A Revision of the Genus *Cinchona* (Rubiaceae–Cinchoneae)

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Abstract

Andersson, L. (Department of Systematic Botany, University of Göteborg, Carl Skottsbergs Gata 22B, S-413 19 Göteborg, Sweden). Mem. New York Bot. Gard. **80:** 1-000. 1997.—Because of its medicinal importance as a source of quinine, the genus *Cinchona* L. has attracted extraordinary attention from taxonomists historically, and more than 330 names are considered. Twenty-three species are recognized here, three of them new to science: *Cinchona antioquiae* L. Andersson (Colombia), *C. fruticosa* L. Andersson (Peru), and *C. pyrifolia* L. Andersson (Peru). *Cinchona krauseana* L. Andersson is presented as a new name for *Ladenbergia coriacea* K. Krause (not *C. coriacea* Poir.). *Cinchona calisaya* Wedd., *C. lancifolia* Mutis, *C. lucumifolia* Pav. *ex* Lindl., *C. macrocalyx* Pav. *ex* DC., and *C. nitida* Ruiz & Pav. are restored from synonymy under *C. officinalis* L., and *C. hirsuta* Ruiz & Pav., *C. mutisii* Lamb., and *C. scrobiculata* Humb. & Bonpl. are restored from synonymy under *C. pubescens* Vahl. *Cinchona officinalis,* as circumscribed here, is endemic to a small area in southern Ecuador, and has never had any medicinal significance. The genus is characterized by presence of a terminal inflorescence, (usually) reddish corollas, corolla lobes without a ridged terminal portion, villous corolla lobe margins, presence of tissue thinnings in the tissue of the corolla tube, different filament lengths in short- and long-styled flowers, and capsules that usually open upward from below. It occurs spontaneously in premontane and montane forests from central Bolivia to northern Colombia and Venezuela, with one widespread species also extending north to Costa Rica, and into the Cordillera de La Costa of northern Venezuela. It is concluded that the ancestor probably occurred in montane forests of the central Andes.

Resúmen

Andersson, L. (Department of Systematic Botany, University of Göteborg, Carl Skottsbergs Gata 22B, S-413 19 Göteborg, Sweden). Mem. New York Bot. Gard. **00:** 000–000. 199X.—Por su importancia medicinal, como una fuente de quinina, el género *Cinchona* L. historicamente ha llamado una atención excepcional entre taxónomos y se consideran más de 330 nombres. En el presente trabajo se reconocen 23 especies, tres de ellas nuevas para la ciencia: *Cinchona antioquiae* L. Andersson (Colombia), *C. fruticosa* L. Andersson (Peru), y *C. pyrifolia* L. Andersson (Perú). Ademas, se presenta *Cinchona krauseana* L. Andersson como un nombre nuevo para *Ladenbergia coriacea* K. Krause (no *C. coriacea* Poir.). Se reestablecen *Cinchona calisaya* Wedd., *C. lancifolia* Mutis, *C. lucumifolia* Pav. *ex* Lindl., *C. macrocalyx* Pav. *ex* DC., y *C. nitida* Ruiz & Pav. sinonimizados bajo *C. officinalis* L., y *C. hirsuta* Ruiz & Pav., *C. mutisii* Lamb., y *C. scrobiculata* Humb. & Bonpl. sinonimizados bajo *C. pubescens* Vahl. *Cinchona officinalis,* como se delimita aquí, es endémica para una región pequeña en el sur del Ecuador y nunca ha tenido importancia medicinal. El género se caracteriza por la presencia de una inflorescencia terminal, (generalmente) corolas rojizas, lóbulos de la corola careciendo de una parte terminal quillada, lóbulos de la corola con márgenes vellosas, presencia de lineas verticales extenuadas en el tejido del tubo de la corola, la longitud de los filamentos es diferente en flores brevistilas y macrostilas, y cápsulas que generalmente se abren desde abajo hacia arriba. El género ocurre espontaneamente en bosques premontanos y montanos desde Bolivia central hasta el norte de Colombia y Venezuela, y una especie también tiene distribución amplia en América Central, hasta Costa Rica en el norte, y en la Cordillera de La Costa en el norte de Venezuela. Se concluye que la especie ancestral probablemente ocurrió en bosques montanos en los Andes centrales.

Introduction

This revision aims to improve the reputation of one of the most infamous genera of Andean plants. Despite its small size, it has been regarded as taxonomically hopeless for more than a century. Part of the problem comes from the fact that, owing to its medicinal importance as a source of quinine, the genus attracted an extreme amount of attention from taxonomists and pharmacists in the late 18th and early 19th century. More than 330 names have been considered in this revision, with little hope that all the variety-level names have been dug out. Considering that nearly all these names were published more than 100 years ago, and most of them more than 150 years ago, and that the original collections mostly consisted of numerous, poorly labeled specimens that often have become confused over the years, it is obvious that nomenclatural work has been more time-consuming than taxonomic work. Real taxonomic problems, on the other hand, are caused by two principal factors: species of *Cinchona* tend to hybridize whenever they meet, and sampling of the southern part of the distribution area, from northernmost Peru and southward, is still very poor and uneven.

Most species of the genus seem to have rather restricted ranges, and most of them do not meet in nature. Where sympatric on a larger scale they seem to be ecologically differentiated, mainly in relation to altitude. Few species, therefore, grow in the immediate vicinity of one another. *Cinchona pubescens* is distributed throughout the range of the genus, however, and also has a wide ecological amplitude. Most spontaneous hybrids are therefore crosses between *C. pubescens* and other species with more restricted ranges. Hybridization seems to have no deleterious effect on such fertility indicators as pollen stainability, fruit set, or seed set. It is not surprising, then, to see morphological indications of extensive introgression in certain areas. Under such circumstances it is inevitable that demarcations between species will have to remain somewhat arbitrary, at least until more-detailed biosystematic studies have been performed.

Around the middle of the 19th century, a number of species that do not meet in nature were grown together in experimental plantations in India and on Java. A surprisingly large proportion of the material from these plantations seems to be hybridogenous, and, without knowledge of the provenance of the material or of which species were grown together, this material is not possible to identify. It is usually not clear whether this extensive hybridization occurred spontaneously or was the result of experiments. It should be added that cultivated material has been quite summarily studied in this revision.

Sampling in Colombia and Ecuador was dramatically improved by the United States Cinchona Missions during World War II (described in some detail by Hodge, 1948). From these countries there now exists a reasonably ample and evenly sampled material. In Peru and Bolivia, on the other hand, the activities of the Cinchona Mission were restricted to a few, small areas, and the material brought together was also much less than that from Colombia and Ecuador. For Bolivia, where only three species seem to occur, this paucity of material is not so significant, but for northern and central Peru, where the number of species is larger, it is a serious obstacle. The treatment of the Peruvian species given here should therefore be regarded as rather tentative.

Cinchona, and specifically the miraculous medicinal properties of its bark, became known in Europe shortly after 1640, in which year the Countess of Chinchón, for whom the genus is named, returned from Peru, bringing with her a supply of the new drug (Markham, 1880). The first detailed description of a species of *Cinchona* was that of La Condamine (1738), on which Linnaeus (1753) eventually based his *Cinchona officinalis.* La Condamine's description is, despite being illustrated, not easy to interpret. Fortunately, he also sent a few leaves with his manuscript, and these leaves are still preserved (Andersson, 1994). Ironically, La Condamine got hold of the wrong species and, according to the analyses of the Cinchona Mission (in schedulae), *C. officinalis* seems never to contain more than traces of quinine. The species extracted for medicinal purposes around Loja was supposedly *C. pubescens,* also growing on the Nudo de Cajanuma, where La Condamine collected his specimen and where it was collected somewhat later by J. de Jussieu. Vahl's (1790) description of *C. pubescens* may in fact have been based on this collection. During the 18th century and the early 19th century, new species were described by, e.g., Mutis (1793), Ruiz and Pavón (1799, 1802), and Humboldt and Bonpland (1805–1808).

In 1804 and 1805, J. Tafalla collected extensively in southern Ecuador and northernmost Peru, bringing together ample material that was sent to Pavón in Madrid. Pavón revised this material and provided names and descriptions of numerous new species. Pavón never published his work, however, but rather sold both the collections and the manuscripts. Many of Pavón's names were soon brought into print by others, e.g., Lambert (1821) and de Candolle (1830), but it was not until J. E. Howard acquired Pavón's manuscript and provided it with illustrations (Howard, 1859–1862) that Pavón's revision was eventually published. The typification and citation problems associated with the Pavón names published by Howard were discussed by Andersson (1994).

The genus was monographed four times during the 19th century, namely by Lambert (1821), de Candolle (1830), Weddell (1849), and Kuntze (1878), without any consensus on the nomenclature being reached. After that, no revision of the genus appeared, although all species were in fact treated by Standley in his series of papers on the Rubiaceae of the Andean states (Standley, 1930, 1931a, 1931b, 1931c, 1936). Standley obviously had not the ambition to revise the genus, however, and, as he says in one of the publications (Standley, 1936: 24), the "enumeration of the *Cinchona* species is far from satisfactory." The major faults with Standley's treatments are mainly attributable to two facts: first, the material available to him was insufficient and derived from a far too uneven sampling, and second, he did not undertake the task of typifying all the names. As already mentioned, the major breakthrough in sampling came with the U.S. Cinchona Missions during World War II. The late Dr. Raymond Fosberg started a revision of this material and, judging from his numerous annotations on the specimens, made good progress, but his treatment was never finished.

Material and Methods

Material

In all essentials, this revision is based on a study of herbarium collections. All available material was studied from the following herbaria (those personally visited are indicated with an asterisk): A, AAU*, B*, BM*, C*, COL*, F*, FI (photos only), G*, GH, GB*, HBG, K*, L, LINN (microfiche only), M, MA*, MO*, NY*, O, P*, QCA, S*, SEL, U, US*, W. Regrettably, no loans were obtainable from LE. A total of ca. 1700 collections (ca. 3500 herbarium specimens) was studied. The study was concentrated on presumably spontaneous material, and material from cultivation was studied only in passing. Cultivated material was recorded only to document the earliest known record of cultivation in a country or region. Identifications for all collections studied are provided in the List of Exsiccatae, excluding those with anonymous collectors.

Macromorphology and Measurements

Descriptions of growth habit are based entirely on label data. Vegetative, inflorescence, and fruit