulvinus partly formed by the thickened lower part of the primary vein at the lower leaf side; sheaths mostly lanuginose, with black margins; lamina narrowly ovate-elliptic to ovate-elliptic, 20–70 by 5–25 cm, base obtuse to acute, apex acute, sometimes shortly acuminate, lower side paler green than the upper side, mostly lanuginose. *Inflorescence* generally repeatedly branched, with 1- or 2-flowered cincinni; pedicels 0–1.5 cm long, to 2 cm in fruit; primary bracts 8–20 cm long, acute; branch bracts 2–15 cm long, acute; floral bracts (narrowly) ovate-triangular to obovate, 0.4–1.5 cm long, acute to obtuse, persistent; bracteoles (narrowly) ovate-triangular, 0.4–2 cm long, acute; rachis, bracts, bracteoles, and sepals glaucous to sometimes lanuginose. *Flowers* orange to yellow or red, sometimes dotted, 6–10 cm long; floral tube more or less curved around the middle resulting in a horizontally orientated entrance to the flower; sepals green to red, narrowly ovate-triangular, 1–2.5 by 0.2–0.7 cm, acute; corolla yellow to red, 6–10 cm long, petals erect, narrowly ovate to narrowly triangular, (1.3–)2.5–8 by 0.2–1.3 cm, acute to acuminate; staminode 1, yellow to red, free part narrowly obovate-elliptic, 4–4.5 by 0.4–0.7 cm, erect; stamen yellow to red, free part narrowly triangular-elliptic, 2–3.5 by 0.4–0.8 cm, theca 0.6–2 cm long; style yellow to red, narrowly elliptic to linear, free part 1.5–2.5 by 0.2–0.5 cm. *Fruit* cream to yellowish brown, covered by red to purplish tubercles, (broadly) ovoid to subglobose or



Map 8. Distribution of *Canna paniculata* Ruiz & Pav.

obovoid, 2–4.5(–8.5) by 1.5–2.5(–3.5) cm. *Seeds* broadly ellipsoid to subglobose, 4–7 by 3–6 mm.

Distribution — S Mexico (Veracruz, Oaxaca), Costa Rica (?), and tropical South America around the Amazon Basin: Venezuela in the north, Ecuador and Peru in the west, and Bolivia, Brazil, Paraguay, and Argentina in the south.

Habitat & Ecology — At elevations of 150–2000(–3000) m; in shady, often wet places in forest, along rivers or roadsides, also in secondary vegetation and cerrado.

Etymology — In their description of *C. paniculata*, Ruiz & Pavón mentioned "panicula terminalis, patens" (i.e. inflorescence paniculate, terminal, with horizontally spreading branches), referring to the relatively large and repeatedly branched inflorescence of this species.

Uses — *Canna paniculata* is cultivated as an ornamental (Peru) and is said to be used as a dye (Brazil); the rhizomes are edible but not very palatable (Peru), and they contain a diuretic (diuretico) and a substance to treat veneral disease (anti-blenorrhagico; Brazil); the leaves are used to cover roofs (Venezuela), they can be made into a compress (cataplasm) to treat wounds (Brazil), and they are used in cooking to wrap around something (called Backblätter by the german colonists of Rio Grande do Sul in Brazil); the seeds are used as rosary beads (Brazil).

Vernacular names — See list.

Pollination — Vogel (1969) supposes pollination of this species by birds because of the short tube, small nectaries, and lack of scent.

Dispersal — No data.

Notes — 1. *Canna paniculata* can be recognized by its pulvinus and a definitely impressed, lower half of the costa at the upper side of the leaves. The lower side of the leaves is lanuginose. The flowers are composed of only 6 erect, red floral parts of about equal length: 3 petals, 1 petaloid stamen, 1 petaloid style, and 1 staminode (the labellum).

2. Moritz had annotated the BM specimen as '*Canna tubiflora*', this is a nomen nudum. The specimens were erroneously identified as *C. indica* by Segeren & Maas (1971: 671), and wrongly labelled *C. jaegeriana* in 1979. The most right-hand flower of the BM specimen must be excluded.

9. **Canna pedunculata** Sims — Map 9

Canna pedunculata Sims (1822d) ad t. 2323 (11 June 1822); Lodd. (1822b) ad t. 622 (July 1822); Roscoe (1824) 29, t. 8; Bouché (1833) 160; (1845) 486; Petersen (1890) 72; Kraenzl. (1912) 52, f. 10D. — Type (here chosen): [icon, neo] Sims (1822d), t. 2323, chosen by Tanaka (2001: 51) as 'holotype'.

Canna reflexa Nees & Mart. (1822) 66a; 1822 (sero) — Type not chosen.

Canna buekii Weinm. (1823–1824) 119 (as '*buckii*'); (1824) 10 (explicit spelling correction). — Type: Specimen annotated '*Canna buckii* Weinmann, 11 July 1823. Ex hort. Imperatricis Matris Pawlosky' (holo LE), origin unknown. Photograph in U. See note 4.

Plants to 2.5 m tall. Rhizome long-creeping, 1.5–2 cm diameter; nodes of stem purplish. *Leaves*: sheaths diverging from the rachis; lamina narrowly ovate to narrowly elliptic, (17–)24–55(–75) by 4–15(–20) cm, base gradually narrowed into the sheath, apex acute, lower side glaucous. *Inflorescence* unbranched, with 2-flowered cincinni; pedicels 1–2 cm long, to 3 cm in fruit; primary bracts 9–20 cm long, acute; branch bracts 1–3 cm long, obtuse; floral bracts (broadly) obovate-elliptic, 0.6–1 cm long, obtuse, caducous; bracteoles (broadly) obovate-elliptic, 0.3–0.4 cm long, obtuse; bracts, bracteoles, and sepals often glaucous. *Flowers* yellow, erect, 3–4 cm long; sepals green, narrowly obovate-elliptic, 0.5–0.8(–1.5) by 0.2–0.3 cm, obtuse; corolla (greenish) yellow, 3–5 cm long, petals reflexed, narrowly triangular-ovate, 2–3.5 by 0.3–0.6 cm, acute; staminodes 4, golden yellow, 4–4.5 cm long, free part narrowly elliptic to narrowly obovate, 1.5–3.5 by 0.5–1 cm, patent, 1 recurved and sometimes dotted with purple; stamen yellow, free part narrowly elliptic-ovate, 1.5–3 by 0.3–0.4 cm, theca 0.5–1 cm long; style yellow, free part narrowly obovate to linear, 2–3.5 by 0.2–0.3 cm. *Fruit* green, ovoid, obovoid to narrowly ellipsoid when young, size of ripe fruit unknown. *Seeds* broadly ellipsoid, c. 5 by 3 mm.

Distribution — SE Brazil (Rio Grande do Sul, Rio de Janeiro, and Santa Catarina).

Habitat & Ecology — Elevation unknown; in swampy areas and forest margins.

Etymology — See note 3.

Uses — According to Baker (1893) this species is "not worth cultivating either for its leaves or its flowers".

Vernacular names — See list.

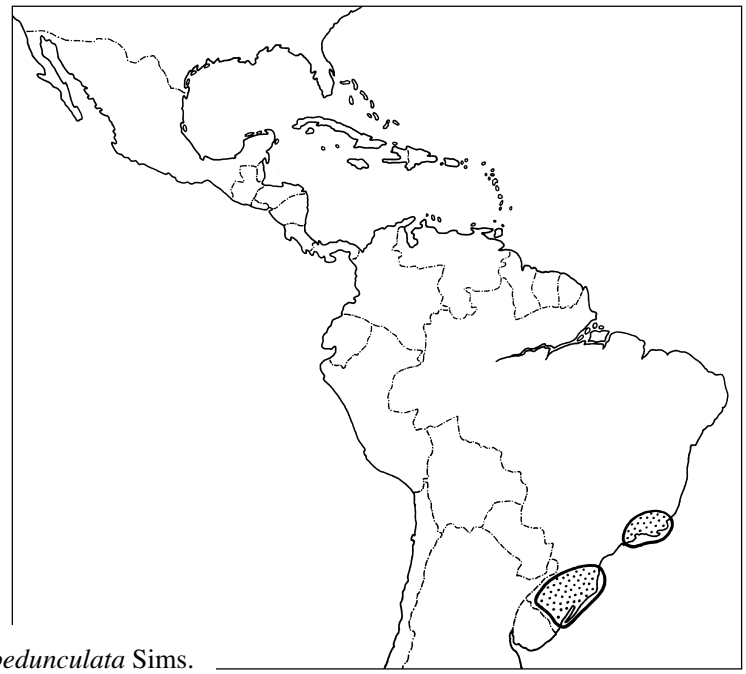
Pollination — No data.

Dispersal — No data.

Notes — 1. *Canna pedunculata* can be recognized by its glaucous and relatively narrow leaves, relatively small (3–4 cm), yellow flowers with reflexed petals, narrow staminodes (0.5–1 cm wide), and obtuse sepals.

2. *Canna pedunculata* shares the glaucous leaves with the Neotropical *C. glauca* and *C. flaccida* from SE USA. However, *C. glauca* has erect petals, whereas *C. flaccida* has large flowers (10–14 cm) with wide staminodes (1.5–6.5 cm wide).

3. In March 1822, a plant of *C. pedunculata* flowered in the stove at Hackney. Sims had received his specimen from Loddiges, who in turn had it from Roscoe who called



Map 9. Distribution of *Canna pedunculata* Sims.

it 'peduncled *Canna*' because it was according to him characterized by "flowers in pairs on long peduncles", referring to the relatively long pedicels of the species.

4. Weinmann's statement 'Patria: Jamaica' must be an error, as the species is only known from Brazil.

10. Canna tuerckheimii Kraenzl. — Fig. 9; Map 10; Plate 8a–c

Canna tuerckheimii Kraenzl. (1912) 70, nom. cons.; Maas & H.Maas (1988) 8. — Type: *Von Tuerckheim II 513 (= Donnell Smith 8321)* (holo US; iso G, GH, K), Guatemala, Alta Verapaz, near Cubilguïtz, 350 m, Dec. 1901.

Canna latifolia Mill. (1768) *Canna* no. 2, nom. rej.; Roscoe (1825) 20, t. 4; Kraenzl. (1912) 67, f. 6A–B; Segeren & Maas (1971) 678, f. 1–3. — Type: [icon, neo] Roscoe (1825) t. 4, chosen by Tanaka (2001: 48) as 'lectotype'.

Canna gigantea F.Delaroche (1811) ad t. 331, nom. rej. — Type: [icon, neo] Redouté (1811) t. 331, chosen by Maas-van de Kamer (2004: 833).

Canna neglecta Weinm. (1820) 607, nom. rej. — Type: Specimen annotated '*Canna gigantea* Desfon. = *Canna neglecta* Weinm. bot. Zeit.' (neo LE), origin unknown. Photograph in U.

Canna sylvestris Roscoe (1827) 33, t. 10, nom. rej. prop.; Bouché (1833) 162; (1845) 493; Petersen (1890) 69. — *Canna coccinea* Mill. var. *sylvestris* (Roscoe) Regel (1867) 85 (as '*ß. sylvestris*'). — Type: [icon, neo] Roscoe (1827) t. 10, chosen by Maas-van de Kamer (2006: 531) as 'lectotype'.

Canna violacea Bouché (1838) 146; (1845) 493; Kraenzl. (1912) 59, f. 12. — Type: [icon, neo] Kraenzlin (1912) f. 12, chosen by Maas-van de Kamer (2004: 833).

Canna anahuacensis Kraenzl. (1912) 65, f. 14. — Type (here chosen): [icon, neo] Kraenzlin (1912) f. 14.

Plants to 3.5(–5) m tall. Rhizome tuberous, c. 2.5 cm diameter. *Leaves*: sheaths more or less lanuginose; lamina pluriplicate, (narrowly) ovate to (narrowly) elliptic, 30–100 by (10–)15–40 cm, base narrowly cuneate to obtuse, apex acute, shortly acuminate,

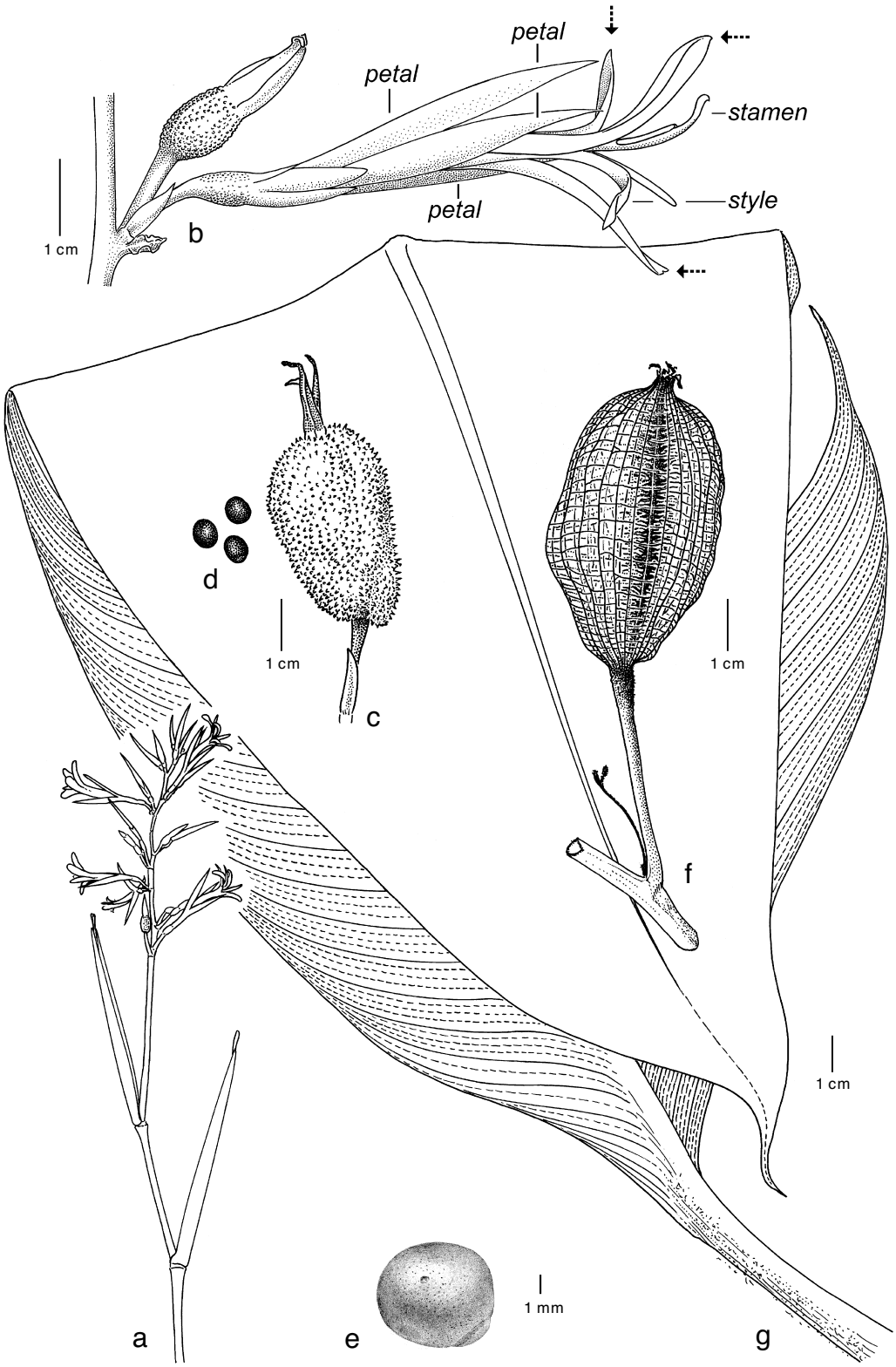


Fig. 9. *Canna tuerckheimii* Kraenzl. a. Inflorescence; b. detail of flower showing sepals, petals, staminodes (marked by arrows), stamen, and style; c. fruit; d. seeds; e. detail of seed showing stomata and elevated area; f. old fruit after shedding of the tubercles; g. leaf (a: *Maas & Dressler 1614*, drawn from a colour slide; b: *Maas & Cobb 4707*, drawn from a colour slide; c–e: *Maas & Cobb 4796*; f: *Davidse 24594*; g: *Maas & Dressler 1614*).

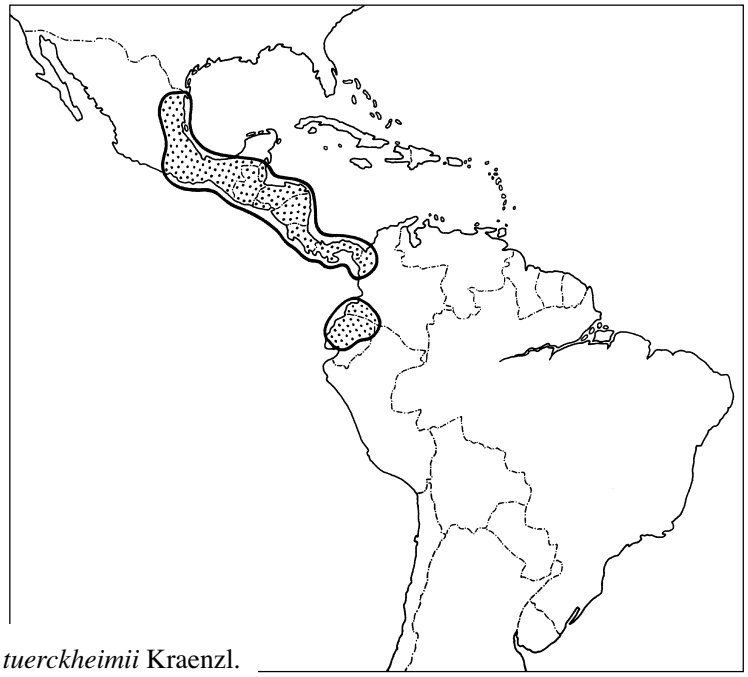
lower side more or less lanuginose. *Inflorescence* often branched, with 2-flowered cincinni; pedicels 0.5–3 cm long, to 5 cm in fruit; primary bracts 18–30 cm long, acute to obtuse; branch bracts 8.5–15 cm long, obtuse to acute; floral bracts (broadly) ovate to (broadly) obovate, 0.3–3 cm long, obtuse to acute, caducous; bracteoles ovate-triangular to narrowly triangular, 0.5–1.6 cm long, acute; bracts, bracteoles, and sepals glaucous. *Flowers* orange to red, generally erect, 5.5–9 cm long; sepals greenish to pinkish, narrowly triangular, 1–2.5 by 0.4–0.6 cm, acute; corolla orange to pale pinkish or brownish, 4–6 cm long, petals erect, narrowly ovate-triangular, 3.5–5 by 0.5–1.1 cm, apex acute; staminodes 4, orange-red to red, sometimes spotted, 5.5–9 cm long, free part narrowly obovate, 1.5–4.5 by 0.5–1 cm, apically patent; stamen orange-red to red, free part narrowly elliptic-obovate, 2.5–3.5 by 0.4–0.8 cm, theca 0.9–1 cm long; style orange-red to red, free part obliquely narrowly obovate-elliptic, 2–2.5 by 0.2–0.5 cm. *Fruit* green, maturing brown, ovoid to ellipsoid or obovoid, 2.5–6 by 2–4 cm. *Seeds* subglobose to broadly ellipsoid, 3.5–7 by 4–6 mm.

Distribution — Mexico in the north through Central America, to Ecuador in the south.

Habitat & Ecology — At elevations of (0–)500–2000(–2600) m; in open, secondary vegetations like forest edges, river banks, and along trails and roadsides, or in lower premontane or cloud or rain forest.

Etymology — *Canna tuerckheimii* has been named after the collector of the type specimen. H. von Türckheim was a German plant collector who was in charge of a coffee plantation in Guatemala around 1900.

Uses — According to Pio Corrêa (1926: 383) writing about plants cultivated in Amazonian Brazil as '*C. gigantea* Desf.', the rhizome has diuretic and febrifugal (diaphoretic) properties and is used to cure wounds and skin ailments (herpeticcas), the juice of the stems is good against throat ailments, the juice of the leaves is anti-rheumatic, and the juice of the fruit is said to cure pain of the ears. In Guatemala leaves are used as food wrapper.



Map 10. Distribution of *Canna tuerckheimii* Kraenzl.

Vernacular names — See list.

Pollination — Kress & Beach (1994) report pollination by hummingbirds.

Dispersal — No data.

Notes — 1. *Canna tuerckheimii* is characterized by straight flowers which are 'quasi hexapetalous' according to Roscoe (1825: 20 describing *C. latifolia*). The free part of the 4 staminodes and the petaloid part of the stamen and style all being equally patent together function as the display organs of the flowers towards the pollinators. The inflorescence is provided with caducous bracts and long-pedicellate flowers. The plants are generally growing at high altitudes and have large leaves with a more or less lanuginose lower side.

2. *Canna bangii*, the other species from high places in the Andes, has 1 recurved staminode at anthesis, and the free part of the other staminodes are longer than those of *C. tuerckheimii*.

3. *Canna jaegeriana* differs from *C. tuerckheimii* by purely orange flowers with the floral tube curved around the middle and the free part of the staminodes erect (versus orange-red straight flowers with free part of staminodes patent), and by ellipsoid (versus globose) seeds.

4. Some specimens of *C. tuerckheimii* from high places in the Andes are difficult to identify. Because of cultivation plants may be larger and may have larger leaves suggesting *C. tuerckheimii*, while the flowers are like those of *C. indica*. There could also be hybrids involved here.

5. Some specimens from Central America too, have relatively small flowers, persistent bracts, and/or a recurved staminode indicating possible hybridization with *C. indica*.

6. *Canna latifolia* and *C. gigantea*, synonyms of *C. tuerckheimii*, have been used many times for large-leaved plants, especially in cultivation. It is not clear if these names, when used for plants in cultivation, have been used only for plants belonging to *C. tuerckheimii*. *Canna musifolia* (and its orthographic variants *C. musaefolia* and *C. museifolia*) is a nom. subnud., also used for large-leaved *Canna's* in cultivation, maybe related to *C. tuerckheimii*.

DOUBTFUL AND EXCLUDED SPECIES

Canna curviflora Horan. (1862) 18.

According to Tanaka (2001: 48) this name is a synonym of *C. tuerckheimii*. It could, however, just as well be *C. jaegeriana*, because of the curved flowers. Horaninow puts it under 'Cannae magis dubiae', and did not designate a type. He described this species as: "4-5-ped. foliis latis fusco-marginatis, flor. pallide-coccineis".

Canna fintelmannii Bouché (1845) 487; Kraenzl. (1912) 52, f. 5A.

Because the leaves of the specimen cultivated as 'Canna Fintelmanniana Bouché' in 'Hort. bot. Berol. 9.41.' by 'B. Auerswald' (BM) are like those of *C. glauca*, but the flower structure and colour are as in *C. indica*, We prefer to regard this name as a nomen dubium. *Canna fintelmaniana* and *Canna fintelmanni* are misspellings.

Canna gemella Nees & Mart. (1823) 22. — Type not chosen.

Imperfect description.

Canna hortensis Guillaumin (1934) 54. — Type not chosen.
Said to be a hybrid, parents not indicated, description undefinable.

Canna jacobiniflora T.Koyama & Nob.Tanaka (2000b) 9. — Type: *Tanaka 15871R* (holo TNS; iso K, NY), Argentina, Corrientes: Capital, Av. Libertad, cultivated in garden of Makino Herbarium, Tokyo Metropolitan University.
This species has rhizomes like *C. glauca*, but the leaves are like *C. indica* (iso K), the flowers are red and somewhat curved, and the staminodes are all erect.

Canna juncea Retz. (1779) 9 is not a species of *Canna*.

Canna lancifolia Schrank (1824) 189 (as '*lanceaefolia*') — Type not chosen.
Description based on *a specimen cultivated in Hort. Bot. Ratisbon.* (Regensburg) from material sent by Martius from Brazil. This might well represent *C. glauca*.

Canna macrophylla Horan. (1862) 18.
Horaninow gives an incomplete description. Kraenzlin (1912: 67) presumes it might be a synonym of *C. latifolia* (the present *C. tuerckheimii*).

Canna noutonnii Carrière (1878) 439 (as '*noutonni*'). Type not chosen.
Incomplete description of a hybrid.

Canna pentaphylla Nees & Mart. ex D.Dietr. (1839) 5.
This name was published with reference to 'Nees & Martius in Nov. Act. XI.'. Dietrich presumably did make a spelling error because his description of *C. pentaphylla* and that of *C. platyphylla* in Nees & Martius (1822: 66a and 1823: 22) are exactly the same.

Canna rotundifolia André (1862) 372, unnumbered figure — Type not chosen.
This is not a wild, but a cultivated *Canna*.

Canna stenantha Nob.Tanaka (2000) 7. — Type: *Tanaka 15877R* (holo TNS; iso MAK, MBK), Argentina.
This species has rhizomes like *C. glauca*, but the flowers are red, and the narrow staminodes are all erect.

INVALID NAMES

Canna aethiopica Petersen (1890) 76, nom. nud.

Canna amoena Bouché ex Regel (1867) 88, nom. nud.

Canna aurea Horan. (1862) 18, nom. nud.

Canna barbadica Bouché (1833) 145, nom. nud.

Canna bifida Herbert ex Sims (1822c) ad t. 2317, in syn.

Canna bihorelli Carrière (1878) 439, nom. subnud., to be treated as a nom. nud., cf Art. 32, Ex. 3 (McNeill et al. 2006).

Canna bolleana Bouché ex Kraenzl. (1912) 34, nom. nud.

Canna brasiliensis Link (1818) 184.
A provisional name, thus not validly published under Art. 34. 1(b). *Canna brasiliensis* Roscoe ex Spreng. concerns a different species.

Canna caripensis Horan. (1862) 18, nom. nud.

Canna carracasana Bouché ex Kraenzl. (1912) 34, nom. nud.

Canna confusa J.W.Richardson & L.B.Sm. (1972) 8, t. 2.
Presented as a 'nom. nov.'; it is not, however, replacing an earlier, illegitimate name. In fact it is the name of a new species. As such, it requires a Latin description or diagnosis and the designation of a type specimen that was seen. These requirements are not fulfilled.

Canna denudata Roscoe var. *major* Kraenzl. (1912) 32, in syn.

Canna divaricata Klotzsch ex Bouché (1845) 493, nom. nud.

Canna ehemannii Anonymus (1882) 42 (as '*ehemanni*'), nom. subnud.
It is suggested that it could be of hybrid origin with *C. iridiflora* as a parent, or a variety of the latter. The author is only indicated as 'W.G.' Mentioned as '*C. ehmanni*' by Petersen (1890: 76) and Kraenzlin (1912: 22).

Canna elata Pohl ex Kraenzl. (1912) 39, in syn.

Canna esculenta Lodd. (1826) 7, nom. subnud. in Loudon (1830) 1.

Canna flava Lam. (1792) 416, nom. subnud.

Canna grandiflora Arcang. (1884) 64, nom. nud.; still a nom. nud. in Petersen (1890) 77.

Canna indica L. forma *rubro-aurantiaca* Makino (1940) 707, nom. nud.

Canna javanica
Name used by Tanaka on a poster presented in 1998 on the Monocot II Conference in Sydney, Australia.

Canna lanata
A specimen with this name in the BR herbarium marked 'Serres chaudes du Jardin Botanique de Bruxelles, M. Martens, Mai 1867' has been identified in 1978 as belonging to the *C. indica*-complex (photograph U, negative number 1416), but could also represent *C. paniculata*.

Canna lanceolata Lodd. (1826) 7, nom. nud.; nom. subnud. in Loudon (1830) 1.

Canna longiflora
This name without author has been found written on a specimen in P (Herbarium E. Drake). It may be a misspelling of *C. longifolia* Bouché, which is a synonym of *C. glauca*.

Canna lutea Mill. var. *genuina* Kraenzl. (1912) 40 is invalid under Art. 24.3.

Canna macrocarpa Horan. (1862) 18, nom. nud.

Canna maxima Lodd. (1820) 5, nom. nud.; in syn. in Roscoe (1828) 16.

Canna metallica Petersen (1890) 77, nom. nud.

Canna mutabilis Horan. (1862) 18, nom. nud.

Canna nudata Lodd. (1823c) 5, nom. nud.

Canna ovata Horan. (1862) 18, nom. nud.

Canna peruviana Arcang. (1884) 64, nom. nud. Still a nom. nud. in Petersen (1890) 77.

Canna petiolata Wallich ex Horan. (1862) 18, nom. nud.

Canna purpureo-spectabilis Kraenzl. (1912) 25, nom. nud.

Canna rosaeflorae Kraenzl. (1912) 25, nom. nud.

Canna rubicunda A.Braun (1861) 4, nom. nud.

Canna sanguinea Bouché (1833) 154, in syn.

Canna straminea A.Braun (1861) 4, nom. nud.

Canna sulphurea Bouché (1833) 150, in syn.

Canna textoria Noronha ex Thouars (1811) 2, nom. nud.

Canna tinei Tod. (1858) 25, nom. subnud.
A spontaneous hybrid, only comment on flower colour given. Thus to be treated as a nom. nud.

Canna tomentosa Bouché ex Kraenzl. (1912) 30, nom. nud.

Canna tubiflora Regel (1860) 27, nom. nud. This name is written on *Moritz 1286* in BM, the lectotype of *C. meridensis*, which is a synonym of *C. paniculata*.

Canna verloti Petersen (1890) 78, nom. nud.

Canna virginiana Petersen (1890) 78, nom. nud.

Canna vitellina Bouché ex Kraenzl. (1912) 58, nom. nud.

Canna zebrina A. Leblois (1887) 294. Only a few anatomical characters given, thus to be treated as a nom. nud.

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ALPHABETICAL LIST OF VERNACULAR NAMES

Abbreviations used in this list:

fam	= Cannaceae	iri	= *Canna iridiflora*
gen	= *Canna*	jae	= *Canna jaegeriana*
ban	= *Canna bangii*	lil	= *Canna liliiflora*
fla	= *Canna flaccida*	pan	= *Canna paniculata*
gla	= *Canna glauca*	ped	= *Canna pedunculata*
ind	= *Canna indica*	tue	= *Canna tuerckheimii*

Achinachinata (ind, Colombia, Panama); achira (pan, Argentina, Bolivia, Peru; jae, Colombia, Peru; ind, Bolivia, Colombia, Ecuador, Peru; ban, Bolivia; gla, Argentina, Brazil, Uruguay); achira amarilla/o (ind, Colombia, Peru; gla, Argentina); achira blanca (ind, Colombia); achira bugueña (ind, Colombia); achira cimarrona (pan, Brazil, Peru); achira colorado (ind, Peru); achira de huerta (ind, Colombia); achira de(l) monte (iri, Peru; pan, Bolivia); ach(ira) formosa (iri, Peru); achira roja (ind, Peru); achiras (ind, Peru); achirilla (ind, Colombia; jae, Colombia); achiro (pan, Peru); achurú (ind, Brazil, Peru); agamían/g (ind, Peru); alalutu (ind, French Guiana); albará (gla, Brazil; ind, Brazil; pan, Brazil); alcabuco (ind, Colombia); añuchira (ind, Peru); araruta bastarda (ind, Brazil); araruta de porco (ind, Brazil); araruta de tolomana (ind, Brazil); arrow-root de Queensland (ind, Brazil); atukli (ind, East Africa); away (ind, Brazil); aztera (ind, Ecuador).

Bacaó (gla, Paraguay); bacaode (gla, Paraguay); Backblätter (pan, Brazil); baiakana (ind, Guyana); balisier (ind, West Indies; jae, Haïti; gen, France); balisier à fleurs d'Iris (iri, France); balisier d'Inde (ind, tue, France); balisier flasque (fla, France); balisier géant (tue, France); balisier gigantesque (tue, Brazil, France); balisier glauque (gla, France); balisier jaune (gla, Guadeloupe, Martinique; ind, West Indies); balisier rouge (ind, Guadeloupe); balisiers (fam, France); bananeira brava (tue, Brazil); bananeira do matto (gla, Brazil); bananeira grande do matto (tue, Brazil); bananeirinha (fla, ind, iri, pan, Brazil); bananeirinha da india (ind, Brazil); bananeirinha de flor (ind, Brazil); bananeirinha-do-mat(t)o (gla, ind, pan, Brazil); bananeirinha roxa (ind, Brazil); bananier marron (jae, Haïti); bandana of the everglades (fla, USA); bandera (ind, Colombia, Mexico, Panama); banderita (ind, Cuba); bery (ind, Brazil); bijagua (ind, El Salvador, Guatemala, Panama); bijao (ind, Guatemala, Panama, Peru; tue, Honduras); bint-el-qûnsûl (ind, Egypt); biri (pan, Brazil); birú manso (ind, Brazil); Blumenrohr (ind, Brazil); Blütenröhre (fam, Germany); buatensmesh (jae, Colombia).

Cacomite (gla, Mexico); caeté/ê (ind, iri, pan, Brazil); caeté-assú (ind, Brazil); caeté de talo roxo (ind, Brazil); caeté do matto (tue, Brazil); caeté dos jardins (ind, Brazil); caeté grande (tue, Brazil); caeté-imbiry (gla, Brazil); caeté mirim (ind, pan, Brazil); caeté roxo (ind, Brazil); caeté vermelho (ind, Brazil); café cimarron (fam, ind, Panama); café silvestre (fam, ind, Panama); caiomite (gla, Mexico); caité (gla, pan, Brazil); caité-conta-de-rosário-compacta (pan, Brazil); caité-conta-de-rosário-de-blumenau (pan, Brazil); caité-conta-de-rosário-de-otto (pan, Brazil); caité-conta-de-rosário-denudado (pan, Brazil); caité-conta-de-rosário-glauco (gla, Brazil); caité-conta-de-rosário-glauco-angusto (gla, Brazil); caité de tallo rojo (ind, Costa Rica); caité do brejo (pan, Brazil); caité-imbiri (gla, pan, Brazil); caligüate (ind, Nicaragua); camjinfacho

(jae, Ecuador); cana (ind, Panama); caña brava (jae, Dominican Republic); caña de la India (gla, Argentina, Brazil, Uruguay); canna (gla, Martinique); canna da India (ind, Brazil); canna do brejo (gla, Brazil); canna do brejo amarela (gla, Brazil); canna flor de lirio (iri, Brazil); canna florifère (ind, Brazil); cannalote (ind, Uruguay); canon (ind, St. Eustatius); capacho (gla, Venezuela; ind, Dominican Republic, Venezuela; pan, Venezuela); capacho manzo (ind, Dominican Republic); chachalaga (ind, Mexico); chancala (tue, Mexico); changara (ind, Mexico); chapelet (ind, West Indies); chias (lil, Bolivia); chilalaga (ind, Mexico); chimalaga (ind, Mexico); chirachirata (ind, Panama); chisgua (ind, Colombia, Peru; jae, Colombia); chui (ind, Bolivia); chumbo de indio (ind, Brazil); ciga(r)rón (ind, Dominican Republic); cocorus (ind, Ambon); coité brasil (ind, Brazil); cojole (gla, Mexico); common Indian Reed (ind, England); common indian shot (ind, England); coquilho (gla, pan, Brazil); coshú (ind, Mexico); coyol de monte (tue, Mexico); coyole (gla, Mexico); cucuyús/z (ind, Guatemala, Panama, Peru; tue, Guatemala); cukr (ind, Guatemala).

Dandoku (ind, Japan); dive (ind, Colombia).

Edible Canna (ind, Puerto Rico); embiri (gla, pan, Brazil); erva das feridas (gla, Brazil); esculent-rooted Indian-shot of Peru (ind, England).

Flaccid Indian Reed (fla, England).

Ganjong (ind, Java); ganyong putih (ind, Java); glaucous-leaved Indian Reed (gla, England); golden canna (fla, gen, USA); graine à chapelets (ind, Jamaica, Martinique, St. Croix, St. Vincent); graue Blumenrohr (gla, Germany); gruya (ind, Puerto Rico).

Herva dos feridos (gla, Brazil).

Imbiri/y (ind, gla, pan, Brazil); Indian flowering Reed (gen, England); Indian Reed (gen, England); indian shot (ind, Panama, West Indies, West Tropical Africa, USA; gen, England, USA; gla, Brazil, North America); iris-flowered Canna (iri, England); ishpa puro (jae, Ecuador).

Joro joro (ind, Surinam).

Kabairo-dandoku (ind, Japan); kaïté (pan, Paraguay); kaña (gla, Surinam); katu-bala (ind, India); khang-gu-pá-chu (ind, Colombia); kibana-dandoku (ind, Japan).

Laced flowered Indian-shot (ind, England); lal surva-juga (ind, Bengal); lembong njeedrå (ind, Java); lirio (ind, Peru; tue, Guatemala); long-peduncled Canna (ped, England).

Mala-inschi (gla, India); ma(r)ráca(s) (gla, Antilles, Brazil; ind, Colombia, West Indies; jae, Puerto Rico); maraca amarilla (gla, Puerto Rico); maraca boba (gla, Puerto Rico); maráca cimarrona (ind, Cuba, West Indies); maraca de pantano (gla, Puerto Rico); maraca montuna (jae, Puerto Rico); maraca roja (tue, Puerto Rico); mberu (ind, Paraguay); mbe(e)ry (gla, pan, Brazil); meeru (gla, ind, Brazil); merú (ind, Brazil); misimisi (ind, Tonga); monte achira (iri, Peru); monte hachira (ban, Peru); moussache (ind, French Guiana); munay achira (ind, Peru); muru/ü/ú (gla, pan, Brazil).

Napaul Canna (ind, Asia); ngai-hoang (ind, China); nodding-flowered Canna (iri, England); nodding-flowered Indian Reed (iri, England).

Paçivira (gla, Brazil); palaka (ind, Surinam); palakagutpë (ind, French Guiana); palakalu'a (ind, French Guiana); papata (ind, Mexico); papatlila (ind, Mexico); parirí (ind, Brazil); patterack-Sa (gla, Siam); peduncled Canna (ped, England); peruvian Canna (iri, England); piriquiti (gla, Brazil); piriquitoya (ind, Costa Rica); pisang sebiak (ind, Malay Peninsula); plantanillo (ind, Peru); platana (tue, Belize); platanillo/a (fam, Panama; gla, Guatemala; ind, Belize, Colombia, Costa Rica, Cuba, Honduras, Mexico, Panama, West Indies; tue, Guatemala, Mexico); platanillo amarillo (ind, Mexico); platanillo de Cuba (ind, Cuba); platanillo gigante (tue, Mexico); platanillo rojo (ind, Mexico); poespa-nidra (ind, Java); purple arrowroot (ind, Java); puspa nidra (ind, Sunda); putterak sa (gla, Thailand).

Quematee (ind, Asia); Queensland arrowroot (ind, Australia).

Red tulama (ind, St. Eustatius); ricefield lily (gla, Guyana).

Sabbeh (ind, Java); safran marron (ind, Brazil); sagou marron (ind, Haïti); sagu (ind, Ecuador); saka wiwii (ind, French Guiana); sakassi (ind, French Guiana); san-sa-bisá (ind, Ecuador); scarlet Indian Reed (ind, England); schmales Blumenrohr (gla, Germany); siakasi (ind, French Guiana); sebek (ind, Malay Peninsula); sebiak (ind, Malay Peninsula); seneetrå (ind, Java); shack-shack (ind, Trinidad); shweta sur-juya (ind, Bengal); shotgun pellets (ind, Brazil); siakasi (ind, French Guiana); sibha (ind, Egypte); sio (ind, Peru); small mkoya (ind, East Africa); spanish arrowroot (ind, Guadeloupe, Jamaica, Martinique); spreading-flowered Indian Reed (ind, England); sumac-achira (iri, Peru); sumakchira (ind, Peru).

Tacara (lil, Bolivia); tall Canna (tue, England); tall Indian Reed (tue, England); tapioca (ind, West Indies); thallo (ind, Brazil); toloman (gla, Martinique; ind, Brazil, French Guiana); toloman mâle (ind, French Guiana); toloman-moussache (ind, French Guiana); toulomá (ind, Dominica); tous les mois (ind, Brazil, St. John, Trinidad, West Indies); tuberous rooted Indian Reed (ind, England); tuju (ind, Peru); tulema (ind, West Indies); tzuk' (tue, Guatemala); tzu'kr (tue, Guatemala).
Vavho (ind, Solomon Islands).
Waimpiak (pan, Peru); water canna (gla, Hawaï); wayáipaí (pan, Peru); wayampai/y (jae, pan, Peru); weglopers hagel (gla, Surinam); western Indian-shot (ind, England); wild arrowroot (ind, Puerto Rico); wild canna (gla, Guyana); wild tapioca (ind, Jamaica); woolly-stemmed Indian shot (tue, England).
Yellow canna (fla, USA; gla, Bermuda); yellow Indian Reed (ind, England); yellow Indian shot (ind, England).

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Accepted names are in roman type and synonyms in *italics*. dbt = doubtful; excl = excluded; inv = invalid. Numbers refer to the species as used in this revision.

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