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Taxonomy of *Cryptocarya* species of Brazil

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by

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Cover illustration: *Cryptocarya moschata* Nees & Martius: ripe fruit, still coloured green at São Pedro, SP, January 2006 (Picture by author).

“What the Gods give they sell”, the Greeks rightly said.
Fernando Pessoa

“Concedo nulli”
(Device of Erasmus)

Preface

This revision of the genus *Cryptocarya* was carried out at the Herbarium Rioclarense of the Universidade Estadual Paulista (HRCB), the Herbarium of the Escola Superior de Agricultura Luiz de Queiroz (ESA), and the Herbarium of the Universidade Estadual de Campinas (UEC).

As André Joseph Guillaume Henri Kostermans, to whom I here pay homage for his achievements on Lauraceae, I have done my best to make the enumeration of the specimens of *Cryptocarya* collected in Brazil as complete and as reliable as possible. For this purpose I have verified 2079 specimens, representing 1146 different collections deposited in 106 different herbaria. This embodies nearly all known herbarium collections of Brazilian species of *Cryptocarya*.

Loans of Brazilian specimens were obtained from nearly all Brazilian and several non-Brazilian herbaria (abbreviations follow Holmgren *et al.*, 1990). In addition various herbaria (ALCB, B, BHCB, BR, CEN, CEPEC, CVRD, ESA, F, HB, HBG, HBR, HPNI, HRCB, HXBH, IAC, IAN, INPA, KIEL, M, MBM, MBML, MG, NY, OUPR, R, RB, SP, SPF, SPFR, SPSF, UEC, UPCB and VIC) were visited in order to find additional specimens belonging to *Cryptocarya*. This was done by examining the entire Lauraceae collections, the specimens identified in genera related to *Cryptocarya* and the unidentified material of the above herbaria. Information and/or images from type and non-type material were kindly provided by various other institutions (A, AAU, B, BC, BHUPM, BM, BO, BR, C, CGE, CTES, FI-W, FR, G, G-DC, GB, GH, GOET, GZU, H, HAL, HBG, K, KIEL, L, LE, LINN, LISU, LZ, M, MA, MO, NY, OXF, P, PI, PR, QCNE, S, SGO, SI, STR, U, UPS, US, VT, and WRSL). Collections of Lauraceae from some other herbaria (BOTU, COR, HTO, PMSP, and UFMT) were also analysed, but no specimens of *Cryptocarya* were retrieved in these collections. The herbaria BA, BHU, BHUPM, BREM, FCAB, GLAM, HEID, HUEM, JE, LD, LIV, MAF, MANCH, NHV, NMW, PAD, PAMG, PORT, RO, ROST, SBT, STU, TUB, TUR, and VAL informed me that they do not house neotropical species of *Cryptocarya*.

Photographs from the *Type Photograph Collection of the Field Museum of Natural History*, Chicago, U.S.A, photographed by J. Francis Macbride (Grimé & Plowman, 1986) are mentioned here as *Photo F Neg. No._*. I have decided to cite these photographs mainly because all *Cryptocarya* type specimens deposited in the Herbarium Berolinense were destroyed during World War II.

In complement to the examination of the collections, an extensive revision of the literature was also done as to contextualise and update available taxon information.

Authors of plant names are based on Brummitt & Powell (1992), and book abbreviations are as proposed by Stafleu & Cowan (1976-1988).

Distribution maps of species were built from the digitised georeferenced ‘map 14’ of the *World Geographical Scheme for Recording Plant Distributions* (http://www.rbgkew.org.uk/gis/tdwg; with the permission of the Trustees of the Royal Botanic Gardens, Kew) (Brummitt, 2001) and the Americas Base Map (Bletter *et al*., 2004), using the program DIVA-GIS (version 5.2.0.2). When the coordinates of localities were not available from the labels, they were taken from the Instituto Brasileiro de Geografia e Estatística’s Catalog of Cities and Villages.

The official classification system of Brazilian vegetation (Veloso & Góes-Filho, 1982; Veloso *et al.*, 1991) was adopted for indicating the phytoecological regions.

For the descriptions of the venation pattern, the general terminology of Hickey (1973, 1979) was employed. All other morphological terms were used as defined by Stearn (1992). Measurements of flower parts were taken from rehydrated herbarium material as well as from ca 1200 SEM micrographs from floral pieces of types, historical voucher specimens and 53 different recent collections (Moraes *et al.*, 2001).

I take the opportunity to thank the Belgian National Focal Point to the Global Taxonomy Initiative (GTI) for sponsoring a research visit to the National Botanic Garden of Belgium (BR) that houses the important private Herbarium Martii and for inviting me to write this volume for the *Abc Taxa series*. This was a unique opportunity for me to liberate my knowledge on the *Cryptocarya* species of Brazil into the lingua franca of English.

Campinas, 7 September 2006.

Abstract

The Brazilian species of *Cryptocarya* are revised. The systematic treatment of its species is provided, and its typification, synonym, general descriptions for morphology, distribution, and ecological features are discussed. As a result, 13 species were recognised with five newly described: *Cryptocarya botelhensis* P.L.R. de Moraes, *C. riedeliana* P.L.R. de Moraes, *C. sellowiana* P.L.R. de Moraes, *C. velloziana* P.L.R. de Moraes, and *C. wiedensis* P.L.R. de Moraes. Illustrations and a key to the species are presented.

Keywords – *Cryptocarya*; Lauraceae; *C. aschersoniana*; *C. botelhensis*; *C. citriformis*; *C. guianensis*; *C. mandioccana*; *C. micrantha*; *C. moschata*; *C. riedeliana*; *C. saligna*; *C. sellowiana*; *C. subcorymbosa*; *C. velloziana*; *C. wiedensis*; new taxon; key; descriptions; plant taxonomy; Brazilian flora.

Resumo

Revisaram-se as espécies brasileiras de *Cryptocarya*. O tratamento sistemático das espécies é apresentado e sua tipificação, sinonímia, descrições gerais morfológicas, de distribuição e ecológicas são discutidas. Como resultado, 13 espécies foram reconhecidas, cinco das quais descritas como novas: *Cryptocarya botelhensis* P.L.R. de Moraes, *C. riedeliana* P.L.R. de Moraes, *C. sellowiana* P.L.R. de Moraes, *C. velloziana* P.L.R. de Moraes, e *C. wiedensis* P.L.R. de Moraes. Ilustrações e uma chave para as espécies são apresentadas.

Palavras-chave – *Cryptocarya*; Lauraceae; *C. aschersoniana*; *C. botelhensis*; *C. citriformis*; *C. guianensis*; *C. mandioccana*; *C. micrantha*; *C. moschata*; *C. riedeliana*; *C. saligna*; *C. sellowiana*; *C. subcorymbosa*; *C. velloziana*; *C. wiedensis*; táxon novo; chave; descrições; taxonomia de plantas; flora brasileira.

Taxonomic novelties

Cryptocarya botelhensis P.L.R. de Moraes sp. nov., p. 51
Cryptocarya riedeliana P.L.R. de Moraes sp. nov., p. 94
Cryptocarya sellowiana P.L.R. de Moraes sp. nov., p. 108
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1. Introduction

When Kostermans (1952) published 'A Historical survey of Lauraceae' he pointed out that the family contains more than 190 generic names holding some 5200 binomials. Of these 190 generic names only about 50 are currently accepted, the exact number depending on generic concepts, which are still a matter of discussion (Rohwer, 1993a, 1993b; van der Werff & Richter, 1996). More recently, two new genera were described for the Neotropics, viz. *Mocinnodaphne* Lorea-Hernández (1995) and *Sextonia* van der Werff (1997). According to van der Werff (2003) the family encompasses 55 genera that are recognised on the basis of combinations of characters that intergrade among taxa. To circumscribe genera, floral and fruiting characters are mostly used; for instance: number and kind of fertile androecial whorls, number of sporangia in the anthers, extent of development of staminodia in the fourth androecial whorl, and the extent of hypanthium development in the fruit (Lorea-Hernández, 1996).

The family Lauraceae belongs to the Order Laurales that is classified in the Subclass Magnoliidae (*sensu* Cronquist, 1981, 1988). Currently, it has been inserted in the Superorder Magnoliidae, in association with Magnoliales, Piperales and Canellales (APG II, 2003). The family is pantropical, including about 50 genera with a probable number of 2500 to 3500 species (Rohwer, 1993a, 1993b). The estimated number of extant Neotropical species is around 700 to 800, belonging to 30 genera (van der Werff, 1988, 1991). Brazil has the majority of the species diversity for this family in the Neotropics (c. 360 known, most probably an underestimation) distributed in 21 genera, and its species are important components of the functional and structural composition in the Atlantic rain forest, Cerrado (Brazilian savanna) and Amazonian forests. *Cryptocarya* R. Brown is one of the largest pantropical genera in the Lauraceae, comprising some 300 to 350 species. *Cryptocarya* can be distinguished from other laurel genera by its bisexual and trimerous flowers, which are very typical in shape (usually slender, urceolate, apically narrowed tube and immersed ovary, six equal to subequal tepals, nine fertile stamens with disporangiate anthers, staminal glands only in the third androecial whorl), and by the characteristic fruit that is enclosed by the accrescent flower tube.

The present taxonomic revision of the *Cryptocarya* species of Brazil is based on intensive fieldwork, mainly in the southeast of the country, but also on more than 2000 specimens that are deposited in 1146 collections (Herbarium abbreviations follow Holmgren *et al.*, 1990).

2. Historical survey

Kostermans (1952) and Bernardi (1962) provided a historical overview of the taxonomy of the Lauraceae. A chronological overview of the names attributed to *Cryptocarya,* mainly based on Kostermans (1952), is provided hereunder.

Feuillée (1725) was the first to describe the Chilean plant called "Boldo" ("*Boldu arbor olivifera*"). Adanson (1763) redescribed *Boldu* Feuillée, and validated the name by diagnosing it properly. However he did not add a specific epithet. Looser

(1935) objected to these descriptions that he found rather confusing. He argumented that Feuillée, in his diagnosis, had mixed the leaves and other vegetative parts of what is called "Boldo" in Chile (Monimiaceae) with the fruit of another Lauraceae species, maybe the Chilean "Peumo". The latter species currently is referred to either *Cryptocarya alba* (Molina) Looser or to *Bellota miersii* Gay (current status: *Beilschmiedia miersii* (Gay) Kosterm.) (Mez, 1889; Kuntze, 1891). The complete history of the nomenclatural intricacies of *Cryptocarya alba* are covered by Looser (1935, 1950, 1963), and Kostermans (1939a, 1952). According to Kostermans (1952), if one cites *Boldu* (Feuillée) Adanson it should only be *pro parte*, *i.e.* without the description of the fruit.

Kostermans (1939b, 1958) treated the Madagascan genus *Ravensara* monographically and recognised 27 species. Recently, van der Werff (1992) successfully (cf. Brummitt, 1994) put forward a proposal to conserve *Cryptocarya* R. Brown 1810 against *Ravensara* Sonnerat 1782. The main argumentation given was that the two genera were separated solely on one fruit character, *i.e.* presence of ruminate cotyledons in *Ravensara* versus non-ruminate cotyledons in *Cryptocarya* (or endocarpic versus nucellar ruminations *sensu* Corner, 1976). More recently, Hyland (1989) corroborated this by documenting ruminate cotyledons for 11 Australian *Cryptocarya* species. He showed that these species did not differ in other characters from the *Cryptocarya* species with non-ruminate cotyledons. Still, Mez (1889) described a fruit of *C. minima* Mez [= *C. citriformis* (Vellozo) de Moraes], collected by *T. Peckolt* in Brazil, as having an imperfectly bicarpellate ovary (*i.e.* with septa intruding into the cotyledons).

The genus *Cryptocarya* was first described by Robert Brown (1810) as a new genus for Australia, with three species, *C. glaucescens*, *C. obovata* and *C. triplinervis*, of which Kostermans (1939b) designated *C. glaucescens* R. Brown as type species. Nees von Esenbeck (1833a) described the first Brazilian species for the genus, *Cryptocarya moschata* Nees & Martius, based on two specimens: the fruiting one of *von Martius*, and the flowering one of *Sellow*. The species was also cited in the same year by Nees (1833b). In 1836, Nees published the first general treatise (*Systema laurinarum*) of all known Lauraceae at his time, describing 13 species under *Cryptocarya*. *Cryptocarya moschata* Nees & Martius was the only species described from tropical America. In the same work, Nees also published the genus *Caryodaphne* with Blume as authority. The latter is comprehensible as it was Blume who suggested the genus, albeit as subgenus, to Nees. Blume's subgenus comprised two species of *Cryptocarya*: *C. laevigata* Blume and *C. densiflora* Blume (1826), to which Nees added a third species, *C. triplinervis* R. Brown. The species were cited as *Caryodaphne laevigata* (Blume) Nees, *C. densiflora* (Blume) Nees, and *C. browniana* Nees. Bentham (1870; 1880) reduced *Caryodaphne* to the synonymy of *Cryptocarya* R. Brown, a decision that is now generally accepted.

The second volume of *Nova genera et species plantarum* (Humboldt, Bonplandt & Kunth, 1817/1818) is of importance to the present work as one of the genera recognised by Kunth (who was the author of the descriptions, see Stafleu & Cowan, 1979) was *Cryptocarya*. One species, *C. canelilla* Kunth, was introduced. Mez (1889) however transferred it to *Aniba*, a decision that still holds.

In 1845, Blanco described *Salgada lauriflora* Blanco (misprinted as *Salgada laurifolia*). Vidal y Soler (1886) later referred the species to *Cryptocarya luzoniensis* Vidal. Merrill (1909, 1918) likewise relegated Blanco's species to *Cryptocarya*, making the combination: *C. lauriflora* (Blanco) Merrill.

Gay (1851/1852), described *Cryptocarya berteroana* Gay, from specimens collected by *Bertero*. In 1857, Philippi described *Icosandra* Phil. with one species: *I. rufescens* Phil. [current status: *C. alba*]. Mez (1889), however reduced *Icosandra* to the synonymy of *Cryptocarya*, a decision that still holds today.

Meissner (1864) elaborated a complete monograph of Lauraceae, accepting 37 species in *Cryptocarya*, from which four were new descriptions for Brazil: *Cryptocarya emarginata* Meissn., *C. mandioccana* Meissn., *C. micrantha* Meissn., and *C. riedelii* Meissn.. The same American species of *Cryptocarya* were also described in the *Flora Brasiliensis* (Meissner, 1866). They were complemented with two additional species: *C. guianensis* Meissn. and *C. moschata* Nees & Martius.

Beccari (1880) coined the generic name *Massoia*, with one species *M. aromatica* Becc.. Kostermans (1949: 169) relegated the genus to *Cryptocarya* R. Brown, giving the name *Cryptocarya aromatica* (Becc.) Kosterm. [current status: *Cryptocarya massoy* (Oken) Kosterm.].

Mez (1889) published a classical monograph on American Lauraceae, adopting chiefly Bentham's (1880) classification of genera (Kostermans, 1952). In his specific circumscription, Mez recognised nine species of *Cryptocarya*: he accepted all species treated by Meissner, except *C. dubia* Kunth [= *Aiouea dubia* (Kunth) Mez; Andean species] and *C. emarginata* [= *Beilschmiedia emarginata* (Meissn.) Mez]. He described *C. aschersoniana* Mez and *C. saligna* Mez, and put *Aydendron floribundum* Meissn. in synonymy with *C. minima* Mez, which has been generally accepted. *Cryptocarya moschata* Nees & Martius was described in a broader sense, including the proposal of *C. moschata* forma *angustifolia* Mez. Mez later (1892, 1893, 1902, 1907) described five new Brazilian species: *Cryptocarya hypoleuca* Mez, *C. longistyla* Mez, *C. minutiflora* Mez, *C. schwackeana* Mez, and *C. subcorymbosa* Mez.

In 1923, Teschner erected the genus *Pseudocryptocarya* Teschner, to accomodate *P. pauciflora* (Lauterbach & K. Schumann) Teschner, a species originally classified in *Cryptocarya*. Kostermans (1937) reduced *Pseudocryptocarya* to the synonymy of *Cryptocarya* R. Brown. Later, Kostermans (1950) synonymised *P. pauciflora* with *Cryptocarya laevigata* Blume.

The last revision of the American species of *Cryptocarya* was done by Kostermans (1937), who studied the historical collections deposited in European and US herbaria. He accepted the following species for Brazil: *Cryptocarya guianensis*, *C. mandioccana*, *C. micrantha*, *C. minima*, *C. moschata* and *C. saligna*. In 1938, after examining the syntype specimen of *Cryptocarya moschata* collected by *von Martius s.n.*, Kostermans (1938a) accepted *C. aschersoniana* and reduced *C. mandioccana* to the synonymy of *C. moschata*. Since Kostermans' monographic revision, voucher material of Brazilian *Cryptocarya* has dramatically increased.

In 1957 (a, b), Kostermans gave a classification of Lauraceae; and proposed three subgenera for *Cryptocarya*: (i) *Cryptocarya* = *Enneanthera* Kosterm., with 9 fertile anthers; (ii) *Hexanthera* Kosterm., with 6 fertile anthers; (iii) *Triandra* Kosterm., with 3 fertile anthers. More recently, Rohwer & Richter (1987) described the genus *Aspidostemon* for a group of eleven closed related lauraceous species from Madagascar, which were previously included in the genus *Cryptocarya*, including those that were assigned under subgeneric rank *Hexanthera* and *Triandra* by Kostermans.

In Brazil, Ida de Vattimo-Gil was the first to systematically study the taxonomy of Lauraceae. In 1956, she published “Lauraceae do Itatiaia”, based on the specimens collected by *W.D. de Barros* in the Parque Nacional de Itatiaia, RJ. She described *Cryptocarya saligna* and one unidentified *Cryptocarya* sp. [current status: *C. riedeliana* P.L.R. de Moraes]. In a following work (Vattimo-Gil, 1957), she treated the species from “Monte Sinai, Governador Portela”, RJ, and recognized *C. micrantha*, *C. moschata*, and *C. saligna*. In 1959, the “Flora da cidade do Rio de Janeiro-Lauraceae” was published with the citation of *C. moschata* and *C. saligna*. In all of three of her works, *Cryptocarya* species circumscriptions were based on Kostermans (1937, 1938a).

In 1965, Beulah Coe-Teixeira studied the *Cryptocarya* species of the state of São Paulo from specimens kept in herbaria NY, RB and SP. She adopted Kostermans’ treatment and presented a key to the species, describing *C. aschersoniana*, *C. moschata* and *C. saligna*.

In 1966, Vattimo-Gil (1966a) published “Lauraceae do Estado da Guanabara”, citing *Cryptocarya moschata* and *C. saligna*. In the same year, Vattimo-Gil (1966b) also published a preliminary study of the Brazilian species of *Cryptocarya*, based mainly on Kostermans’ criteria, but with several different interpretations of synonyms and specific status. She also provided drawings for all species and described three new ones: *C. granulata* Vattimo-Gil, *C. jacarepaguensis* Vattimo-Gil and *C. nigropunctata* Vattimo-Gil.

In 1978, Vattimo-Gil started a series of publications on the geographic distributions of Lauraceae species. In the first one (Vattimo-Gil, 1978), she incorporated specimens of *C. aschersoniana* from Paraná and Rio Grande do Sul, *C. moschata* [current status: *C. mandioccana*] from Paraná, and *C. saligna* from São Paulo. Vattimo-Gil (1979a) treated the genus *Cryptocarya* for the “Flora Ilustrada Catarinense”, describing *C. aschersoniana* and *C. moschata* [current status: *C. mandioccana*], basically from the collections made by *Reitz & Klein* housed in HBR. In the same year, she gave the localities of occurrence for *C. guianensis*, *C. micrantha*, *C. moschata*, and *C. saligna* (Vattimo-Gil, 1979b), and new localities of occurrence for *Cryptocarya aschersoniana* from Paraná and Rio Grande do Sul, and for *C. moschata* [current status: *C. mandioccana*] from Paraná (Vattimo-Gil, 1979c).

In the taxonomic treatment of the Lauraceae for the “Flora Fanerogâmica do Parque Estadual das Fontes do Ipiranga”, SP, Baitello & Coe-Teixeira (1987) described *C. moschata* Nees [current status: *C. mandioccana*]. In this same year, Pedralli (1987) published part of his dissertation on Lauraceae from Rio Grande do Sul (Pedralli, 1983), with recognition of *C. aschersoniana* and *C. moschata*.

In 1997, Sara Tressens was the first to report *Cryptocarya aschersoniana* for Argentina, providing it with a detailed and illustrated description. Nicolau (1999) presented her study on the Lauraceae species of Serra da Juréia, SP. In the taxonomic treatment, she recognised *C. aschersoniana*, *C. moschata* [current status: *C. mandioccana*] and *C. saligna*.

Quinet & Andreata (2002), after the study of Quinet (2001), published the taxonomic treatment of Lauraceae for the Reserva Ecológica de Macaé de Cima, Nova Friburgo, RJ, citing the occurrence of *C. moschata* sensu Kostermans and *C. micrantha*.

In the "Flora Fanerogâmica do Estado de São Paulo", Moraes (2003) presented the taxonomic study of *Cryptocarya* species from collections of São Paulo herbaria and HB, R and RB. Based on Kostermans' revision (1937; 1938a), *C. aschersoniana*, *C. moschata*, and *C. saligna* were recorded for the state.

Moraes (2005a) published the lectotypification of names of Brazilian species of *Cryptocarya*, accepting eight species: *Cryptocarya aschersoniana*, *C. citriformis* (Vellozo) P.L.R. de Moraes (comb. nov., = *C. minima*), *C. guianensis*, *C. mandioccana*, *C. micrantha*, *C. moschata*, *C. saligna*, and *C. subcorymbosa*. In the same year, the synopsis of Lauraceae from the states of Goiás and Tocantins was published (Moraes, 2005b; see also Moraes & Oliveira, 2007), with *C. moschata* Nees & Martius as a new record for Goiás. In the same year, Baitello & Moraes (2005) presented a taxonomic treatment of Lauraceae for the "Flora Fanerogâmica da Ilha do Cardoso", SP, describing *Cryptocarya* aff. a*schersoniana* and *C. mandioccana*.

In his taxonomic synopsis of Lauraceae for the state of Rio de Janeiro, Quinet (2005) recognised eight species, viz. *Cryptocarya aschersoniana*, *C. granulata*, *C. jacarepaguensis*, *C. micrantha*, *C. minima*, *C. moschata*, *C. nigropunctata* and *C. saligna*, accepting Kostermans' treatment (1937, 1938a) and the species described by Vattimo-Gil (1966b). Both *C. granulata* and *C. nigropunctata* are species only known from their type locality, the former from Minas Gerais, the latter from Amazonas. *C. jacarepaguensis* is only known by the type collection from Rio de Janeiro, which is so far missing. Assis *et al*. (2005) treated *C. micrantha* from the Reserva Biológica da Represa do Grama, Descoberto, MG.

3. Morphology and anatomy

3.1. Leaf[1]

The leaves of Brazilian *Cryptocarya* are evergreen, simple, entire, petiolate, without stipules, alternate in arrangement, mostly coriaceous or leathery in nature,

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[1] Section authored by Pedro Luís Rodrigues de Moraes & Marília de Moraes Castro.

with a pinnate secondary venation pattern. Venation is always pinnate with secondary veins alternately arranged and evenly spaced along the midrib. Secondary veins range in number from 4 to over 14 per side, but usually number 6 to 8 pairs. Even if rarely found in Australia and Papua New Guinea (Brouwer & Clifford, 1990), *Cryptocarya* species generally do not bear domatia. The presence of pellucid dots is a distinct macromorphological character of the leaf laminae.

3.1.1. Epidermis

According to Faggetter (1987), the micromorphology of the outer leaf surface provides few characters of diagnostic value within the Lauraceae. The trichomes are always simple and unicellular, they can vary in respect to presence/absence, distribution, and size. The outer periclinal walls of the epidermal cells may be flat (and the cells are consequently tabular), more or less convex, or domed, while those of the abaxial epidermis may be papillate. The occurrence of cells with the pattern of straight walls is the preponderant epidermal character of the family (Petzold, 1907). Another important diagnostic trait that occurs in a small number of species is the presence of cell wall undulation in the adaxial epidermis. Petzold (1907), who dealt with the American members of the genus, reported that *Cryptocarya aschersoniana*, *C. mandioccana*, *C. moschata*, and *C. schwackeana* present such cell wall undulation, with the degree of undulation being constant, in the abaxial epidermis. *Cryptocarya minutiflora*, by exception, shows cell wall undulation in the adaxial epidermis, and straight cell walls in the abaxial one. The lateral walls of the epidermal cells of both *C. minutiflora* and *C. subcorymbosa* were described as bending in a zig-zag manner with ridge-like projections, which protrude in the apices of the angles.

Moraes (1993), summarised in Moraes & Paoli (1999), found that the adaxial epidermis of eophylls (first pair of leaves) of seedlings of *Cryptocarya mandioccana* is similar to that of nomophylls (mature leaves) of adult trees, composed of cells with strongly undulate and thick walls; in costal regions, cells are more longitudinally elongated, with almost straight walls (Fig. 1 A-B, D-E). The abaxial epidermis is composed of cells that are similar to those of the adaxial epidermis. They are nevertheless smaller, with slightly undulate and less thick walls, in the possession of more trichomes, and with paracytic stomata, two subsidiary cells completely enclosing the guard cells and with parallel long axes (Fig. 1 C, F-H). However, the observation that the leaves of the studied species show a pronounced variation in the epidermal cell wall outlines, makes that this is not the best taxonomic character.

Petzold (1907) reported that, in Brazilian species of *Cryptocarya*, the stomata seen from surface view (paradermal section) show only a narrow aperture of subsidiary cells, strongly thickened, over the guard cells. In mid position, he reported two apertures, one from the subsidiary cells and one from the guard cells, giving a cruciform appearance. In an inner position, the proper stomatal pore can be observed. Apart from three species (*C. guianensis*, *C. micrantha*, and *C. minima*), which Petzold did not have at his disposal, and from *C. saligna*, all other Brazilian species of *Cryptocarya* were described as possessing depressed stomata, viz. *Cryptocarya aschersoniana*, *C. longistyla*, *C. mandioccana*, *C. moschata* Martius (= *C. moschata* Nees & Martius), *C. schwackeana*, and *C. subcorymbosa*.

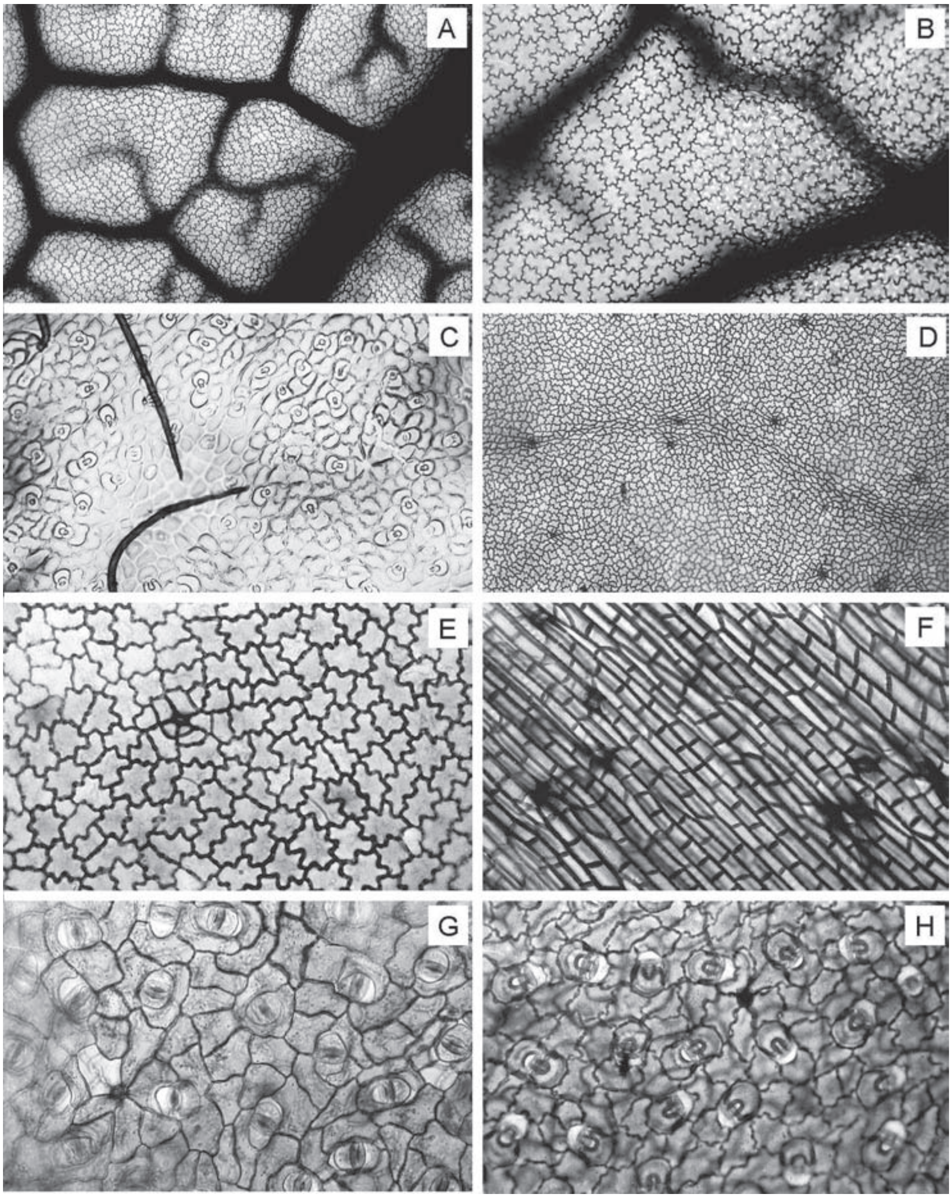

Fig. 1. Leaf surface view of *Cryptocarya mandioccana* Meissner. A-B. Eophylls: adaxial epidermis over intercostal region (A ×30; B ×100); C. Eophylls: abaxial epidermis, paracytic stomata and trichomes (×100). D-E. Nomophylls: adaxial epidermis over intercostal region (D ×30; E ×300); F. Nomophylls: abaxial epidermis over midrib (×300); G-H. Nomophylls: abaxial epidermis, paracytic stomata (×300). (Photomicrographs by author).

Van der Merwe & van Wyk (1994) studied leaf epidermal, particularly stomatal, characters in all southern African species of Lauraceae (five *Cryptocarya* spp.). Anatomically, infrageneric groups were discernible in *Cryptocarya*, but individual species could not always be distinguished. They found that all taxa have paracytic stomata, with small sunken guard cells, abaxially overarched by the subsidiary cells.

According to Christophel *et al*. (1996), “the paracytic arrangement is uniform across the family, and all species are hypostomatic”, that means stomata are only found on the abaxial surface of the leaves. However, they also reported that the exclusive use of cuticular features within Australian species of *Cryptocarya* proved to be challenging, since they found no good generic delimiting characters, even with the examination of approximately 20 additional species from this genus occurring outside of Australia.

Christophel & Rowett (1996) described the leaf architecture and cuticular features of all leafy Australian species of Lauraceae (including 50 *Cryptocarya* species) from a taxonomic perspective, based on the treatment made by Hyland (1989). Within *Cryptocarya*, Christophel & Rowett (1996) recognised five groups on the basis of the degree of undulation of the anticlinal wall of the epidermal cells of both surfaces. This is in contrast to Hyland (1989) who recognised nine groups with a tenth group consisting of five species which he considered not fitting elsewhere. Christophel & Rowett (1996) concluded that the genus *Cryptocarya* is either: (i) a non-natural taxon, (ii) a taxon with a lot of parallel evolution – perhaps reflecting its relative antiquity, or (iii) a taxon wherein foliar features are inappropriate for consideration at generic level, at least for Australian species.

3.1.2. Mesophyll

Petzold (1907) showed that in *Cryptocarya* leaves are dorsiventral, hypostomatic, and have two to three layers of palisade parenchyma (Brazilian species with two layers). In some cases the spongy parenchyma contains large lacunae, which are filled with stellate tissue. The latter is however not the case with *Cryptocarya aschersoniana*, *C. minutiflora*, and *C. subcorymbosa*. Hypodermis, in the form of a single cell layer, was recorded on the adaxial side of the leaf in all *Cryptocarya* species examined. According to Kostermans (1957a), *Cryptocarya* and *Endiandra* however tend to form a hypodermis with two layers. Sclerenchymatic cells are often seen in the leaf margins.

3.1.3. Secretory idioblasts and crystals

According to Solereder (1908), Lauraceae are characterised by the constant presence of oil cells, and occurrence of mucilage cells in many genera. These secretory cells frequently give rise to transparent dots in the leaf laminae; they are found both in the palisade and spongy parenchyma. They are generally spherical in shape; those situated in the palisade appear as enlarged sac-like cells. The walls of the secretory cells are suberised, and their contents are homogeneous and in most cases yellowish. In the survey of Baas & Gregory (1985) concerning oil and mucilage cells and Gregory & Baas (1989) reviewing mucilage cells, the occurrence of these secretory idioblasts is mentioned to a few Lauraceae genera such as *Cinnamomum*, *Laurus*, *Persea*, *Sassafras,* and

Umbellularia. Bakker *et al*. (1992), in their comprehensive study of leaf anatomy of *Cinnamomum*, described the morphology and distribution of oil and mucilage cells in the leaf of 150 species, ascertaining that these idioblasts were always present in the palisade and the spongy parenchyma.

Petzold (1907) stated that mucilage cells are present only in the palisade parenchyma of *Cryptocarya* species. However, he also noted that such cells are absent in *C. aschersoniana*, *C. mandioccana*, *C. minutiflora*, *C. moschata*, and *C. subcorymbosa*. Oil cells occurring only in the palisade parenchyma were found in *Cryptocarya moschata* Martius and *C. saligna*, while in *C. schwackeana* they are present only in the spongy parenchym.

Crystals occur mostly in the form of small needles or spindles, not only in the mesophyll, but, although rarely, also in the epidermis of the leaves in Lauraceae. In a recent anatomical study of leaves of *Cryptocarya* aff. *aschersoniana* Mez, Castro & Watanabe (ined.) found that leaves are structurally dorsiventral (Fig. 2). The adaxial and abaxial epidermises are both uniseriate. Stomata are restricted to the abaxial side. Secretory hypodermis with lipophilic substances (revealed by buffered neutral formalin fixative; FNT) are also uniseriate and occur in both sides of the laminae; in the abaxial surface, hypodermis is interrupted by substomatal chambers. The chlorenchyma presents one layer of palisade parenchyma, and five to nine layers of spongy parenchyma. Secretory idioblasts with lipophilic content (revealed by FNT) are observed in the palisade and spongy parenchyma. Single raphides and prismatic crystals are found in parenchyma cells. Vascular bundles are collateral and surrounded by a lignified bundle-sheath. The bundle-sheath and bundle-sheath extensions of the vascular bundles are composed of thick-walled parenchyma cells, which walls become impregnated with lignin.

Sclerified cells are also observed as supporting tissues in the midrib and at the leaf margins.

3.1.4. Venation pattern

Similarly to what has been described by Nishida & Christophel (1999) for the Neotropical species of *Beilschmiedia*, all the Brazilian species of *Cryptocarya* have penninerved leaves (pinnately nerved). Klucking (1987) gave a comprehensive account on this topic; it is here succinctly repeated.

Many leaves have one kind of venation in their basal part, another kind in the middle part and a third kind in the upper part of the leaf. The secondary venation of a leaf begins to form in the basal part of the leaf and develops progressively apically or acropetally. Since the secondary venation develops acropetally, the venation in the basal part of the leaf is formed first, that in the middle part of the leaf next, and that in the apical part last. Each of these venation types – the basal, middle, and apical – has different characteristics and is distinct. As each of these venation types are formed during a different phase of development, they are commonly termed *early phase venation*, *middle phase venation*, and *late phase venation*. These three types of venation usually are not present in equal amounts on the leaf. One or another type commonly makes up half or more of

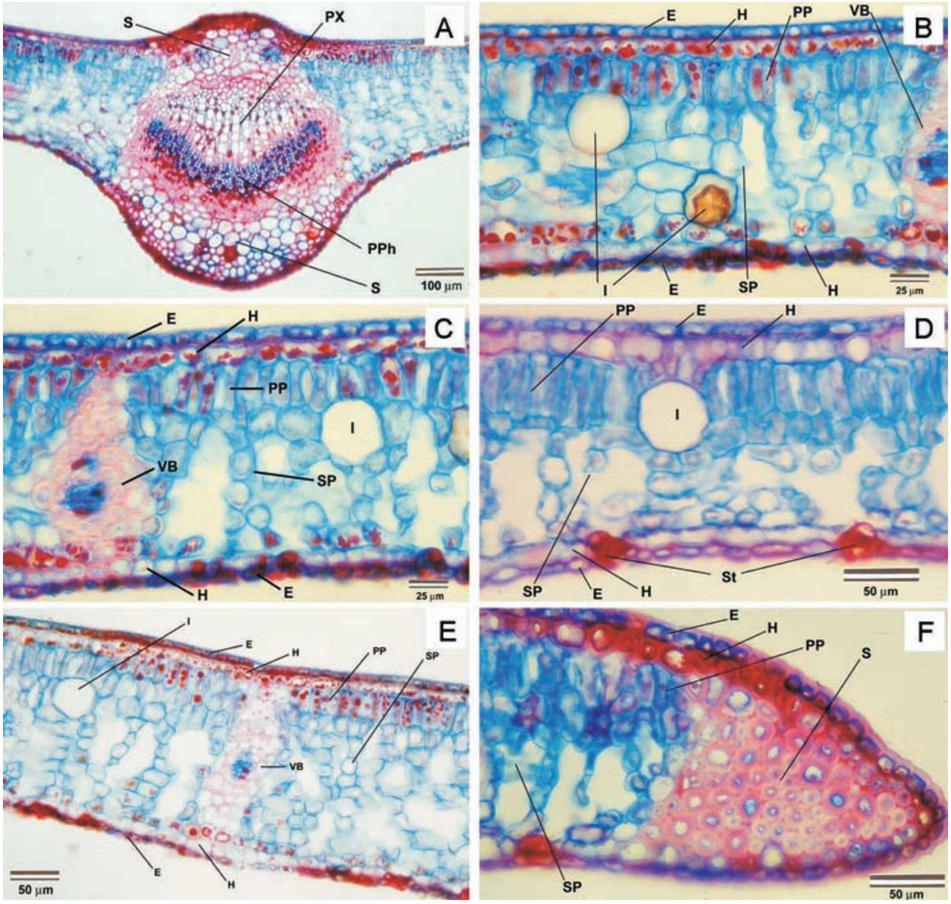

Fig. 2. Transections of leaves of *Cryptocarya* aff. *aschersoniana* Mez (from *Moraes 2389*). A. Midrib; B-D. Intermediary region; E-F. Marginal region. (A-C, E fixed in FNT; D, F fixed in FAA). (E = epidermis, H = secretory hypodermis, I = secretory idioblast, PP = palisade parenchyma, PPh = primary phloem, PX = primary xylem, S = sclerified cells, SP = spongy parenchyma, St = stomata, VB = vascular bundle). (Photomicrographs by M. de M. Castro & T.M. Watanabe).

the total pattern and so the leaf venation pattern is named after that dominant type of venation, (e.g. if early phase venation is present on half or more of the leaf, one terms the venation pattern for that leaf '*early phase venation*').

"Secondary veins are veins that depart from the midvein or primary vein. They are termed *pinnate* if they are directed more laterally; they're called *acrodromal* if they are directed more apically than laterally.The area between the secondary veins is termed the *intercosta* or *intercostal area*. The inner boundary of the intercosta is the midvein. Its outer or marginal boundary is formed when the secondary vein branches and the distal branch continues the secondary course apically terminating by connecting with the basally directed branch from the secondary vein above. This boundary that boxes in the intercostal area is called *closure*. Secondary veins are termed *brochidodromous* when the closure connection is arched and definite (adapted from Hickey, 1973).

Klucking (1987) examined the leaf structure of 245 species of *Cryptocarya*. Of 49 species he gave a description. From Brazil, only *C. aschersoniana* was cleared, and described. This species had the predominant venation pattern of the genus, *i.e.* "Early Phase Pinnate Venation dominant with small amounts of Middle Phase and Late Phase Venation present in the apical part of the leaf".

Moraes (1993; see also Moraes & Paoli, 1999), studied the leaf venation pattern of *C. mandioccana*, for eophylls and nomophylls (Fig. 3 A-B), the latter also showed the predominant venation pattern as described by Klucking (1987).

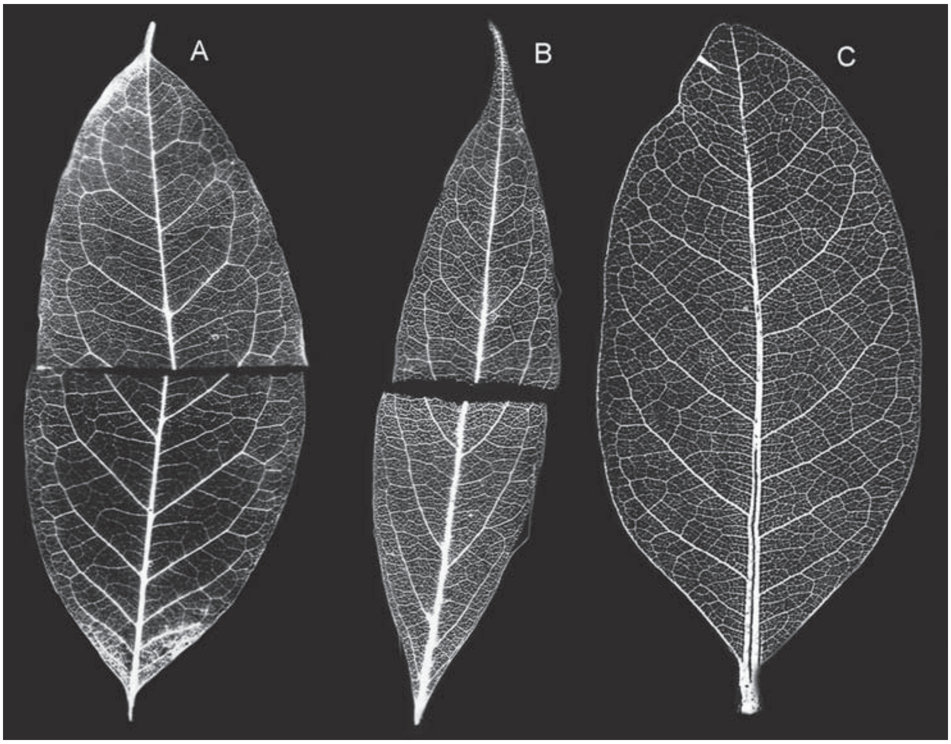

Fig. 3. Cleared leaves of *Cryptocarya*. A-B. Eophyll and nomophyll of *C. mandioccana* Meissner, respectively, from Parque Estadual Carlos Botelho (Photographs by author). C. "*Cryptocarya* sp. nov.", from tropical America (ex von Ettingshausen, 1861; fig. 14, p. 45).

They found eophylls and nomophylls presenting pinnate, camptodromous-brochidodromous venation pattern (secondary veins not terminating at the margin or secondary veins joined together in a series of prominent arches). However, eophylls differed from nomophylls in arrangement, number and course of secondary veins, as well as in reticulation, size and type of areoles and veinlets. Most eophylls with 5 to 8 pairs of secondary veins, mainly 6 pairs and a few with 4 pairs, courses curved, curving gently apically as it extends laterally from the midrib, merging into the marginal looping; secondary courses running at high angles (most of the lateral course of the secondary veins is oriented at 55 degrees or more to the midrib), spacing broad, narrow, or a mixture of broad and narrow; marginal vein and/or marginal thickening present; intercostal venation scalariform or random reticulate; areoles are incomplete, larger than those of nomophylls, with random arrangement, shape irregular, intrusive veinlets multi-branched or multi-forked (pattern dendroid), sometimes with more than one veinlets per areole, with less freely ending veinlets than those of nomophylls (Fig. 4 A-B). Nomophylls with laminae narrow-elliptical to elliptical, apices acute to acuminate, base cuneate; most of nomophylls with 5 to 8 pairs of secondary veins, some with 4 pairs and a few with 9 or more pairs, courses curved or geniculate (the secondary vein departs at a high angle to the midrib and after a short distance it has an abrupt apical change in its course direction), curving sharply distally at closure and merging into the marginal looping; secondary courses running at moderate or high angles, spacing broad and/or narrow; marginal vein and intersecondary veins present; intercostal venation scalariform or random reticulate; areoles are imperfect, small or large, with random arrangement, shape irregular, intrusive veinlets mostly multi-branched or multi-forked (pattern dendroid), sometimes with more than one veinlets per areole; some with perfect reticulation; in young leaves, open reticulation, without branched endings (Fig. 4 C-J).

The minor venation of *Cryptocarya mandioccana* is variable between different individuals of a population (Moraes, 1993). Both perfect and imperfect reticulation was found, composed of subrotund or polygonal areoles, with low to highly ramified veinlet terminations. Genetical, environmental, and/or ontogenetical variation would explain the variability at this level. However, major venation of *C. mandioccana* is much more conservative and thus useful for identifying the species.

3.2. Wood and bark

Richter (1987) gave a summary of the structural features of the secondary phloem, based on barks from about 400 specimens representing 310 species and 35 genera of Lauraceae. I have here retaken the information relevant to *Cryptocarya* species.

Sclerenchymatous tissue (mechanical tissue) is always present in lauraceous bark. “True” or normal phloem fibres are lacking entirely in *Cryptocarya*. Sclereids are present in nearly all lauraceous barks and show great variability in type, form and distribution. The morphology of these sclereids permits them to be classified in two categories, viz: columnar sclereids longitudinally elongated, usually with blunt but rarely with pointed ends, typically hexagonal in transverse section; or, polygonal, isodiametric sclereids clustered into small or large nests or tangential groups.

A combination of both columnar and isodiametric sclereids occurs in individual species of *Beilschmiedia* and *Cryptocarya*. Lignified parenchyma (of sclerotic cells with extremely thick, polylamellate walls) is developed exclusively in the non-functional phloem and often very clearly demarcates the functional part, being typical of *Cryptocarya*. Some species of *Cryptocarya* present dilated rays expanding into wedge-shaped ends in the outer phloem. Most of such dilated tissue is sclerotic.

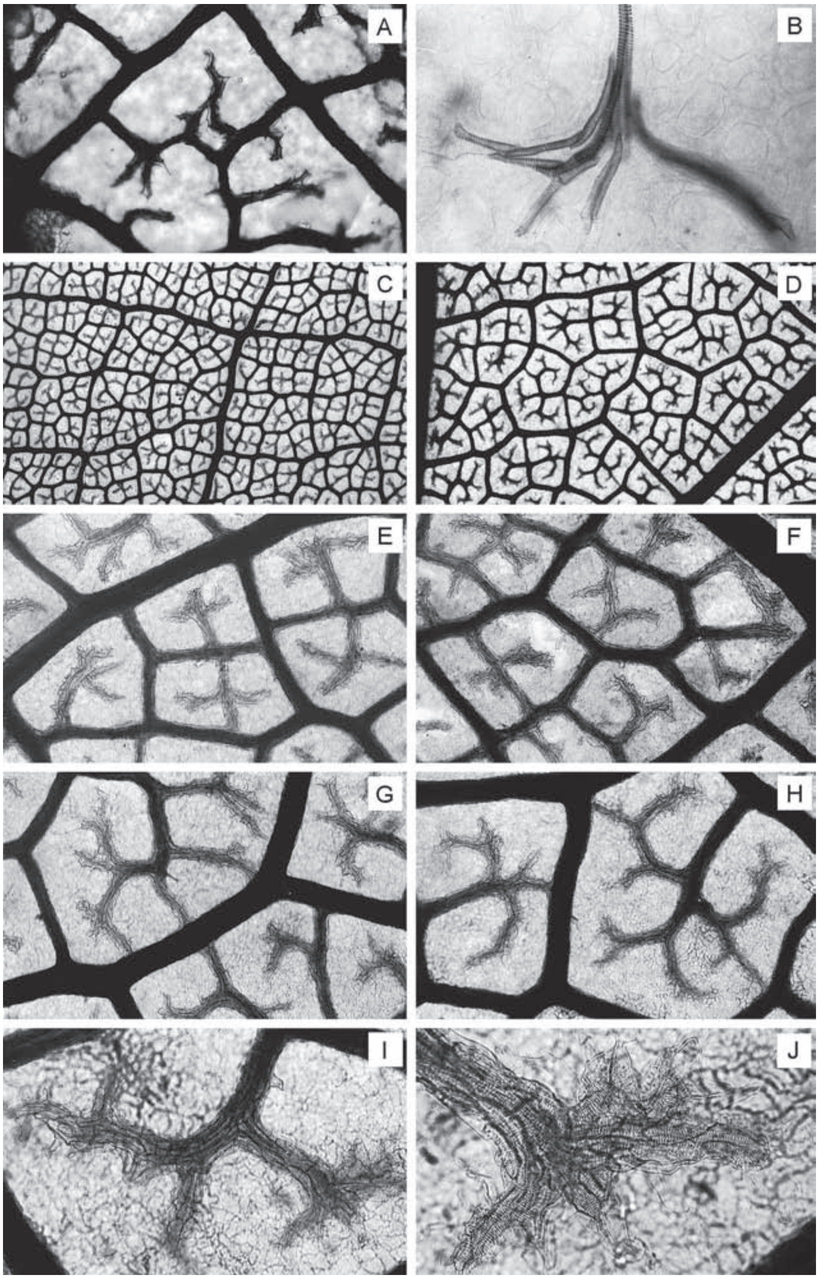

Fig. 4. Minor venation in leaves of *Cryptocarya mandioccana* Meissner.
A. Eophylls: incomplete reticulation, detail of anastomosis (×30); B. Eophylls: detail of veinlet (×300). C. Nomophylls: perfect reticulation, veinlet termination few-branched, intercostal region (×18.75); D. Nomophylls: imperfect reticulation, dendroid veins, intercostal region with secondary vein (×18.75);
E-H. Nomophylls: detail of areoles and veinlet termination (×30);
I-J. Nomophylls: detail of veinlet termination (I ×100; J ×300).
(Photomicrographs by author).

Lauraceae commonly have inorganic inclusions such as large rhomboid crystals. These are diagnostically valuable. They are associated with all types of sclereids in *Cryptocarya* (the Brazilian *C. aschersoniana* and *C. moschata*, current status *C. mandioccana,* being the exception). Compact blocks or plugs of "vitreous" or "dense" silica in fibre and/or sclereid lamina are characteristic of the barks of *C. aschersoniana* and *C. moschata*. Oil and mucilage cells are common throughout the entire secondary phloem, being particularly numerous in some species of *Cryptocarya*.

In mature secondary xylem, vessels are never exclusively solitary; rather they mostly appear as mixed solitary and in short (2-4) radial multiples in varying proportions. In species of *Cryptocarya* they are typically arranged in a radial pattern (multiple of up to 10 vessels). Perforations are typically simple in *Cryptocarya* although scalariform perforations are found to a very limited degree in species of the "Longotra" group of Madagascar (*Cryptocarya humbertiana* Kosterm., *C. lacrimans* Kosterm., *C. louvellii* Danguy, *C. percoriacea* Kosterm., *C. perrieri* Danguy, *C. scintillans* Kosterm. and *C. trianthera* Kosterm.. All species except *C. louvellii* are now classified under *Aspidostemon)* (Rohwer & Richter, 1987).

Fibres are predominantly libriform and arranged in radial rows, being horizontally stratified in *Cryptocarya*; with numerous pits restricted almost exclusively to radial walls, small (2-4 µm) and slightly conspicuous. Fibres are for the most part non-septate in *Cryptocarya* (except in "Longotra" group). Solid organic contents ("gums") are extremely rare and were reported to "Longotra" group.

In *Cryptocarya* (except the "Longotra" group) and *Ravensara*, the parenchyma (axial) is basically paratracheal, with distribution sparse to weakly vasicentric, in combination with multiseriate (2-4 up to 8) marginal bands. Rays are predominantly 2-3 cells wide and less than 1 mm high. Uniseriates and multiseriates up to four cells wide are characteristic for *Cryptocarya*. Rays are conspicuously heterogeneous, *i.e.* uniseriates are composed of mostly upright cells, whereas multiseriates have one to several marginal rows of upright cells. The occurrence of aggregate rays within the family is restricted to a few species of *Cryptocarya* from the South East Asian and Australo-Pacific regions [*C. australis* (Cunn. ex Hook.) Benth. (current status: *C. laevigata*), *C. chinensis* (Hance) Hemsl., *C. corrugata* C.T. White & Francis, *C. densiflora*, *C. glaucescens*, *C. mannii* Hillebr., *C. meissneri* F. Muell. (current status: *C. glaucescens*), and *C. nitens* Kood. & Valet.]. Sheath cells are developed sporadically in several species of *Cryptocarya*. Rays are typically storeyed in the "Longotra" group of Madagascar.

Inorganic deposits are quite frequent in lauraceous wood. However, simultaneous occurrence of both calcium-oxalate (CaC_2O_4) crystals and silicon dioxide (SiO_2) is extremely rare and restricted to a few species of *Cryptocarya* and *Beilschmiedia*. In the "Longotra" group, no crystals have been observed in the secondary xylem, and the presence of silica is restricted to some species of *Cryptocarya*.

The work of Richter (1981), based on the anatomy of 41 Lauraceae genera (830 species, represented by more than 1600 specimens), has shown that certain groups of genera show a high degree of anatomical uniformity. This, in turn, makes that wood and/or bark structure cannot be used to corroborate the generally accepted generic distinctions. This applies particularly to the large *Beilschmiedia* complex (comprising *Beilschmiedia*, *Endiandra*, *Potameia*, *Triadodaphne*), and the *Cryptocarya* complex consisting of *Cryptocarya* and *Ravensara*. Richter (1987) further proposed that wood and bark anatomy suggest a bipartite subdivision of the family. One subdivision holds the *Beilschmiedia* and *Cryptocarya* complexes, while the other houses the remaining taxa except for the parasitic climber *Cassytha* (Richter, 1987).

3.3. Inflorescence

Inflorescences of Lauraceae are rarely terminal, sometimes pseudoterminal, usually axillary. Inflorescences originate from the axils of frondose or bracteose leaves of a proliferating main axis and, as a rule, have a determinate growth. In the tribe Cryptocaryeae Nees (*sensu* van der Werff & Richter, 1996), inflorescences are paniculate to ± cymose (basically of thyrsoid or thyrso-paniculate type in the sense of Weberling, 1989) (Fig. 5), *i.e.* they start with a racemose branching pattern, but are cymose (usually dichasial) in their distal parts (Rohwer, 1993a). The lateral flowers of a "cyme" are not quite opposite, and flowers can appear individually placed along an inflorescence axis (van der Werff & Richter, 1996).

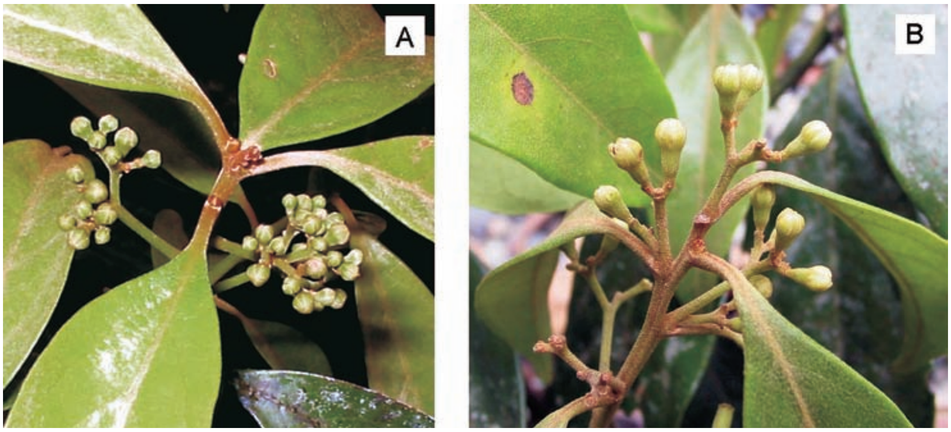

Fig. 5. Inflorescences of *Cryptocarya mandioccana* Meissner. A. Axillary, with flower buds; B. Axillary and pseudoterminal, with flowers almost at anthesis and scars of fallen flowers. (Photographs by author and A.J. Cavalheiro, respectively).

3.4. Flower

Species of Brazilian *Cryptocarya* have a typical lauracean flower structure, as described by van der Werff (1991, 2001) and Rohwer (1993a, 1994). Flowers are actinomorphic, perigynous, pedicellate, bracteate, hermaphroditic (bisexual), trimerous, with "complete" floral diagram (Fig. 6), *i.e.*, there are two perianth whorls of three sepaloid tepals each, which are usually equal in size and shape; the androecium is arranged in three whorls of three fertile stamens each, and one whorl of well-developed staminodes (Fig. 7 F), while the gynoecium is the central pistil. Whorls are counted from the outside to the centre of the flower. Whorl I is positioned opposite the outer tepals, whorl II is facing the inner tepals, whorl III is opposite whorl I, and whorl IV (staminodes) opposite whorl II. The stamens of whorls I and II are nearly identical and seemingly form one whorl of six stamens, with introrse anthers. The stamens of whorl III have a pair of basal-lateral appendages (glands; Fig. 7 F), and the anthers are lateral or lateral-extrorse (Fig. 7 F). Anthers are disporangiate, with one functional, valvately dehiscing pollen sac per theca (*i.e.*, one sporangium per theca, which opens by a valve) (Fig. 7, 8). The receptacle is enlarged, urceolate, and completely enclosing the gynoecium, which invariably consists of a single carpel with superior ovary containing a single ovule.

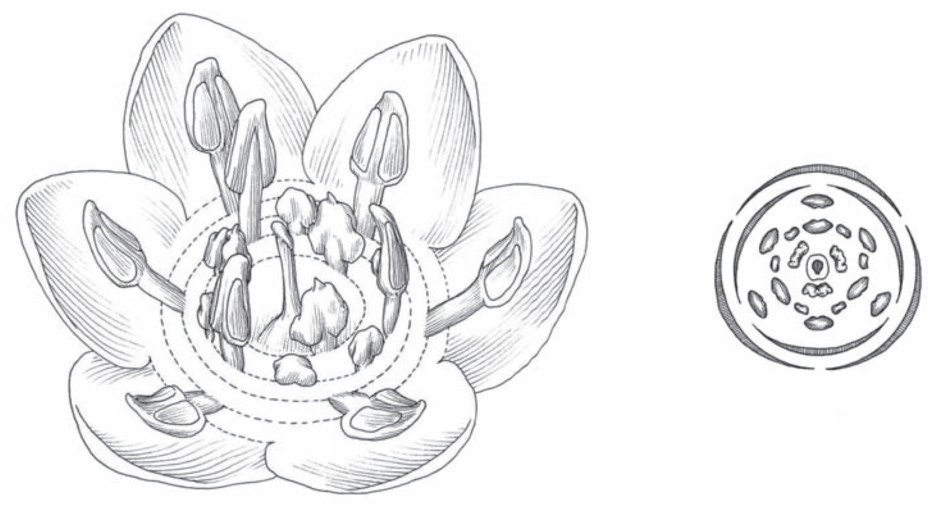

Fig. 6. Schematic flower and floral diagram of *Cryptocarya*.
Floral formula: ⊕ P: 3 + 3; A: 3 + 3 + 3 + (3); G: 1.

Within the limits of this basic organization, Brazilian *Cryptocarya* species do not show pronounced floral variation. Flower shape is rather infundibular (funnel-shaped) with erect or erect-patent tepals. The androecium is also little variable. Stamens of the outer androecial whorls are (sub-)equal and in all species the filaments are as long as or (slightly) shorter than anthers (rarely stamens are stipitate). Two different anther types occur in whorl I and II stamens. In species of the *Cryptocarya moschata* group (*C. aschersoniana*, *C. botelhensis*, *C. guianensis*, *C. micrantha*, *C. moschata*, *C. riedeliana, C. subcorymbosa*), and *Cryptocarya mandioccana* group (*C. mandioccana*, *C. sellowiana, C. wiedensis*), anthers are (nearly) ovate with protruding connectives that emerge between and beyond locelli. Locelli are elliptical, occupying almost all the available space and sterile tissue is located mostly above locelli. In the *Cryptocarya citriformis* group (*C. citriformis* and *C. saligna*), anthers are depressed-oblong to broad-ovate in shape, and connective tissue is either reduced between or level with the two locelli, the latter being suborbicular. Glands of whorl III stamens are either sessile or raised on short to long stalks.

After the anthesis the tepals usually fall off as a continuous ring, together with all stamens, and staminodes (Fig. 7 A; also illustrated in Meissner, 1866). As a rule, remnants of flower parts on the apex of the accrescent tube are only found in some immature fruiting material (except for *C. sellowiana* and *C. subcorymbosa*). According to Endress & Hufford (1989), in the Lauraceae, each pollen sac opens independently via an uplifting flap, which is hinged at its apex (Fig. 7 A). Mez (1888) pointed out that the anther does not deform at dehiscence, except for the valves that may shrink to one-third of the original size, remarkably in *Aydendron* and *Acrodiclidium.* In *Cryptocarya*, shrunken flaps of valves are found in all Brazilian species, but most visible in *C. aschersoniana*, *C. citriformis*, *C. mandioccana*, *C. micrantha*, and *C. saligna* (cf. Fig. 7 B, D; 8 A-B). Another noteworthy feature in the Lauraceae is the stickiness of the pollen grains (see Kubitzki & Kurz, 1984). This stickiness holds pollen together, whereby they adhere to the surface of the pollinator's body or to the flaps. This seems to be a mechanism of exhibition and release of pollen (also reported for *Endlicheria* by Chanderbali, 2004) (Fig. 7 C-E).

As discussed by Rohwer (1994), the number of pollen sacs per anther and their position are traditionally regarded as very important systematic characters in the Lauraceae, although with diverging opinions about the evolutionary direction in these characters. According to Drinnan (cited by Rohwer, 1994), disporangiate anthers represent the plesiomorphic condition in the family, since all close outgroups (Monimiaceae-Atherospermatoideae, Gomortegaceae, Hernandiaceae), and the earliest known fossil lauraceous flowers (Drinnan *et al*., 1990) have disporangiate anthers.

Like indicated by Rohwer (1994) for *Brassiodendron fragrans* C.K. Allen (Rohwer, 1994 – Fig. 4; current status: *Endiandra montana* C.T. White) and several species of *Endiandra* (Hyland, 1989 – Fig. 76F, 78B, 79B; Rohwer, 1994 – Fig. 5), Brazilian *Cryptocarya* spp. have four pollen sacs, but the two pollen sacs of each theca open by means of a common, sometimes slightly two-lobed, flap (Fig. 7 B, E; 8 A-D; 30 C; 36 D). This represents one of the three transitional (intermediate) forms between disporangiate and tetrasporangiate anthers. As these intermediate forms are distributed over several genera, the transition must have occurred several times within the family, weakening the argument that disporangiate anthers represent the primitive state. Rohwer (1994) also pointed out that a reduction from four pollen sacs to two appears much more likely and can be interpreted as both more economical and allowing a better pollen presentation. Even if disporangiate anthers were plesiomorphic within the Lauraceae, one would have to allow for independent reversals from the tetrasporangiate to the disporangiate condition.

3.5. Fruit and seed

The mature fruit of *Cryptocarya* is completely covered by the accrescent hypanthium (receptacular tube or receptacle). According to Rohwer (1993a), "the fruit of the Lauraceae can be described as a one-seeded berry or as drupe with a weakly developed endocarp". Under the systematic treatment of fruit types proposed by Spjut (1994), the fruits of *Cryptocarya* are classified in Eucarpia (one or more closed carpels), Category I – Simple Fruits, Series A – Angiocarpi,

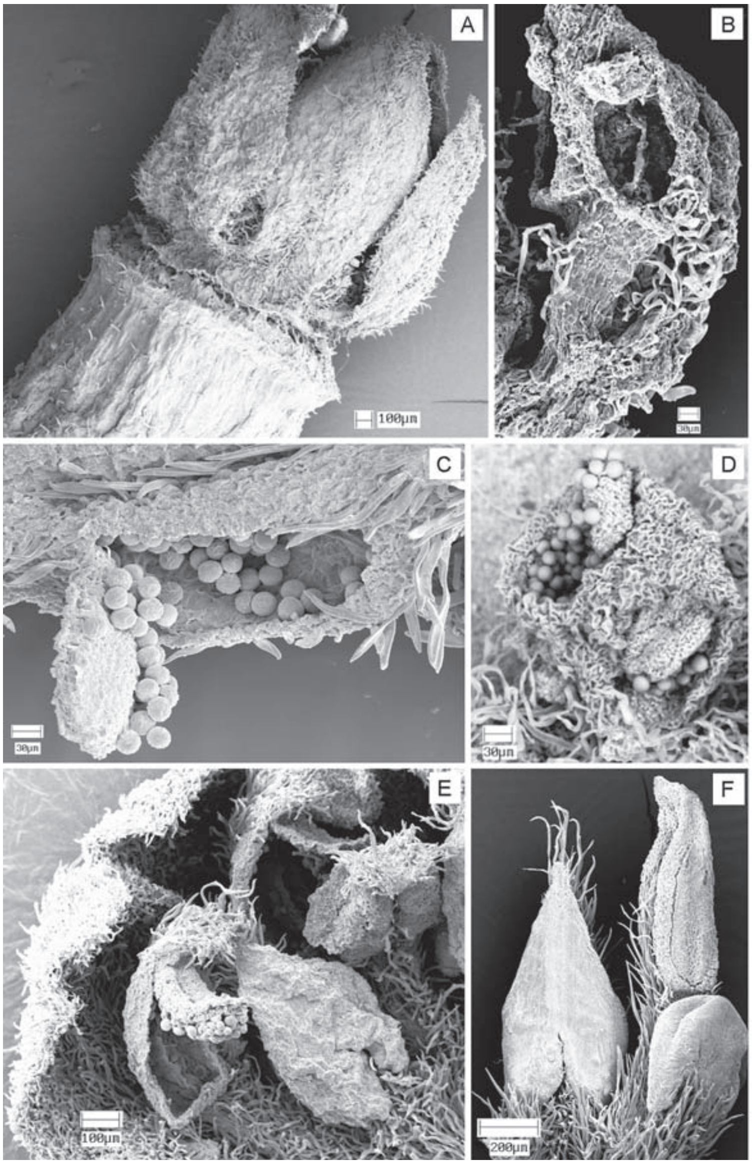

Fig. 7. SEM micrographs. A. *Cryptocarya moschata* Nees & Martius, detachment of tepals and androecial parts from the flower tube after fertilization; B. *Cryptocarya citriformis* (Vellozo) P.L.R. de Moraes, stamen of androecial whorl I showing shrunken flaps (from *Peckolt 166*); C. *Cryptocarya botelhensis* P.L.R. de Moraes, stamen of androecial whorl III, detail of valvate dehiscence via an uplifting flap, hinged at its apex (from *Moraes 2329*); D. *Cryptocarya saligna* Mez, stamen of androecial whorl II (from *Moraes 2305*); E. *Cryptocarya moschata* Nees & Martius, stamens and staminode (from *Moraes 2241*); F. *Cryptocarya mandioccana* Meissner, staminode (left), gland (right), and stamen of androecial whorl III with anther lateral (from *Santos 2811*). (Photomicrographs by author).

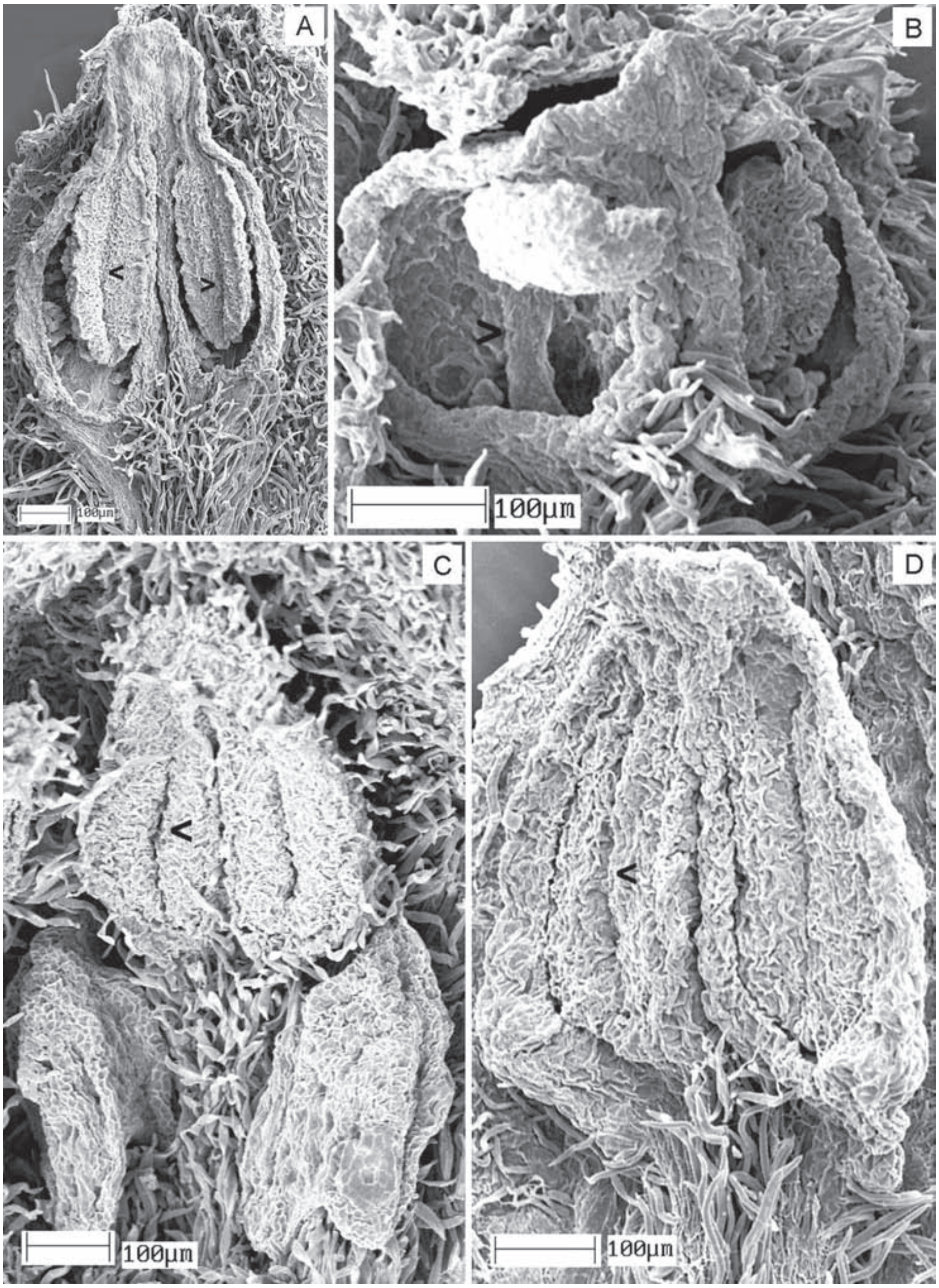

Fig. 8. SEM micrographs of adaxial side of stamens of androecial whorls II and II, introrse. A. *Cryptocarya mandioccana* Meissner (from *Esteves 16*, SPSF); B. *Cryptocarya micrantha* Meissner (from *Heringer 913*, VIC); C. *Cryptocarya riedeliana* P.L.R. de Moraes (from *Duarte 7991*, RB); D. *Cryptocarya subcorymbosa* Mez (from *Glaziou 18436*, OUPR). Note furrow in the middle of the flaps (A, C, D) and longitudinal septum in the middle of the anther locule in B (<). (Photomicrographs by author).

Acrosarcum (simple indehiscent fruit with an undifferentiated pericarp lacking a stony endocarp and surrounded by an accrescent fleshy exocarp derived from perianth or receptacle) or Pseudodrupe (anthocarpous fruit with an undifferentiated indurate pericarp surrounded by a fleshy or coriaceous exocarp). Under the classification of fruits proposed by Barroso *et al*. (1999) for Brazilian Dicotyledons, the fruit of *Cryptocarya* is classified as Nucoid (Hertel, 1959), Nucula type.

When the fruit is completely enclosed in the accrescent receptacular tube the latter assumes the function of the exocarp and mesocarp (Kostermans, 1957a), and usually takes over the attractive colouring (Rohwer, 1993a). In *Cryptocarya* the pericarp of the fruit becomes woody and is often ribbed. The accrescent flower tube becomes entirely adnate to the fruit, although the ovary in the flower is still free from the tube.

In Lauraceae, as a rule, mature fruits are black in colour, sometimes red, rarely yellow (Kostermans, 1957a). For instance, in 43 of the 46 species of Australian *Cryptocarya* described by Hyland (1989), the fruits were indicated as black, blue-black, purple or black, bluish black, or purplish black when perfectly ripe; the three remaining species had more vivid colours (*i.e.* yellow, orange or red in *C. laevigata*; red, orange-red, pinkish orange or orange in *C. oblata* Bailey and pink or red in *C. pleurosperma* C. White & Francis). From the 20 species of *Cryptocarya* occurring in China, 13 are described with black fruits when ripe, and only *C. chingii* Cheng with red fruits (Li Xi-wen *et al*., ined.; but black in Allen, 1942). According to van der Merwe *et al*. (1988), the prevailing colour in all African species of *Cryptocarya* is black or red. Brazilian species of *Cryptocarya* have their ripe fruits coloured yellow (or at least yellowish, in *Cryptocarya aschersoniana*, *C. botelhensis*, *C. guianensis*, *C. mandioccana*, *C. micrantha*, *C. moschata*, *C. riedeliana*, *C. subcorymbosa*), yellow, orange or red (*C. saligna*), brown (*C. citriformis*), and black (*C. sellowiana*). Finally, it can be noted that, Kostermans (1937) reported that the fruits of *C. alba* are red or pink. Looser (1963) on the other hand states that they can sometimes be white or whitish, at least partially.

The shape of the fruits of Brazilian *Cryptocarya* is usually globose, sometimes ellipsoid (*C. citriformis*, *C. saligna*), and often provided with a neck at the base, presenting considerable variation (Fig. 9). To highlight the variation in the shape of fruits Moraes (1993) collected 1892 fruits of *C. mandioccana* from 27 trees of the population at Parque Estadual Carlos Botelho. Most trees (16) presented fruits that are strictly prolate (polar radius > equatorial radius), whereas 11 trees presented fruits prolate, spherical and oblate (equatorial radius > polar radius), from which only one tree bore fruits strictly oblate (Fig. 10).

The size of mature fruits is to be measured with the accrescent receptacular tube, also called anthocarp (see Spjut, 1994). More details on the biometry of mature fruits of *C. mandioccana* and *C. moschata* can be found in Moraes & Alves (2002).

According to Endress (1972, 1990), Corner (1976), Heel (1981), Rohwer (1986), and Endress & Igersheim (1997) the ovary of the Lauraceae is unicarpellate,

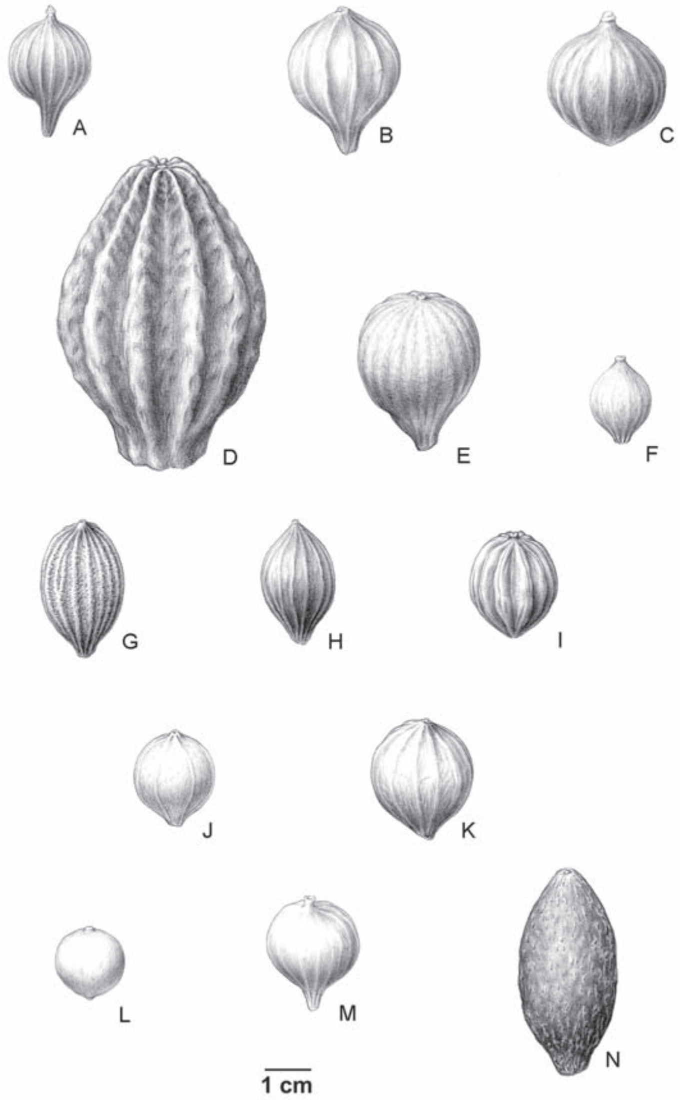

Fig. 9. Diaspores of Neotropical *Cryptocarya*. A-C. *Cryptocarya guianensis* Meissner (from *Lescure 356*, *Prévost & Grenand 2016*, and *Oldeman 1816*, respectively); D. *Cryptocarya citriformis* (Vellozo) P.L.R. de Moraes (from *Moraes 2154*); E & G. *Cryptocarya micrantha* Meissner (from *Moraes 2156* and *Moraes 2449*, respectively); F. *Cryptocarya aschersoniana* Mez (from *Moraes & Oliveira 2504*); H. *Cryptocarya mandioccana* Meissner (from *Moraes 2452*); I. *Cryptocarya botelhensis* P.L.R. de Moraes (from *Moraes 1243*); J-K. *Cryptocarya moschata* Nees & Martius (from *Moraes 2101* and *Moraes 2115*, respectively); L-M. *Cryptocarya aschersoniana* Mez (from *Reitz & Klein 2633* and *Moraes 2424*, respectively); N. *Cryptocarya saligna* Mez, without remotion of the accrescent receptacular tube (from *Kuhlmann s.n.* – RB, fruit collection 1576).

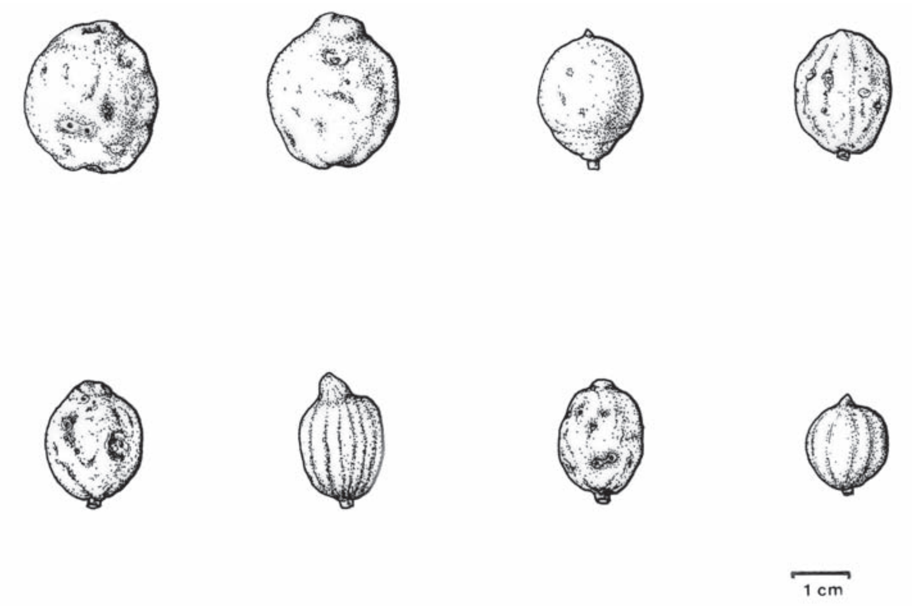

Fig. 10. Variation in shape and size of mature fruits (without remotion of the accrescent receptacular tube) of *Cryptocarya mandioccana* Meissner from the population of Parque Estadual Carlos Botelho, São Miguel Arcanjo, SP (from Moraes, 1993).

small to medium, ascidiate (pitcher-shaped), with the ovarial cavity being almost completely filled by the solitary ovule in central median placentation. The carpel is closed at anthesis and its mode of angiospermy is represented by postgenital fusion of the stylar (and ovarial) slit. The ovule is anatropous, pendent, with dorsal raphe and the micropyle on the placental side with overarching funicle, bitegmic, pachychalazal (or perichalazal), crassinucellate; ovule size at maturity varies between 750-1400 µm; *o.i.* (outer integument) 3-5 cells thick, semiannular; *i.i.* (inner integument) 2-4 cells thick (integument thickness is quite uniform in Lauraceae); micropyle closed by the endostome or by the nucellus; chalaza massive, unspecialised; embryo-sac often large and elongate.

The reduction to a single carpel makes that the single ovule can develop into a large and exalbuminous seed. According to Corner (1976), this structure secures rapid establishment of the seedling in the forest.

The structure of the seed in Lauraceae has been described by Corner (1976). The seed is massive, with thin testa, 4-20 cells thick, more or less multiplicative, most layers persistent or the inner crushed (crushed entirely in *Cryptocarya* except for the inner epidermis), without stomata, outer epidermis as a layer of cuboid cells with tannin, or unspecialised; mesophyll unspecialised, without oil cells; inner epidermis typically composed of longitudinally and tangentially elongate, narrow tracheids with spiral or annular thickening, slightly lignified or not, 2-3 layers of tracheids at the micropyle; tegumen not or scarcely thickening, soon crushed; nucellus soon absorbed or persistent as ruminations (*Cryptocarya*, *Ravensara*); endosperm nucellar, absorbed by the embryo.

For *Cryptocarya wightiana* Thwaites, Corner (1976) described the ovule with the "*o.i.* 3 cells thick, *i.i.* 2-3 cells thick; testa 4-5 cells thick, thin-walled, unspecialised (except inner epidermis) and becoming crushed; *i.e.* composed of longitudinal tracheids with annular or closely spiral, lignified thickening, differentiating soon after fertilization, forming a pellicle over the embryo; tegumen not multiplicative, soon crushed; vascular bundle of the raphe not branching, becoming a flattened band in the perichalaza, with a thin brownish hypostase; chalaza extending into a perichalaza in the lower part of the seed; nucellus well-developed, forming a crescentic ingrowth from the perichalaza between the cotyledons, appearing as a rumination, eventually drying up". Still, "the persistent perianth-tube, surrounding the immersed pericarp, gives to the fruit in section the appearance of a large seed in which the perianth-tube would represent the testa, the pericarp the tegmen, the testa the nucellus, and the nucellus the endosperm".

Moraes (1993), summarised in Moraes & Paoli (1996), studied the morphology of fruits and seeds of *Cryptocarya mandioccana* from material collected at Parque Estadual Carlos Botelho. Fruits were classified as nucoids (*sensu* Hertel, 1959), one-seeded, surrounded by the fleshy accrescent hypanthium. The pericarp is thick and lignified, forming indentations in the fleshy portion (Fig. 11). The diaspores are constituted by pericarp plus seed, presenting pronounced variation in shape, within and among individual trees (Fig. 12). The pericarp is externally whitish, with the inner epidermis brown; apex mucronate, with a small pore, which internally (in the seed) corresponds to the site of micropyle (Fig. 11). Seeds are anatropous, endotestal, exalbuminous, with crushed tegumen, not adhered to pericarp, ellipsoid. External colour of integument is dark brown, glossy. Seed cavity entirely filled by the embryo (Fig. 11). Embryo is constituted by fleshy cotyledons, massive, whitish, asymmetric, plane-convex, and mucronate at apex, completely covering the radicle-hypocotyl axis, which is minute, flattened, and rhombic; axis is ascendant and the plumule is turned towards the centre of cotyledons; below the plumule, in the centre of radicle-hypocotyl axis there are two minute lateral appendices that articulate with the cotyledons.

4. Karyology

Up till now relatively few studies have been performed on the cytogenetics of South American Lauraceae. Okada & Tanaka (1975) provided a summary. The base number is $x = 12$ ($2n = 24$), with very little variation in the karyotype throughout the family. Polyploidy has however been observed in *Cassytha*, *Laurus*, *Litsea* and *Sassafras* ($2n = 48$), and in species of *Laurus* and *Neolitsea aciculata* ($2n = 72$). Metaphase chromosomes are 1-3 µm long (5-7 µm in *Cassytha*); position of centromere varies from median to subterminal; heterochromatin is found only in the proximal regions of both arms (more evenly distributed in *Cassytha*). Fig. 13 (from Moraes & Gardingo, 1996) shows a typical *Cryptocarya* karyotype

More recent information on the karyology of the Lauraceae can be found in Contim *et al.* (2005) and Oginuma & Tobe (2006). It can be concluded that more studies are needed to clarify chromosome evolution in the Lauraceae.

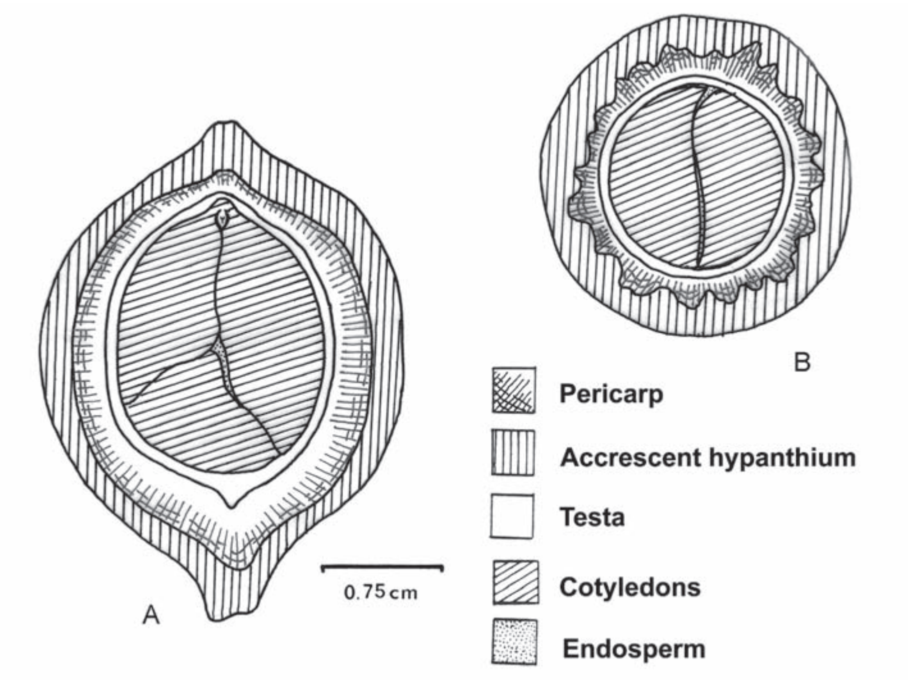

Fig. 11. Fruit diagrams of *Cryptocarya mandioccana* Meissner. A. Longitudinal section; B. Transversal section (adapted from Moraes, 1993, and Moraes & Paoli, 1996).

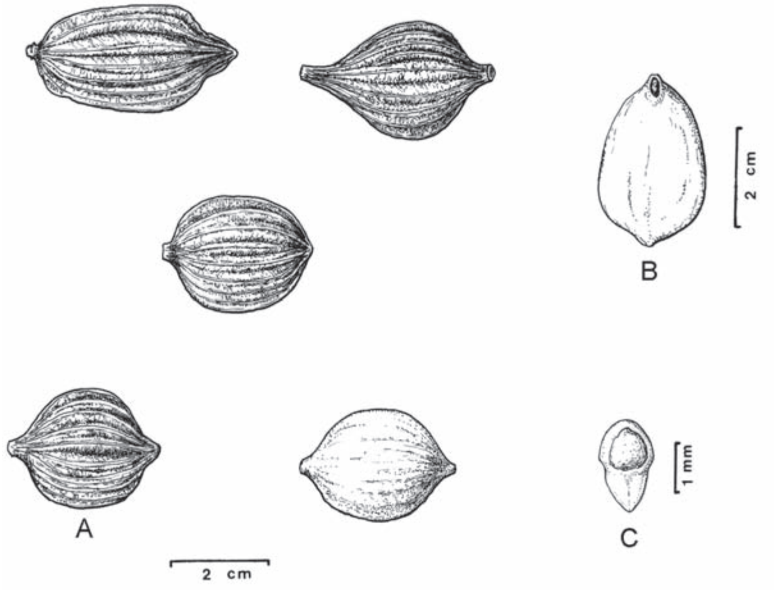

Fig. 12. *Cryptocarya mandioccana* Meissner. A. Morphological variation of diaspores (pericarp and seed); B. Embryo with one of the cotyledons detached; C. Radicle-hypocotyl axis (from Moraes, 1993, and Moraes & Paoli, 1996).

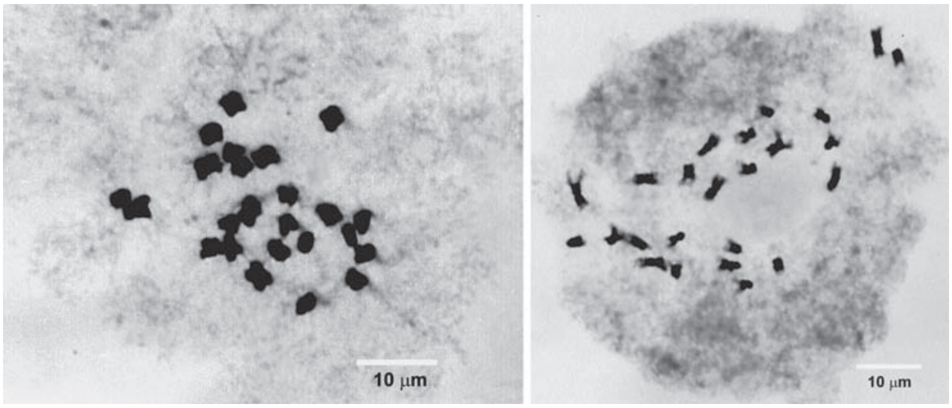

Fig. 13. Photomicrographs of somatic chromosomes of *Cryptocarya mandioccana* Meissner ($2n = 24$). (Photomicrographs by J.R. Gardingo & author).

5. Palynology

The pollen grains of species of *Cryptocarya* have been described as inaperturate, spheroidal, with a characteristic pollen wall, that has an "extreme thinness of exine and a massive nature of the intine" (Veloso & Barth, 1962; Raj & van der Werff, 1988). However, in southern African *Cryptocarya* species, the pollen grains are strongly flattened, peroblate/oblate (van der Merwe *et al*., 1988, 1990). The exine surface of a pollen grain can be either more or less smooth or variously verrucate (wrinkled).

Examples of descriptions of pollen grains can be found in Veloso & Barth (1962), Raj & van der Werff (1988) or (Rohwer, 1993a).

It is interesting to note that palynological studies can provide important windows for understanding the evolutionary history of the taxon. For instance, Raj & van der Werff (1988) put forward the hypothesis that, *Cryptocarya* is isolated from other neotropical genera, because its pollen grains are quite different, as they seem to be devoid of spinules and spinuloid excrescences in the exine surface. However, Rohwer (1993a) reported that the exine sculpture in some species of *Cryptocarya* presents a pattern densely covered with minute spinules. This variability registered from the palynological record made Rohwer (1993a) suspect that the genus may not be a natural group.

Figure 14 shows some SEM micrographs of flower pieces of herbarium specimens. Pollen grains of some of the species are shown.

However, it must be noted that, according to Drinnan *et al*. (1990) and Herendeen *et al*. (1994), the palynological record of the Lauraceae is very poorly documented because their pollen grains have thin exine with little sporopollelin in the mature pollen wall and consequently are seldom preserved (see also Kubitzki, 1981; Hesse & Kubitzki, 1983). For Eklund & Kvaček (1998), this might explain why the family is completely absent in Early Cretaceous palynofloras.

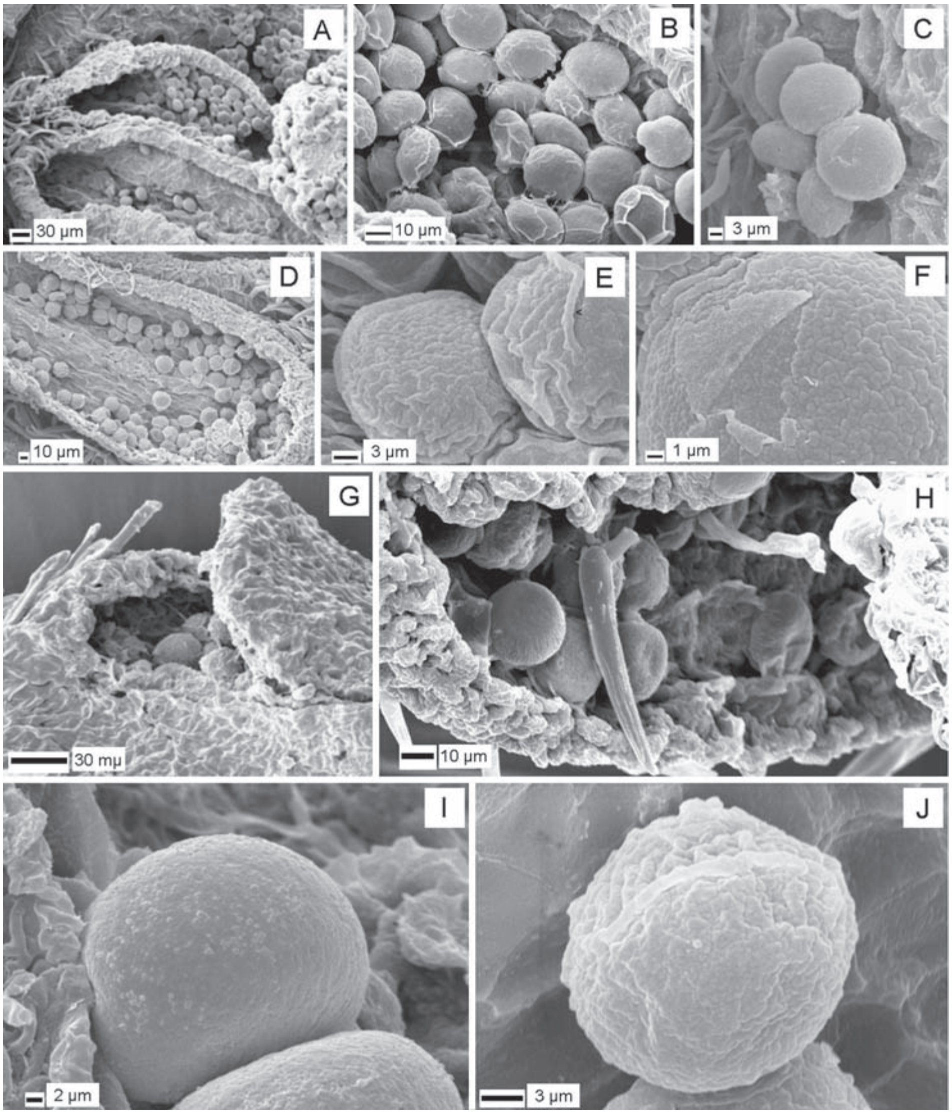

Fig. 14 SEM micrographs of pollen grains. *Cryptocarya aschersoniana* Mez: A-B. *Klein 3960* (HBR); C, F. *Smith & Reitz 13266* (HBR); D-E. *Barbosa & Abe 397* (MBM). *Cryptocarya guianensis* Meissner: G. *Pires & Silva 1388* (Herbário Jari). *Cryptocarya mandioccana* Meissner: H. *Santos* 2811 (CEPEC); I. *Hatschbach 5175* (MBM). *Cryptocarya moschata* Nees & Martius: J. *Hoehne s.n*. (HB-53855).
(Ridges – < – are due to shrivelled exine surface when dry).
(Photomicrographs by author).

6. Distribution

According to Chanderbali *et al*. (2001), species of Cryptocaryeae are predominantly southern hemispheric, with a distribution that indicates a Gondwanan history. *Beilschmiedia* and *Cryptocarya* are the most widespread genera of Lauraceae. From molecular data, the genetic distance-based age estimations have shown that these genera diverged from their most recent common ancestor about 90 ± 20 million years ago, indicating also a direct migration throughout Gondwana, and a widespread pre-drift distribution for both genera. *Cryptocarya* is present in South America, South Africa, Madagascar, Asia, Australia and Oceania (van der Werff, 1992). Although species relationships have not been investigated yet, Kostermans (1938b) indicated a possible connection between the African species *C. angustifolia* E. Meyer and the Chilean *C. alba*, since their fruits are strongly alike.

In the Neotropics, *Cryptocarya* ranges from Costa Rica to south Brazil, northeast Argentina, Uruguay and central Chile, with species registered for Andean Venezuela, Guyana, Surinam, French Guiana, Brazilian Amazon, Bolivia, Peru, and Ecuador (Fig. 15). Southeastern Brazil is the main centre of diversity of Neotropical *Cryptocarya*, with 12 species, nine of them endemic to this region. Except for the Chilean endemic, *Cryptocarya alba*, which occurs in semiarid vegetation (Mediterranean-type vegetation-sclerophyllous shrublands and woodlands), the other species occur in moist forest habitats from elevations of around sea level to 2000 m at Andean Upper Montane Forest in Cajamarca, Jaén, Peru. However, according to Armesto & Martinez (1978) and Celis-Diez & Bustamante (2005), *C. alba* inhabits south-facing slopes and humid ravines supporting the inference of a topographic moisture gradient, with the south-facing slope representing the mesic end and the north-facing slope the xeric end.

Cryptocarya is present in three out of the four biomes of the Brazilian flora. It is present in the Amazon Forest, the Atlantic Forest (“Mata Atlântica” *sensu lato*), and the Savanna (which comprises the “Cerrado” *sensu lato* and also the Brazilian swampland – the “Pantanal”), and absent from the Steppe (which comprises both the Semiarid northeast – “Caatinga” and the southern grasslands – “Campos Sulinos” or “Pampas”). The absence of *Cryptocarya* species from the Caatinga indicates that low water availability restricts their spreading (*C. alba* being an exception).

The sparse and scattered distribution of *C. guianensis* in the Amazon Basin and the relatively low distribution of species from West-central states can be explained as a collecting artefact. The presence of *C. guianensis* in the south of Bahia is an example of an Amazonic species that has invaded the Atlantic forest. According to Joly *et al.* (1991), the occurrence of some typical Amazonic species in the Atlantic forest in the south of the state of Bahia and north of Espírito Santo, on one hand, and the presence of species typical to the Paraná and Uruguay river basins in the Atlantic forest of Santa Catarina, Paraná and the south of São Paulo state, on the other hand, suggests that the Atlantic rain forest has gone through a process of expansion and retraction mainly as a consequence of climatic variations (see also Joly *et al*., 1999). The deposition of the Formação

Fig. 15. Distribution of Neotropical *Cryptocarya*, excepting for *C. alba* from Chile.

Barreiras (Berier Formation), during the Tertiary Period, allowed the expansion of the Amazonic formations into the Atlantic forest. The existence of Hiléia Bahiana as far south as the region of Colatina, Espírito Santo, shows that the periods of high humidity that occurred at the end of the Tertiary or beginning of the Quaternary Period had a strong influence on the floristic composition of the coastal formations. According to Behling *et al.* (2000), only the cold and very wet climatic conditions with short annual dry seasons characteristic of the late glacial period allowed an expansion of mountain forests, floodplain forest and gallery forests along NE Brazilian rivers. Floristic exchanges between the Atlantic and Amazon rain forest were possible during the Late glacial period. De Oliveira (2005) reported that from the transition Pleistocene/Holocene up to c. 10540 years B.P. the climate of the Caatinga region in northeastern Brazil was humid and relatively colder than is currently the case. This favoured the establishment of an exuberant tropical forest that has a large floristic affinity with Amazonian and Atlantic coast rain forests.

Pollen spectra of this period represent the first botanical evidence of the forest corridor between the Amazon and the Atlantic rain forest, which could explain the great floristic similarity between both biomes. A gradual drying of landscape eliminated such vegetation up to c. 6790 years B.P. The establishment of the modern Caatinga vegetation has been dated at 4535 years B.P. from the fossil sand dunefields of Bahia (De Oliveira *et al*., 1999). The register from the marine core GeoB 3104-1 (Behling *et al*., 2000) also indicated that between 15500 and 11800 year B.P. there was an impressive increase in rainfall, making it the wettest recorded period for NE Brazil. The palaeoenvironmental observations made by Behling *et al.* (2000) support the biogeographical hypothesis of a connection between the Amazonian and Atlantic rainforests, by migration routes in Late Pleistocene when wetter and colder climate conditions persisted. This is also supported by botanical data (Ducke & Black, 1954; De Andrade-Lima, 1966), the palynological record and paleontological data (Cartelle & Hartwig, 1996; Hartwig & Cartelle, 1996; De Oliveira *et al*., 1999).

For the southern and south-eastern states which have been relatively well-sampled, some species have a narrow or scattered distribution and/or may be rare. The latter is the case for *C. citriformis*, *C. micrantha*, *C. riedeliana*, *C. sellowiana*, *C. velloziana*, and *C. wiedensis* for which the known populations are composed of only few individuals. On the other hand, *C. botelhensis* is known from only a few localities, but its populations have relatively many individuals in protected areas. The presence of *Cryptocarya moschata* in the Savanna domain is due to a contact with the riparian forests or due to contact with semi-deciduous forests, the latter representing its predominant habitat.

In the vegetation of southern Brazil, *Cryptocarya aschersoniana* is a preferential species of the Ombrophilous Mixed Forest (“Araucária Pine Forest”, “Mata-de-araucária”, “Pinhal”, or “Pinheiral”; Klein, 1975), *i.e*. it is more or less abundant in various forest formations, but it predominates or reaches better vitality in *Araucaria* forests. According to Reitz *et al*. (1983, 1988), in Rio Grande do Sul, the distribution of *C. aschersoniana* is almost restricted to areas of the East plateau and North of the state, where the “araucária” is present. The species has not been found in forests of the Upper Uruguay River and from the Central Depression region, where it is very rare or completely absent. In “Pinhais” of Santa Catarina, it behaves as a hygrophytic selective species, preferring foothills, river banks, as well as the well-drained soils, where it can become one of the most frequent species of the forest’s upper layer. It has a wide geographic distribution in the plateau of Santa Catarina, occurring under high abundance, always in moist or slightly undulated soils of the Araucária Formation region. It is also fairly frequent in the Atlantic pluvial forest, especially in deep valleys, lower slopes, and in floodplains along rivers (Klein, 1974, 1975; Reitz *et al*., 1978).

7. Intergeneric relationships

Intergeneric relationships within Lauraceae remain poorly understood, despite the recognised economical and ecological importance of many of its species (van der Werff, 1991).

Poor generic concepts are a central problem, allied to the variability of species that are difficult to recognise and that are usually poorly represented in herbaria (Hammel, 1986; Burger, 1988; Burger & van der Werff, 1990). Confusion at generic level is partially due to conflicting evidence from characters of fruits, flowers and wood anatomy (van der Werff & Richter, 1985).

Neotropical species of *Cryptocarya* and *Beilschmiedia* share morphological similarities except for the length of the pistils (long or short), depth of the receptacles (deep or shallow), and enclosure of the fruits (enclosed by floral tube or without cupules) (Nishida, 1999).

According to Rohwer (2000), essentially the same limited set of characters (listed by Kostermans, 1957a) has been used in nearly all classification systems proposed (Nees von Esenbeck, 1836; Meissner, 1864; Bentham, 1880; Mez, 1889; Pax, 1889; Kostermans, 1957a; Hutchinson, 1964; Rohwer, 1993a), but the resulting classification has depended on the author’s opinion on the reliability and inferred taxonomic importance of these characters. Bentham (1880), Mez (1889) and Hutchinson (1964) considered the presence vs. absence of an involucre around several flowers as an important phylogenetic character (Rohwer, 1993b). Rohwer (1993a) followed the latter line of reasoning and recognised only two tribes, Laureae with an involucre, and Perseeae (including *Cryptocarya*) without an involucre. On the other hand, Kostermans (1957a) placed more emphasis on the development of the flower tube in fruit, *i.e*. whether the fruit is (nearly) free on the pedicel at the base surrounded by a cupule, or completely enclosed in receptacular tissue. According to Rohwer (1993b), who does not deny the importance of development of the flower tube in fruit, it often conflicts with flower structure and/or wood anatomy (Richter, 1981). Van der Werff & Richter (1996) reviewed the classifications proposed for the Lauraceae and concluded that androecial characters such as the number of sporangia were not useful in a generic classification of the family. They proposed a classification based on inflorescence structure as well as on wood and bark anatomy.

From the most recent phylogenetic investigation of the Lauraceae (Rohwer & Rudolph, 2005), the tribe Cryptocaryeae showed to be clearly monophyletic. The authors also pointed out that “the genus *Beilschmiedia* is clearly paraphyletic in its current circumscription, with respect to *Endiandra* and *Potameia*”. Still, “the genera *Brassiodendron* and *Triadodaphne*, which both were included in *Endiandra* (the former by Kostermans, 1957a, and Hyland, 1989, the latter by Rohwer, 1993a) can safely be placed in *Beilschmiedia* s.l., although they have not been studied with molecular markers yet”. Last but not least, “the rare South African *Dahlgrenodendron* and the possibly extinct Malaysian *Hexapora* most likely also belong to the *Cryptocarya* group”.

8. Infrageneric relationships

The tentative grouping of the Brazilian species of *Cryptocarya* as proposed here is based on overall gross morphological similarity. The groups are heterogeneous and have not been defined by single characters. Thus, they neither necessarily represent monophyletic groups, nor intend to reconstruct phylogeny. The reason for this approach is due to the fact that Brazilian *Cryptocarya* species usually share quite similar flowers and fruits and thus make it difficult to discuss their relationships based solely on reproductive characters. Additionally, there is no single character that shows a clear-cut discrimination of possible groups.

Similarly to what has been stated by Rohwer (1993b) in his treatment of *Nectandra*, the circumscription of *Cryptocarya* species faces a considerable morphological variability, with the occurrence of intermediate forms between some species, which makes the identification of taxa to species level a difficult task, especially from herbarium specimens. This scenario of overlapping ranges of morphological variation can be notably apprehended from the circumscriptions proposed by Nees von Esenbeck (1833a, 1836), Meissner (1864, 1866), Mez (1889), Kostermans (1937, 1938a), and Vattimo-Gil (1966b), which denote many incongruities and disagreements.

In the present revision of *Cryptocarya*, minor leaf venation pattern, presence of papillae and pubescence type on lower leaf surface, pubescence of floral parts, and morphology of elements of androecial whorls as well as persistence of tepals in fruit, are some of the characters used for taxonomic segregation of taxa. Regardless of the fact that floral characters have been inadequately used for diagnostic (identification) or discriminatory (classification) purposes, within the specific context of Lauraceae (as discussed by van der Werff & Richter, 1996), Moraes *et al.* (2001) accepted the proposed synomyms of *Cryptocarya schwackeana, C. hypoleuca*, and *C. longistyla* under *C. micrantha, C. minima,* and *C. saligna*, respectively, after studying in detail their flowers through SEM micrographs. Flower characters used here for characterization of species showed to be a helpful tool for their discrimination as well. Similar to the systematic revision of Neotropical species of *Cinnamomum* (Lorea-Hernández, 1996, 1997), here the assumption of independent genetic control for these characters was made, expecting that morphological entities corresponded to biological species. Likewise, all the specimens coming from different populations, but with similar set of characters, were linked to the same species.

The only species that cannot yet be placed in any group is *Cryptocarya velloziana*, in part because it is still known only from few fruiting collections. Although it shares several features with species of the *Cryptocarya moschata* group: its strikingly different leaves (and also the outer bark) that are rigid-coriaceous, relatively large, thick, tip broadly acute to rounded, base obtuse, prominulously and laxly reticulate on both surfaces are more characteristic for Brazilian *Beilschmiedia rigida* (Mez) Kosterm. and *B. linharensis* Sa. Nishida & van der Werff. Therefore, its possible affinity to other species deserves special attention and additional studies.

Contrary to Hyland (1989) working on Australian species of *Cryptocarya*, no clear groups could be discerned in the Brazilian species that have gross morphological resemblance. One of the subdivisions employed by Hyland (1989) was done on the basis of the presence or absence of ruminate cotyledons, from which the former showed to be associated with foetid flowers. As pointed out before, according to Mez (1889) *C. citriformis* is the only Brazilian species so far reported to have fruits with septa intruding into the cotyledons but its flowers are otherwise faintly scented. Allied to this, the species would be also considered isolated from the others by its unusual large fruits (up to 11.0 x 6.27 cm), only paralleled in size by those of *Anaueria brasiliensis* Kosterm., *Beilschmiedia angustifolia* Kosterm., *B. emarginata*, *B. linharensis*, and *B. rigida*, for instance. However, in spite of these differences, *C. citriformis* is seemingly related to *C. saligna* based on their overall similarity of leaves, flowers, outer barks, and partially overlapping geographical distributions. Both species have the same distinctive pattern of flowers with the tube slender, anthers of outer whorls broad-ovate with locelli suborbicular, glands sessile to short-pedicelled, staminodes with stalks inconspicuous, and gynoecium exserted at anthesis (nearly always the androecium too). Likewise, the leaves of several collections can also be easily confused, not only due to their alikeness in shape and size, but also because they are often glaucous on the lower surface and may be clothed in similar indument. From the reasons given above and from isozyme evidence, I consider both species as pertaining to the *C. citriformis* group.

In contrast to the previous group, representatives of the *Cryptocarya mandioccana* group (*C. mandioccana*, *C. sellowiana* and *C. wiedensis*) are typical members of the Atlantic rain forest, sharing similar floral features, *e.g.* infundibular shape, anthers of outer stamens ovate with protruding connectives located mostly above locelli, and constant hairy surface of branchlets, leaves (lower surface, also papillate), petioles, inflorescences and flowers. If this combination of characteristics proves to be really constant within populations of *C. sellowiana* and *C. wiedensis*, which are up to the present only known from very few collections, the relationship proposed would be truly ascertainable. However, as discussed under the treatment of *C. wiedensis*, this species seems to be also linked to the *Cryptocarya moschata* group. For the Brazilian species, the presence of hairs on the surface of vegetative organs, mainly on leaves and branchlets, may be the ancestral condition since the majority of the neotropical species is glabrous and glabrescent forms are frequently found within their populations, which would represent a reversal to the plesiomorphous character (the opposite has not been observed so far).

The *Cryptocarya moschata* group (*C. aschersoniana*, *C. botelhensis*, *C. guianensis*, *C. micrantha*, *C. moschata*, *C. riedeliana*, *C. subcorymbosa*) differs from the *C. mandioccana* group by the absence (or nearly so) of indument on branchlets, petioles, and leaves (lower surface), which is a common feature to all members of the former group. How coherent and reliable a group is, based mainly on those features is legitimately questionable. However, except for *C. botelhensis* and *C. micrantha* which share contrasting foliar affinities in the shape and venation pattern to the other members of this group, the remaining species look quite similar in overall appearance, but may show several diagnostic and/or non-diagnostic characteristics that would allow their recognition. Nevertheless, *C. moschata* is the catch-all species of its group, bordering morphologically on most other species within the group and also sharing characters with *C. mandioccana*.

Another synthetic character used by Hyland (1989) for grouping the Australian *Cryptocarya* was the presence of longitudinal ribs on the pericarp of fruits, a character that allowed him to group three species, viz. *C. laevigata*, *C. meisneriana* Frodin (≡ *C. meisnerana* Frodin), and *C. pleurosperma*. This character could not be used for the Brazilian species because it proved non-constant within taxa. Nevertheless, it would be really important to evaluate how effective this character could be to diagnose the genus as a whole, comparing species with fruits conspicuously ribbed from Madagascar (*e.g. C. caryoptera* Kosterm.), Asia (*e.g. C. chingii*), Oceania, and America, but also contrasting other characters and/or evidences.

On the basis of isoenzyme data (P.L.R. de Moraes, ined.; Moraes, 2005c), we demonstrated that the discriminant analysis can be used for efficient marker-based allocation of individual trees into pre-defined groups of species of *Cryptocarya*, complementing information obtained from a classical taxonomic study. Since the gold standard for any taxonomic system is its ability to deliver accurate species identifications, the classification criteria generated by the discriminant approach were satisfactorily concurrent, supporting greatly the provenances of individuals and the taxonomic interpretations predicated on morphology. Additionally, the unsupervised classification through the cluster analysis revealed that *Cryptocarya mandioccana* and *C. moschata*, as well as *C. citriformis* and *C. saligna*, are closely related species, corroborating morphological evidence and the former indication by Moraes *et al*. (2002). *Cryptocarya botelhensis* and the two populations ascribed to *C. aschersoniana* have shown that at least genetically they are rather divergent from the formers. However, to infer the phylogenetic relationships within *Cryptocarya*, true cladistical methods should be used, based on relevant and practicable outgroups. Also, DNA sequencing would provide more accurate estimations of genetic divergences among neotropical species of *Cryptocarya*, however such data are presently lacking.

The systematic treatment of the different Brazilian *Cryptocarya* species as described below, only deals with morphology.

9. Systematic treatment

9.1. Generic description

***Cryptocarya* Robert Brown,** *Prodr*. 402 (1810), *nom. cons*.. Nees, *Syst. laur*. 205 (1836). Gay, *Fl. Chil*. 5: 299. 1851-52 (1849) (misspelled *Cryptocaria*). Meissner, in *Prodr*. (DC.) 15(1): 68 (1864). Mez, *Jahrb. Königl. Bot. Gart. Berlin* 5: 7 (1889). For further bibliography see Kostermans (1964). – Type: *C. glaucescens* R. Br. (lectotype designated by Kostermans, *Not. Syst*. 8: 112 (1939b)). – Lectoype (designated by Frodin, 1976): "East Coast"? Hawkesbury River, *R. Brown s.n.* (BM).

= *Agathophyllum* Jussieu, *Gen. pl.* 431 (1789) – Type: *A. aromaticum* (Sonnerat) Willdenow, *Spec. Pl*. 2(2): 842. 1799.
= *Caryodaphne* Blume ex Nees, *Syst. laur.* 225 (1836). – Type: *C. laevigata* (Blume) Nees. *Cryptocarya laevigata* Blume, *Bijdr. fl. Ned. Ind.* 11: 556 (1826) (basionym). (lectotype *fide* Kostermans, *J. Sci. Res.* (Jakarta) 1(5): 122 (1952)).
= *Evodia* Gaertner, *Fruct. sem. pl.* 2(1): 100 (1790), non J.R. Forster & G. Forster, 1775, nom. illeg. – Type: *E. ravensara* Gaertner, *Fruct. sem. pl.* 2(1): 101 (1790).
= *Icosandra* Philippi, *Linnaea* 29: 39 (1857). – Type: *I. rufescens* Philippi, *Linnaea* 29: 40 (1857-1858).
= *Massoia* Beccari, in d'Albertis, *New Guinea* 2: 398 (1880). – Type: *M. aromatica* Becc. (basionym) ≡ *Cryptocarya aromatica* (Becc.) Kostermans, *Tectona* 39: 169 (1949).
= *Pseudocryptocarya* Teschner, *Bot. Jahrb. Syst*. 58: 411 (1923). – Type: *P. pauciflora* (Lauterbach & K. Schumann) Teschner. *Cryptocarya pauciflora* Lauterbach & K. Schumann, *Fl. Schutzgeb. Südsee* 333 (1901) (basionym). (= *C. laevigata* Blume, fide Kostermans, *Bull. Jard. Bot. Buitenzorg*, ser. 3, 18: 439 (1950); and Hyland (1989)).
= *Ravensara* Sonnerat, *Voy. Indes Orient.* 2: 226; (octavo ed.) 3: 248 (1782). – Type: *R. aromatica* Sonnerat, *Voy. Indes Orient.* 2: 226; (octavo ed.) 3: 248 (1782). (≡ *Cryptocarya agathophylla* van der Werff, *Adansonia* 30, 2008, in press)
= *Salgada* Blanco, *Fl. Filip.*, *ed. 2*, 221 (1845). – Type: *S. lauriflora* Blanco (basionym) ≡ *Cryptocarya lauriflora* (Blanco) Merrill, *Philipp. J. Sci.* 4(3): 254 (1909).

Etymology - From Greek *κρυπτος*, kriptos = hidden, and *καρυον*, karyon = nut; the fruit is covered by the accrescent flower tube.

Diagnosis - *Trees* or rarely shrubs, up to 35 m tall. *Branchlets* sericeous to villose or glabrous. *Leaves* alternate or sub-opposite, chartaceous to rigid-coriaceous, exstipulate, glabrous or pilose. *Inflorescences* paniculate and pseudoterminal, sometimes almost cymose and axillary. *Flowers* bisexual, small, trimerous, involucre missing; flower tube conspicuous, deep, enclosing the ovary and later the fruit, usually slender, urceolate, constricted below the tepals, abruptly enlarging into the perianth; tepals 3 + 3, symetric, usually equal in length; fertile stamens 9, in three whorls, outer 6 introrse + inner 3 extrorse, lateral or introrse; anthers usually large, 2-celled; connectives often strongly protruding beyond the cells; stamens of the third whorl with adnate glands (or somewhat distant from base), the latter often stalked; fourth whorl consisting of conspicuous, stipitate staminodes, usually cordate-ovate, acuminate, foliaceous; ovary superior, glabrous (in American species), immersed in the flower tube; stigma small or inconspicuous, rarely peltate. *Fruits* ellipsoid, pyriform or globose, entirely included in the enlarged flower tube, often leaving only a minute pore at apex, the latter sometimes crowned by the remnants of the tepals. *Seeds* with cotyledons large, flat-convex; plumule and radicle minute.

Comments - Extra Brazilian specimens collected in Costa Rica, Ecuador, Peru, Venezuela and Bolivia likely represent undescribed species. Some Central American species described under *Cryptocarya* proved to belong to other taxa (*e.g. Cryptocarya hintonii* C.K. Allen = *Prunus brachybotrya* Zucc.; *Cryptocarya kostermansiana* C.K. Allen = *Beilschmiedia costaricensis* (Mez & Pittier) C.K. Allen; *Cryptocarya zapoteoides* (Lundell) Miranda ≡ *Beilschmiedia zapoteoides* (Lundell) Kosterm.). The status of specimens from Ecuador and Peru, with resemblance to *Cryptocarya aschersoniana* Mez or *C. moschata* Nees & Martius (van der Werff & Smith, 1989), can only be ascertained once more voucher material, especially flowering material, is collected.

Eighteen of the voucher specimens of Brazilian *Cryptocarya*, deposited at the Herbarium Berolinense – viz. *Araujo in Herb. Schwacke 6680* (holotype of *C. schwackeana*), *Glaziou 14205* (syntype of *C. saligna*), *18436* (holotype of *C. subcorymbosa*), *18437* (holotype of *C. minutiflora*), *19801* (holotype of *C. longistyla*), *20443*, *Hoehne s.n.* ex SP-23796, *s.n.* ex SP-23802, *s.n.* ex SP-28200, *Mélinon 109* and *s.n.*, *Mendonça 184*, *Müller s.n.*, *Riedel s.n.* (isotype of *Aydendron floribundum*), *s.n.* (isotype of *C. mandioccana*), *s.n.* (isotype of *C. micrantha*), *Schwacke s.n.*, *Sellow s.n.* (*1375*) (syntype of *C. moschata*), *s.n.* (holotype of *C. aschersoniana*) – and listed by Mez (1889, 1892, 1893, 1902, 1907) and Kostermans (1937) were destroyed in World War II. In addition two specimens deposited at the *Museo Historiae Naturalis Vindobonensi* (formerly Museum Palatinum – Vienna Herbarium – W), viz. *Peckolt 166* and *166β* (syntypes of *C. hypoleuca*) – are lost to science.

9.2. Key to the Brazilian species of *Cryptocarya*

Except for *C. sellowiana* and *C. velloziana,* the following key is based on complete material because the study of flowers or fruits is necessary to determine the genus. Due to the variability of several species and the ambiguity of many characters, it became inevitable that some species appeared more than once in the key. In some rare cases, ambiguous collections are likely to key out of their species (see commentaries under species treatment).

1. Leaves relatively large (up to 24 cm long, 12 cm broad), broad-ovate, thick, rigid-coriaceous, tip broadly acute to rounded; petioles relatively large (up to 20.0 mm long), thick (up to 4.0 mm), flattish above .... **12. *C. velloziana***

1'. Leaves smaller (up to 22 cm long, 7 cm broad), narrow-elliptic to lanceolate or obovate, relatively thinner, chartaceous to coriaceous; tip acute to obtuse, rounded or acuminate; petioles mostly smaller (up to 18.0 mm long), seldom larger (up to 29.0 mm long, as in *C. riedeliana*), thinner (up to 3.3 mm), acanaliculate to slightly or deeply canaliculate above....................................... **2**

2. Lower surface of mature leaves manifestly pubescent.............................. **3**

2'. Lower surface of mature leaves glabrous or glabrescent.......................... **6**

3. Leaves sparsely pubescent on both surfaces, base obtuse....................... .... **13. *C. wiedensis***

3'. Leaves glabrous to glabrescent on upper surface, base acute to cuneate **4**

4. Midrib on upper surface of mature leaves prominulous, leaves with long, ± erect straight hairs on lower surface; petioles deeply canaliculate, glabrescent to sparse pubescent, with long, ± appressed and ± ascending hairs.................. .... **10.** ***C. sellowiana***

4'. Midrib on upper surface of mature leaves impressed or flattish; leaves with short to long, straight to curled, appressed to ascending or erect hairs on lower surface; petioles slightly to deeply canaliculate, glabrescent to densely tomentellous, with short and/or long, ± appressed and/or ± ascending hairs.... **5**

5. Flowers densely rusty-tomentellous, tube slender, stamens and gynoecium exserted, glands (sub)sessile, staminodes stipiform, stalks inconspicuous......... .... **3.** ***C. citriformis***

5'. Flowers minutely yellowish-tomentose, tube stout, stamens and gynoecium included, glands long-pedicelled, staminodes sagittate, stalks conspicuous....... .... **5.** ***C. mandioccana***

6. Inflorescences and/or flowers glabrous to glabrescent.............................. **7**

6'. Inflorescences and/or flowers manifestly pubescent **10**

7. Stamens and/or gynoecium exserted.................................. **9.** ***C. saligna***

7'. Stamens and gynoecium included **8**

8. Leaves chartaceous, mostly narrow-elliptic to elliptical (0.9-2.9 cm broad), tip mostly long acuminate (acumen up to 1.6 cm), base acute, revolute, with papillae inconspicuous on lower surface; flowers with glands long-pedicelled, adnate to the filaments; staminodes clearly with two small elliptical protuberances at the base in lateral/abaxial side, stalks conspicuous..........**2.** ***C. botelhensis***

8'. Leaves chartaceous to coriaceous (rigid-coriaceous in some collections), narrow-elliptic to ovate or obovate (0.4-7.0 cm broad), tip acute to acuminate or obtuse to rounded, base acute to attenuate or obtuse, slightly revolute, without or with papillae conspicuous or inconspicuous on lower surface; flowers with glands short to long-pedicelled, somewhat adnate to or distant from the filaments; staminodes without conspicuous protuberances at the base in lateral/abaxial side, stalks conspicuous **9**

9. Leaves epapillate or with papillae inconspicuous on lower surface, midrib on upper leaf surface prominulous, impressed to level towards the base, prominulous to prominent on lower surface; flowers with stamens of whorl III with anthers narrow-ovate to ovate, glabrous, 0.67-1.24 mm long, 0.22-0.56 mm broad, filaments rather slender, equal or longer than anthers; glands globose to subglobose, pedicels short to long, somewhat adnate to the filaments; or, flesh portion of mature fruits originated from the accrescent flower tube usually thin (up to 5 mm)... **1.** ***C. aschersoniana***

9'. Leaves with papillae conspicuous on lower surface, midrib on upper surface impressed to level to prominulous, prominent on lower surface; flowers with stamens of whorl III with anthers narrow-ovate, ciliate, 0.63-0.86 mm long, 0.26-0.37 mm broad, filaments rather stout, equal or shorter than anthers; glands subglobose, sagittate, pedicels long, rather distant from the filaments; or, flesh portion of mature fruits originated from the accrescent flower tube usually thick ....**7. *C. moschata***

10. Stamens and/or gynoecium exserted..................................**9. *C. saligna***

10'. Stamens and gynoecium included **11**

11. Mature leaves glabrous on both surfaces...**12**

11'. Mature leaves glabrous on upper surface, glabrescent on lower surface **18**

12. Mature leaves epapillate or with papillae inconspicuous on lower surface. **13**

12'. Mature leaves with papillae conspicuous on lower surface.....................**16**

13. Midrib on upper leaf surface prominulous...**14**

13'. Midrib on upper leaf surface impressed to level or slightly convex or prominulous towards the base..**15**

14. Leaves with tip obtuse to acuminate, base acute, tapering, slightly revolute at the base; midrib impressed to level towards the base on upper surface; flowers mostly glabrous, but also glabrescent in some collections; or, mature fruits with pericarp smooth to slightly ribbed ....**1. *C. aschersoniana***

14'. Leaves with tip acute to obtusely or broadly acuminate, or caudate and rarely retuse, base acute to obtuse, midrib not impressed to level towards the base on upper surface; flowers densely yellowish-tomentellous, with ± long, ± ascending hairs; or, mature fruits with pericarp manifestly ribbed................... .... **6. *C. micrantha***

15. Petioles 4.5-10.2 mm long, 1.0-2.5 mm thick, slightly to deeply canaliculate above, occasionally flattened; flowers with stamens of whorls I, II, and III with anthers glabrous..**4. *C. guianensis***

15'. Petioles 12.0-29.0 mm long, 1.0-3.3 mm thick, slightly to canaliculate or acanaliculate to flattish above; flowers with stamens of whorls I, II, and III with anthers sparse pilose or ciliate ....**8. *C. riedeliana***

16. Flowers with glands long-pedicelled, distant from the filaments, staminodes conspicuously pedicelled; or, mature fruits with pericarp slightly ribbed to smooth or with vestigial ribs...**17**

16’. Flowers with glands short pedicelled to sub-sessile, adnate to the filaments, staminodes nearly sessile; or, mature fruits with pericarp manifestly ribbed....... .... **6. *C. micrantha***

17. Midrib on upper leaf surface impressed to level to prominulous, prominent on lower surface; venation pattern camptodromous-brochidodromous; flowers with tepals subequal, tube urceolate, relatively long, stamens of whorls I and II with anthers sparse pilose or ciliate; or, mature fruits with flesh portion originated from the accrescent flower tube usually thick, without remnant of tepals........... ....**7. *C. moschata***

17’. Midrib on upper leaf surface prominulous, impressed to level towards the base, prominulous on lower surface; venation pattern brochidodromous; flowers with tepals equal, tube cylindrical-urceolate, relatively short, stamens of whorls I and II with anthers glabrous; or, mature fruits with flesh portion originated from the accrescent flower tube usually thin, often with remnant of tepals .... **11. *C. subcorymbosa***

18. Leaves coriaceous to rigid-coriaceous, petioles long and stout, 12.0-29.0 mm long, 1.0-3.3 mm thick; or, mature fruits ellipsoid, 1.9-3.9 cm long, 1.3-2.5 cm broad, with pericarp many-ribbed ....**8. *C. riedeliana***

18’. Leaves chartaceous to coriaceous (rigid-coriaceous in some collections), petioles shorter and thinner, 3.7-17.7 mm long, 0.7-2.0 mm thick; or, mature fruits ellipsoid to globose, or obovate, or top-shaped, 1.2-3.5 cm long, 1.0-2.8 cm broad, with pericarp smooth to slightly ribbed or with vestigial ribs; if pericarp many-ribbed, then pear-shaped with a neck at base, or ellipsoid to globose, 1.4-4.0 cm long, 0.9-3.0 cm broad...**19**

19. Flowers densely tomentellous, with ± long, ± ascending hairs completely covering the surface; or, mature fruits with pericarp manifestly ribbed, pear-shaped with a neck at base, or ellipsoid to globose .... **6. *C. micrantha***

19’. Flowers glabrous or glabrescent or sparsely to densely pubescent, with ± short or ± long, ± appressed hairs, not covering the surface completely; or, fruits with pericarp smooth to slightly ribbed or with vestigial ribs, ellipsoid to globose, or obovate, or top-shaped...**20**

20. Flowers densely tomentellous towards the base, with ± long, ± appressed hairs; or, mature fruits globose to top-shaped, relatively small, 1.4-1.9 cm long, 1.3-1.9 cm broad, pericarp smooth or with vestigial ribs, often with remnant of tepals.. **11. *C. subcorymbosa***

20’. Flowers glabrous or glabrescent or sparsely to densely pubescent, with ± short, ± appressed hairs; or, fruits ellipsoid to globose, or obovate, 1.2-3.2 cm long, 1.0-2.8 cm broad, pericarp smooth to slightly ribbed or with vestigial ribs, without remnant of tepals...**21**

21. Leaves epapillate or with papillae inconspicuous on lower surface, midrib prominulous on upper surface, impressed to level towards the base, prominulous to prominent on lower surface; flowers with stamens of whorl III with anthers narrow-ovate to ovate, glabrous, 0.67-1.24 mm long, 0.22-0.56 mm broad, filaments rather slender, equal or longer than anthers; glands globose to subglobose, pedicels short to long, somewhat adnate to the filaments; or, flesh portion of mature fruits originated from the accrescent flower tube usually thin (up to 5 mm).. **1. *C. aschersoniana***

21'. Leaves with papillae conspicuous on lower surface, midrib on upper surface impressed to level to prominulous, prominent on lower surface; flowers with stamens of whorl III with anthers narrow-ovate, ciliate, 0.63-0.86 mm long, 0.26-0.37 mm broad, filaments rather stout, equal or shorter than anthers; glands subglobose, sagittate, pedicels long, rather distant from the filaments; or, flesh portion of mature fruits originated from the accrescent flower tube usually thick ....**7. *C. moschata***

9.3. Species descriptions (in alphabetical order)

1. *Cryptocarya aschersoniana* Mez

Jahrb. Königl. Bot. Gart. Berlin 5: 11 (1889). – Lectotype (designated by Moraes, 2005a): Brazil. "Hab. in Brasilia, loco non indicato", s.d. (fl.), *F. Sellow s.n.* (F-646890! – Photo F Neg. No. 3842! and fragments! from B†; photo in UEC!). Plate I A (cf. Appendix 13.5); epitype (designated by Moraes, 2005a): Brazil. Santa Catarina, Ilha de Santa Catarina, Saco Grande, selva 200-400 m, 20 Dec. 1967 (fl.), *A. Lourteig 2329* (HB!; isoepitypes: P-00571417 – photo in UEC!, K!). Plate I B (cf. Appendix 13.5).

Illustrations - Vattimo-Gil (1966b, Fig. 29-37, flower pieces; 55, leaf; 61, 64-65, fruits), Reitz *et al*. (1988, p. 241, Fig. 50, habit, flowers and fruits), Tressens (1997, Fig. 1, habit, flower pieces and fruits), Moraes (2003, p. 166, pr. 3H, fruit).

Vernacular names - Armecica, canela-amarela, canela-areia, canela-batalha, canela-branca, canela-cinza, canela-de-porco, canela-durão, canela-fogo, canela-lageana, canela-nhotinga, canela-nhutinga, canela-pimenta, canela-pururuca, imbuia, nhutinga.

Description - *Trees* or small trees, (4-10-)20-30 m tall, trunk usually thick, knotted, often multistemmed, DBH 80-120 cm (Vattimo-Gil, 1979a; Reitz *et al*., 1983, 1988), bark chestnut-brown to brownish or rusty, smooth, flaky in old trees, relatively smooth to rugose in the young (Fig. 17 A-H). *Branches* cylindrical, thick, rusty-red to dark brownish, relatively smooth, with lenticels, breakable. *Branchlets* 5 cm below terminal bud c. 1.4-2.9 mm in diameter, rusty-red to light or dark brownish, initially angular from the beginning, terete towards the base, smooth to rugose, glabrous, somewhat shining; terminal buds minute, ovoid, subglabrous to pubescent, sparsely to densely covered by yellow-rusty or yellowish, short, ± appressed hairs. *Petioles* thin, 5.0-14.8(-15.0) mm long, 1.0-1.7 mm thick, deeply to slightly canaliculate to flattish above, roundish below, glabrous or glabrescent. *Leaves* (Fig. 18 A-F) alternate, narrow-elliptic-lanceolate to ovate or obovate, (1.3-)3.5-7.0(-14.5) cm long, (0.4-)1.1-3.7(-7.0) cm broad, chartaceous-coriaceous or coriaceous, rigid-coriaceous in some collections; young leaves glabrous above, glabrous to glabrescent below, adult leaves mostly glabrous on both surfaces or sometimes glabrescent below, tip obtuse to acuminate, base acute, tapering, slightly revolute at the base, margin flat, hardly recurved, sclerified; on both surfaces shining (less often opaque) and rather poorly reticulate or lax to densely and prominulously reticulate; beneath paler, epapillate or with papillae inconspicuous; midrib prominulous above, impressed to level towards the base, prominulous to prominent below, secondary veins patent to erect-patent (5-12 per side), arcuate, poorly reticulate to prominulous on both surfaces; tertiary venation inconspicuous to densely, prominulously reticulate below; venation pattern camptodromous-brochidodromous. *Inflorescences* (Fig. 16 A) axillary or subterminal, thyrso-paniculate, pyramidal, few or many-flowered, 0.6-1.5 mm in diam. at the base, (2.2-)2.7-9.0 cm long, either glabrescent to glabrous or sparse to densely pubescent, with ± short, ± appressed and ± ascending yellowish or yellow-rusty hairs (rusty-strigose), usually shorter than leaves; peduncles glabrescent to pubescent; bracts and bracteoles minute, tomentelous. *Flower buds* reddish. *Flowers* (Fig. 16 B-J; 19 A-G) cream, pale-green, green, greenish, green-yellowish or yellow-greenish, mostly glabrous, glabrescent in several collections, c. 2.3-4.0(-7.0) mm long, 1.6-3.4 mm in diam. at apex; tube urceolate to subcylindrical-urceolate, 1.1-2.5(-3.0) mm long, 0.8-1.7(-2.0) mm in diam.; pedicels mostly tomentose or glabrescent, 0.26-1.2 mm long; tepals subequal to equal, 1.5-2.7 mm long ($\bar{X}$ = 1.98 ± 0.30 mm; N = 35), 0.8-1.5 mm broad ($\bar{X}$ = 1.09 ± 0.17 mm; N = 31), concave, elliptical or ovate-elliptical, tip acute to obtuse, pilose to glabrescent within; stamens included; stamens of whorls I and II introrse, rather incurved, 0.9-1.9 mm long ($\bar{X}$ = 1.37 ± 0.30 mm; N = 21), anthers glabrous to sparse pilose or ciliate, ovate to ovate-oblong, 0.57-1.08 mm long ($\bar{X}$ = 0.79 ± 0.12 mm; N = 39), 0.3-0.6 mm broad ($\bar{X}$ = 0.49 ± 0.08 mm; N = 41), connectives prolonged beyond the large sporangia, tip obtuse, filaments densely pilose, as long or shorter than anthers, adnate to tepals; stamens of whorl III lateral to extrorse-lateral, erect, 0.99-1.91 mm long ($\bar{X}$ = 1.46 ± 0.24 mm; N = 23), anthers narrow-ovate to ovate, glabrous, 0.67-1.24 mm long ($\bar{X}$ = 0.85 ± 0.11 mm; N = 34), 0.22-0.56 mm broad ($\bar{X}$ = 0.39 ± 0.08 mm; N = 18), connectives obtuse to truncate, prolonged beyond the large sporangia, filaments rather slender, equal or longer than anthers, pilose; glands globose to subglobose, 0.34-0.68 mm long ($\bar{X}$ = 0.54 ± 0.09 mm; N = 35), 0.31-0.65(-1.0) mm broad ($\bar{X}$ = 0.46 ± 0.07 mm; N = 26), pedicel short to long, pilose, somewhat adnate to the filaments; staminodes relatively small, ovate-acute, 0.54-1.1 mm long ($\bar{X}$ = 0.77 ± 0.14 mm; N = 29), 0.27-0.77 mm broad ($\bar{X}$ = 0.43 ± 0.12 mm; N = 16), tip and abaxial side pilose, stalks conspicuous, mostly short, stout, pilose; gynoecium immersed in the tube, glabrous, 1.88-3.85 mm long ($\bar{X}$ = 2.57 ± 0.55 mm; N = 12), ovary ellipsoid, 0.64-1.41(-2.0) mm long ($\bar{X}$ = 0.95 ± 0.22 mm; N = 14), 0.29-0.84 mm in diam. ($\bar{X}$ = 0.52 ± 0.17 mm; N = 15), gradually merging into the about 0.98-2.53 mm long ($\bar{X}$ = 1.58 ± 0.38 mm; N = 16) cylindrical style with small, discoid stigma. *Immature fruits* (Fig. 18 C-D, 20 A-B), 1.16-2.5 cm long ($\bar{X}$ = 1.75 ± 0.26 cm; N = 265), 0.86-2.1 cm broad ($\bar{X}$ = 1.27 ± 0.17 cm; N = 265). *Mature fruits* (Fig. 9 F, L, M; 16 K; 20 C-D) yellow, light yellow, yellowish, yellow-greenish, cream, whitish, light green or dark green, ellipsoid to globose or obovate, smooth to slightly ribbed, 1.22-3.2 cm long ($\bar{X}$ = 1.94 ± 0.36 cm; N = 103), 1.02-2.53(-2.8) cm broad ($\bar{X}$ = 1.54 ± 0.34 cm; N = 103); flesh portion originated from the accrescent flower tube usually thin (up to 5 mm).

Phenology - Flowering material mostly from October to December, also in April to September. Immature fruits from October to March, predominantly from January to March. Mature fruits from February to December, mainly in February and March. Three collections with both flowers and immature fruits in October and November.

Distribution and habitat (Fig. 21) - In south and southeast Brazil, Argentina in Province of Misiones and one collection from Uruguay. Tressens (1997) registered the occurrence of the species in hygrophilous forest with *Araucaria* along the stream Gramado, tributary of River Urugua-í Grande, at 685 m altitude. According to Reitz *et al.* (1983, 1988), the species is almost restricted to areas of the east plateau and north of Rio Grande do Sul state, in the Ombrophilous Mixed Forest

(*Araucaria* Forest). According to Mauhs (2002), in Rio Grande do Sul the species is still found in relatively well-preserved remnant fragments of the Ombrophilous Mixed Forest, being absent in disturbed fragments like that studied by him in Vacaria. In the plateau of Santa Catarina, it has a wide and abundant distribution mostly in the region of *Araucaria* forests (Klein, 1974, 1975, 1979; Reitz *et al*., 1978). Klein (1979) pointed out that it is frequently found in the vegetation of old alluvious terraces along River Itajaí-mirim. In hygrophilous forests (swamp forest), the species is rare and only represented by juveniles. From 3-10 m altitude in Coastal Plain Forest, 50-1000 m altitude in slopes and top regions of the Ombrophilous Dense Forest, 300-1100(-1600) m altitude in the Ombrophilous Mixed Forest, c. 1100 m altitude in Semi-deciduous Forest, and in gallery forests.

Uses - The wood is used for the manufacturing of oars. According to Reitz *et al*. (1988), its wood has a moderate basic specific gravity (0.550-0.600 g/cm^3), heartwood whitish, slightly pinkish. It is used for manufacturing boxes and crates, mouldings, beams, wooden posts, boards, linings, laths, for carpentry, interior joinery, baseboards, etc.. Traditionally it was not heavily exploited as the presence of large amount of silica in its wood make it difficult to saw. However, in recent years, it is increasingly used for veneers and plates, what caused an intensive exploitation in the plateau of states of Paraná and Santa Catarina. Rolim & Chiarello (2004) reported that the species is used as a shade tree for cocoa in the state of Espírito Santo. Spencer *et al*. (1984), reported for the first time the antigermination activity of extracts of *C. aschersoniana* seeds against velvetleaf (*Abutilon theophrasti* Medic.), a troublesome competitor of corn and soybeans. At Serra do Japi, São Paulo, the flowers are used as nourishment by the butterfly *Protesilaus protesilaus nigricornis* (Staudinger, 1884) as well as various other species of moths.

Comments - Moraes (2003) followed the circumscription proposed by Kostermans (1937, 1938a) with *C. aschersoniana* encompassing only the specimens with glabrous leaves on the lower surface. In the present circumscription, this character is not used as the main criterion for delimiting the species.

Cryptocarya aschersoniana is here interpreted from the set of characters presented predominantly by populations of southern Brazil, which are in agreement with the pattern of the type collection (Moraes, 2005a). It can be recognised in most cases by its leaves that are usually coriaceous, often glabrous, shining on both surfaces, upper surface smooth, with midrib prominulous but impressed to level towards the base, lower surface epapillate or with papillae inconspicuous, allied with its flowers most nearly glabrous, and mature fruits with pericarp smooth to slightly ribbed, with the flesh portion originated from the accrescent flower tube usually thin. *Cryptocarya aschersoniana* seems to have a characteristic growth form, often with multistemmed trunk, with bark predominantly brownish to rusty and smooth. Additionally, it presents some phenological differences from *C. moschata*, and *C. riedeliana*, by flowering mainly from October to December and fruiting mainly in February to March.*Cryptocarya aschersoniana* shows continuous variation of the shape and the length of the mature leaves, which varies considerably from 1.3 cm to 14.5 cm.

For the state of São Paulo, the population of Parque Estadual Intervales, Sete Barras, is the only one that has been completely collected; the samples can be referred to *C. aschersoniana* without hesitation. Its flowering and fruiting material agree perfectly with several collections from Santa Catarina. Also, the overall appearance in the field, the bark and the multistemmed habit also fit well with *C. aschersoniana*. Collections of Serra do Japi and Parque Estadual de Campos do Jordão are composed of only immature flowers and fruits. Nevertheless, their nearly glabrous flower buds, relatively slow fruit development and field characteristics of the bark (rusty and smooth in Campos do Jordão, like the observed in population of Morro do Bau, SC) and growth habit (multistemmed in Serra do Japi) allowed me to identify the collection as *C. aschersoniana*, although their vegetative morphology is mostly similar to that of *C. moschata*. It should be noted that population of Serra do Japi occurs in a transition between the Ombrophilous Dense Forest and the Semi-deciduous Forest, and the population of Campos do Jordão in a remaining Ombrophilous Mixed Forest. Both populations merit more thorough examination so that more complete material can be gathered. Undoubtly this would lead to a better delimitation of *C. aschersoniana* and *C. moschata*.

The holotype of *Cryptocarya aschersoniana* was deposited in Berlin and unfortunately was destroyed during WW II. No isotypes are known, except for a poor fragment from F-646890 (therefore selected as lectotype), that contains one leaf, an inflorescence branch and one flower, kept together with the photo of the holotype, and with a drawing of the flower made by C. K. Allen in 1963. As pointed out in earlier work (Moraes, 2005a), these remnants of the type and its photo are not adequate to identify the species without ambiguity, thus justifying my decision to erect an epitype from a well-preserved specimen from southern Brazil, which is the principal region of distribution of *C. aschersoniana*. I chose the *Lourteig 2329* specimen at HB because it presents the typical form of the species and has duplicates in Kew and Paris.

Kostermans (1938a) considered the syntype of *Cryptocarya moschata* Nees & Martius, *Sellow s.n.* (*1375*), to be a specimen of *C. aschersoniana* Mez (see discussion with *C. moschata*). Obviously I do not share Kosterman's opinion, as I have elected Sellow's syntype as the lectotype of *C. moschata*.

Specimens examined - 239 (listed in appendix 13.3)

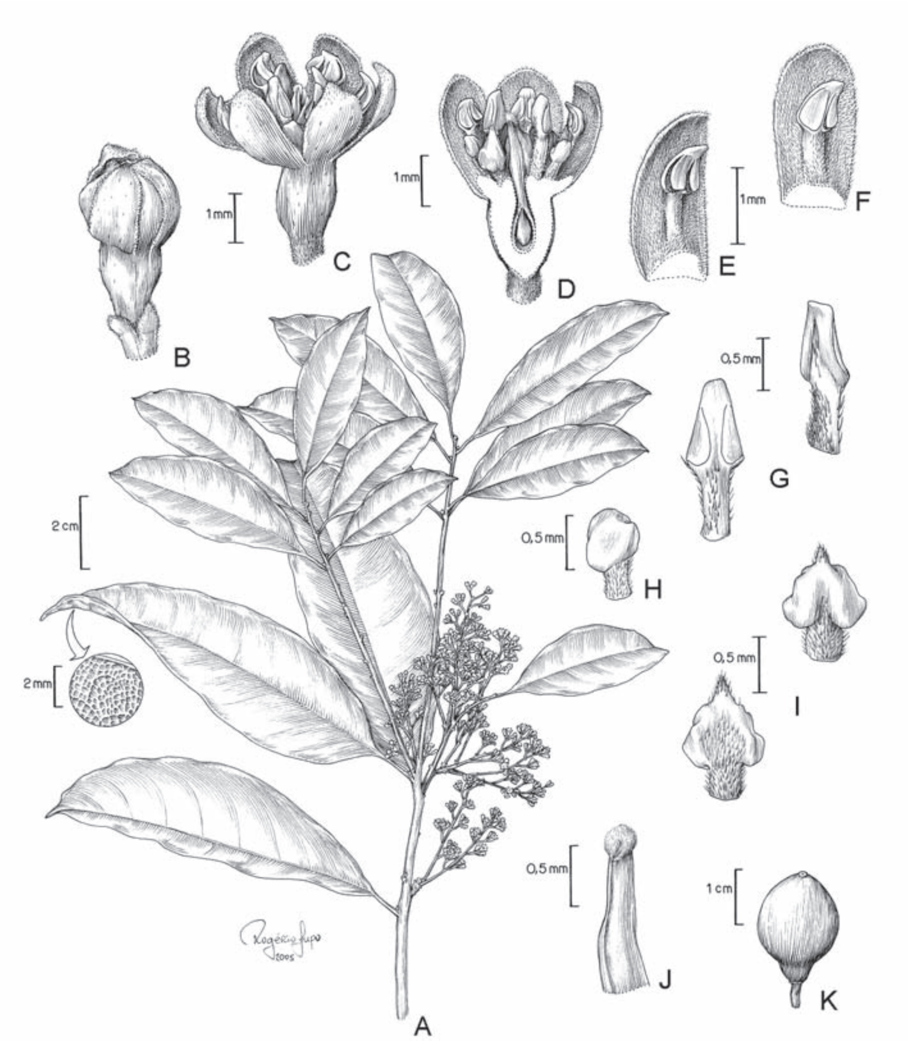

Fig. 16. *Cryptocarya aschersoniana* Mez (habitus and floral parts from *Moraes 2543*). A. Habitus; B. Flower bud; C-D. Flowers at anthesis; E. Stamen of androecial whorl I; F. Stamen of androecial whorl II; G. Stamens of androecial whorl III; H. Gland; I. Staminodes; J. Detail of style and stigma; K. Fruit (from *Moraes 2544*).

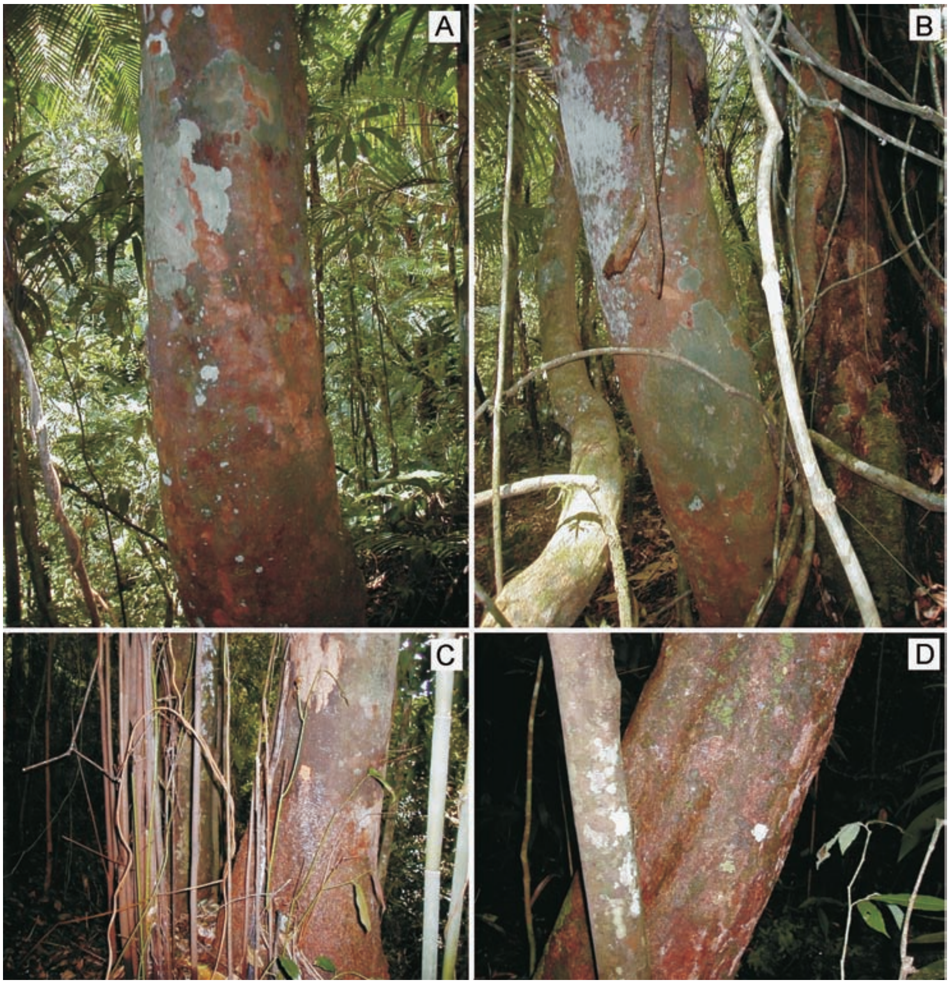

Fig. 17.1. Appearance of barks of *Cryptocarya aschersoniana* Mez. A-B. Morro do Baú, Ilhotas, SC; C-D. Bocaiúva do Sul, PR (Photographs by author).

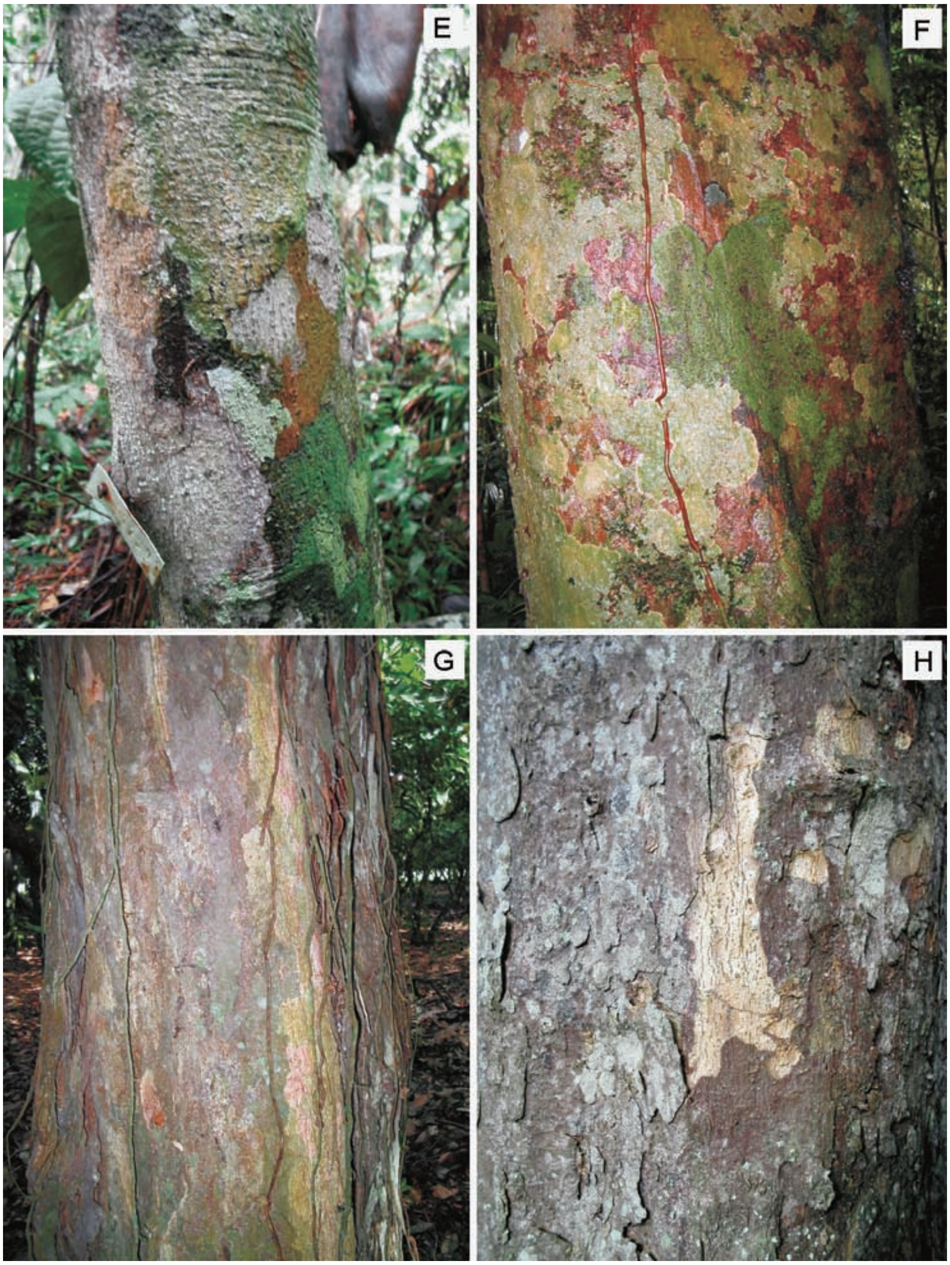

Fig. 17.2. Appearance of barks of *Cryptocarya aschersoniana* Mez. E. Young tree, Estação Biológica de Santa Lúcia, Santa Teresa, ES; F. Estação Biológica de Santa Lúcia, Santa Teresa, ES; G-H. Linhares, ES. (Photographs by author).

Fig. 18. *Cryptocarya aschersoniana* Mez. A-B. Branches collected at E.E. Juréia-Itatins, Núcleo Rio Verde, SP; C-D. Branches collected at Campos do Jordão, SP; E-F. Detail of leaves. (Photographs by author).

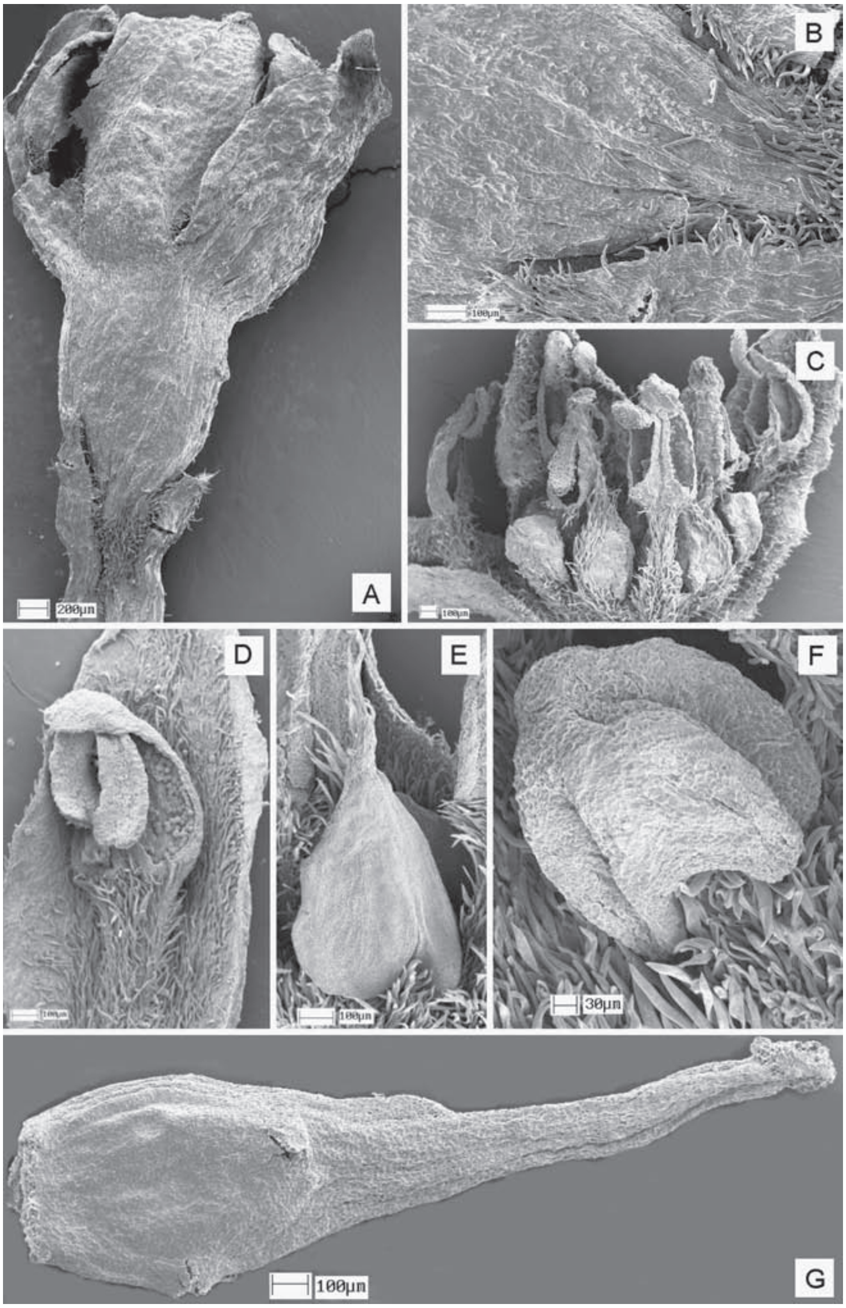

Fig. 19. SEM micrographs of flowers of *Cryptocarya aschersoniana* Mez. A. Flower bud (from *Lourteig 2329*, HB); B. External indument (from *Lourteig 2329*, HB); C. Longitudinal section of flower bud (from *Reitz & Klein 7523*, HBR); D. Adaxial side of stamen of the androecial whorl I, introrse (from *Barbosa & Abe 397*, MBM); E. Abaxial side of staminode (from *Barbosa & Abe 397*, MBM); F. Adaxial side of detail of gland (from *Barbosa & Abe 397*, MBM); G. Gynoecium (from *Barbosa & Abe 397*, MBM). (Photomicrographs by author).

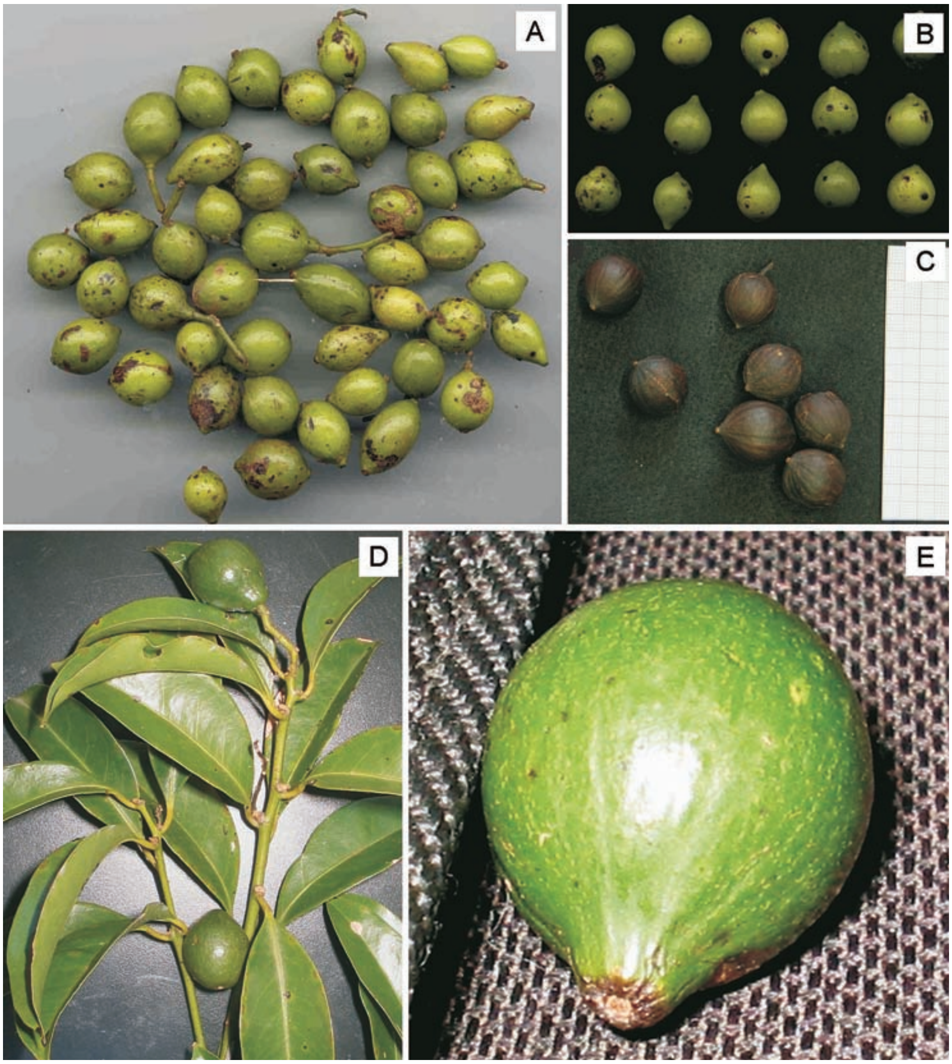

Fig. 20. *Cryptocarya aschersoniana* Mez. A. Immature fruits collected at P.E. Campos do Jordão, SP, in March 2001; B. Immature fruits collected at Serra do Japi, SP, in February 2001; C, E. Mature fruits collected at Linhares, ES, in May 2005; D. Mature fruits from *Reitz* & *Klein 8581* (HBR), Rio do Sul, SC. (Photographs by author).

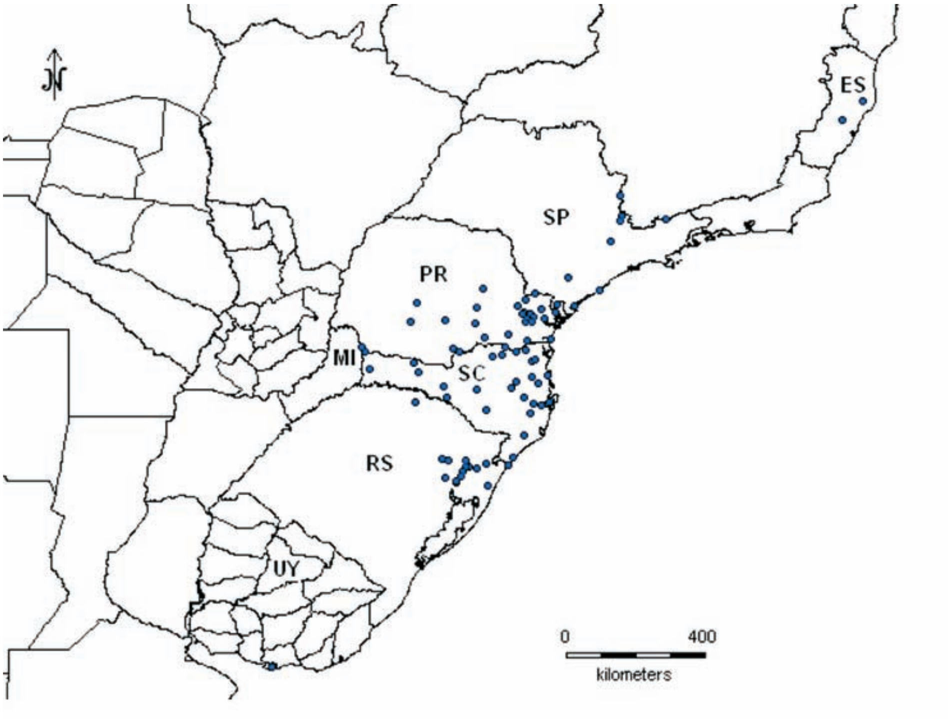

Fig. 21. Distribution of *Cryptocarya aschersoniana* Mez.

2. *Cryptocarya botelhensis* P.L.R. de Moraes sp. nov.

Holotype: Brazil. São Paulo: Parque Estadual Carlos Botelho, São Miguel Arcanjo, 24º03'45.8"S, 47º57'46.2"W, c. 840 m alt., 9 Jan. 2001 (fl.), *P.L.R. de Moraes 2323* (UEC; isotypes: B, C, ESA, HBG, M, MBM, MO, NY, RB, SP, UEC). Fig. 22; Plate II B (cf. Appendix 13.5).

A *Cryptocarya micrantha* Meissner et speciebus proximis foliorum apice longo-acuminato, petiolis profunde canaliculatis et floribus glabrescentibus differt.

Differs from *Cryptocarya micrantha* Meissner and related species in the tip of the leaf long acuminate, petioles deeply canaliculate, inflorescences and flowers glabrescent.

Etymology - This species has been found only in a few localities of state of São Paulo, with Parque Estadual Carlos Botelho having its most abundant population; the specific epithet was chosen because of this.

Vernacular name - Canela-de-jacu.

Description - *Trees* up to 20 m tall, trunk cylindrical, DBH 27-54.11 cm ($\bar{X}$ = 36.88 ± 6.99 cm; *N* = 12), bark brownish, somewhat flaky, with lenticels (Fig. 23 A-D). *Branches* terete, with longitudinal lenticels. *Branchlets* 5 cm below terminal bud c. 1.2-1.5 mm in diam., light brown in dried material, initially angular and flattened from the beginning, longitudinally striate, glabrous, somewhat shining; terminal buds minute, inconspicuous. *Petioles* 4.8-14.1 mm long, 0.5-1.7 mm thick, slender, somewhat roundish below, deeply canaliculate above, sulcate, glabrous. *Leaves* (Fig. 24 A-D) alternate, mostly narrow elliptical to elliptical, widest at the middle or most slightly below, sometimes obovate, 3.0-9.8 cm long, 0.93-2.92 cm broad, chartaceous, glabrous on both surfaces, tip short to mostly long acuminate, acumen up to 1.6 cm, base acute, revolute, margin flat to slightly recurved, sclerified; above pale, poorly reticulate; beneath paler, with papillae inconspicuous; midrib impressed to level above, slightly convex below, secondary veins rather patent (4 to 8 per side), slightly salient on both surfaces; tertiary venation loosely, slightly raised below; venation pattern brochidodromous. *Inflorescences* (Fig. 22 A) green-yellowish, panicles in the axils of distal leaves, often subterminal, many-flowered, 0.6 mm in diam. at the base, 1.63-9.8 cm long, sparsely pubescent to glabrescent, with ± short, ± appressed hairs; peduncles sparsely pubescent, short or long. *Flowers* (Fig. 22 B-N; 25 A-H) yellow, glabrescent, c. 3.3-3.98(-5.0) mm long, 1.8-2.75 mm in diam. at apex; tube urceolate, 1.2-1.5(-2.0) mm long, 0.7-1.1(-1.5) mm in diam.; pedicels glabrescent, 0.4-0.9 mm long; tepals subequal, 1.58-2.27(-2.6) mm long, c. 0.77-1.21 mm broad, concave, slightly incurved at apex, ovate, roundish to acutish, pilose within; stamens included; stamens of whorls I and II introrse, c. 0.95-1.3 mm long, anthers pilose, ovate, c. 0.46-0.78 mm long, 0.36-0.54 mm broad, connectives prolonged beyond the large sporangia, tip rounded to obtuse, filaments rather slender, pilose, as long as or slightly shorter than anthers, somewhat adnate to tepals; stamens of whorl III lateral to extrorse-lateral, c. 1.1-1.7 mm long, anthers narrowly ovate, pilose, c. 0.6-0.9 mm long, 0.4-0.5 mm broad, connectives rounded to obtuse, prolonged beyond the large sporangia, filaments rather slender, longer than anthers, pilose; glands subglobose, c. 0.38-0.8 mm long, 0.36-0.5 mm broad, long-pedicelled (up to. 0.6 mm), pedicel pilose, adnate to the filaments; staminodes relatively small, triangular-ovate, acute, c. (0.65-)0.7-1.0 mm long, 0.39-0.62 mm broad, tip and abaxial side pilose, adaxial side flattened, glabrous, with two conspicuous small elliptical protuberances at the base in lateral/abaxial side, stalks conspicuous, stout, pilose; gynoecium immersed in the tube, glabrous, c. 1.77-2.67(-4.3) mm long, ovary ellipsoid, c. 0.59-0.93 mm long, 0.2-0.5 mm in diam., gradually merging into the cylindrical-conical, glabrous, 1.1-1.8 mm long style with small, discoid stigma. *Immature fruits* green (Fig. 26 A), *mature* ones yellow, ellipsoid to globose, many-ribbed (Fig. 9 I; 22 O; 26 B-D), 1.86-3.22 cm long ($\bar{X}$ = 2.29 ± 0.24 cm; N = 53), 1.42-2.32 cm broad ($\bar{X}$ = 1.74 ± 0.17 cm; N = 53); flesh portion originated from the accrescent flower tube relatively thin.

Phenology - Flower buds in December; flowers at anthesis in January and June. Immature fruits in March and August; mature fruits in January, February, April, and June.

Distribution and habitat (Fig. 27) - Up to now, the species is only known from collections of São Paulo state, inhabiting the Montane Ombrophilous Dense Forest, from c. 600 to c. 1000 m altitude. Its populations are relatively abundant at Parque Estadual Carlos Botelho and Parque Estadual da Serra do Mar, Núcleo Cunha-Indaiá. The population at Estação Biológica de Paranapiacaba most possibly suffers from the harmful effects of pollution in recent decades as no individual has been recently located.

Uses - It is known that muriquis (woolly spider monkeys) at P.E. Carlos Botelho consume the fruit and as such contribute to the dispersal of the species.

Comments - *Cryptocarya botelhensis* is recognised by its very characteristic leaf shape, with the slender acumen representing 1/6 to 1/4 of the entire length of the leaf, inflorescences and flowers nearly glabrous, and by its fruits manifestly ribbed, which are constant characters in its different populations. In the state of São Paulo, the species is sympatric with *C. mandioccana*, from which it can be easily distinguished by the absence of leaf indument. A close relative of *C. botelhensis* seems to be *C. micrantha*, which differs mainly by its inflorescences and flowers densely pubescent, and by its fruits usually larger and less clearly ribbed. However, vegetative material of some collections could be a source of confusion between these species.

Specimens examined - 26 (listed in appendix 13.3).

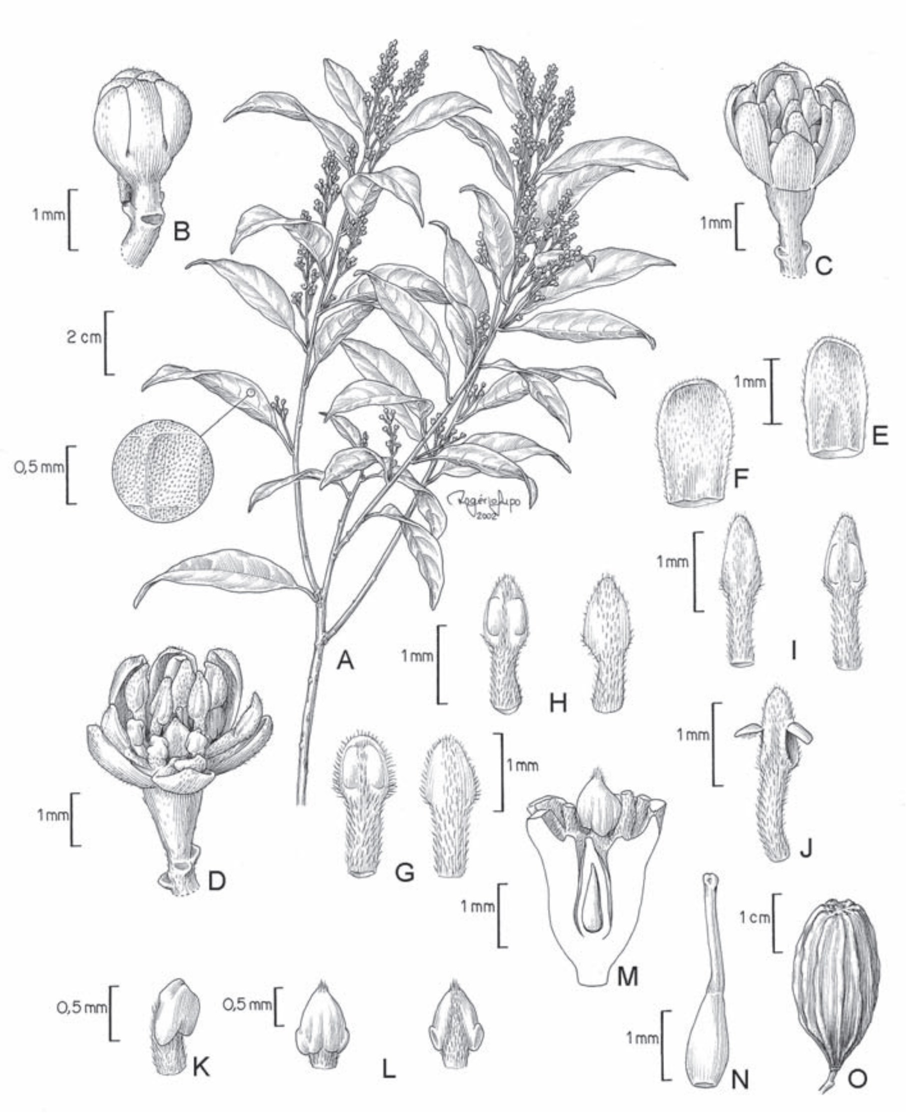

Fig. 22. *Cryptocarya botelhensis* P.L.R. de Moraes. A. habitus (from *Moraes 2311*). Flower pieces (from *Moraes 2325*): B. Flower bud; C-D. Flowers at anthesis; E-F. Tepals of inner and outer whorls, respectively; G. Stamens of whorl I; H. Stamens of whorl II; I-J. Stamens of whorl III; K. Gland; L. Staminodes; M. Cross section of flower tube; N. Gynoecium; O. Fruit (from *Moraes 1264*).

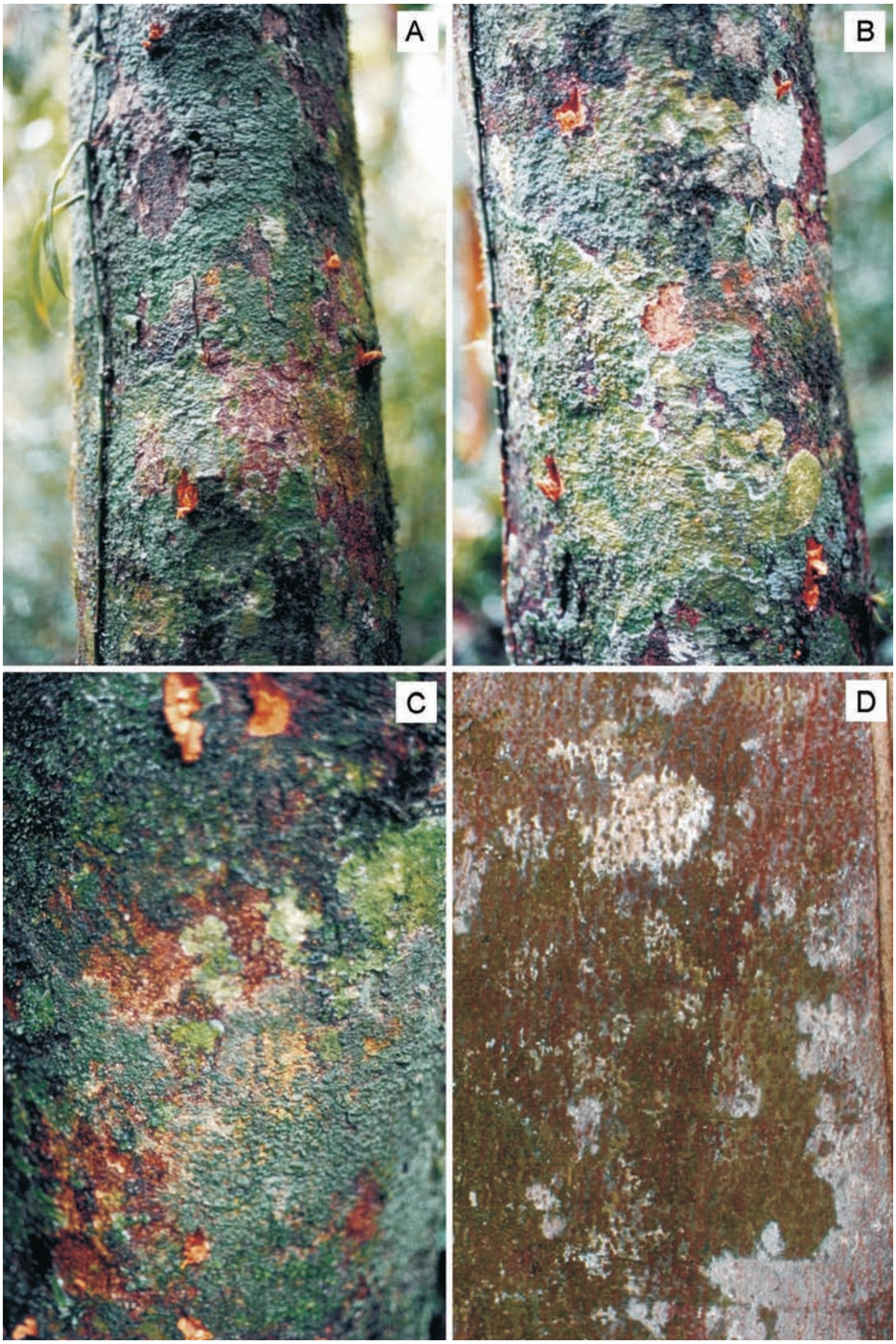

Fig. 23. Barks of *Cryptocarya botelhensis* P.L.R. de Moraes. A-D. Collected at P.E. Carlos Botelho, SP. (Photographs by author).

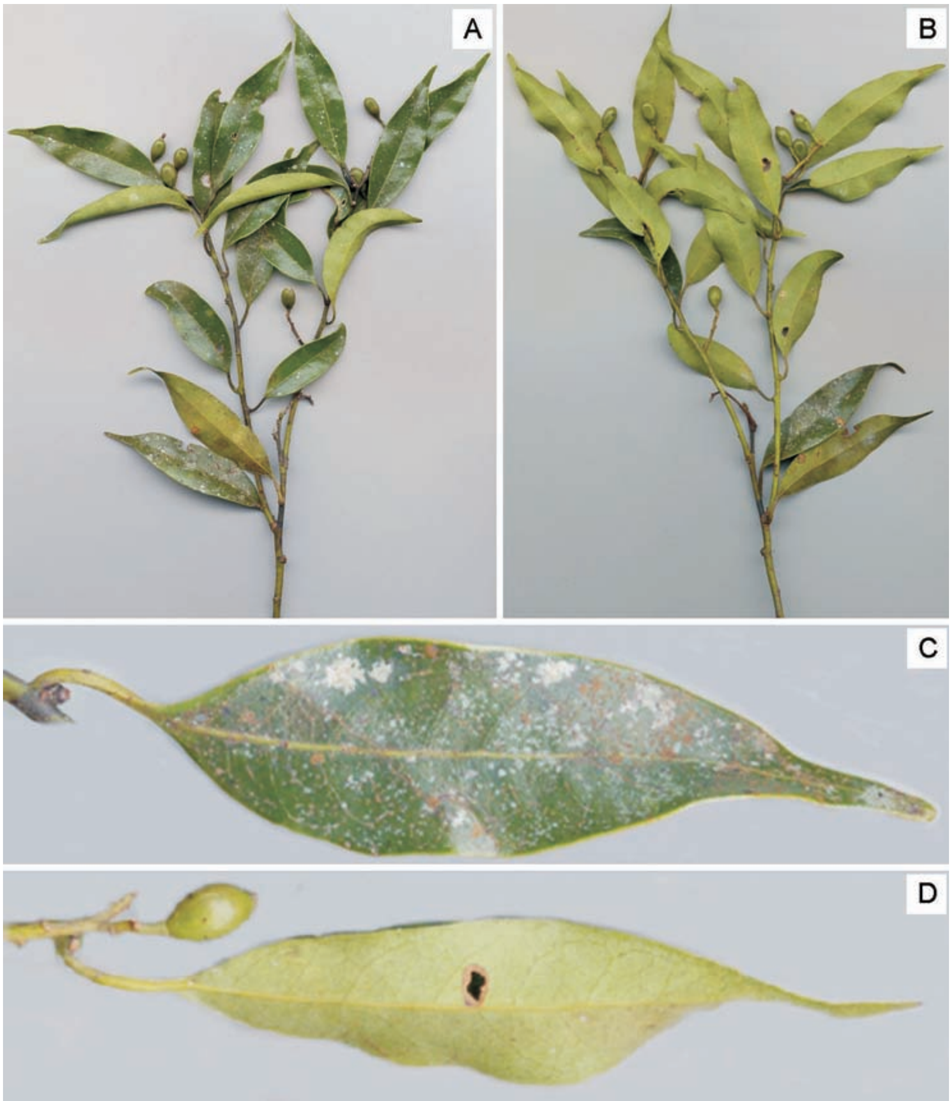

Fig. 24. Branches of *Cryptocarya botelhensis* P.L.R. de Moraes. A-B. Collected at P.E. Carlos Botelho, SP; C-D. Details of leaves. (Photographs by author).

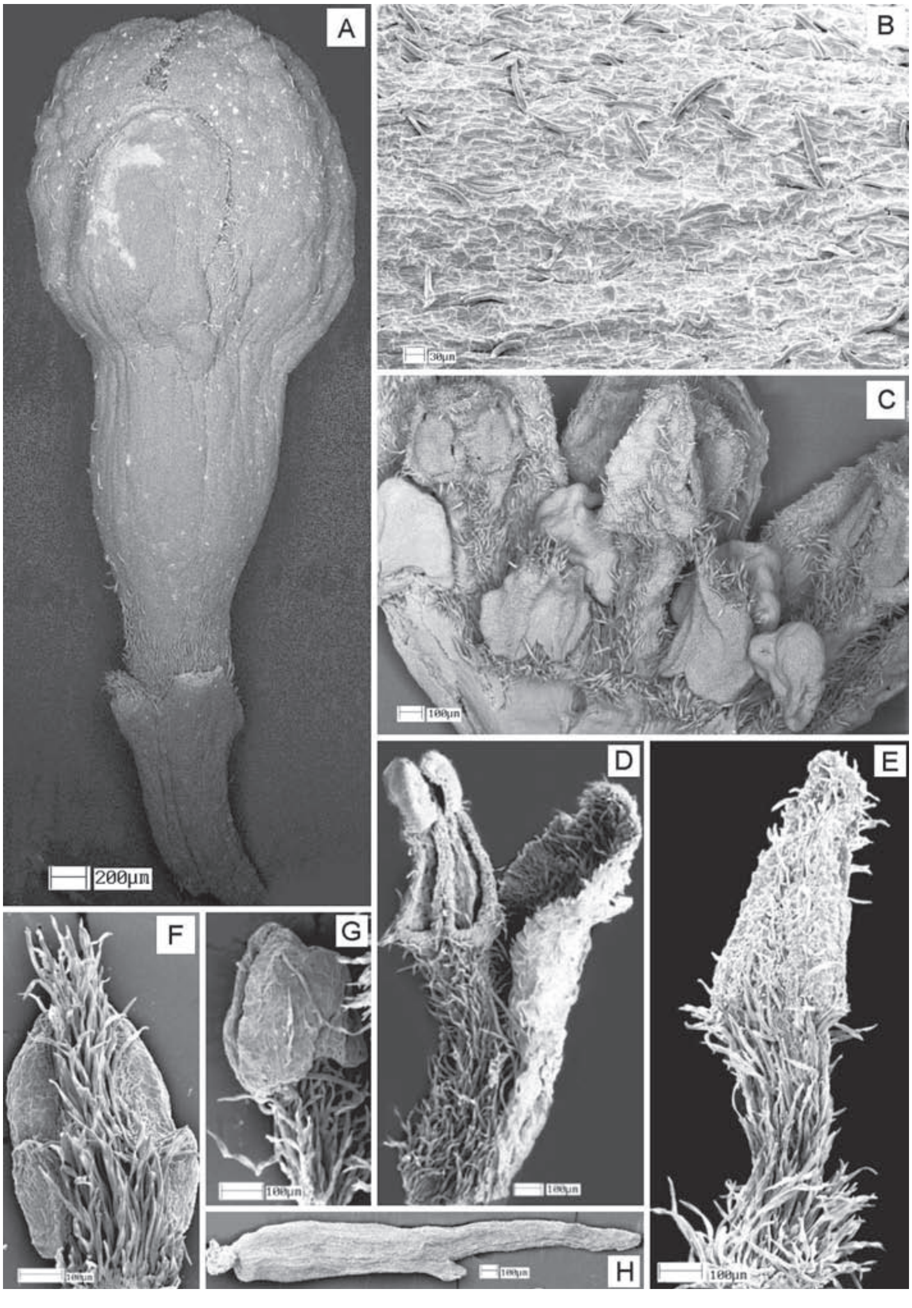

Fig. 25. SEM micrographs of flowers of *Cryptocarya botelhensis* P.L.R. de Moraes. A. Flower bud (from *Moraes 2327*, ESA); B. External indument (from *Moraes 2324*, ESA); C. Longitudinal section of flower (from *Moraes 2327*, ESA); D. Adaxial side of stamen of the androecial whorl II, introrse (from *Moraes 2324*, ESA); E. Adaxial side of stamen of the androecial whorl III, lateral-extrorse (from *Moraes 2324*, ESA); F. Adaxial side of staminode (from *Moraes 2324*, ESA); G. Abaxial side of detail of gland (from *Moraes 2324*, ESA); H. Gynoecium (from *Moraes 2324*, ESA). (Photomicrographs by author).

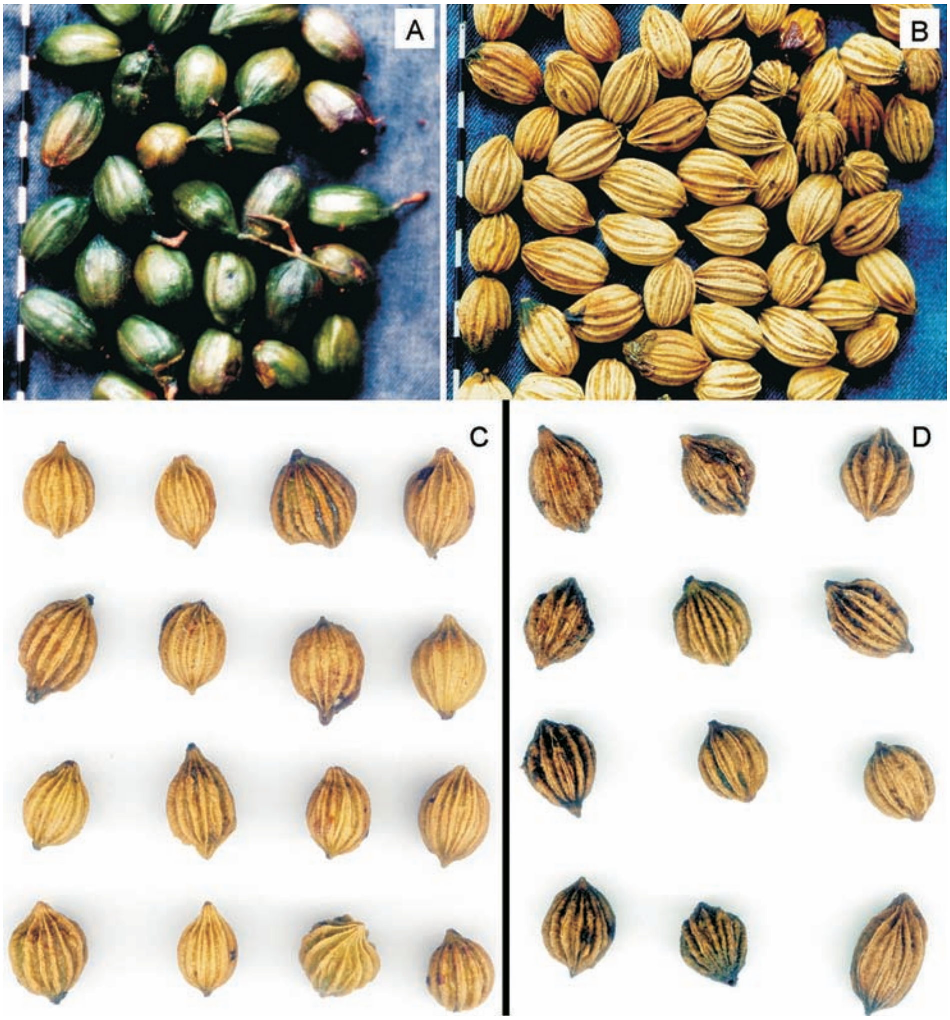

Fig. 26. *Cryptocarya botelhensis* P.L.R. de Moraes. A-B. Fruits and diaspores collected at P.E. Carlos Botelho, SP, February 1996; C. Diaspores collected at P.E. Serra do Mar, Núcleo Cunha-Indaiá, SP, February 2002; D. Diaspores collected at P.E. Serra do Mar, Núcleo Santa Virgínia, SP, August 2001. (Photographs by author).

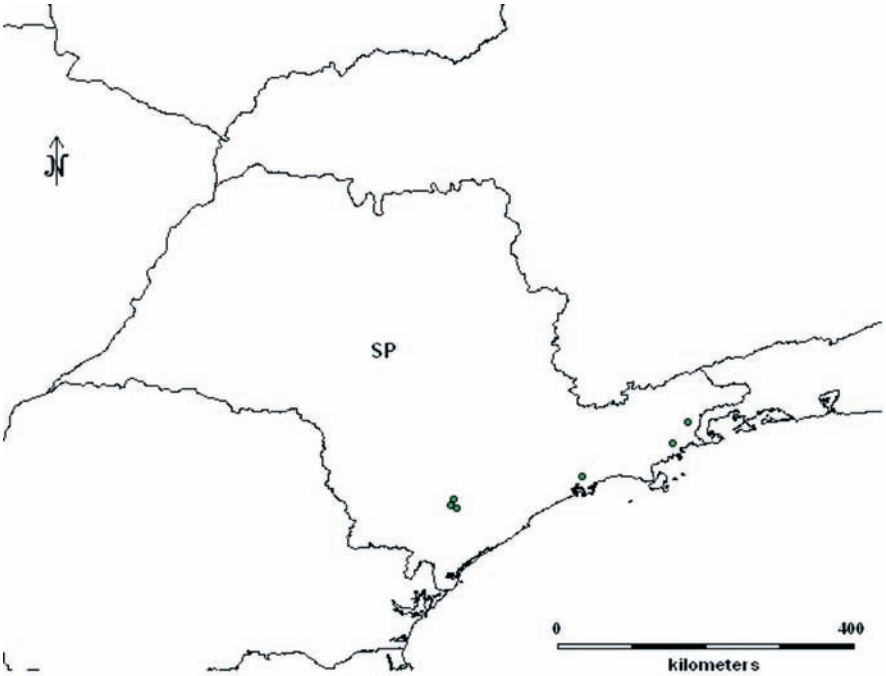

Fig. 27. Distribution of *Cryptocarya botelhensis* P.L.R. de Moraes.

3. *Cryptocarya citriformis* (Vellozo) P.L.R. de Moraes

Taxon 54(3): 791 (2005) ≡ *Laurus citriformis* Vellozo, *Fl. Flumin.*: 251 (1829 [1825]). – Lectotype (designated by Moraes, 2005a): Brazil (original plate! on parchment of “Flora Fluminensis” [photos in UEC!] in the Manuscript Section of the Biblioteca Nacional of Rio de Janeiro, of *Fl. Flumin. Icon*. 4: 53 (1831 [1827]). Plate III A, B (cf. Appendix 13.5).

= *Cryptocarya minima* Mez, *Jahrb. Königl. Bot. Gart. Berlin* 5: 14 (1889). ≡ *Aydendron floribundum* Meissner, in *Prodr*. (DC.) 15(1): 88 (1864). – Holotype: Brazil. Rio de Janeiro, “In sylv. Mandiocca”, Sep. 1823 (fl.), *L. Riedel s.n.* [LE, photo in UEC!; isotypes: B†, G (negatives in UEC!), K! (cibachrome in UEC!), L-0036201! (photo in UEC!), LE (2 sheets, photos in UEC!), NY-00354874! (photo in UEC!), NY-00354875! (photo in UEC!), OXF (left-hand specimen, photo in UEC!)]. Plate IV A (cf. Appendix 13.5).

= *Cryptocarya hypoleuca* Mez, in *Ann. K. K. Naturhist. Hofmus.* (Wien) 22(2/3): 139 (1907). – Lectotype (designated by Moraes, 2005a): Brazil. Rio de Janeiro, “Cantagallo”, Sep. (fl.), *T. Peckolt 166* [U, photo in UEC! Syntype: W†)]. Plate IV B (cf. Appendix 13.5).

Illustrations - Meissner (1866, *Fl. Bras*. 5(2): t. 62, 105 – II), Vattimo-Gil (1966b, Fig. 54, leaf; 58, fruit).

Vernacular names - Canela-abacate, canela-branca, canela-do-brejo, lombo-de-jacaré, louro-abacate.

Description - *Trees* up to 35 m tall, trunk cylindrical, DBH 21.01-56.66 cm ($\bar{X}$ = 31.13 ± 14.64 cm; *N* = 5), bark brownish to rusty, relatively rough to slightly rugose, with lenticels (Fig. 28). *Branches* cylindrical, glabrous, light to dark-brown or grayish, longitudinally striate to sulcate, with lenticels. *Branchlets* 5 cm below terminal bud c. 1.7-2.4 mm in diam., slender, initially angular from the beginning, sparse to densely yellowish or rusty lanuginose-tomentellous, with ± short, ± appressed hairs; terminal buds yellowish or rusty lanuginose – tomentellous; some collections with perules at terminal and/or axillary buds. *Petioles* 4.5-10.2 mm long, 0.8-2.3 mm thick, hardly canaliculate to canaliculate, roundish below, rugose, flattish above, sparse to densely yellowish or rusty-tomentellous, with short, curled, ± ascending hairs. *Leaves* alternate (Fig. 29), elliptical to lanceolate or ovate to obovate, 5.0-16.8 cm long, 1.4-6.2 cm broad, chartaceous to stiffly chartaceous, tip obtusely, broadly, shortly acuminate, or roundish, base acute, margin flat, hardly recurved, sclerified; above slightly shining, green, glabrous, densely, rather obscurely to prominulously reticulate; beneath dull, pruinose and/or glaucous in some collections, yellowish tomentellous, with ± short, ± appressed hairs, or yellowish to rusty lanuginose-tomentose, with ± short, ± ascending to erect hairs; midrib impressed to level or flattish above, prominent below, secondary veins erect-patent (6-9 per side), slightly arcuate, slightly prominulous above, prominent to prominulous below; tertiary venation densely reticulate, slightly prominulous below; venation pattern camptodromous-brochidodromous. *Inflorescences* axillary, paniculate, rather many-flowered, 0.7-1.7 mm in diam. at base, 2.3-9.7 cm long, dense, narrowly pyramidal, densely yellowish to rusty lanuginose-tomentellous, or sparse yellowish tomentellous, with ± short, ± appressed hairs; peduncles short and thick; bracteoles minute, densely tomentose. *Flower buds* green to greenish. *Flowers* greenish, yellow to yellowish, densely rusty-tomentellous, (2.0-)2.74-3.16(-4.3) mm long, (1.1-)1.3-1.72(-2.2) mm in diam. at apex (Fig. 30); tube slender, subcylindrical-urceolate, glabrous within, (0.8-)1.17-1.61(-2.0) mm long, 0.6-1.1 mm in diam.; pedicels densely tomentellous, (0.5-)0.61-0.88(-1.1) mm long; tepals equal, rather patent, 0.7-0.94(-1.8) mm long, c. 0.4-0.65(-0.97) mm broad, scale-shaped, incurved, ovate, acute, pilose within; stamens exserted; stamens of whorls I and II introrse, 0.57-1.0 mm long ($\bar{X}$ = 0.72 ± 0.12 mm; N = 19), anthers glabrous, broadly ovate to trapeziform, c. 0.2-0.83 mm long ($\bar{X}$ = 0.44 ± 0.12 mm; N = 37), c. 0.3-0.53 mm broad ($\bar{X}$ = 0.42 ± 0.06 mm; N = 30), connectives obtuse, slightly prolonged beyond the large sporangia, filaments slender, densely villose-hirsute, slightly shorter, adnate to the tepals; stamens of whorl III lateral, c. 0.7-1.16 mm long ($\bar{X}$ = 0.89 ± 0.16 mm; N = 12), anthers glabrous, ovate, c. 0.39-0.88 mm long ($\bar{X}$ = 0.58 ± 0.15 mm; N = 14), c. 0.22-0.37 mm broad ($\bar{X}$ = 0.28 ± 0.06 mm; N = 6), connectives obtuse to truncate, slightly prolonged beyond the sporangia, filaments slightly narrower, about as long, densely hirsute; glands small, globose, 0.2-0.5 mm long ($\bar{X}$ = 0.33 ± 0.09 mm; N = 13), 0.27-0.45 mm broad ($\bar{X}$ = 0.35 ± 0.08 mm; N = 5), depressed, (sub)sessile; staminodes slender, minute, stipitiform, acute, c. 0.47-0.95 mm long ($\bar{X}$ = 0.64 ± 0.17 mm; N = 12), c. 0.55 mm broad, tip and abaxial side pilose, stalks inconspicuous, pilose; gynoecium exserted, glabrous, 1.6-3.3 mm long, ovary ellipsoid, 0.5-0.76(-1.1) mm long ($\bar{X}$ = 0.65 ± 0.08 mm; N = 7), 0.27-0.42 mm in diam. ($\bar{X}$ = 0.34 ± 0.06 mm; N = 7), gradually merging into the about 1.1-1.83(-2.2) mm long ($\bar{X}$ = 1.43 ± 0.25 mm; N = 7), slender style with small, discoid stigma. *Mature fruits* brown, large, oblong-oval, smooth, 3.91-11.0 cm long ($\bar{X}$ = 6.86 ± 1.51 cm; N = 20), 3.0-6.27 cm diam. ($\bar{X}$ = 4.89 ± 0.84 cm; N = 20), with many broad, obtuse, longitudinal ribs (Fig. 9 D; 31 B); flesh portion originated from the accrescent flower tube relatively thick.

Phenology - Flowering material in July to September. Immature fruits in June to August; mature fruits in June, September, and October.

Distribution and habitat (Fig. 32) - Species sparsely distributed from Bahia to Rio de Janeiro, mostly collected in the Ombrophilous Dense Forest, but also in gallery and hygrophilous (swamp) forests, from 10 to c. 800 m altitude.

Uses - According to Pio Corrêa (1926) the wood is white and porose and thus suitable for carpentry and woodworking; cooked leaves are recommended for washing ulcerations, the pericarp of fruits is strongly astringent, and seeds are tonic and efficient against leucorrhoea (Dragendorff, 1898; Pio Corrêa, 1926).

Comments - *Cryptocarya citriformis* is recognised by its pubescent branchlets, with ± short, ± appressed hairs, leaves chartaceous, lower surface pruinose, pubescent, frequently glaucous, with secondary veins erect-patent, prominent to prominulous, inflorescences and flowers tomentellous, tube slender, stamens and gynoecium exserted, and mostly by its fruits that are unusually large for the genus. The species is closely related to its partly sympatric *C. saligna*, from which it can only easily be discriminated by examination of the fruiting material. In its vegetative characters *C. citriformis* is almost undistinguishable from some populations of *C. saligna* (mainly those of *C. longistyla* pattern), and therefore sterile specimens and individuals with very immature flowers or fruits are difficult to identify. Nevertheless, the leaves glabrous on both surfaces, with papillae inconspicuous on the lower surface, which are usually found in the latter species, in most cases allows to discriminate between both species.

Specimens examined – 15 (listed in appendix 13.3).

Fig. 28. Appearance of bark of *Cryptocarya citriformis* (Vellozo) P.L.R. de Moraes, Serra da Estrela, Petrópolis, RJ. (Photographs by author).

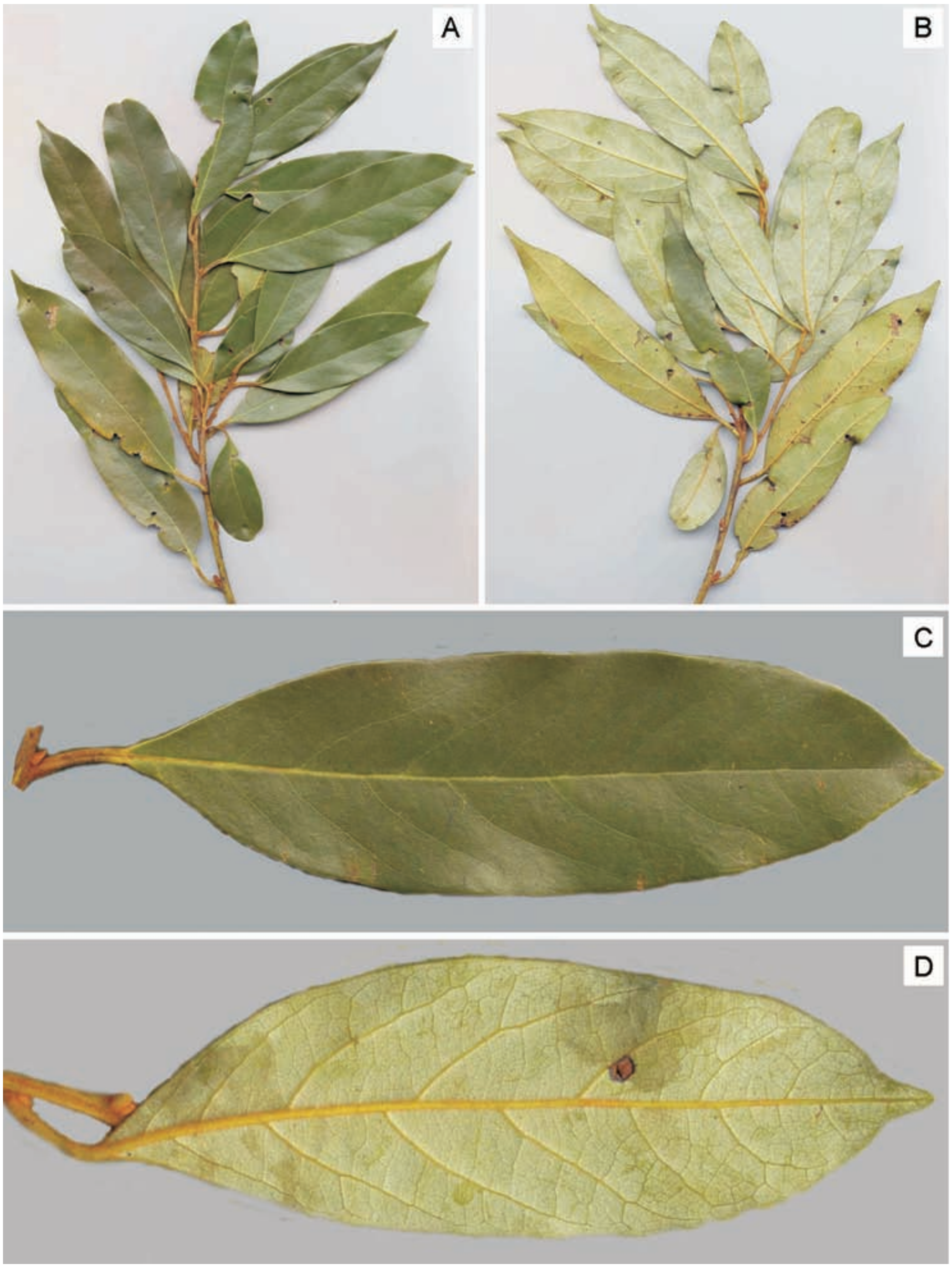

Fig. 29. Branches of *Cryptocarya citriformis* (Vellozo) P.L.R. de Moraes. A-B. Collected at Serra da Estrela, Petrópolis; C-D. Detail of leaves. (Photographs by author).

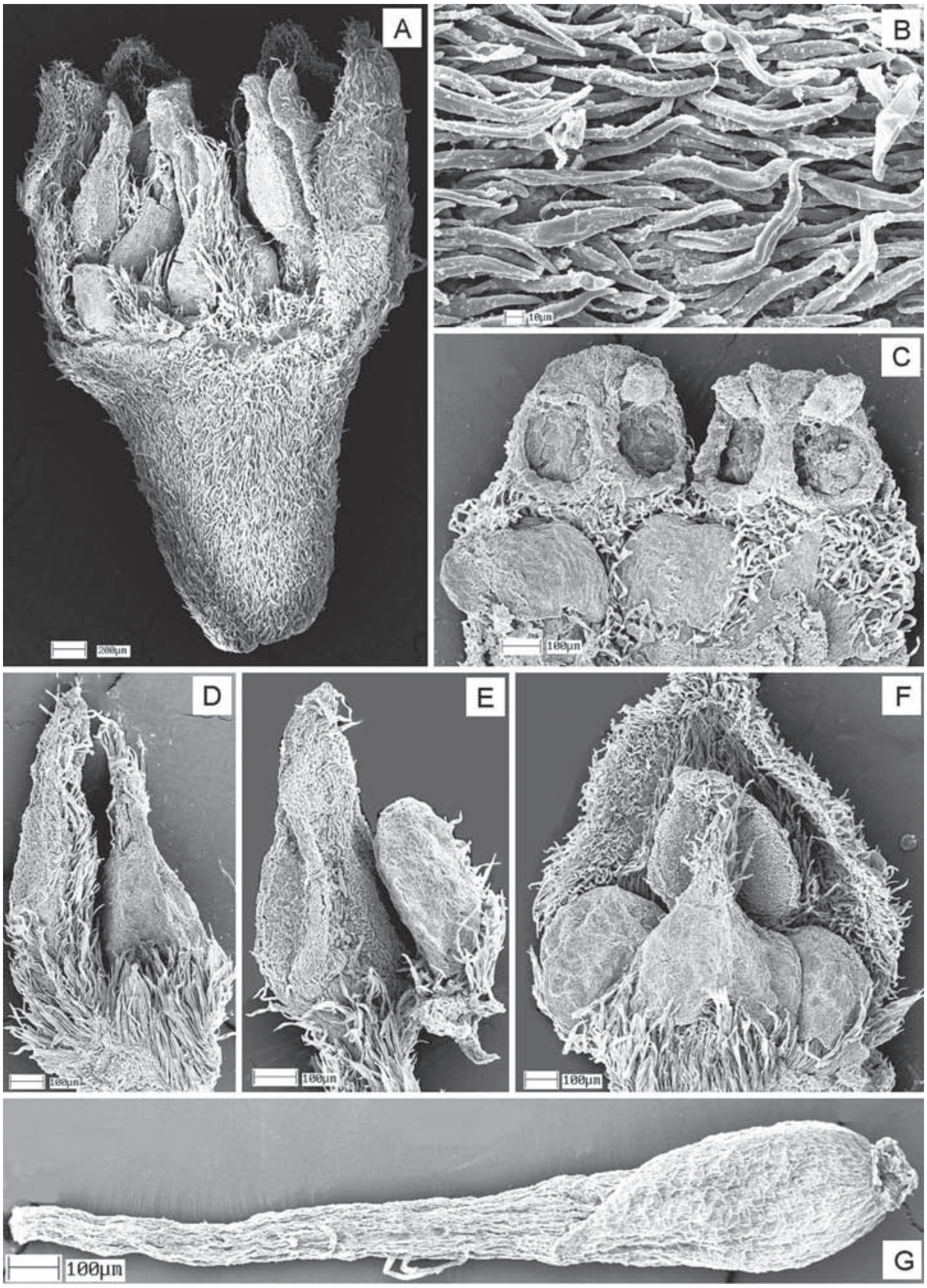

Fig. 30. SEM micrographs of flowers of *Cryptocarya citriformis* (Vellozo) P.L.R. de Moraes. A. Flower bud; B. External indumenta; C. Adaxial side of stamens of the androecial whorls I and II, introrses, and glands; D. Lateral side of stamen of the androecial whorl III, lateral-extrorse, and staminode; E. Abaxial side of stamen of the androecial whorl III, lateral-extrorse, and gland; F. Adaxial side of stamen of the androecial whorl II, introrse, glands and staminode; G. Gynoecium (from *Riedel s.n.*, L-0036201). Only C & G from fully developed flower. (Photomicrographs by author).

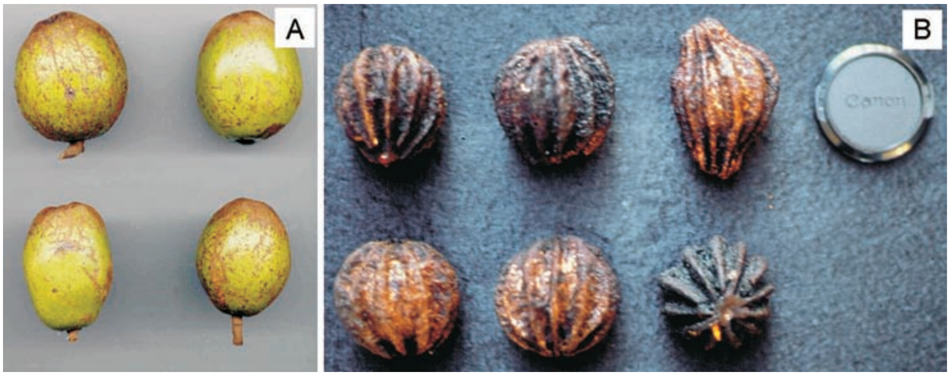

Fig. 31. *Cryptocarya citriformis* (Vellozo) P.L.R. de Moraes. A-B. Unripe fruits and diaspores germinating at Serra da Estrela, Petrópolis, RJ, July 2000. (Photographs by author).

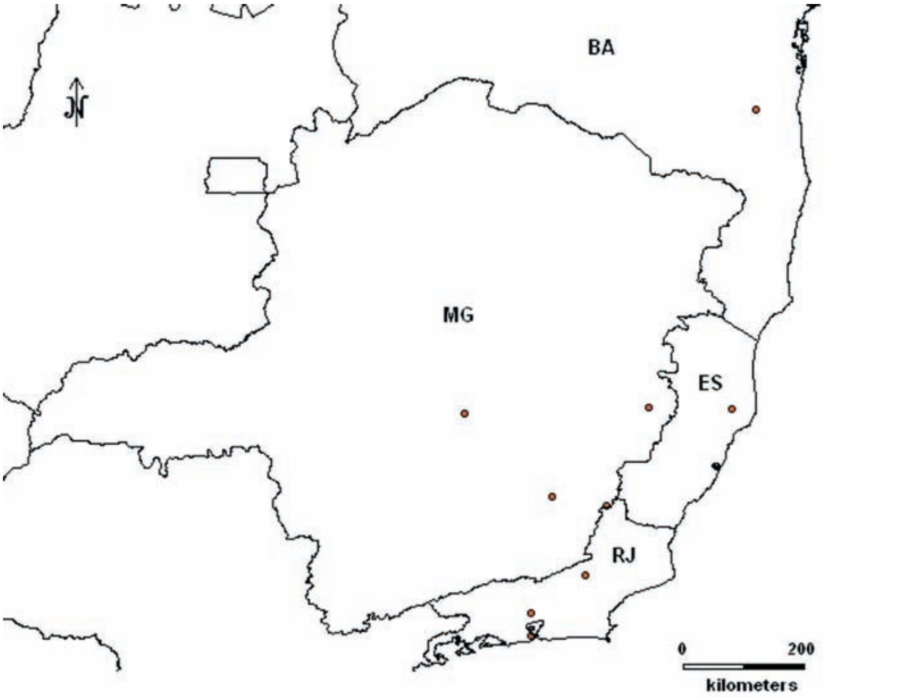

Fig. 32. Distribution of *Cryptocarya citriformis* (Vellozo) P.L.R. de Moraes.

4. *Cryptocarya guianensis* Meissner

in Podr. (DC.) 15 (1): 75 (1864). – Lectotype (designated by Moraes, 2005a): French Guiana. 1839 (fl.), “Laurus”, *M.E. Moricand* 113 [G-DC, photo in UEC!; isolectotypes: G (3 sheets, negatives in UEC!)]. Plate V A (cf. Appendix 13.5).

= *Cryptocarya maroniensis* Benoist, *Bull. Mus. Hist. Nat.* (Paris) 30: 510 (1924). – Holotype: French Guiana. Maroni, “environs de Godebert”, s.d. (fl.), *G. Wachenheim 68* (P-00221227, photo in UEC!; F Neg. No. 35309!). Plate V B (cf. Appendix 13.5).

= *Cryptocarya nigropunctata* Vattimo-Gil, *Rodriguésia* 25(37): 222, 233, *f.* 17-22, 237, *f.* 66, 70, 73 (1966b) p.p. – Holotype: Brazil. Basin of Rio Madeira, Municipality Humayta, near Tres Casas, on low terra firma”, 14 Sep. – 11 Oct. 1934 (fl.), *B. A. Krukoff’s 5th Expedition to Brazilian Amazonia 6356* (RB-60616! 2 sheets, photos in UEC!; isotypes: BR-880578! (photo in UEC!), MO-1290390! (photo in UEC!), NY-00621924 (photo in UEC!), U-0017938!). – Lectotype (designated by Moraes, 2005a): unknown provenance, (fl.), *collector unknown* (RB-60616!; only the fragment of inflorescence inside an envelope). Plate VI A (cf. Appendix 13.5).

Illustrations - Vattimo-Gil (1966b, Fig. 23-28, flower pieces; 67, flower; 77, leaf), van Roosmalen (1985, plate 55, Fig. 5 a, b).

Vernacular names - Caá-xió, cahaxio, caiaxio, cèdre, cèdre-canelle, cèdre-de-marécage, cèdre-jaune-de-marécage, cèdre-marécage, ïwa-pane (in Wayãpi, meaning “arbre malchanceux” due to the aspect of the tree), wen kamwi (in Palikur meaning “which resembles wen”, this last being *Ocotea guianensis* Aubl., louro-catana).

Description - *Trees* or mostly small trees, 4-25 m tall, trunk cylindrical, DBH 8-40 cm, bark gray, brownish to blackish to green and smooth to greenish stained of gray and red to green-reddish, sapwood white (in the live tree) to yellow to reddish to bright brown. *Branches* cylindrical, striate, with lenticels, very breakable and fibrous. *Branchlets* 5 cm below terminal bud c. 1.6-2.2 mm in diam., brownish to reddish, initially slightly angular or roundish from the beginning, smooth, glabrous, somewhat shining; terminal buds ovoid, sparsely yellowish tomentellous, with a dense cover of ± short, ± appressed hairs. *Petioles* 4.5-10.2 mm long, 1.0-2.5 mm thick, slightly to deeply canaliculate above, occasionally flattened, roundish below, glabrous. *Leaves* alternate, elliptical to oblong-lanceolate, widest at the middle or mostly slightly below, (2.6-)4.2-19.0(-22.0) cm long, 1.16-6.4 cm broad, coriaceous to subcoriaceous, glabrous on both surfaces, tip acuminate (short to long), base acute, margin flat to slightly recurved; above shining, varnished, rather poorly reticulate; beneath paler, rather dull, with papillae inconspicuous; midrib impressed to level or slightly convex above, prominent below, secondary veins rather patent (6-12 per side), impressed above, prominent below; tertiary venation densely, prominulously reticulate below; venation pattern brochidodromous. *Inflorescences* white to whitish to yellow, panicles in the axils of distal leaves, few-flowered, 1.0-1.6 mm in diam. at the base, 1.4-10.0 cm long, densely subsericeous-tomentellous; peduncles glabrescent towards the base, short, branchlets (if present) very short. *Flowers* (Fig. 33 A-G) cream, creamy, pale yellow, yellow, yellow-greenish or green-yellowish, densely grayish to yellowish subsericeous-tomentellous, with ± short, ± appressed hairs, (2.5-)3.25-3.68(-3.8) mm long, (1.6-)1.79-2.25(-3.0) mm in diam. at apex; tube urceolate, 0.86-1.2 mm long, 0.8-1.0 mm in diam.; pedicels sericeous, (0-)0.4-0.6(-2.0) mm long; tepals subequal, white, yellow, (1.7-)1.86-2.4(-2.5) mm long, c. 1.0-1.66 mm broad, slightly concave, erect or erect-patent and slightly incurved at apex, widely ovate to ovate-elliptical, tip acutish or obtuse, pilose to glabrescent within; stamens included, yellowish; stamens of whorls I and II introrse, 0.94-1.44 mm long ($\bar{X}$ = 1.19 ± 0.17 mm; N = 10), conspicuously shorter than tepals, anthers large, glabrous, ovate, c. 0.55-0.96 mm long ($\bar{X}$ = 0.68 ± 0.11 mm; N = 19), 0.38-0.51 mm broad ($\bar{X}$ = 0.43 ± 0.05 mm; N = 12), connectives obtuse, strongly protruding beyond the large sporangia, filaments rather slender, densely pilose, as long as or slightly shorter than anthers, somewhat to manifestly adnate to tepals; stamens of whorl III lateral or extrorse-lateral, c. 1.3-1.7 mm long, anthers narrowly ovate, glabrous, c. 0.7-1.0(-1.5) mm long, 0.4 mm broad, connectives thick, sub-clavate, obtuse, strongly prolonged beyond the sporangia, filaments rather slender, as long or longer, densely pilose; glands subglobose, 0.4-0.7 mm long, 0.4-0.8 mm broad, compressed, rather long to short pedicelled to sub-sessile, pedicel pilose, rather distant from the filaments; staminodes large, triangular-ovate, sub-cordate, acute, 0.56-1.2(-1.5) mm long, 0.37-0.8 mm broad, tip and abaxial side pilose, adaxial side flattened, glabrous, stalks conspicuous, stout, pilose; gynoecium immersed in the tube, glabrous, 2.2-4.3 mm long, ovary ellipsoid, 0.8-1.87(-2.1) mm long, 0.4-1.2 mm in diam., gradually merging into the cylindrical-conical, glabrous, 1.38-2.4 mm long style with small, truncate, discoid stigma. *Fruits* yellow with green tinges, pale yellow, yellow or yellowish with pulp white juicy, green-yellowish, ellipsoid-ovoid to pyriform, usually with a neck at the base, many-ribbed (12-15), c. 2-3.27(-4) cm long, c. 1.36-2.52 cm in diam. (Fig. 9 A-C).

Phenology - Flowering material in March to May, and July to October. Fruiting material in January, February, April, May, and August to December. Mature fruits mostly in December. Three collections with both flowers and immature fruits in August to October.

Distribution and habitat (Fig. 34) - Species with disjunct distribution, registered from Venezuela, Guyana, Surinam, French Guiana, and Brazil. In French Guiana, the species is reported to be rare, occurring in riverine and creek forests (Benoist, 1931; van Roosmalen, 1985). In Brazil, the species has been sparsely collected in Amapá, Bahia, Mato Grosso, Pará and Rondônia, mostly in riparian and floodplain (várzea) forests, but also in terra firme (non-inundated) forest. From sea level to 1300 m altitude.

Uses - According to Pio Corrêa (1926) and Le Cointe (1934), its yellowish wood is well-suited for carpentry and woodworking, fruits are stimulative as well as carminative. Benoist (1931) informed also that the wood is rather soft, excellent for joinery and framing. Dragendorff (1898), citing Peckolt, stated that the species has the same uses as *C. moschata*. Fruits are indicated as endozoochorous (eaten by specialised frugivores; van Roosmalen, 1985). According to P. Grenand (pers. comm.) the vernacular name *Wayãpi* indicates that the fruits are eaten by agoutis.

Comments - *Cryptocarya guianensis* is recognised by its somewhat cinnamon/ochre-coloured-drying leaves, shiny with rudimentary reticulation on upper surface; flowers with tepals subequal, large; stamens of whorls I and II conspicuously shorter than tepals; anthers glabrous; glands subglobose relatively large and broad, and by its mature fruits usually globose, ribbed, with a neck at the base. Overall similarity of floral features and sometimes even leaves suggests that *C. moschata* is the closest relative of *C. guianensis*.

The type of *Cryptocarya maroniensis*, a subjective junior synonym of *C. guianensis*, was unfortunately not available to me, but its images from Paris and Field Museum were. However, since Benoist's (1924) description does not provide distinguishing characters, I followed Kosterman's (1937) decision on synonymy under *C. guianensis*.

It should be noted that *C. guianensis* as circumscribed here is a species poorly collected in Brazilian Amazon or even in the Guiana Shield (mainly in French Guiana). From information available on specimen's labels, the species has been reported either as small trees ranging from 4 to 15 m thus reproducing in the understorey, or as large trees up to 25 m. Additionally, the contrasting colours quoted on its bark and sapwood would also suggest it is a rather variable entity or that more than one taxon could be involved, not necessarily related to the characters evoked by Benoist. Both *C. guianensis* and *C. maroniensis* have been cited in the checklists of the plants of the Guianas (Boggan *et al.*, 1997; Hollowell *et al*. 2001).

Specimens examined - 43 (listed in appendix 13.3).

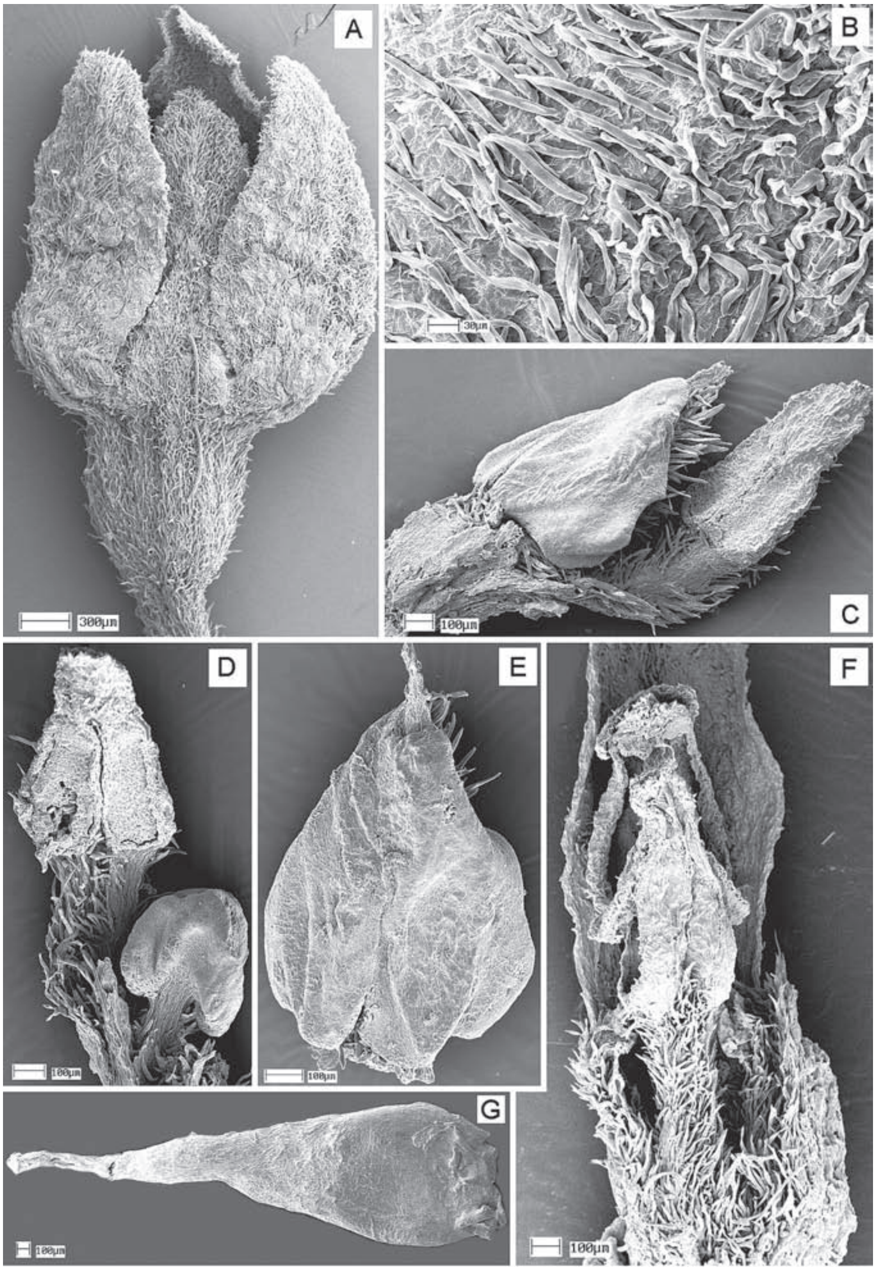

Fig. 33. SEM micrographs of flowers of *Cryptocarya guianensis* Meissner. A. Flower bud (from *Kuhlmann 2118*, RB); B. External indument (from *Kuhlmann 2118*, RB); C. Adaxial side of stamen of the androecial whorl II, introrse, and staminode (from *Pires & Silva 1388*, RB); D. Adaxial side of stamen of the androecial whorl I, introrse, and gland (from *Pires & Silva 1388*, RB); E. Abaxial side of staminode (from *Pires & Silva 1388*, RB); F. Adaxial side of stamens of the androecial whorls I and III (from *Kuhlmann 2118*, RB); G. Gynoecium (from *Kuhlmann 2118*, RB). (Photomicrographs by author).

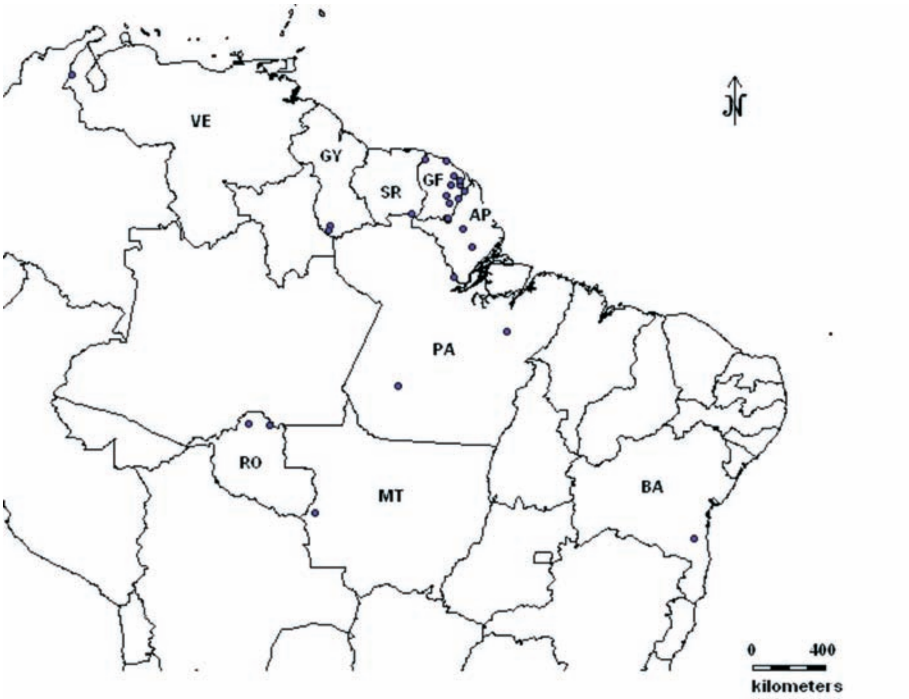

Fig. 34. Distribution of *Cryptocarya guianensis* Meissner.

5. *Cryptocarya mandioccana* Meissner

in *Prodr*. (DC.) 15 (1): 75 (1864). – Holotype: Brazil. Rio de Janeiro, “In sylvis Mandiocensis”, Oct. 1823 (fl.), *L. Riedel s.n.* (LE, photo in UEC!; sheet with number 91 in original label, plus label of determination by Carl Mez in 1887, plus label of Holotype, conf. by Henk van der Werff in 1988; isotypes: B† [F Neg. No. 3844!], GOET! (2 sheets, photos in UEC!]), K! (cibachrome in UEC!), L-0036185! (photo in UEC!), L-0036186! (photo in UEC!), LE (photo in UEC!), NY-00355045! (photo in UEC!), OXF (right-hand specimen, photo in UEC!), OXF (photo in UEC!), U (photo in UEC!). Plate VI B (cf. Appendix 13.5).

Illustrations - Vattimo-Gil (1957, Fig. 7, habit and fruit), Vattimo-Gil (1966b, Fig. 38-46, flower pieces; 68, flower; 69, leaf; 74-76, fruits), Coe-Teixeira (1965, táb. I, Fig. 3, leaves, flower pieces and fruit), Moraes (2003, Pr. 3, I, stamen of androecial whorl; I-K, fruits and fresh material).

Vernacular names - batalheira, beribebas, cajati or cajaty, canela-batalha, canela-branca, canela-de-porco, canela-fogo, canela-inhotinga, canela-moscada, canela-nhotinga, canela-nhutinga, canela-noz-moscada, inhutinga, nhotinga, nhutinga, noz-moscada, noz-moscada-brasileira, noz-moscada-do-brasil.

Description - *Trees* up to 35 m tall, trunk cylindrical, DBH 15.91-104.0 cm ($\bar{X}$ = 45.46 ± 15.06 cm; *N* = 494), bark (Fig. 35) laterite (dark brick red) to rusty-brownish, flaky in adult trees, relatively smooth to rugose when young, with lenticels. *Branches* cylindrical, thick, dark to light brownish, relatively smooth to rugose or verrucose. *Branchlets* (Fig. 36 A-D) 5 cm below terminal bud c. 1.6-2.4 mm in diam., dark to light brownish, initially angular from the beginning, terete towards the base, relatively smooth to striate, glabrescent to densely pubescent, with short, appressed, yellowish hairs; terminal buds minute, ovoid, pubescent, densely covered by yellowish appressed hairs. *Petioles* 8.5-18.0 mm long, 1.0-2.0 mm thick, slightly to deeply canaliculate above, roundish below, striate to rugose, glabrescent to minutely pubescent, with short and/or long, curled to straight, ± appressed and/or ± ascending hairs. *Leaves* (Fig. 36 A-E) alternate, narrow-elliptic-lanceolate to broad-ovate or obovate, 5.0-17.7 cm long, 1.85-7.0 cm broad, chartaceous to chartaceous-coriaceous to coriaceous; young leaves pubescent on both surfaces, with short, appressed, yellowish hairs; adult leaves glabrous to glabrescent above, pubescent below, with short to long, straight to curled, mostly appressed to ascending, yellowish hairs, tip acute to acuminate, base acute to cuneate, margin slightly flat to recurved, sclerified; above pale to somewhat shining in some collections, poorly to prominulously reticulate; beneath paler, opaque, with papillae conspicuous; midrib impressed to level above, prominent below, rusty-red in some collections, secondary veins erect-patent (5-9 per side), often arcuate near the margin, inconspicuous to prominulous above, prominulous to prominent below; tertiary venation poorly to prominulously reticulate above, prominulous below; venation pattern camptodromous-brochidodromous. *Inflorescences* (Fig. 5) greenish, axillary to subterminal, thyrso-paniculate, few to often many-flowered, 0.7-1.2 mm in diam. at the base, 4.8-8.7 cm long, pubescent to rusty-strigose, with ± short, ± appressed and ± ascending yellowish or yellow-rusty hairs, often shorter than leaves; peduncles pubescent; bracts and bracteoles deciduous. *Flower buds* cream, white-greenish or greenish. *Flowers* (Fig. 37) white, whitish, greenish, green-yellowish, cream or yellowish, minutely tomentose, 3.4-4.6(-6.0) mm long, 1.6-2.8(-4.0) mm in diam. at apex; tube urceolate to narrow-subconic-urceolate, 1.3-1.64 mm long, 0.9-1.3 mm in diam.; pedicels tomentose, 0.5-1.5 mm long; tepals equal to subequal, 1.64-2.5 mm long, 0.8-1.34(-2.0) mm broad, concave, ovate to sub-elliptical, tip acute, pilose within; stamens included; stamens of whorls I and II introrse, 1.0-1.64 mm long ($\bar{X}$ = 1.33 ± 0.22 mm; N = 18), anthers glabrous to ciliate, sub-triangular, 0.56-1.12 mm long ($\bar{X}$ = 0.79 ± 0.12 mm; N = 44), 0.3-0.58 mm broad ($\bar{X}$ = 0.45 ± 0.05 mm; N = 30), connectives prolonged beyond the large sporangia, tip obtuse to truncate, filaments densely pilose, shorter than anthers, adnate to tepals; stamens of whorl III lateral to introrse-lateral, erect, 0.99-1.85 mm long ($\bar{X}$ = 1.39 ± 0.25 mm; N = 19), anthers narrow-ovate, glabrous to ciliate, 0.64-1.0 mm long ($\bar{X}$ = 0.84 ± 0.11 mm; N = 31), 0.29-0.44 mm broad ($\bar{X}$ = 0.36 ± 0.04 mm; N = 12), connectives prolonged beyond the large sporangia, tip obtuse-rounded to truncate, filaments rather slender, equal to longer than anthers, pilose; glands subglobose, 0.32-0.89 mm long ($\bar{X}$ = 0.54 ± 0.14 mm; N = 31), 0.28-0.6 mm broad ($\bar{X}$ = 0.44 ± 0.08 mm; N = 20), pedicel long, pilose; staminodes relatively large, sagittate, 0.59-1.2 mm long ($\bar{X}$ = 0.91 ± 0.16 mm; N = 23), 0.4-0.66 mm broad ($\bar{X}$ = 0.49 ± 0.06 mm; N = 14), tip and abaxial side pilose, stalks conspicuous, short, stout, pilose; gynoecium immersed in the tube, glabrous, 1.72-3.52 mm long ($\bar{X}$ = 2.57 ± 0.59 mm; N = 9), ovary ellipsoid, 0.6-1.0 mm long ($\bar{X}$ = 0.86 ± 0.14 mm; N = 10), 0.29-0.65 mm in diam. ($\bar{X}$ = 0.41 ± 0.10; N = 10), gradually merging into the about 0.94-2.45 mm long ($\bar{X}$ = 1.67 ± 0.49 mm; N = 9) style with small, discoid stigma. *Mature fruits* (Fig. 38) straw-coloured, cream, ivory, white, yellow, pale-yellow, yellowish, yellow-whitish or yellow-greenish. *Mature fresh fruits* (without remotion of the accrescent receptacular tube) from the population of Parque Estadual Carlos Botelho are ellipsoid to globose, 1.45-3.06 cm long ($\bar{X}$ = 2.26 ± 0.28 cm; N = 1892), 1.29-2.55 cm broad ($\bar{X}$ = 1.90 ± 0.24 cm; N = 1892), longitudinally ribbed (nearly always). The diaspores (pericarp and seed) from the former fruits are 1.34-3.00 cm long ($\bar{X}$ = 2.17 ± 0.27 cm; N = 1764), 1.16-1.92 cm broad ($\bar{X}$ = 1.52 ± 0.11 cm; N = 1764; Moraes & Alves, 1997). Dried fruits (with receptacular tube adnate) from herbarium specimens, 1.85-3.14 cm long ($\bar{X}$ = 2.52 ± 0.24 cm; N = 142), 1.19-2.0 cm broad ($\bar{X}$ = 1.69 ± 0.14 cm; N = 142) (Fig. 9 H); flesh portion originated from the accrescent flower tube usually thin.

Phenology - Flowering material in February, and July to December; flowering peak between October and December. Immature fruits in January to April, July, November, and December; mature fruits in March to August, October, and November; fruiting peak mainly from May to August.

Distribution and habitat (Fig. 39) - Species registered from states of Bahia, Minas Gerais, Paraná, Rio de Janeiro, Santa Catarina and São Paulo. Mostly in Montane and Submontane Ombrophilous Dense Forest, less frequent in Semi-deciduous forests of Minas Gerais and São Paulo. From 10 to c. 1180 m altitude.

Uses - von Martius [in von Spix & von Martius' *Reise Bras.* II. 543 n. 1. 1828; 1843, 1868, and *obs. 1095b* (Plate X, B)] registered that the fruits are distinct by their aroma and flavour, being carminative and digestive (cardiac); folk medicine using the terms “fava de puchury” or “pichury” comes to the same insight. Further, Nees von Esenbeck (1836) pointed out that the dried fruits provide ethereal oils with pleasant sweet scent, resembling cloves [*Syzygium aromaticum* (L.) Merr. & L.M. Perry]; Peckolt (1868) reported that the aromatic fruits are an excellent carminative and, externally, in cataplasms, they have good effect against the “debility of stomach” and colics of children; Caminhoá (1877) also indicated that the species produces essential oils, the fruits are carminative, stimulative, and can be used as a substitute for nutmeg; according to Dragendorff (1898; after Peckolt), Peckolt & Peckolt (1899) and Pio Corrêa (1926), the bark is bitter and aromatic, considered to be stomachical and used against colics and diarrhoea etc. Record & Hess (1942) indicated that its ”timber is useful for general construction, but that the species’ chief interest is with the fruits which resemble nutmegs in appearance and pungent flavour”. The species is honey-producing (Pio Corrêa, 1926).

Traditional people from the region of Marliéria and Timóteo, Minas Gerais, Parque Estadual do Rio Doce, still use the fruits as spice (pers. obs.). Rossato (1996) reported that *caiçaras* at Picinguaba, São Paulo, use the tea from its seeds against stomachache, and its crushed leaves mixed with water against aches and colics; its wood has been used to manufacture canoes. This species is rich in alkaloids, styrylpyrones (Cavalheiro, 1995; Cavalheiro & Yoshida, 2000), and flavonoids (Pascoli *et al*., 1997).

Fruits are widely consumed by primate populations [brown howler monkeys (*Alouatta fusca* (Geoffroy Saint-Hilaire, 1812)), brown capuchins (*Cebus apella* (Linnaeus, 1758)), and woolly spider monkeys or “muriquis” (*Brachyteles arachnoides* (Geoffroy Saint-Hilaire, 1806)], and cracid birds [*Pipile jacutinga* (Spix, 1825) and *Penelope obscura* (Temminck, 1815)] (Kuhlmann, 1975; Moraes, 1992a, b, 1993; Galetti *et al.* 1997; Moraes *et al*., 2002; pers. obs.). Pizo & Oliveira (2000) also reported the chemical composition of the pulpy diaspores of *C. mandioccana* collected at Parque Estadual Intervales, Saibadela Research Station, Sete Barras, SP and indicated that 8 species of ants were attracted by the diaspores, which were part of their diet. Vieira *et al*. (2003) reported the consumption of fruits of *C. mandioccana* by small rodents of the Parque Estadual Intervales, SP. They found that the fleshy part of the fruit (accrescent tube) was eaten by *Akodon serrensis* (Thomas, 1902), *Nectomys squamipes* (Brants, 1827), *Oligoryzomys nigripes* (Olfers, 1818), and *Oryzomys russatus* (Wagner, 1848), whereas both the fleshy part and the seed were eaten by *Delomys dorsalis* (Hensel, 1872), *Oecomys* aff. *concolor* (Wagner, 1845), and *Trinomys iheringi* (Thomas, 1911). The authors also indicated that *O. russatus* is likely to be a secondary disperser of the seeds (see also Briani *et al*., 2001).

Comments - *Cryptocarya mandioccana* is a well-collected species with a relatively wide distribution. It can be recognised by its leaves that are manifestly pubescent on the lower surface, with conspicuous papillae, midrib impressed to level above, prominent below, inflorescences and flowers densely pubescent, and by its mostly ellipsoid fruits, medium-sized, clearly ribbed, with the fleshy portion usually thin. Its closest relatives seem to be *C. moschata* and *C. riedeliana* as it shares similar floral characters with them; *C. riedeliana* also has, to some extent, similar fruits.

Although *Cryptocarya mandioccana* can be easily distinguished from other congeneric species by its pubescent indument on the lower leaf surface, some collections of *C. citriformis* have been confused with it due to their general vegetative alikeness and because both species may share similar foliar indument on the lower surface. Hair orientation, whether ascending to erect or appressed to the leaf surface, appears to be stable within the species, but both extremes are found in the circumscription adopted here. Usually only one type of hair is produced on a surface. Collections of *C. mandioccana* bearing short, straight, appressed hairs on the abaxial side of leaves (which is the pattern found in the type specimen) are mainly found in populations of Bahia, Minas Gerais, Rio de Janeiro, and from Anhembi, Cunha, São Luiz do Paraitinga, and Ubatuba in state of São Paulo. The population of Serra da Cantareira, SP, shows individuals either with the former pattern of foliar indument, or with long, curled, ascending hairs on the abaxial side of leaves. The latter pattern is mainly found in populations from Paraná, Santa Catarina, and from Cubatão, Pariqüera-Açu, São Paulo, São Roque, and São Sebastião in state of São Paulo. Collections from Itajaí, SC, also show both patterns of foliar indument.

Specimens examined - 279 (listed in appendix 13.3).

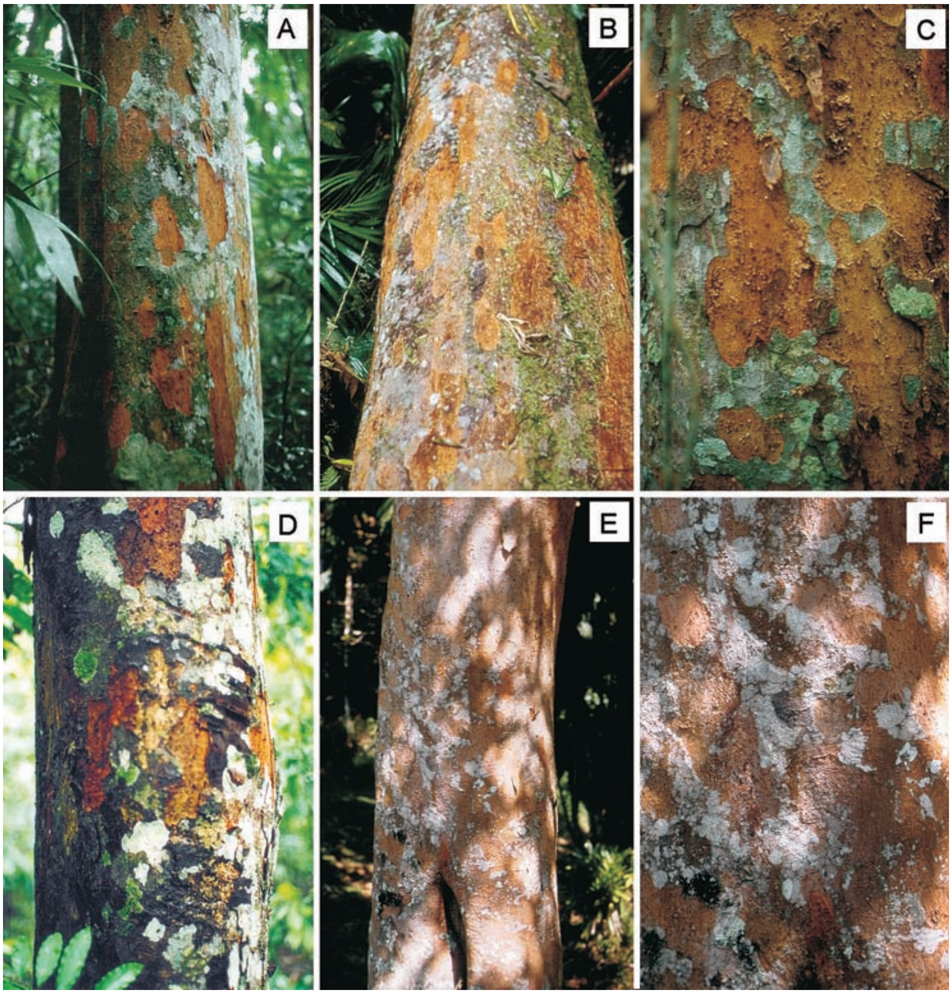

Fig. 35. Barks of *Cryptocarya mandioccana* Meissner. A-C. P.E. Carlos Botelho, São Miguel Arcanjo, SP; D. P.E. Rio Doce, MG; E-F. Serra da Estrela, Petrópolis, RJ. (Photographs by author).

Fig. 36. *Cryptocarya mandioccana* Meissner. A-B. Branches collected at P.E. Cantareira, São Paulo; C-D. Branches collected at P.E. Intervales, Núcleo Saibadela, SP; E-F. Detail of leaves. (Photographs by author).

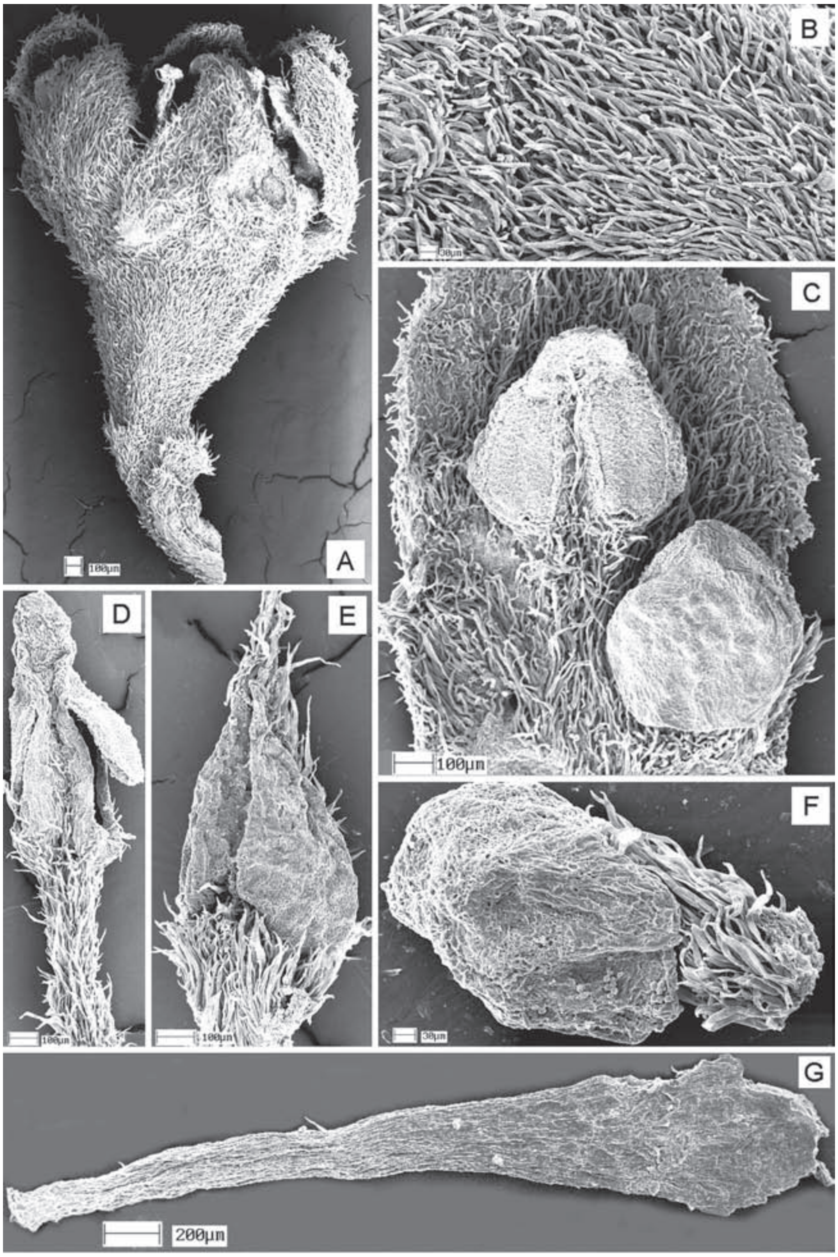

Fig. 37. SEM micrographs of flowers of *Cryptocarya mandioccana* Meissner. A. Flower bud; B. External indumenta; C. Adaxial side of stamen of the androecial whorl I, introrse, and gland; D. Abaxial side of stamen of the androecial whorl III, lateral-extrorse; E. Abaxial side of staminode; F. Detail of gland; G. Gynoecium (from *Riedel s.n.*, L-0036185). (Photomicrographs by author).

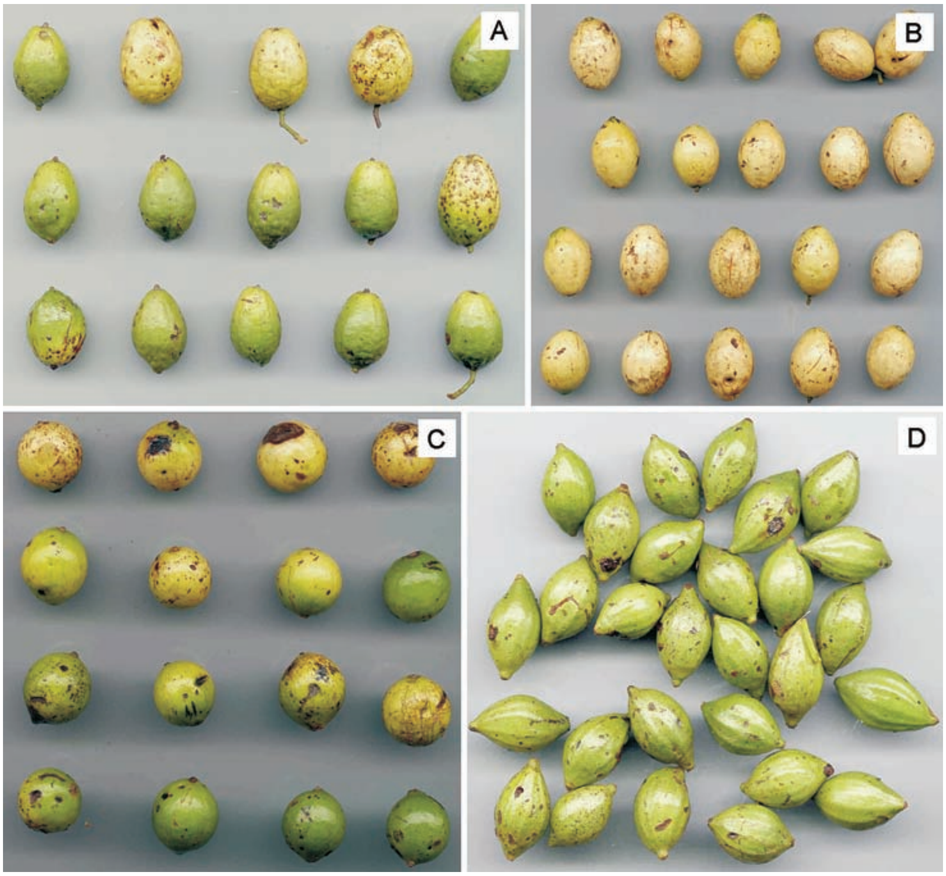

Fig. 38. *Cryptocarya mandioccana* Meissner: A-B. Mature fruits, Serra da Estrela, Petrópolis, RJ, June 2001; C. Mature fruits, E.E. Juréia-Itatins, SP, May 2001; D. Immature fruits, P.E. Intervales, Nucleus Saibadela, SP, April 2001. (Photographs by author).

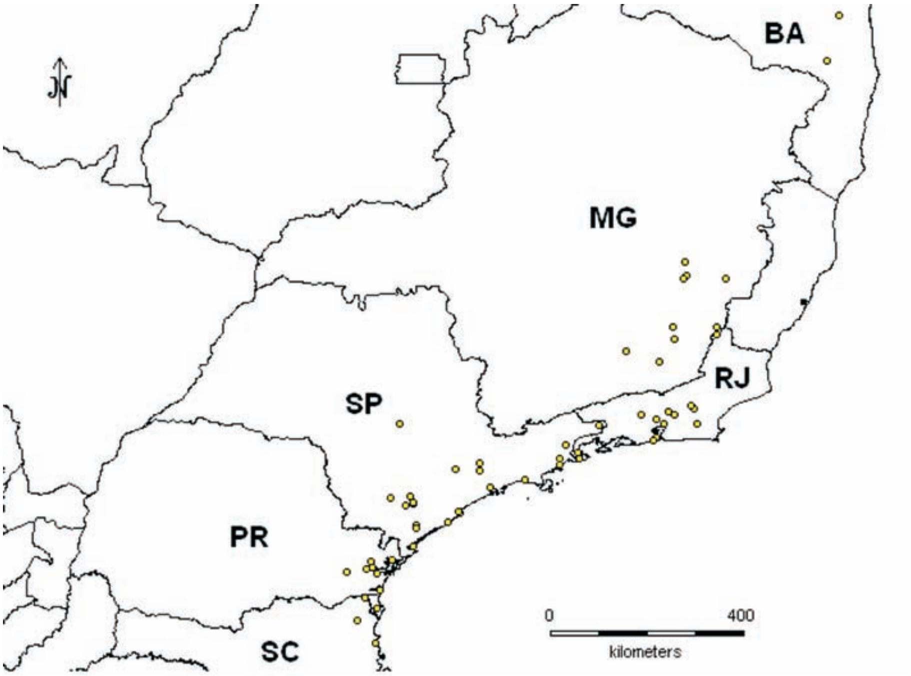

Fig. 39. Distribution of *Cryptocarya mandioccana* Meissner.

6. *Cryptocarya micrantha* Meissner

in *Prodr*. (DC.) 15 (1): 75 (1864). – Holotype: Brazil. Rio de Janeiro, “In sylv. umbr. Mand.”, Oct. 1823 (fl., fr.), *L. Riedel s.n*. [LE, photo in UEC!; isotypes: B† (F Neg. No. 3845!), GOET! (2 sheets, photos in UEC!), K! (cibachrome in UEC!), L-0033190! (photo in UEC!), L-0036191! (photo in UEC!), LE (photo in UEC!), NY-00355046! (photo in UEC!)]. Plate VII A (cf. Appendix 13.5).

= *Cryptocarya granulata* Vattimo-Gil, *Rodriguésia* 25(37): 222 et 237, *f*. 71 et 72 (1966b). – Holotype: Brazil. Minas Gerais, Vargem Alegre, Fazenda das Pedras, 25 Jul. 1928 (fr.), *J.G. Kuhlmann 39* [RB!, photo in UEC!; sheet with label of “Serviço Florestal do Brasil no. 351”, plus label of “Herbário do Jardim Botânico do Rio de Janeiro no. 91292”; isotypes: BO n.v., RB! (3 sheets, photos in UEC!)]. Plate VII B (cf. Appendix 13.5).

= *Cryptocarya schwackeana* Mez, *Arbeiten Königl. Bot. Gart. Breslau* 1: 107 (1892). – Lectotype (designated by Moraes, 2005a): Brazil. Minas Gerais, Rio Novo, s.d. (fl.), *F.P.L. Araújo s.n. in Herb. Schwacke 6680* [RB-48690!, photo in UEC! (Holotype: B†)]. Plate VIII B (cf. Appendix 13.5).

Illustrations - Mez (1889, t. III – Fig. 12, fruit), Vattimo-Gil (1957, Fig. 6, habit and fruits), Vattimo-Gil (1966b, Fig. 47-51, flower pieces; 59, fruit), Quinet (2001, Fig. 4 C, habit and flower pieces; 5 C, photograph of fruiting branch) and Quinet & Andreata (2002, Fig. 3 C, habit and flower pieces), Assis *et al*. (2005, Fig. 3 B, fruit).

Vernacular names - Canela-batalha, goiaba-de-mico.

Description - *Trees* or small trees, 3-20 m tall, trunk cylindrical, DBH 6.37-35.01 cm ($\bar{X}$ = 18.24 ± 10.12 cm; *N* = 13), bark cinnamon to red-brown, flaky, with lenticels (Fig. 40 A-B). *Branches* terete, slender, brown to gray or reddish, slightly warty, with lenticels. *Branchlets* 5 cm below teminal bud c. 1-1.6 mm in diam., slender, smooth, glabrous, dark to light-brown (dried), initially angular from the beginning; terminal buds ovoid, densely yellowish to rusty-strigose, with short, ± appressed hairs. *Petioles* thin, 5.0-10.0 mm long, 0.8-2.0 mm thick, seldom deeply to slightly canaliculate or flattish above, somewhat roundish below, glabrous, smooth to striate, dark (dried). *Leaves* alternate, elliptical to elliptic-lanceolate, 4.1-12.0 cm long, 1.1-4.5 cm broad, chartaceous to rather stiffly chartaceous (rarely coriaceous) (Fig. 41 A-D), glabrous above, glabrous to glabrescent with very sparse hairs mainly along midrib below, tip acute to obtusely or broadly acuminate, or caudate and rarely retuse, base acute to obtuse, margin flat and hardly recurved, sclerified; above green, somewhat shining in dried material, prominulously and rather reticulate, granulate in some collections; beneath paler, dull, glaucescent in some collections, papillae conspicuous to inconspicuous; midrib prominulous above, prominent below, secondary veins rather patent (7-12 per side), arcuate towards margin, prominulous on both surfaces; tertiary venation prominulous and densely reticulate below; venation pattern camptodromous-brochidodromous. *Inflorescences* axillary and subterminal, thyrso-paniculate, few to many-flowered, 0.5-2.4 mm in diam. at the base, 1.2-10.0 cm long, lax, broadly pyramidal, yellowish to rusty-tomentellous; peduncles short, smooth; bracts and bracteoles minute, ovate, acute, densely yellowish tomentellous, sub-persistent. *Flower buds* green to greenish or cream-greenish. *Flowers* greenish-yellow, whitish to greenish-white, densely yellowish-tomentellous (Fig. 42 A), with ± long, ± ascending hairs (Fig. 42 B), 2.6-3.2(-4.3) mm long, 1.2-2.0(-2.2) mm in diam. at apex; tube cylindrical sub-urceolate, glabrous within, 0.89-1.5(-1.6) mm long, 0.8-1.2 mm in diam.; pedicels nil or up to 1.3 mm long; tepals equal, 0.9-2.5 mm long, (0.6-)1.1-1.3 mm broad, concave, erect and slightly incurved at apex, ovate, roundish to acutish, pilose within; stamens included (Fig. 42 C); stamens of whorls I and II introrse, 0.5-1.0 mm long, anthers glabrous, broadly triangular-ovate (Fig. 42 D), c. (0.22-)0.28-0.66 mm long ($\bar{X} = 0.52 \pm 0.14$ mm; $N = 11$), c. (0.17-)0.33-0.45 mm broad ($\bar{X} = 0.41 \pm 0.03$ mm; $N = 12$), connectives prolonged beyond the large sporangia, tip obtuse or acutish, filaments rather slender, pilose, as long as or shorter than anthers, adnate to tepals; stamens of whorl III extrorse (Fig. 42 E), c. 0.6-1.4 mm long, anthers glabrous, c. 0.3-0.9 mm long ($\bar{X} = 0.54 \pm 0.18$ mm; $N = 13$), 0.24-0.37 mm broad ($\bar{X} = 0.29 \pm 0.04$ mm; $N = 9$), connectives thick, prolonged beyond the large sporangia, tip truncate, filaments rather stout, as long or slightly shorter than anthers, pilose; glands subglobose, 0.37-0.5 mm long, 0.3-0.5 mm broad, often with hollows, adnate to the filaments, short pedicelled to sub-sessile, pedicel pilose; staminodes relatively small (Fig. 42 F), triangular-ovate, three-edged, acute, c. 0.3-0.8 mm long, 0.25-0.3 mm broad, tip and abaxial side long pilose, nearly sessile; gynoecium ellipsoid (Fig. 42 G), 1.0-2.2 mm long, glabrous, ovary ovoid, 0.6-0.8 mm long, c. 0.3-0.5 mm broad, style 0.6-1.4 mm long, cylindrical-conical, stigma small, truncate, obtuse. *Immature fruits* green (Fig. 41 E). *Mature fruits* green-yellowish, green or orange, pear-shaped with a neck at base (Fig. 9 E), or ellipsoid to globose (Fig. 9 G; Plate VII A-B (cf. Appendix 13.5), many-ribbed, 1.45-4.1 cm long ($N = 150$; $\bar{X} = 3.08 \pm 0.43$ cm), 0.95-3.0 cm broad ($N = 150$; $\bar{X} = 2.12 \pm 0.34$ cm); flesh portion originated from the accrescent flower tube usually thin.

Phenology - Flowering material in January, May, June, August to November. Immature fruits in April to September, November and December; mature fruits in June, July, October, and November.

Distribution and habitat (Fig. 43) - Species restricted to the states of Espírito Santo, Minas Gerais, Rio de Janeiro and São Paulo. Mostly in the Ombrophilous Dense Forest, but also collected in Semi-decidual forests of Minas Gerais, from 10-900 m altitude. Judging from my own collections at Serra da Juréia and Serra da Estrela and from the scarce material deposited in herbaria (52 collections), the species likely occurs only at low frequency and low density in the known populations.

Comments - *Cryptocarya micrantha* can be recognised by its branchlets glabrous, leaves elliptical, chartaceous, glabrous above, glabrous to glabrescent below, midrib prominulous above, prominent below, secondary veins prominulous on both surfaces, tertiary venation prominulous and densely reticulate below, petioles almost always slightly canaliculate or flattish above, inflorescences and flowers densely tomentellous, and fruits relatively large, pear-shaped with a neck at base or ellipsoid to globose, many-ribbed. As pointed out previously, the species seems to be related to *C. botelhensis*, and also with *C. moschata*, which can be easily mistaken for this species due to overall vegetative alikeness of some collections.

As pointed out by Kostermans (1937), the ring around the style, described by Mez (1892) in *C. schwackeana*, does not occur in all specimens and it seems to be the result of compression of the style in the narrow throat of the flower tube. Specimens from Serra da Juréia, SP bear fruits differing from the predominant pear-shaped pattern presented by collections of *C. micrantha* from Rio de Janeiro and Minas Gerais. However, their vegetative and flower characters are alike, except for the tip of leaves being caudate from several samples of the former.

Fresh leaves of *C. micrantha* showed to possess a high concentration of mucilage, which was observed during extractions of total DNA and isozymes for subsequent analyses.

Specimens examined - 52 (listed in appendix 13.3).

Fig. 40. Appearance of barks of *Cryptocarya micrantha* Meissner at Serra da Estrela, Petrópolis, RJ. (Photographs by author).

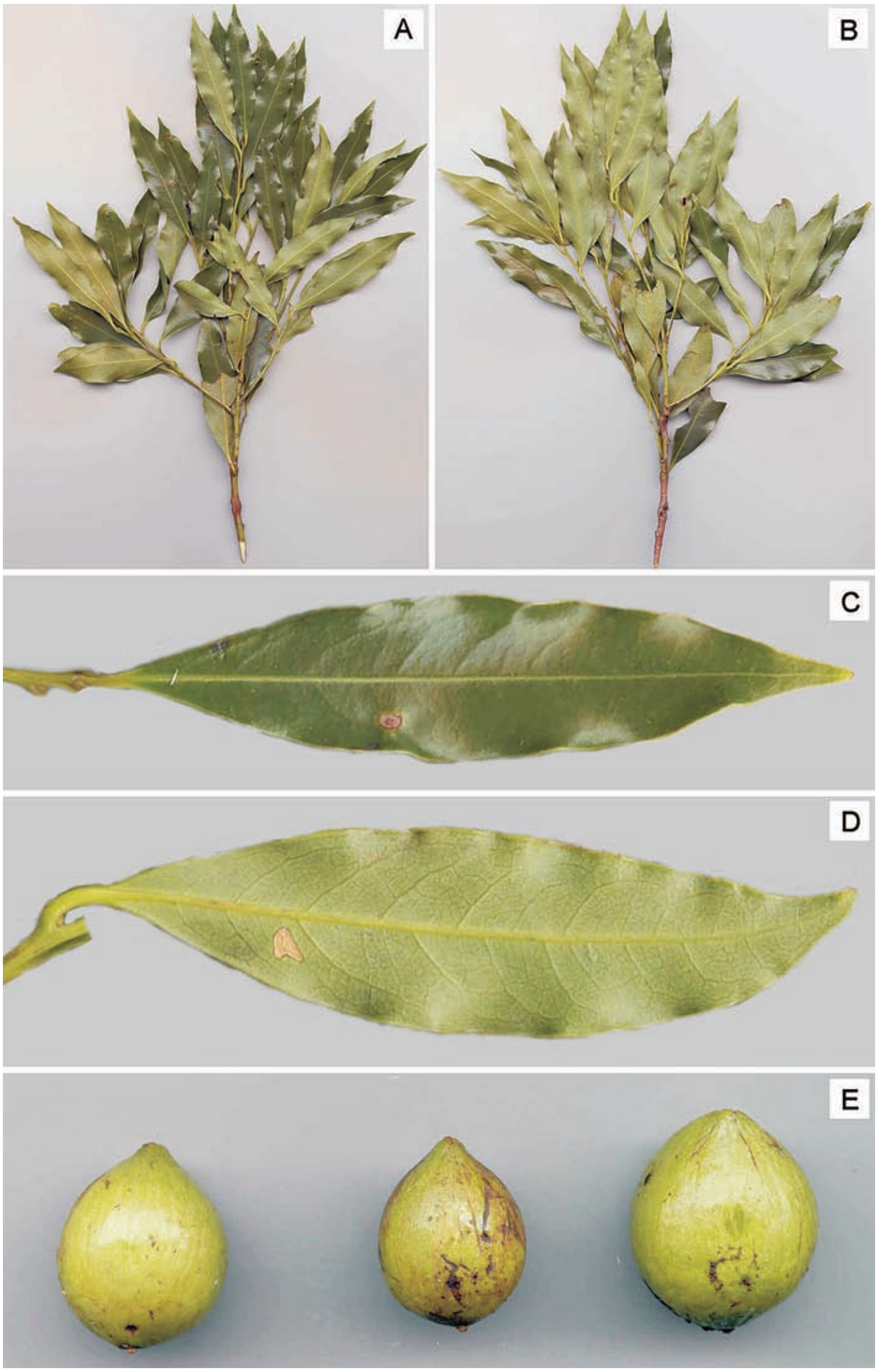

Fig. 41. *Cryptocarya micrantha* Meissner. A-B. Branches collected at Serra da Estrela, Petrópolis; C-D. Detail of leaves; E. Immature fruits, June 2001. (Photographs by author).

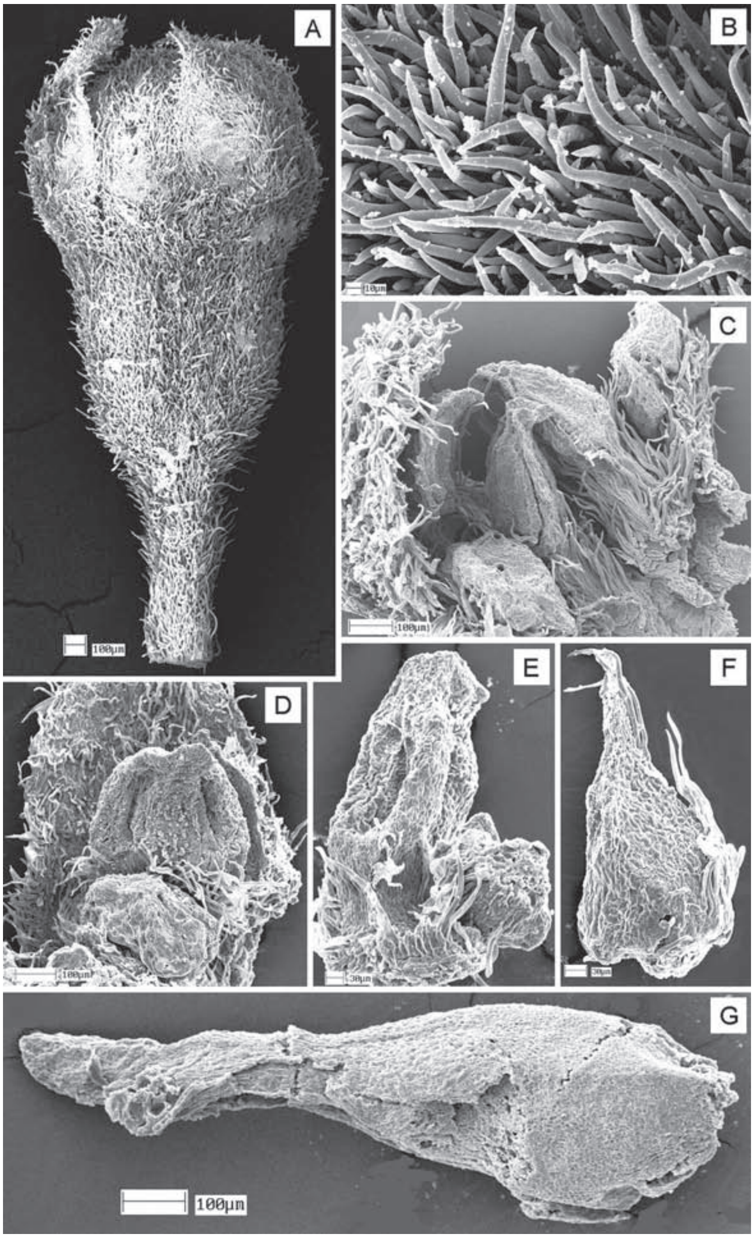

Fig. 42. EM micrographs of flowers of *Cryptocarya micrantha* Meissner. A. Flower bud (from *Riedel s.n.*, L-0036191); B. External indument (from *Riedel s.n.*, L-0036191); C. Longitudinal section of fully developed flower (from *Heringer 913*, ESA); D. Adaxial side of stamen of the androecial whorl I, introrse, and gland (from *Riedel s.n.*, L-0036191); E. Abaxial side of stamen of the andreocial whorl III, lateral-extrorse, and gland (from *Riedel s.n.*, L-0036191); F. Abaxial side of staminode (from *Riedel s.n.*, L-0036191); G. Gynoecium (from *Riedel s.n.*, L-0036191). (Photomicrographs by author).

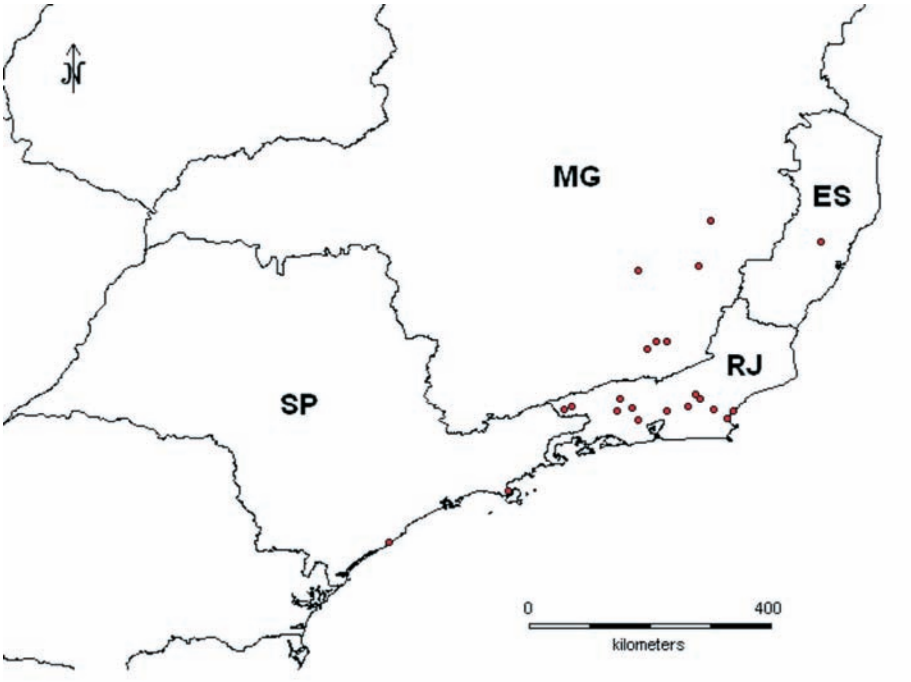

Fig. 43. Distribution of *Cryptocarya micrantha* Meissner.

7. *Cryptocarya moschata* Nees & Martius ex Nees

Linnaea 8: 37 (1833). – Lectotype (designated by Moraes, 2005a): Brazil. “Brasilia tropica”, s.d. (fl.), *F. Sellow s.n.* (*1375* fide Nees, 1836) [LE, photo in UEC!; isolectotypes: B† (F-619557!, fragments, photo in UEC!), CGE (photo in UEC!), E-109558! (photo in UEC!), HAL-101917 (photo in UEC!), K! (cibachrome in UEC!), K! (cibachrome in UEC!), KIEL! (photo in UEC!), L-0246990! (photo in UEC!), L-0246991! (photo in UEC!), US-00811475 (photo in UEC!)]. Fig. 49; Plate IX A (cf. Appendix 13.5).

= *Cryptocarya moschata* forma *angustifolia* Mez, *Jahrb. Königl. Bot. Gart. Berlin* 5: 9 (1889). – Lectotype (designated by Moraes, 2005a): Brazil. Minas Gerais, 1845 (fl.), *J.F. Widgren 394* (BR-837722!, photo in UEC!; isolectotypes: K! (cibachrome in UEC!), LE (photo in UEC!), NY! (fragments, photo in UEC!), O!, R-30946! (photo in UEC!), S (3 sheets, photocopies in UEC!), U-0017916!, UPS (photo in UEC!). Plate IX B (cf. Appendix 13.5).

= *Nectandra robusta* Löfgren & Everett (1905) ex E. Navarro de Andrade & O. Vecchi, in *Les bois indigènes de São Paulo* 43 (1916). – Lectotype (designated here): drawing of branch with fruits and fruits in longitudinal and transversal sections in Navarro de Andrade & Vecchi (1916). Plate X A (cf. Appendix 13.5).

Illustrations - Meissner (1866, plate LVI), Coe-Teixeira (1965, Tab. I, Fig. 1, leaf, flower pieces and fruit), Moraes (2003, pr. 3 F-G, flower and stamen of androecial whorl I).

Vernacular names - Bataia, bataira, bataeira, batalha, batalheira, cajaty, canela-bastarda, canela-batalha, canela-batalheira, cabela-branca, canela-cega, canela-de-papagaio, canela-preta, farinha-seca, fruto-de-jacu, louro-precioso, pau-santo, tiriveiro.

Description - *Trees* up to 35 m tall, trunk cylindrical, DBH 8.0-199.90 cm ($\bar{X}$ = 55.37 ± 28.37 cm; *N* = 205), bark (Fig. 44) cinnamon to ochre-coloured or tawny, flaky in adult trees, smooth to rugose in the young, with lenticels. *Branches* cylindrical, thick, light to dark brown or grayish to blackish, smooth or with conspicuous longitudinal lenticels. *Branchlets* (Fig. 45 A-B) 5 cm below terminal bud c. 1.2-3.2 mm in diam., light or dark brownish, initially sub-angular or terete from the beginning, smooth to estriate, glabrous to glabrescent, with yellowish or rusty, mostly short, ± appressed hairs, somewhat shining; terminal buds minute, ovoid, pubescent, densely covered by yellowish, short, ± appressed hairs. *Petioles* thin, (3.7-)6.0-17.7 mm long, 0.7-1.8 mm thick, deeply canaliculate to subcanaliculate to flattish above, roundish below, rugose, glabrous. *Leaves* (Fig. 45 A-D) alternate, narrow-elliptical to lanceolate or obovate, (2.2-)3.5-16.0 cm long, (1.0-)1.5-6.5 cm broad, chartaceous to chartaceous-coriaceous (rarely rigid-coriaceous); young leaves sparsely pubescent on both surfaces, whereas adult leaves mostly glabrous on both surfaces, but some collections glabrescent below, with sparse hairs along midrib; tip mostly acute to acuminate to short-cuspidate or obtuse to rounded, base acute to attenuate or rarely obtuse, margin flat, incurved towards the base in some collections, sclerified; above rather shining, prominulous reticulate, rarely inconspicuous; beneath paler, with papillae conspicuous; midrib impressed to level to prominulous above, prominent below, secondary veins patent to erect-patent (5-11 per side), mostly prominulous or rarely poorly reticulate on both surfaces; tertiary venation loosely to mostly reticulate; venation pattern camptodromous-brochidodromous. *Inflorescences* axillary, paniculate, many-flowered, 0.6-1.1 mm in diam. at base, 1.7-10.0 cm long, sparse yellowish pubescent to rusty-strigose, often glabrescent towards the base, shorter than leaves; bracts and bracteoles minute, densely tomentelous. *Flowers* (Fig. 46) cream, light-cream, green, greenish, green-yellowish, yellow, yellowish or yellow-greenish, sparsely to densely pubescent, seldom glabrescent, with ± short, ± appressed hairs, c. 2.7-4.0(-5.0) mm long, 1.4-2.84(-4.0) mm in diam. at apex, tube urceolate, 0.98-2.6 mm long, 0.5-1.77 mm in diam.; pedicels mostly tomentose, glabrescent in few collections, 0.3-0.7(-1.0) mm long; tepals subequal, 1.47-2.44(-2.5) mm long (X̄ = 1.84 ± 0.29 mm; *N* = 17), 0.68-1.73 mm broad (X̄ = 1.04 ± 0.32 mm; *N* = 13), concave, ovate, tip acute to obtuse or rounded, pilose within; stamens included; stamens of whorls I and II introrse, incurved, 1.0-1.67 (X̄ = 1.32 ± 0.19 mm; *N* = 13), anthers sparse pilose or ciliate, ovate to ovate-oblong, 0.51-0.99 mm long (X̄ = 0.72 ± 0.13 mm; *N* = 24), 0.3-0.58 mm broad (X̄ = 0.46 ± 0.06 mm; *N* = 22), connectives prolonged beyond the large sporangia, tip acute or obtuse to truncate, filaments rather slender, densely pilose, usually shorter than anthers, adnate to tepals; stamens of whorl III lateral to extrorse-lateral, erect, 1.0-1.73 mm long (X̄ = 1.29 ± 0.19 mm; *N* = 15), anthers narrow-ovate, ciliate, 0.63-0.86 mm long (X̄ = 0.73 ± 0.07 mm; *N* = 19), 0.26-0.37 mm broad (X̄ = 0.33 ± 0.04 mm; *N* = 7), connectives obtuse to truncate, prolonged beyond the large sporangia, filaments rather stout, equal or shorter than anthers, pilose; glands subglobose, sagittate, 0.4-0.66 mm long (X̄ = 0.52 ± 0.07 mm; *N* = 17), 0.31-0.43 mm broad (X̄ = 0.37 ± 0.05 mm; *N* = 7), pedicel long, pilose, rather distant from the filaments; staminodes relatively small, triangular-ovate, flattened, 0.52-0.9 mm long (X̄ = 0.68 ± 0.11 mm; *N* = 20), 0.33-0.48 mm broad (X̄ = 0.40 ± 0.05 mm; *N* = 10), tip and abaxial side pilose, stalks conspicuous, stout, pilose; gynoecium immersed in the tube, glabrous, 2.0-3.21 mm long (X̄ = 2.39 ± 0.31 mm; *N* = 12), ovary ellipsoid, 0.73-1.26 mm long (X̄ = 0.90 ± 0.13 mm; *N* = 16), 0.3-0.8 mm in diam. (X̄ = 0.47 ± 0.13 mm; *N* = 18), gradually merging into the about 1.2-1.88(-2.0) mm long (X̄ = 1.50 ± 0.22 mm; *N* = 12) style with small, truncate, discoid stigma. *Fruits* yellow, light-yellow, yellowish, yellow-whitish, whitish or reddish. *Mature fresh fruits* (with the accrescent flower tube) from 37 trees of 11 populations are ellipsoid to globose (Moraes & Alves, 2002), 1.78-3.47 cm long (X̄ = 2.50 ± 0.28 cm; *N* = 1487), 1.10-3.20 cm broad (X̄ = 2.37 ± 0.22 cm; *N* = 1487) (Fig. 47). The diaspores from the former fruits are 1.38-3.00 cm long (X̄ = 2.15 ± 0.24 cm; *N* = 1283), 1.00-2.16 cm broad (X̄ = 1.50 ± 0.15 cm; *N* = 1283; Moraes & Alves, 2002). Dried fruits from herbarium specimens 1.26-2.52 cm long (X̄ = 2.21 ± 0.21 cm; *N* = 198), 1.02-1.8 cm broad (X̄ = 1.33 ± 0.13 cm; *N* = 198), slightly ribbed to smooth or with vestigial ridges (Fig. 9 J-K); flesh portion originated from the accrescent flower tube usually thick.

Phenology - Flowering material in June to October. Immature fruits in February, March, May, and July to December. Mature fruits in January to May, and August. At Fazenda Barreiro Rico, Assumpção (1983) reported that fruit production is massive and fruits are available at least from December to March.

Distribution and habitat (Fig. 48) - Species collected in Alagoas, Bahia, Distrito Federal, Goiás, Mato Grosso, Minas Gerais, Paraná, Pernambuco, and

São Paulo. Mainly in Semi-deciduous forests, but also in riparian forests, from c. 20 to 1660 m altitude. According to Kuhlmann & Kühn (1947), it is found in dry and stony soils, being indicative of poor lands for agriculture.

Uses - Assumpção (1983) reported that ripening fruits are eaten by the monkeys *Alouatta guariba*, *Brachyteles arachnoides*, *Callicebus personatus* and *Cebus apella*, at Fazenda Barreiro Rico; Galetti *et al*. (1994) observed that in the Santa Genebra Reserve, *A. guariba* and the bat *Artibeus lituratus*, also consume the fruits; further at Bosque dos Jequitibás, Campinas, fruits are eaten by agoutis (*Dasyprocta agouti*) that have been introduced in the area.

Formariz *et al*. (2002) evaluated the antiproliferative activity of crude extracts from leaves and stems of *Cryptocarya moschata*. The antitumoral activity was evaluated in human tumour cell lines that have phenotypical resistance for multiple drugs viz. melanoma, breast, lung, ovary, prostate, kidney, colon and breast.

The species has also been recommended for mixed plantations in programs of restoration of disturbed areas, degraded environments, gallery forests and recuperation of margins of hydroelectric reservoirs.

Comments - *Cryptocarya moschata* can be recognised by its usually chartaceous to chartaceous-coriaceous leaves, adult leaves mostly glabrous on both surfaces, rather shining above, generally prominulous reticulate, paler and conspicuously papillate beneath, midrib little to prominulous impressed above, prominent below, glands subglobose, sagittate, long-pedicelled, rather distant from the filaments, and mature fruits ellipsoid to globose, with pericarp slightly ribbed to smooth or with vestigial ridges and with the flesh portion developed from the accrescent flower tube usually thick. As mentioned before, it is difficult to separate *C. aschersoniana* from *C. moschata*. The variational range of the latter species includes almost all characteristics of *C. aschersoniana*, but the two can be best be distinguished with mature fruit collections and some differences in the field (e.g. outer bark, habit).

Rohwer (1993b), in his revision of neotropical *Nectandra*, included *N. robusta* Löfgren & Everett ex E. Navarro de Andrade & O. Vecchi in the list of doubtful names and excluded the taxon since no type was indicated. Instead, Rohwer (1993b) judged that the drawing represents a *Cryptocarya* sp. Indeed, the common name 'Batalha', its drawing and the general description would support the identification as *C. moschata*. However, the name *Nectandra robusta* can still be found in recent compilations of arboreal species from Brazil, as a valid species (Camargos *et al*., 1996).

Specimens examined - 289 (listed in appendix 13.3).

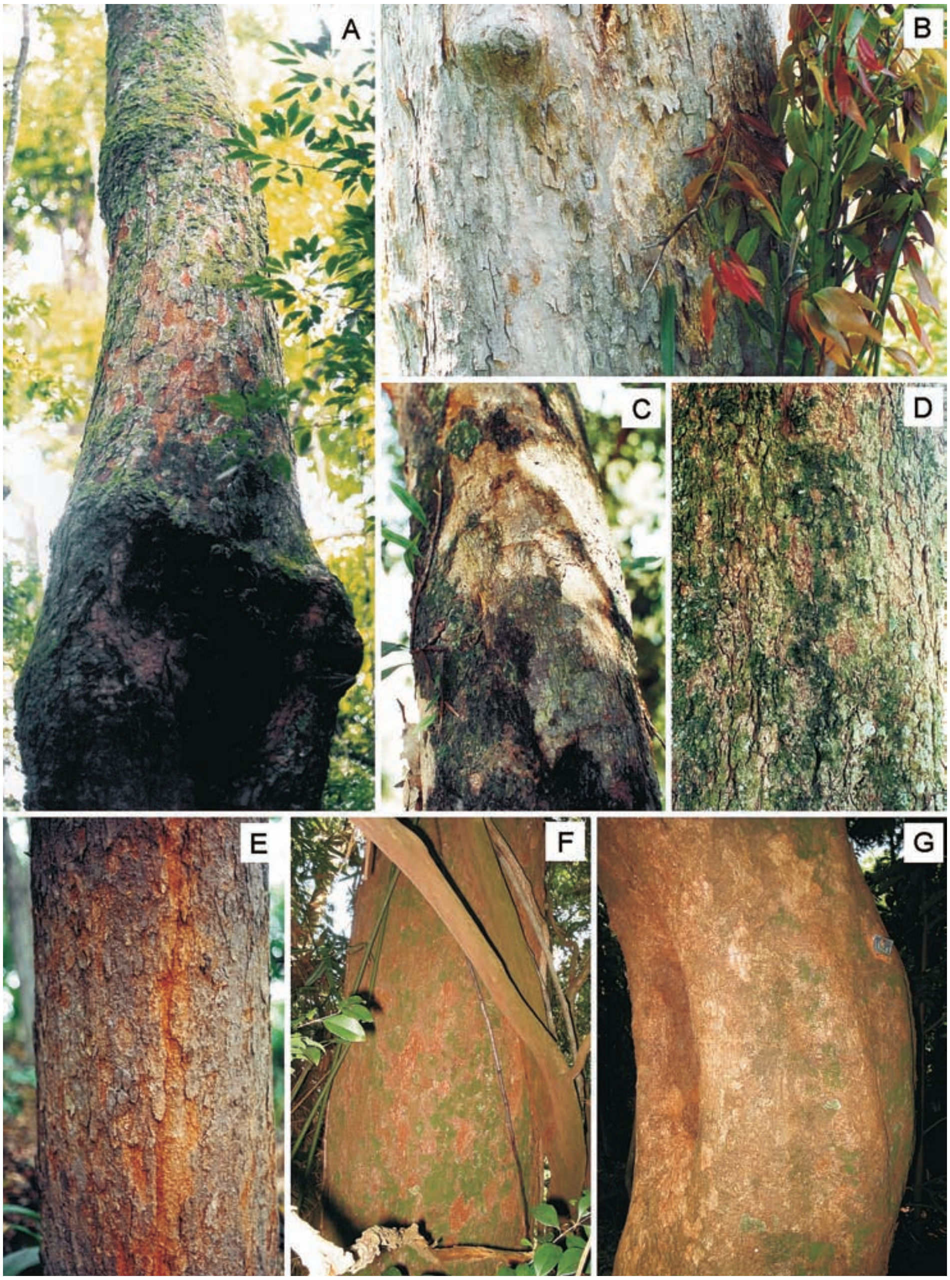

Fig. 44. Barks of *Cryptocarya moschata* Nees & Martius. A. Fazenda Barreiro Rico, Anhembi, SP; B. São Tomás de Aquino, MG, with lateral stems and young red leaves; C. Andradas, MG; D. Fazenda São José, Rio Claro, SP; E. Bosque dos Alemães, Campinas, SP; F. São Pedro, SP; G. Bosque dos Jequitibás, Campinas, SP. (Photographs by author).

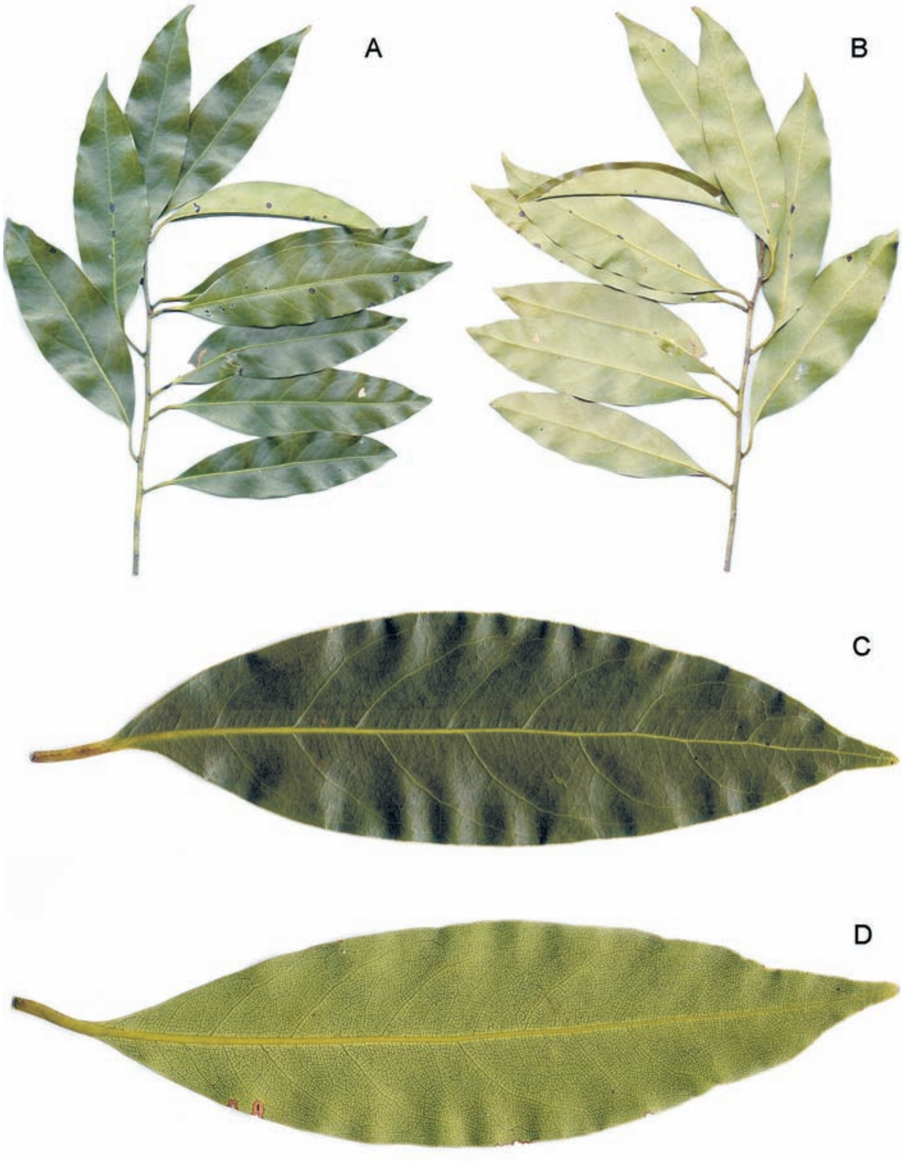

Fig. 45. *Cryptocarya moschata* Nees & Martius. A-B. Branches collected at São Pedro, SP; C-D. Detail of leaves. (Photographs by author).

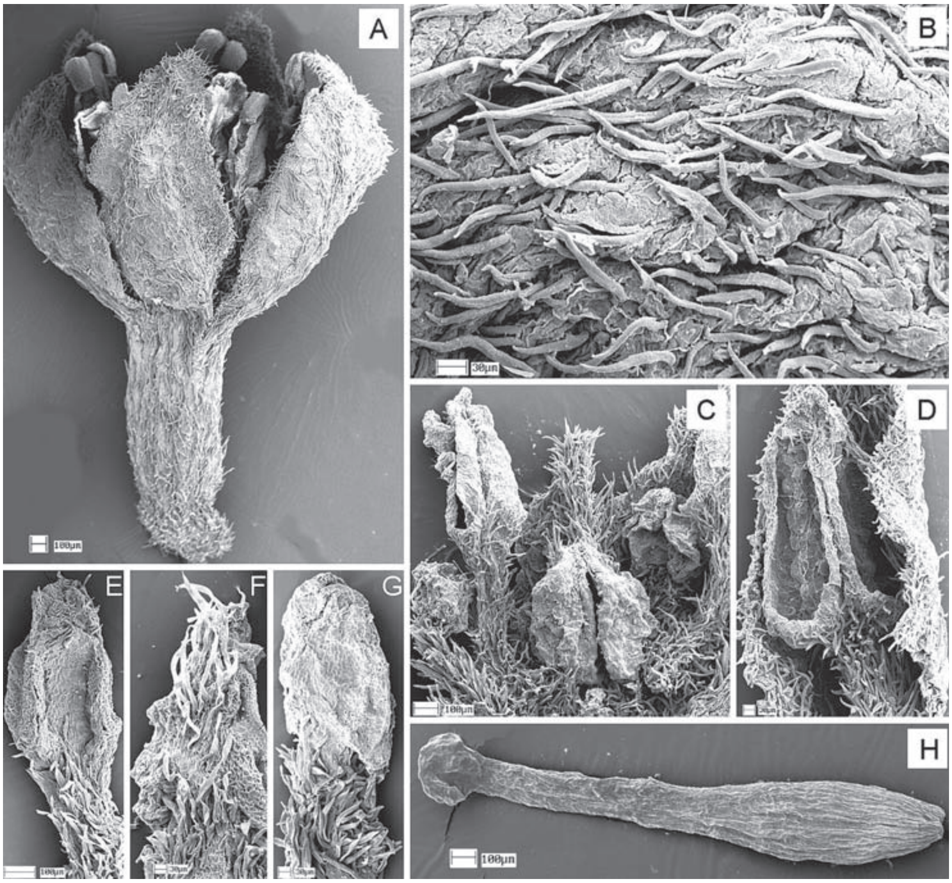

Fig. 46. SEM micrographs of flowers of *Cryptocarya moschata* Nees & Martius. A. Flower bud (from *Warming 684*, C); B. External indument (from *Sellow s.n.*, L-0246991); C. Longitudinal section of flower (from *Sellow s.n.*, L-0246991); D. Adaxial side of stamen of the androecial whorl I, introrse (from *Sellow s.n.*, L-0246991); E. Abaxial side of stamen of the androecial whorl III (from *Sellow s.n.*, L-0246991); F. Adaxial side of staminode (from *Sellow s.n.*, L-0246991); G. Detail of gland (from *Sellow s.n.*, L-0246991); H. Gynoecium (from *Warming 684*, C). (Photomicrographs by author).

Fig. 47. *Cryptocarya moschata* Nees & Martius. A. Ripe fruits still in green colour at São Pedro, SP, in January 2006; B. Fruits collected at Mata do Alemão, Ibaté, SP, January 2001; C. Fruits collected at Mogi Mirim, SP, January 2001; D. Fruits collected at Fazenda Palmital, Santo Antonio de Posse, SP, January 2001. (Photographs by author).