A REVISION OF THE WHITE-FLOWERED SPECIES OF CHONDROSCAPHE (ORCHIDACEAE: ZYGOPETALINAE)

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ABSTRACT. The taxonomic history of *Chondroscaphe* and the *Chondrorhyncha bicolor* group is summarized. Full description, distribution, ecology and taxonomic discussion are provided for each species, and most taxa are illustrated with one or more composite plates. A new species, *C. venezuelana*, is described and illustrated from the State of Merida in Venezuela. An artificial key to the white-flowered species of *Chondroscaphe* is provided.

KEY WORDS: Orchidaceae, Zygopetalinae, *Chondroscaphe, C. venezuelana,* Venezuela, new species

Introduction

The color of the flowers is not usually regarded as a good indicator of taxonomic relationships, even within the limits of a single genus. There are good reasons, however, to use such an informal grouping to delimit a discrete number of species and to better understand some specific concepts in the genus *Chondroscaphe* (Dressler) Senghas & G. Gerlach.

When *Chondroscaphe* was originally created as a section of the polymorphic *Chondrorhyncha* Lindl., several features were mentioned as characteristic of the group, including the inflorescences born successively on a comparatively long cincinnus (Rolfe 1894), the thick and rigid ventral throat of the flower, the presence of a second, distal callus on the lip, and the well-developed stipe of the pollinarium, attached to the upper surface of the viscidium (Dressler 1983). According to these characters, Sect. *Chondroscaphe* was intended to group both the *Chondrorhynhca* fringed-lip species close to *C. flaveola* Rchb.f. and the white-flowered taxa allied to *C. bicolor* Rolfe. When Senghas and Gerlach elevated the section *Chondroscaphe* to generic rank (Senghas & Gerlach 1993), they characterized the new genus by the presence of a narrowly grooved callus formed within the tube at the base or in the basal half of the lip, occasionally with a further callus in front of it, the unequal sepals and petals (the latter finely toothed at least in the upper half), the forceps-like rostellum with a short central tooth, the very unequal pollinia, the stipe and viscidium completely separate, and the yellowish to yellow flowers. In turn, *Chondrorhyncha* was mainly defined by the greenish and white flowers, the 2-lobed or shortly multiseriate callus usually sitting in the center of the lip, the distinctly footed column forming a mentum with the lip, the lateral sepals spreading off or back, and the dorsal sepal and the petals often reclinate over the column. In this narrow meaning, *Chondroscaphe sensu* Senghas & Gerlach only included the large-flowered South American species provided with fimbriate labella, while the mostly Central American species of the *C. bicolor* complex were retained in *Chondrorhyncha*. This interpretation was followed by Rungius (1996, 1998) in his nomenclatural rearrangements in *Chondroscaphe*, which were essentially limited to the taxa native to the Andes.

In 2001, in describing two new Mesoamerican species of *Chondroscaphe*, Dressler offered further morphological evidence supporting the inclusion of the *C. bicolor* group in *Chondroscaphe*, adding as new diagnostic characters the stipe attached to the upper surface of the viscidium (rather than to the edge) and the presence of teeth from the stigmatic margin that clasp the rostellum, named "pararostellar lobules" (Dressler 2001). At that time, studies of DNA sequences were in progress at the Florida Natural History Museum, led by W.M. Whitten (Dressler 2001), and the preliminary results already suggested that *Chondrorhyncha sensu lato* was a polyphyletic grade, and that the *C. bicolor* complex was clearly part of *Chondroscaphe*. Dressler's conclusions about a broad circumscription of *Chondroscaphe* were amply supported by the combined molecular analysis carried out by Whitten and collaborators (2005). In the cladistic analysis of combined DNA data set, *Chondroscaphe* (including the *C. bicolor* group) forms a strongly supported branch, sister to the clade of *Warczewiczella* Rchb.f., *Pescatorea* Rchb.f., *Chaubardiella* Garay, *Ixyophora* Dressler, and *Aetheorhyncha* Dressler (Pupulin, in press [a]).

The taxonomy of the Andean, yellow-flowered species of *Chondroscaphe* was discussed by Dodson and Neudecker (1993) and Dodson and Luer (2005), who prefer treating *Chondroscaphe* at subgeneric rank, but no previous attempts have been made to critically revise the mainly Mesoamerican complex of *Chondroscaphe* species with white flowers and usually not fimbriate lips. Among the genera related to *Chondroryncha*, *Chondroscaphe* may be recognized by the large plants (up to 60 cm tall) with narrow, strap-shaped leaves, the successive, 1-flowered inflorescences produced from a cincinnus, the comparatively large flowers provided with a more or less 3-lobed lip, the lateral lobes erect, flanking the column, the midlobe usually reflexed, with a basal, laminar callus ending into a free, bilobed apex, and a second, distal callus, somewhat reduced to a longitudinal thickening of the lamina in front of the basal callus.

The History of White-Flowered *Chondroscaphe*

Although the first species of this group to be formally described was *Chondrorhyncha bicolor* Rolfe in 1894, some twenty-five years before A.R. Endrés had sent

Reviewed and approved by two anonymous peers.

Chondroscaphe endresii (Pupulin 3516)

materials of a white "Zygopetalum" from Costa Rica to H.G. Reichenbach. Endrés accompanied his specimen (*A.R. Endrés 166* = Endrés' Zygopetalum N° 6) with two detailed descriptions and fine analytical drawings of the flower, floral dissections, and enlargements of the rostellum and the pollinarium (Fig. 1). Reichenbach annotated the specimen with the intended name of "Chondrorhyncha umbonata" (W *Rchb-Orch* 49751!) but, as it was often the case with Endrés collections, he never described the new finding of his collaborator in Costa Rica. It was not until 1894, when the Swiss grower Richard Pfau sent to Kew living plants, dried specimens and the colored sketch (Fig. 2) of a white "*Chondrorhyncha*" from Costa Rica, that R.A. Rolfe brought for the first time this group of plants to the attention of botanists (Rolfe 1894). Apparently, some time before, Pfau also sent to Hamburg a watercolor painting of the same species (Fig. 3), but probably Reichenbach never associated the two discoveries from Costa Rica. The true identity of *Chondrorhyncha bicolor* challenged the students of Mesoamerican orchid flora until recently. Rolfe's protologue was less than adequate, stating that the lip of the new species had no calli (Rolfe 1894), and the type flower is severely distorted (Fig. 4), as commonly happens with the thin flowers of *Chondroscaphe* that Reichenbach compared to those of *Utricularia* "as disagreeable objects for examination" (Reichenbach 1872).

Around 1915, Rudolf Schlechter first had access to the herbarium of Reichenbach, just opened to the public at the Hof Imperial Museum in Vienna (now Museum of Natural History). Here he found the white *Chondroscaphe* sent from Costa Rica by Endrés almost 50 years before, and honored the meticulous work of Endrés describing it with the name of *Chondrorhyncha endresii* (Schlechter 1921). For the first time, Schlechter noted the semilunate, subverruculose "thickening" lying in front of the basal callus (Fig. 5—6), and it is not strange that he considered the new species easy to distinguish by its thick-oblong, apically bilobed callus, mainly if compared with the other, "ecallose", white-flowered "*Chondrorhyncha*" from Costa Rica.

More than sixty years elapsed before another species of the group was described from Central America, when Dressler published the distinctive *Chondrorhyncha eburnea* from the hills north of El Valle de Antón in central Panama (Dressler 1983), also recording the occurrence in Panama of a natural hybrid of *Chondrorhyncha eburnea* [= *Chondroscaphe eburnea* (Dressler) Dressler] with *C. reichenbachiana* Schltr. [= *Benzingia reichenbachiana* (Schltr.) Dressler]. According to the recent generic realignments in the *Chondrorhyncha* complex (Whitten *et al.* 2005), this nothogenus is still without a botanical name. Dressler's paper further mentions for the first time the pollination of *C. bicolor* in Chiriquí, Panama, by the perfume-collecting bee *Euglossa hyacinthina* (Dressler 1983).

In the last fifteen years six other white-flowered species of *Chondroscaphe* where described (Dodson & Neudecker 1993, Bennett & Christenson 1994, Dressler 2001, Pupulin 2005). They include the Ecuadorean *C. embreei* (Dodson & Neudecker) Rungius, which is treated in the present paper due to the color of its flowers, varying from pale yellow to white (Fig. 7—8), although if technically it belongs to the *C. flaveola* group.

Taxonomically Informative Features

VEGETATIVE ARCHITECTURE

Plants of *Chondroscaphe* are usually large epiphytes, reaching 60cm in size, without pseudobulbs, with a very reduced stem completely covered by the imbricating sheaths. These are strongly conduplicate, sometimes ancipitous, varying in number from 5 to 9, and generally provided with scarious, hyaline margins, becoming dry-papyraceous with age. The 2—3 basal cataphylls are normally triangular, non-foliaceous, often drying in place and becoming brown-papyraceous as the shoot matures. The upper sheaths are articulated with the leaves, arranged like a fan and progressively increasing in size. The leaves are narrowly oblanceolate, acuminate, more or less stiff, often with slightly undulate margins, varying in texture from thin-herbaceous to subcoriaceous. They are provided with a distinctly protruding abaxial midvein. There are subtle specific variations in plant size and leaf shape, but these differences are often obscured by ecological factors. Under uniform, optimal *ex-situ* conditions, plants of *C. atrilinguis* Dressler are normally larger (the leaves up to 37 x 3 cm), while those of *C. yamilethiae* Pupulin have distinctly stiff, erect foliage, and the leaves of *C. eburnea* (Dressler) Dressler are mostly gently arched in natural position. The inflorescences are slender, with the filiform peduncles up to 10 cm long,

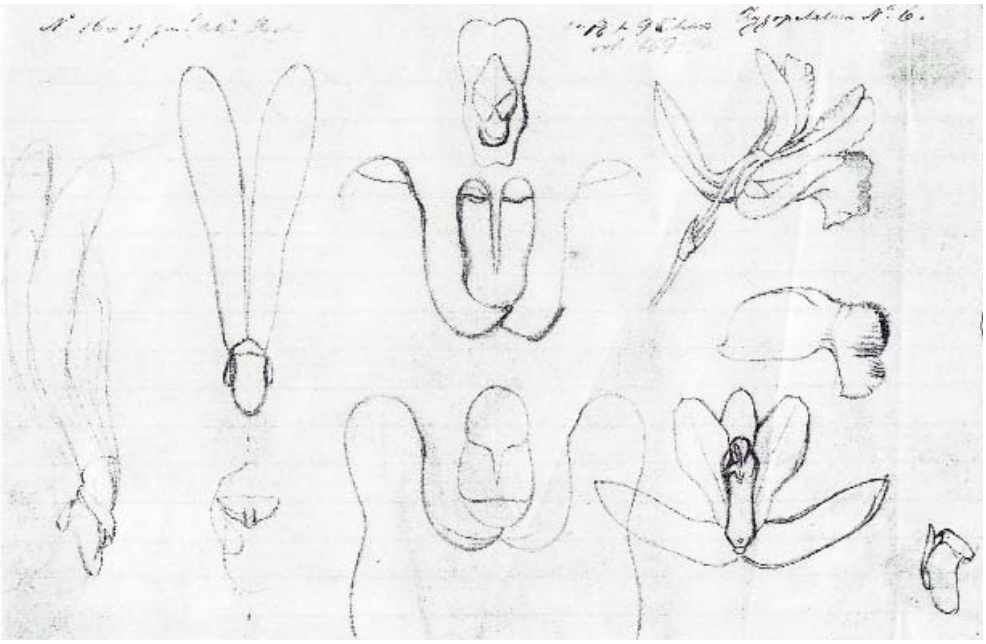

Figure 1.
Sketches by A.R. Endrés (around 1869-1870) from the plant that eventually served as the holotype of *Chondrorhyncha endresii* (W *Rchb-Orch* 10664). Note the fine details of the pollinarium and the characteristic rostellum flanked by stigmatic lobes. Reproduced with permission by the Naturhistoriches Museum, Vienna.

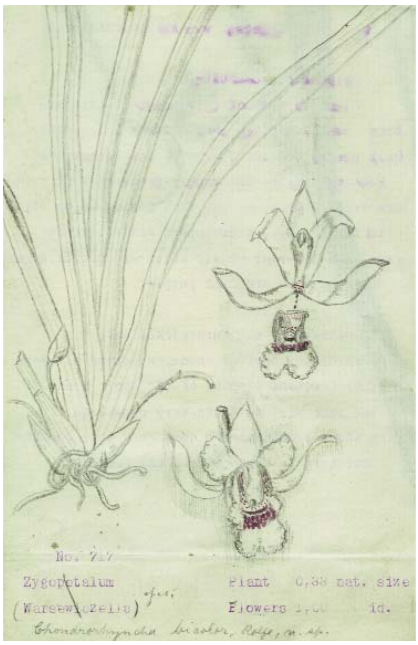

Figure 2.
Colored sketch of *Chondrorhyncha bicolor* by Richard Pfau. Reproduced with permission by the Board of Trustees of the Royal Botanic Gardens, Kew.

born erect and then curving under the weight of the flower (which is usually presented almost pendulous). Rolfe (1894) noted that several peduncles are produced in succession from the main axis of the inflorescence, entirely concealed by the leaf-sheath, so that the inflorescence of *Chondroscaphe* is technically a cincinnus, with the lateral branches arising alternately on opposite sides of the false axis. Dodson & Bennett (1989) illustrate the cincinnus of *C. fimbriata*. In the studied species, one flower at a time is produced over two or three years. With the exception of *C. eburnea*, which has rather short peduncles bearing the flower horizontally, the shape of the inflorescence is not taxonomically informative, and in general terms vegetative traits of *Chondroscaphe* are too influenced by the environmental conditions to be useful for taxonomic purposes.

GROSS FLOWER MORPHOLOGY

The general flower scheme of white-flowered *Chondroscaphe* species is largely uniform. The dorsal sepal is invariably smaller than the lateral ones; it born almost parallel to the column axis, and then is gently curved back to expose the column apex. The lateral sepals are distinctly concave, sometimes almost convolute toward the base, where the inrolled basal margins form a sepaline tube that plays an important role in attracting pollinators by mimicking nectaries. Even though the flowers of most species close to *Chondrorhyncha* attract male euglossine bees searching for perfume compounds, James Ackerman also recorded the visit of *Cochleanthes* (=*Warczewiczella*) *lipscombiae* in Panama by female euglossine looking for food resources, which extend their tongue into the back-swept lateral sepals in search of nectar (Ackerman, 1983). In *C. eburnea* the lateral sepals are distinctly hooked distally. The degree of reflexion of the lateral sepals is largely dependent on flower age and environmental conditions. In most species the lateral sepals spread to form an angle of *ca.* 90º with the pedicel + ovary, although in some taxa the sepals are incurved toward the apex. In *C. bicolor* (Rolfe) Dressler and, at a less extent, in *C. atrilinguis* Dressler and *C. venezuelana*, mature flowers may have the lateral sepals completely turned back and twisted upwards (Fig. 9, 15); also in these cases, however, the sepals of immature flowers, or in a wetter environment, only spread out horizontally (Fig. 10—11, 15). The oblanceolate to obovate petals are inserted along the margins of the column foot; they are porrect, flanking the column in natural position, and gently curved back at apex, where the margins are usually lightly to strongly crisped and the apex sometimes mucronulate. The petals of *C. eburnea* are distinctive in being strongly conduplicate-concave at apex, provided with a prominent, rounded abaxial keel (Fig. 12). The lip is obscurely 3-lobed, rarely entire, ovate-elliptic in some species, broadly elliptic to subrounded in other taxa. The basal portion of the lip is horizontal, mostly slightly concave but strongly concave in *C. yamilethiae* (the outline of the lip distinctly convex in lateral view), while the midlobe is usually more or less reflexed. The rounded basal margins are entire and erect, clasping the column; they are distinctly thickened in *C. eburnea*, forming prominent cheeks adaxially. The lip midlobe is transversely elliptic to subrhombic, retuse at apex, with the margins crisped or rarely minutely serrate (*C. venezuelana*); the margins in this group of species are never lacerate-fimbriate with

Figure 3.
Watercolor illustration of a white-flowered *Chondroscaphe* species, likely sent from R. Pfau, in the Reichenbach Herbarium. Reproduced with permission by the Naturhistoriches Museum, Vienna.

Figure 4.
The holotype of *Chondrorhyncha bicolor* (K 79618). Reproduced with permission by the Board of Trustees of the Royal Botanic Gardens, Kew.

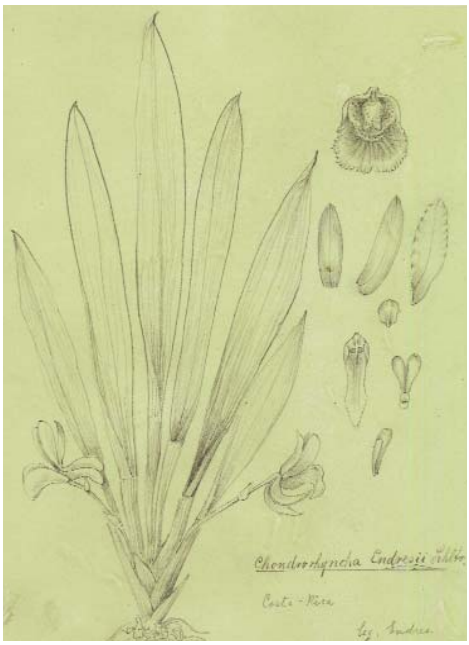

Figure 5.
Copy of Schlechter's tracing of the holotype of *Chondrorhyncha endresii* (AMES 106743). Reproduced with permission by the Director, Harvard University Herbaria.

the exception of *C. embreei*, which in fact pertains to the *C. flaveola* group and is treated in this paper only because of its often white flowers. The midlobe is usually conduplicate-concave, more or less spreading at apex. In a few cases, the lateral lobes of the lip are only gently upcurved, forcing the midlobe to spread out almost completely (Fig. 13); however, flowers with this lip morphology are spread among populations with normal concave-conduplicate midlobe, and they are rarely produced on the same plants that usually produce "normal" flowers (Fig. 15). In all the taxa of the group, the lip is provided with a basal, bilobed callus; in most of the species, the callus just arises as a thickened knob in the center of the disk, but in *C. plicata* it is composed by two low lamellae running from the base of the lip to the disc. The callus is narrower toward the apex in all the species except *C. eburnea,* in which the bilobed callus is wider distally. The base of the lip is glabrous in *C. eburnea* and *C. yamilethiae*, while in the other species it is provided with short, rigid hairs arranged in longitudinal lines running to the callus. In front of the basal callus *Chondroscaphe* species present a second thickening, which has been variously described. In some species the thickening is short and distinct, forming a second, rounded "knob" in front of the basal callus, and it is often associated with a rugulose area where most of the color blotches are concentrated. However, in other taxa the distal callus is less well defined, and it extends as a rounded median thickening almost to the apex of the lip.

The variability in flower gross morphology of *Chondroscaphe* species is astonishing. The size of flowers, the degree of twisting of the lateral sepals and the

Figure 6.
Detail of the lip, from the copy of Schlechter's tracing of *Chondrorhyncha endresii* holotype (AMES 106743). Note the thickened, distal callus in front of the bilobed basal callus. Reproduced with permission by the Director, Harvard University Herbaria.

amount of spreading of the lip, the relative "thickness" and the indumentum of the distal callus, are highly plastic within species, on the same individuals at different flowerings, and also on different simultaneous flowers of the same plant (Fig. 14—15).

COLUMN MORPHOLOGY

The shape of the column is taxonomically informative in the group. The column is generally straight to slightly curved, stout, terete-subclavate, provided with more or less prominent, rounded wings, a transverse, slit-like stigma, and a shallow clinandrium. The area of the clinandrium is narrower than the median portion of the column in all the species with the exception of *C. atrilinguis*, which has a very broad clinandrium; on the other side of the spectrum, the clinandrial region of *C. bicolor* is distinctly narrow. The ventral surface of the column is covered with long verrucose processes in *C. plicata*. As in most of the species of the *Chondrorhyncha* complex, the rostellum of

Figure 7.
The pale-yellow form of *Chondroscaphe embreei.* Ecuador, *Pupulin 6632* (CIOA-spirit).

Figure 8.
The white-flowered form of *Chondroscaphe embreei.* Ecuador, *Pupulin 6510* (JBL-spirit).

Figure 9.
The reflexed and up-twisted lateral sepals are frequently seen in *C. bicolor*, as in this specimen from the A.M. Brenes Biological Reserve in the Tilarán range, northen Costa Rica (*Bianchi 68*, JBL-spirit). This floral shape was illustrated by A.R. Endrés in the original drawing of the plant that served as the holotype of *Chondrorhyncha endresii.*

Chondroscaphe is triangular to narrowly triangular-acuminate, cartilagineous, stiff; it is distinctly short in *C. atrilinguis* and *C. yamilethiae*. Next to the rostellum, 2 projections arise from the stigmatic margins. Among the genera close to *Chondrorhyncha*, the presence of such extensions is not at all restricted to *Chondroscaphe*, and pararostellar, rounded to acute teeth are present, at various degrees, in *Aetheorhyncha, Benzingia* Dodson ex Dodson, *Chaubardia* Rchb. f., *Chaubardiella, Chondrorhyncha, Cochleanthes* Raf., *Daiotyla* Dressler, *Kefersteinia* Rchb.f., *Stenia* Lindl., *Stenotyla* Dressler, and *Warczewiczella*. However, in none of these genera do the stigmatic projections attain the size of *Chondroscaphe*, and the term of pararostellar "arms" has been coined to better describe them (Dressler 2001). The relative position, morphology and size of pararostellar arms are taxonomically informative at the species level. In *C. eburnea* the arms are short and triangular (actually, they are better described as teeth), and arise from the lower portion of the upper stigmatic margin; two additional, short, rounded knobs flank the acuminate rostellum. *Chondroscaphe atrilinguis* and *C. yamilethiae* have short pararostellar arms pointing toward the rostellum; they are born at the middle of the upper stigmatic margin in *C. atrilinguis*, while arise next to the rostellum in *C. yamilethiae*. Short teeth closely flank the rostellum in *C. merana* (Dodson & Neudecker) Dressler and *C. plicata* (D.E. Bennett & Christenson) Dressler. The pararostellar arms are particularly well developed in *C. bicolor* and *C. venezuelana*; they run parallel to the rostellum and are abruptly reflexed distally ("L" shaped) to embrace the rostellum, and are likely a derived condition within the genus. Dressler (2003) interpreted the arms of *C. bicolor* as divergent and obtuse, but suspected that they were damaged in the type specimen. Recently, Diego Bogarín rehydrated the type flower of *C. bicolor* and had the opportunity to draw details of the column (Fig. 16). As Dressler suspected, one of the arms is broken, but the other arm, folded under the column wings, is ligulate, and characteristically L-shaped. A specimen of *C. bicolor* with divergent pararostellar arms was collected in the premontane slopes of the Talamanca mountain range in Costa Rica (*Pupulin s.n.*, USJ 031205) (Fig. 28). Ligulate, L-shaped lobes of the stigma are also characteristic of *C. endresii* (Schltr.) Dressler and *C. laevis* Dressler, both treated here under the synonymy of *C. bicolor*.

POLLINARIUM MORPHOLOGY

Characteristics of the pollinarium have been used as a tool for orchid classification at least since the times of Reichenbach, who devoted his doctoral dissertation to the study of pollinaria as indicators of species relationships (Reichenbach, 1852). Diversity in structure, organization and shape of pollinaria (including the presence of caudicles and their composition, and the presence, number and shape of stipes), have been employed as a source of characters at various systematic levels (Pupulin & Karremans, 2008). As pollinaria are less subject to parallelism than other floral features, their morphology also has played a significant role in the construction of phylogenetic hypotheses (i.e., Williams, 1970a, 1970b, 1972; Dressler, 1986, 1993; Chase, 1987; Freudenstein & Rasmussen, 1997). Among the highly evolved Neotropical groups of the Epidendroideae, where the pollinia are accompanied by distinct viscidia and stipes, pollinarium morphology is often taxonomically informative at generic and specific levels, with recent examples of studies in the Oncidiinae (Dressler & Klikunas, 2006) and the Zygopetalinae (Whitten et al., 2005; Pupulin, in press [b], in press [c]).

In the species of the genus *Chondroscaphe*, the 4

Figure 10.
In immature flowers, or under more humid environmental conditions, the lateral sepals of *C. bicolor* just spread out horizontally, perpendicular to the ovary. The photograph is from a specimen without collecting data, flowered at Lankester Botanical Garden (*Pupulin 2423,* JBL-spirit)

Figure 11.
Flower of *C. bicolor* with the lateral sepals partially uptwisted, from a plant collected in the high basin of the Sarapiquí River in northern Costa Rica.

Figure 12.
The flower of the Panamanian *C. eburnea*, flowering at Lankester Botanical Garden (*Dressler 6826* , JBL-spirit). Note the uncinate apices of the lateral sepals.

pollinia are arranged in 2 pairs very different in size, dorsoventrally superposed. The outer pair of pollinia are usually narrowly oblong to ligulate, sometimes slightly sigmoid in lateral view, and often adaxially concave to "host" the inner, smaller couple of pollinia. Exceptions are the pollinia of *C. flaveola* (Rchb.f.) Dressler, the type species of the genus, which are narrowly obovate (Reichenbach, 1872) (Fig. 17), and those of *C. amabilis* and its close relatives, in which the outer pollinia are somewhat falcate toward the apex (Fig. 18). Among the species of the *C. bicolor* group, the outer pollinia are rounded to subattenuate in *C. bicolor, C. merana*, and *C. plicata*, while they are diagonally truncate at the base in *C. atrilinguis, C. eburnea*, and *C. yamilethiae*; the inner pollinia are basally truncate only in *C. atrilinguis* and *C. eburnea* (Fig. 19).

Unlike many other genera in the *Chondrorhyncha* complex, in which the stipe of the pollinarium is con-

Key to the White-Flowered Species of *Chondroscaphe*

1. Margins of the lip distinctly fringed --- *C. embreei*
1a. Margins of the lip entire or minutely denticulate --- 2
2. Pararostellar lobes of the column ligulate, abruptly inflexed at apex (rarely divergent) --- 3
3. Flowers pendent; midlobe of the lip retuse, wider than the spread lateral lobes, with margins undulate-crisped; stipe of the pollinarium subquadrate, short --- *C. bicolor*
3a. Flowers horizontal; midlobe of the lip obtuse, narrower than the spread lateral lobes, with margins minutely serrate; stipe of pollinarium ligulate, long --- *C. venezuelana*
2a. Pararostellar lobes of the column triangular --- 4
4. Basal callus of the lip running from the base to the disc; viscidium and stipe narrow, ca. 1 mm wide --- 5
5. Ventral surface of the column glabrous --- *C. merana*
5a. Ventral surface of the column with verrucose extensions --- *C. plicata*
4a. Basal callus of the lip emerging in the middle of the disk; viscidium and stipe wide, to 2-3 mm in width --- 6
6. Lateral lobes of the lip adaxially thickened; petals apically deeply concave, distinctly keeled dorsally --- *C. eburnea*
6a. Lateral lobes of the lip not thickened adaxially; apex of petals not concave, without dorsal keel --- 7
7. Flower large (the lip to 45 mm long); basal portion of the lip slightly convex in outline; column widest at apex, adaxially puberulent --- *C. atrilinguis*
7a. Flower medium in size (the lip to 33 mm long); basal portion of the lip deeply convex in outline; column widest around the stigmatic area, glabrous --- *C. yamilethiae*

Figure 13.
In some plants of *C. bicolor,* the midlobe of the lip is completely spread. This specimen was originally collected at Peralta, on the lower Caribbean slopes of the Talamanca mountain range in Central Costa Rica (*Pupulin 3525*, JBL-spirit).

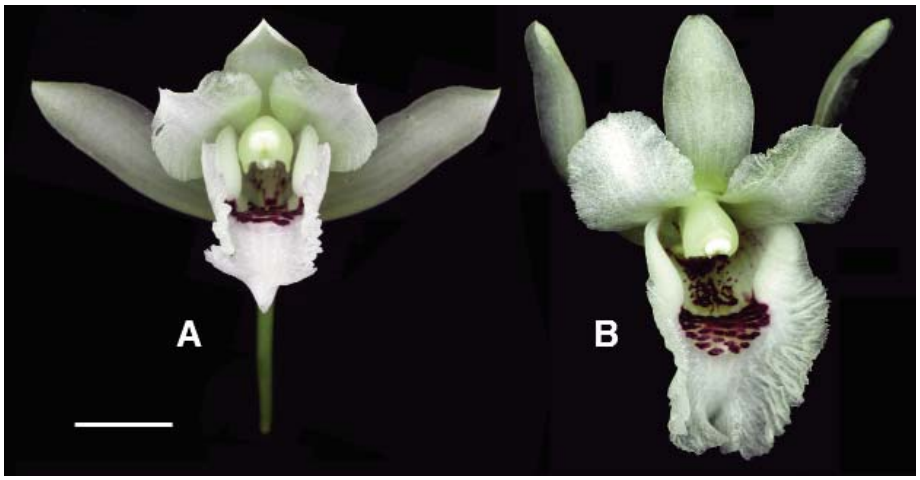

Figure 14.
Floral variations of *Chondroscaphe bicolor* on a same plant (Costa Rica. Alajuela: San Ramón, A.M. Brenes Biological Reserve, *M. Bianchi 68*). Flowered on: **A**, April 25, 2005; **B**, May 3, 2006. Vouchers in the Spirit collection at Lankester Botanical Garden. Scale bar = 1 cm.

nected to the viscidium almost apically, the stipe of *Chondroscaphe* arises in the middle of the upper surface of the viscidium (Fig. 20). Within this general scheme, species-specific variations can be observed. In *C. bicolor, C. merana, C. plicata*, and *C. venezuelana*, the stipe and the viscidium are almost as wide as the width of the outer pollinium (ca. 1 mm), while in the other species of the group the stipe and viscidium are more than 2 mm wide (up to 3 mm wide in *C. eburnea*). The stipe is subquadrate in all the species with the exception of *C. venezuelana*, which has a ligulate stipe. The viscidium is peltate in *C. atrilinguis*, ovate in *C. eburnea* and *C. yamilethiae*, and almost elliptic in *C. bicolor, C. merana* and *C. venezuelana.*

Taxonomy

1. ***Chondroscaphe atrilinguis*** Dressler, Orquideología 22(1): 16. 2001.

TYPE. PANAMA. Bocas del Toro. Floreció en cultivo, 8 Sept. 2000, *R.L. Dressler* 6289 (holotype, MO).

Epiphytic, caespitose **herb**, to 40 cm tall. **Roots** 1.5-3 mm in diameter. **Stem** short, completely hidden by the imbricating sheaths. **Sheaths** strongly conduplicate, provided with scarious margins, to 6 cm long, the upper one foliaceous. **Leaves** 5-7, the conduplicate base 4.5-6 cm long, the blade oblanceolate, acuminate, 18-37 x 2.2-4 cm. **Inflorescence** basal, 1-flowered, peduncle to 4.5 cm long. **Floral bracts** in pairs, the outer one infundibular, elliptic, acute, to 11 x 10 mm, the innner elliptic, 10 x 3-4 mm. **Ovary** and pedicel terete, to 2.7 cm long. **Flower** with sepals and petals cream to pale greenish, the petals and lip cream, the throat of the lip and the column foot spotted purple. **Dorsal sepal** narrowly elliptic, acute, to 33 x 11 mm. **Lateral sepals** lanceolate, acute, the basal margins incurved, to 42 x 11 mm. **Petals** elliptic-ovate, acute, apiculate, 30 x 13-14 mm. **Lip** elliptic-ovate, acute or apiculate, 38-45 x 26-31 mm; the lateral lobes erect, entire, keeled, enfolding the column; the blade with crenulate-subfimbriate margins; basal callus rounded to shallowly retuse, glandular, reaching 18-20 mm from the base, the free apex 3-4 x 9 mm; distal callus rounded, oblong, rugose, 8-10 x 5-7 mm. **Column** terete, subquadrate toward apex, widest above stigma, 18-20 x 6 mm, with slightly spreading wings to about 5 mm below stigma, ventral surface puberulent, column foot 6-7 mm long, with subapical tooth, rostellar teeth narrowly triangular, introrse, pararostellar lobes narrowly triangular-subfalcate. **Anther cap** cucullate, ovate, 2-celled. **Pollinia** 4, in two pairs of different size, oblong-clavate, on a suborbicular stipe; viscidium elliptic-peltate. Fig. 21—24.

ETYMOLOGY: From the Latin *atri-*, dark, black, and *lingua*, tongue, referring to the popular name of "boca negra" (black mouth), by which the species is known in Panama.

OTHER SPECIMENS STUDIED: **Costa Rica**. Alajuela: San Ramón, Reserva Biológica A.M. Brenes, floreció en cultivo en el Jardín Botánico Lankester, 15 mayo 1999, *F. Pupulin 1454* (MO, USJ); same data, flowered in cultivation at Jardín Botánico Lankester, 11 October 2002 (JBL-Spirit). **Panama**. Bocas del Toro: Culebra, entre los ríos Estrella y Changuinola, Finca Drácula, collected by E. Olmos, flowered in cultivation at Jardín Botánico Lankester, 30 May 2007, *D. Bogarín 2950* (JBL-Spirit).

DISTRIBUTION: Costa Rica and Panama.

ECOLOGY: A large epiphyte from premontane wet forests at elevations of 800-1200 meters, apparently restricted to the Caribbean watershed of the mountains of Costa Rica and western Panama. Flowering has been recorded in May-June, and in September-November, corresponding to the rainy season in southern Central America.

Chondroscaphe atrilinguis has the largest flowers in the group, grossly 1/3 larger than any other species. The clinandrium, wider than the stigmatic area, and the broad viscidium distinguish this species.

Figure 15.
Floral variations of *Chondroscaphe bicolor* on a same plant (Costa Rica. Cartago: Turrialba, Peralta, *F.Pupulin 3525*). Flowered on: **A**, March 12, 2007; **B**, October 29, 2006; **C**, April 4, 2007. Vouchers in the Spirit collection at Lankester Botanical Garden. Scale bar = 1 cm.

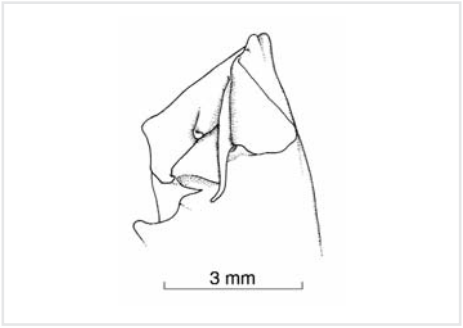

Figure 16.
Apex of the column from the holotype of *Chondrorhyncha bicolor* (K 79618). Note the broken right pararostellar lobe (on the left in the illustration) and the L-shaped intact lobe. From a sketch of the rehydrated flower by Diego Bogarín.

Figure 17.
Pollinarium of *Chondroscaphe flaveola* in dorsal (left) and ventral (right) views. Voucher: Ecuador, *F. Pupulin 6474* (Lankester Botanical Garden orchid pollinaria collection). Scale bar = 1 mm.

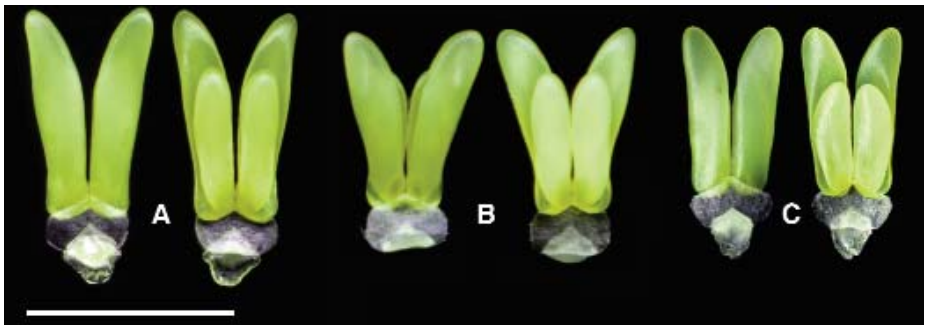

Figure 18.
Pollinaria of *Chondroscaphe* species in dorsal and ventral views. **A**, *C. amabilis* (Ecuador, *Pupulin 6513*); **B**, *C. chestertonii* (Ecuador, *Pupulin 6959*); **C**, *C. embreei* (Ecuador, *Pupulin 6510*). All vouchers in the orchid pollinaria collection at Lankester Botanical Garden. Scale bar = 5 mm.

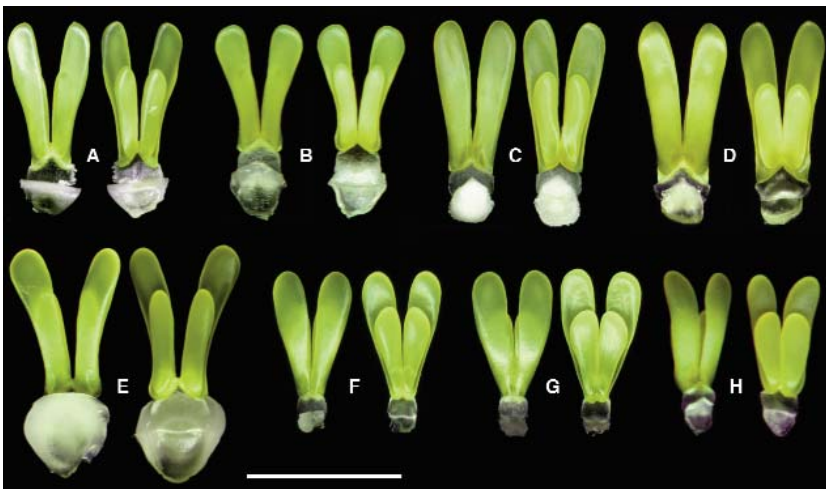

Figure 19.
Pollinaria of *Chondroscaphe* species in dorsal and ventral views. **A—B**, *C. atrilinguis* (Panama, *Bogarín 2950, Dressler 6596*); **C—D**, *C. yamilethiae* (Costa Rica, *Pupulin 4637* and *4638*); **E**, *C. eburnea* (Panama, *Dressler 6826*); **F—G**, *C. bicolor* (Costa Rica, *Bogarín 984, Pupulin 3525*); **H**, *C. merana* (Ecuador, *Acaro & Medina s.n*). Vouchers: A—G in the orchid pollinaria collection at Lankester Botanical Garden; H at the Ángel Andreetta Research Center on Andean Orchids, University Alfredo Pérez Guerrero – Extension Gualaceo. Scale bar = 5 mm.

Figure 20.
Pollinaria of Zygopetalinae species in lateral view. **A**, *Daiotyla xanthina* (Colombia, *Pupulin 5891*); **B**, *Ixyophora viridisepala* (Ecuador, *Pupulin 6554*); **C**, *"Chondrorhyncha" velastiguii* (Ecuador, *Pupulin 6622*); **D**, *Chondroscaphe atrilinguis* (Panama, *Bogarín 2950*); **E**, *Chondroscaphe bicolor* (Costa Rica, *Pupulin 3525*). All the vouchers in the orchid pollinaria collection at Lankester Botanical Garden. Scale bar = 5 mm.

2. C***hondroscaphe bicolor*** (Rolfe) Dressler, Orquideología 22(1): 22. 2001.

Bas.: *Chondrorhyncha bicolor* Rolfe, Bull. Misc. Inform. Kew 1894 (95): 393. 1894.

TYPE. COSTA RICA. Without specific locality, *Pfau s.n.* (holotype, K).

Chondrorhyncha endresii Schltr., Repert. Sp. Nov. Regni Veg. 17: 14. 1921, ***syn. nov.*** *Chondroscaphe endresii* (Schltr.) Dressler, Lankesteriana 3(3): 28. 2002, **syn. nov.** *Chondrorhyncha umbonata* Rchb.f., *nom. herb.* (W Rchb-Orch 49751 ≡ type of *Chondrorhyncha endresii* Schltr.).

TYPE: COSTA RICA. Ohne nähere Standortsangabe, *A.R. Endrés 166* (holotype, W; drawing of the holotype, AMES; drawings of the plant that served as the holotype, W).

Chondroscaphe laevis Dressler, Orquideología 22(1): 20. 2001, ***syn. nov.***

TYPE: COSTA RICA. Alajuela: San Ramón, Reserva Biológica A. M. Brenes, floreció en cultivo en Jardín Botánico Lankester, 15 May 1998, *G. Hoffmann s.n.* (holotype, MO; isotype, US).

Epiphytic, caespitose **herb**, to 50 cm tall. **Roots** 1.5-2.3 mm in diameter. **Stem** short, completely hidden by the imbricating sheaths. **Sheaths** strongly conduplicate-ancipitous, provided with scarious margins, to 5-7 cm long, the upper one foliaceous. **Leaves** 3-7, the conduplicate base 4-5 cm long, the blade oblanceolate to narrowly oblanceolate-ligulate, acuminate, 16-45 x 1.3-2.5 cm. **Inflorescence** basal, 1-flowered, peduncle to 8 cm long. **Floral bracts** in pairs, the outer one infundibular, ovate, acute, to 9 x 6 mm, the innner elliptic-lanceolate, 9 x 2.5-3 mm. **Ovary** and pedicel terete, to 2.1 cm long. **Flower** white to cream, the petals and lip white, the throat of the lip and the column foot spotted purple. **Dorsal sepal** narrowly elliptic, acute, to 18-30 x 6-9 mm. **Lateral sepals** elliptic to elliptic-oblanceolate, acute, the basal margins incurved, to 32 x 11 mm. **Petals** elliptic-obovate, acute, apiculate, 18-25 x 8-10 mm. **Lip** broadly elliptic-ovate to subquadrate-obovate, subentire to obscurely 3-lobed, retuse, 22-32 x 20-30 mm; the lateral lobes erect, entire, enfolding the column; the blade with crenulate-subfimbriate margins; basal callus bilobed, ending in 2 rounded to subtriangular teeth, puberulent-scurfy, reaching 13-15 mm from the base, the free apex 2-2.5 x 6 mm; distal callus rounded, rugose or (rarely) glabrous, 4 x 9 mm. **Column** terete, cuspidate toward apex, widest around stigma, 10-13 x 6 mm, with obscure, rounded wings to about 3 mm below stigma, column foot 6-7 mm long, with subapical tooth, rostellar teeth narrowly triangular-acuminate, pararostellar lobes ligulate, abruptly convergent apically. **Anther cap** cucullate, ovate, 2-celled. **Pollinia** 4, in two pairs of different size, oblong, on a small subquadrate stipe; viscidium elliptic. Fig. 9—11, 13—15, 25—31.

ETYMOLOGY: From the Latin *bicolor*, of two colors, in allusion to the white flowers spotted with purple in the throat of the lip.

OTHER REPRESENTATIVE SPECIMENS STUDIED: **Costa Rica**. Alajuela: San Ramón, Ángeles, Reserva Biológica A.M. Brenes, Aug. 1991, flowered in cultivation at Jardín Botánico Lankester, 24 Apr. 2005, *E. Bianchi 68* (JBL-spirit); San Ramón, Ángeles, Reserva Biológica Alberto M. Brenes, Sendero Pájaro Sombrilla, 10°13'06" N 84°36'11" W, 850 m, 3 Oct. 2003, flowered in cultivation at Jardín Botánico Lankester, 2 Oct. 2006, *D. Bogarín 426* (JBL-spirit); Upala, Aguas Claras de Buenos Aires. Hotel Termales Azules, camino por la ladera del Volcán Rincón de La Vieja, 10°49'N 85°16'W, 700-1500 m, 6 de Apr. 2004, *A. Karremans 253* (JBL-spirit). Cartago: Turrialba, La Suiza, camino entre Pacayitas y La Suiza, 2 km al sur de Pacayitas, 9°52'29.9"N 83°35'03.6.4"W, 1150 m, 8 Marzo 2006, flowered in cultivation at Jardín Botánico Lankester, 19 Oct. 2006, *D. Bogarín 2642, R.L. Dressler, A. Karremans & F. Pupulin* (JBL-spirit); Turrialba, Pacayitas, calle a La Suiza, ca. Km 8, 9º52'29.9"N 83º35'03.6"W, 1150 m, bosque húmedo premontano, 4 Mar. 2007, *A. Karremans 1654 & D. Karremans* (JBL-spirit); Turrialba, Peralta, a plant collected by Rafael A. González July 2001, flowered in cultivation at Jardín Botánico Lankester, 24 Feb. 2002, *F. Pupulin 3525* (JBL-spirit); Turrialba, Peralta, a plant donated by D. Bogarín, 6.2001, flowered in cultivation at Jardín Botánico Lankester, 5 March 2003, *F. Pupulin 4370* (JBL-spirit); Turrialba, Santa Rosa, entre Verbena y El Carmen, Reserva Biológica Privada Espino Blanco, 9°56'55.18"N 83°41'30.02"W, 1200-1400 m, 22 Jul. 2007, *A. Karremans 1928* (JBL-spirit); Turrialba, Siquirres, Tres Equis, Jul. 1989, *F. Pupulin s.n.* (USJ); Turrialba, Tayutic, Grano de Oro, al lado del camino entre Grano de Oro y

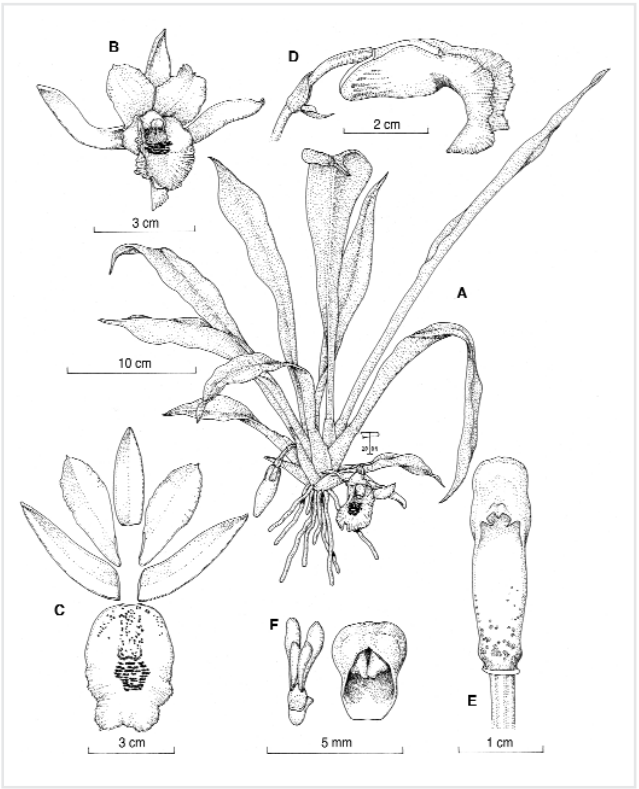

Figure 21.
Chondroscaphe atrilinguis. **A**, habit. **B**, flower. **C**, Perianth flattened. **D**, column and lip, lateral view. **E**, column, ventral view. **F**, pollinarium and anther cap. Illustration voucher: *Pupulin 1454* (MO, USJ).

Figure 22.
Flower of a Costa Rican specimen of *C. atrilinguis*, flowered at Lankester Botanical Garden (*Pupulin 1454*, MO, USJ).

Figure 23.
The flower of *C. atrilinguis* from a Panamanian specimen without collecting data, flowered at Lankester Botanical Garden (JBL-spirit).

Figure 24.
A specimen of *C. atrilinguis* from Culebra, Panama (*Bogarín 2950*, JBL-Spirit).

Llanos del Quetzal, 9°48'23"N 83°26'53"W, 1000-1200 m, 30 Jul. 2005, flowered in cultivation at Jardín Botánico Lankester, 22 May 2008, *Karremans 883 & P. Ferreira* (JBL-spirit). Guanacaste: Tilarán, Tierras Morenas, desviación a la izquierda después del Río Cabuyo, camino al Proyecto Geotérmico Tenorio y Cerro Jilguero, ca. 4.5 km norte de Tierras Morenas, ladera sureste del Volcán Tenorio, 10°36'11.6"N 85°00'05.3"W, 900-1000 m, 2 Feb. 2006, flowered in cultivation at Jardín Botánico Lankester, 3 May 2006, *D. Bogarín 2379, R.L. Dressler & R. Gómez* (JBL-spirit). Heredia: Varablanca, high drainage of Río Sarapiquí, flowered in cultivation at Jardín Botánico Lankester, 21 Dec. 2001, *F. Pupulin 3509* (JBL-spirit). **Panama**. Panama: La Eneida, flowered in cultivation at Jardín Botánico Lankester, accession No. 11412, 2 Oct. 2006, *R.L. Dressler s.n.* (JBL-spirit).

DISTRIBUTION: Costa Rica and Panama.

ECOLOGY: A frequent epiphyte from climax vegetation in premontane wet forests at 900-1200 m elevations, restricted to the Caribbean watershed of Costa Rica and Panama mountain ranges. Flowering begins at the end of the dry season in March-June, with a second flowering peak in October-November, during the rainiest months in southern Central America.

Chondroscaphe bicolor may be recognized, among the species of its genus, by the ligulate, abruptly inflexed at apex (rarely divergent) pararostellar lobes of the column, a feature that it shares only with *C. venezuelana.* However, in *C. bicolor* the midlobe of the lip is retuse, with crenulate margins, and broader than the spread lateral lobes (vs. obtuse, marginally serrulate, narrower than lateral lobes in *C. venezuelana*), and the stipe of the pollinarium is subquadrate, short (vs. ligulate, long).

Originally described on the basis of a poorly preserved specimen (K 79618), *C. bicolor* has been at the center of a taxonomic puzzle, and Dressler (2002) considered it a "lost species", not corresponding to any other Central American taxon. However, discussing *Chondroscaphe* species from Costa Rica, Pupulin (2005) noted that, from an analysis of the holotype, several "anomalous" features of *C. bicolor* were attributable to Rolfe's interpretation, and that the type was essentially indistinguishable from Costa Rican populations treated as *C. endresii.* Rolfe himself determined as *C. bicolor* another Costa Rican specimen received from Charles H. Lankester (*Lankester 516-13,* K); this better preserved plant well corresponds to the later concept of *C. endresii,* also described from Costa Rica (*Endrés 166,* W). Diego Bogarín kindly rehydrated and drew for our study critical details of the column from the type flower of *C. bicolor* (Fig. 16), and we have now a much better concept of this species' identity.

When Rudolf Schlechter (1921) described the forgotten collection by Endrés kept in Reichenbach's herbarium, together with detailed drawings of the plant habit, the flower, and flower details prepared by the collector, he could not suspect that it corresponded with the schematic description of *C. bicolor* provided by Rolfe. It is now clear that the shape of the lip, with its oblong, thick, apically bilobed callus, used by Schlechter to characterize *C. endresii,* is identical to that of *C. bicolor*. The drawing of the rostellum of *C. endresii* made by Endrés, who illustrated the characteristically ligulate, abruptly introrse stigmatic arms, perfectly corresponds to the morphology of the column of *C. bicolor.*

Chondroscaphe laevis was described from a specimen originally collected by G. Hoffmann on the Caribbean slopes of the Tilarán mountain range in northern Costa Rica, and prepared from the cultivated plant in 1998 (Dressler, 2001). Pupulin (2005: 115—117) tentatively referred to this species two other collections from the Pacuare region in the Talamanca range (*Pupulin 3516*, IBL-spirit) and from Monteverde (*Barboza s.n.*, not preserved), both characterized by small flowers with the area of the distal callus only slightly verrucose. A collection by Hoffmann from the type locality (perhaps

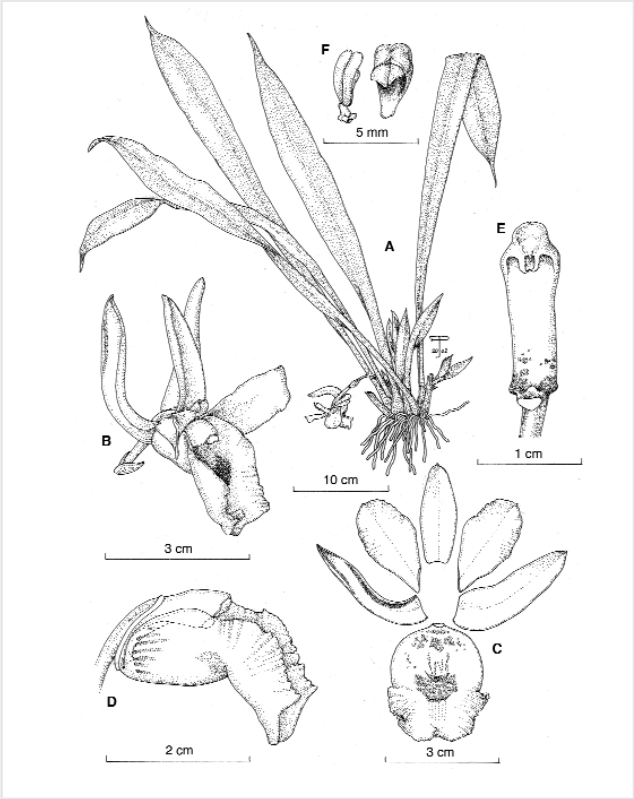

Figure 25.
Chondroscaphe bicolor. **A**, habit. **B**, flower. **C**, Perianth flattened. **D**, column and lip, lateral view. **E**, column, ventral view. **F**, pollinarium and anther cap. Illustration voucher: *Pupulin 3509* (JBL-spirit).

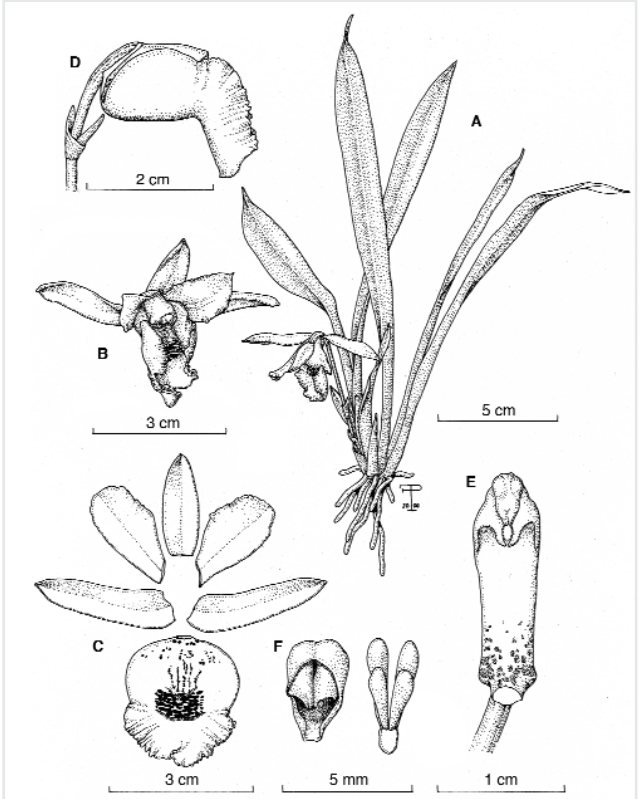

Figure 26.
Chondroscaphe bicolor. **A**, habit. **B**, flower. **C**, Perianth flattened. **D**, column and lip, lateral view. **E**, column, ventral view. **F**, pollinarium and anther cap. Illustration voucher: *Pupulin 2423* (JBL-spirit).

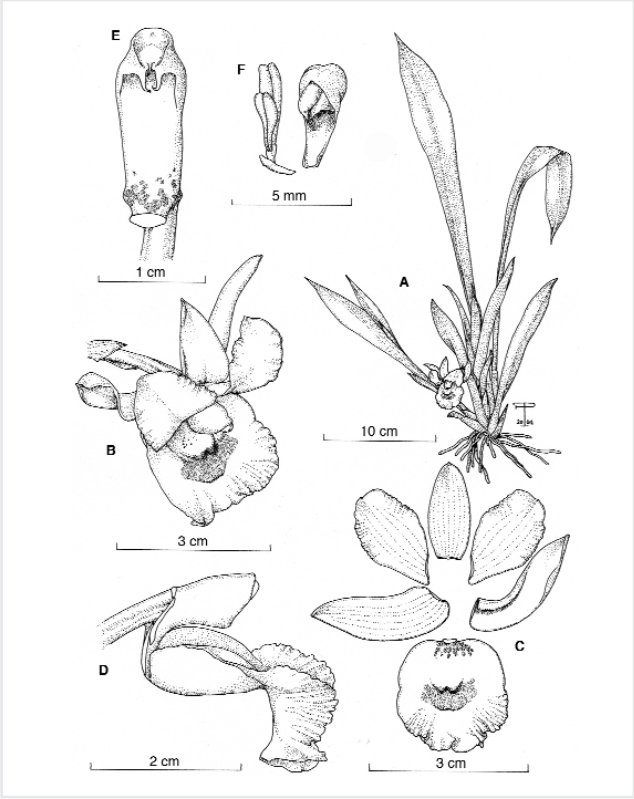

Figure 27.
Chondroscaphe bicolor. **A**, habit. **B**, flower. **C**, Perianth flattened (the left lateral sepal in natural position). **D**, column and lip, lateral view. **E**, column, ventral view. **F**, pollinarium and anther cap. Illustration voucher: *Pupulin 3525* (JBL-spirit).

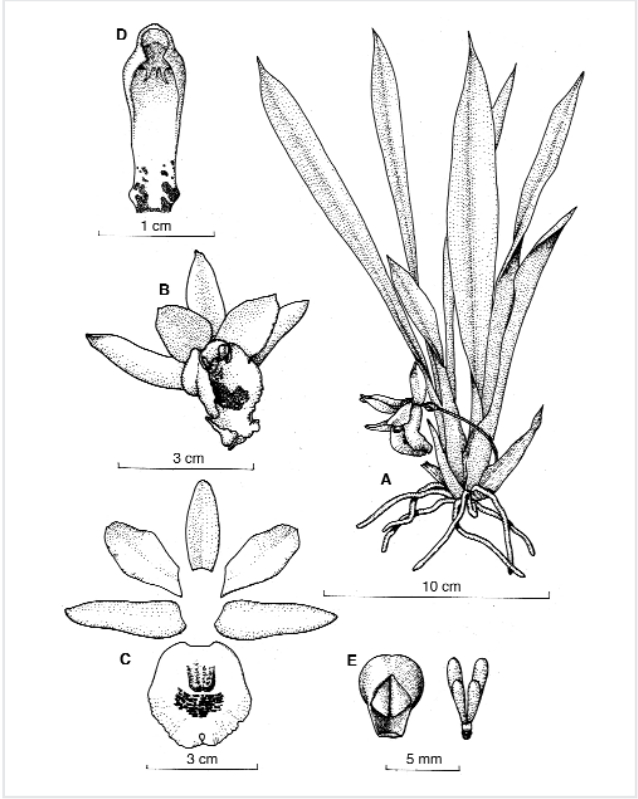

Figure 28.
Chondroscaphe bicolor. **A**, habit. **B**, flower. **C**, Perianth flattened. **D**, column, ventral view. **E**, anther cap and pollinarium. Illustration voucher: *Pupulin s.n.* (USJ).

Figure 29.
A specimen of *C. bicolor* from the A.M. Brenes Biological Reserve in Costa Rica (the type locality of *C. laevis*), flowered at Lankester Botanical Garden in 1998 (*Hoffmann s.n.*, JBL-spirit).

Figure 30.
Another specimen of *C. bicolor* from Grano de Oro, on the lower slopes of the Talamanca range in Central Costa Rica, flowered at Lankester Botanical Garden on May 2008 (*Karremans 883*, JBL-spirit).

Figure 31.
A specimen of *Chondroscaphe bicolor* from Costa Rica (*Hoffmann s.n.*), flowered at Lankester Botanical Garden in March 2004 (JBL-spirit).

part of the same specimen from which the holotype was prepared) and grown at Lankester Botanical Garden under accession No. JBL-07899, flowered in cultivation in May 1998 and in March 2004 (Fig. 29, 31). The distal thickening of the lip of this specimen is distinctly verrucose. On the other side, true specimens of *C. bicolor* were collected from various spots at the A.M. Brenes Biological Reserve (the type locality of *C. laevis*) in several opportunities (i.e., *Bianchi 68, Bogarín 426, Bogarín 985, Bogarín 996, Bogarín 1894, Bogarín 1908, Bogarín 1914, Bogarín 1929, Bogarín 2874,* all the vouchers JBL-spirit).

3. ***Chondroscaphe eburnea*** (Dressler) Dressler, Orquideología 22(1): 22. 2001.

Bas.: *Chondrorhyncha eburnea* Dressler, Orchidee 34(6): 224. 1983.

TYPE. PANAMA. Coclé: Cerro Caracoral, hills north of El Valle de Antón, ca. 850 m, 9 July 1982, *R.L. Dressler 6070* (holotype, US; isotype, PMA).

Epiphytic, caespitose **herb**, to 45 cm tall. **Roots** 1.5-2.5 mm in diameter. **Stem** short, completely hidden by the imbricating sheaths. **Sheaths** strongly conduplicate, provided with scarious margins, to 6 cm long, the upper one foliaceous. **Leaves** 3-4, the conduplicate base 6-7 cm long, the blade narrowly oblanceolate, acuminate, 15-37 x 2.5-4 cm. **Inflorescence** basal, 1-flowered, peduncle to 5 cm long. **Floral bracts** in pairs, the outer one infundibular, triangular-ovate, acute, to 12 x 10 mm, the innner elliptic-lanceolate, 10 x 3-4 mm. **Ovary** and pedicel terete, to 2 cm long. **Flower** with sepals cream to greenish cream, the petals and lip white, the throat of the lip and the column foot spotted purple, the calli yellow. **Dorsal sepal** elliptic to ovate-elliptic, acute, folded at apex, to 27 x 10 mm. **Lateral sepals** oblanceolate, acute, apically hooked, 35 x 10 mm. **Petals** obovate-oblanceolate, acuminate, apiculate at the deeply concave apex, 27-30 x 10-11 mm. **Lip** oblong-obovate from a broadly cuneate base, weakly 3-lobed, rounded, 30-35 x 27-30 mm; the lateral lobes erect, entire, rounded, enfolding the column, strongly thickened adaxially; the blade with crenulate margins; basal callus bilobed, ending in 2 rounded teeth, puberulent-scurfy, reaching 10-12 mm from the base, the free apex 2.5-3 x 6 mm; distal callus a median thickening, running to the lip apex. **Column** terete, widest above stigma, 14-15 x 7.5 mm, with obscure, subquadrate wings to about 2 mm below stigma, column foot 10-12 mm long, rostellar teeth narrowly triangular-acuminate, pararostellar lobes narrowly ligulate-acuminate, introrse. **Anther cap** cucullate, ovate, 2-celled. **Pollinia** 4, in two pairs of different size, linear-oblong, curved, on a broad rounded-subquadrate stipe; viscidium oblong-ovoid, large. Fig. 12, 32—34.

OTHER SPECIMEN STUDIED: **Panama**. Coclé: Cerro Pilón, 27 June 1976, *H.P. Butcher s.n.* (MO). Without specific locality, flowered in cultivation at Lankester Botanical Garden, 12 June 2007, *R.L. Dressler 6826* (JBL-Spirit).

DISTRIBUTION: Known only from Panama.

ECOLOGY: A uncommon epiphyte from the cloud forests on the Pacific slopes of the continental division in central Panama, at 800-1000 m elevation. Flowering has been recorded in June and July, at the beginning of the rainy season in Panama.

Chondroscaphe eburnea can be easily distinguished by the thickened lateral lobes of the lip, forming two distinct cheeks in the inner side (Fig. 35), the deeply concave apex of petals, and the very large, orbicular viscidium.

4. ***Chondroscaphe embreei*** (Dodson & Neudecker) Rungius, Orquideología 22(1): 22. 2001.

Bas.: *Chondrorhyncha embreei* Dodson & Neudecker, Orquideología 19(1): 82. 1993.

TYPE: ECUADOR. Pichincha: San Miguel de los Bancos, 1500 m, 25 Sept. 1980, *A. Andreetta 1209* (holotype, SEL).

Epiphytic, caespitose **herb**, to 40 cm tall. **Roots** produced in the axils of the lower leaves, 2-2.5 mm in diameter. **Stem** short, completely surrounded by the imbricating, distichous sheaths. **Sheaths** strongly conduplicate,, to 5 cm long, the upper one foliaceous. **Leaves** 5-8, the conduplicate base to 8 cm long, the blade narrowly oblanceolate, strap-shaped, acute-acuminate, 14-32 x 1.8-2.5 cm. **Inflorescences** basal, from the axils of the lower sheaths, 1-flowered, suberect-arching to pendent, to 10 cm long, with 1 or 2 appressed, ovate bracts. **Floral bracts** in pairs, the outer one infundibular, triangular-ovate, acute, to 8 x 7 mm, the innner elliptic-lanceolate, 6 x 1.5-2 mm. **Ovary** and pedicel terete, to 2.5 cm long. **Flower** with sepals and petals yellow-green to white, the lip white, the throat of the lip yellow to pale orange, spotted red-brown, the basal callus and the base of the column spotted purple. **Dorsal sepal** oblong-elliptic, acute at the apex, born parallel to the column and then up-curved to erect, slightly folded at apex, 28 x 10 mm. **Lateral sepals** obliquely oblong-elliptic, acute, spreading-recurved, 40 x 10 mm. **Petals** elliptic-obovate, rounded-subtruncate, apiculate at the slightly concave apex, the distal margins finely serrulate-denticulate, 28-30 x 12-14 mm. **Lip** obovate-flabellate from a broadly cuneate base, deeply bilobed at the apex, 32-35 x 21-25 mm, the basal margins erect, entire, rounded, enfolding the column; the blade slightly to strongly reflexed, with irregularly fimbriate-lacerate margins; basal callus rectangular, broader at the base, raised from the lip base, ending in 2 truncate teeth, reaching 13-15 mm from the base, the free apex 2.5-3 x 5 mm; distal callus very prominent, triangular. **Column** terete-clavate, widest around stigma, 18-21 x 6-7 mm, with obscure, elliptic wings to about 3 mm below stigma, column foot 5-6 mm long, rostellar teeth triangular-acuminate, pararostellar lobes traingular, short. **Anther cap** cucullate, ovate, 2-celled. **Pollinia** 4, in two pairs of different size, linear-elliptic, on a transversely ovate stipe; viscidium elliptic-peltate, small. Fig. 7—8, 36.

EPONYMY: named in honor of Mr. Alvin Embree, North American patron of orchidology, who participated in the collection of the specimens.

OTHER SPECIMENS STUDIED: El Oro: Pinas to Machala, km 12, 950 m, 6 Aug. 1979, *C.H. Dodson 8633* (SEL). Carchi: Maldonado, 1650 m, 13 Apr. 1989, *M.T. Madison 3864* (SEL). Imbabura: Selva Alegre, 1870 m, 1 May 1981, *J. Kuhn 19* (SEL).

DISTRIBUTION: Endemic to Ecuador.

ECOLOGY: Epiphytic in premontane and submontane rain forests on the western side of the Ecuadorian Andes at elevations of 1200-2000 meters. According to the documented records, *C. embreei* flowers year round, with flowering peaks during the months of September and March.

For its dentate petals, deeply fimbriate-lacerate lip, and pollinarium morphology, *C. embreei* belongs to the

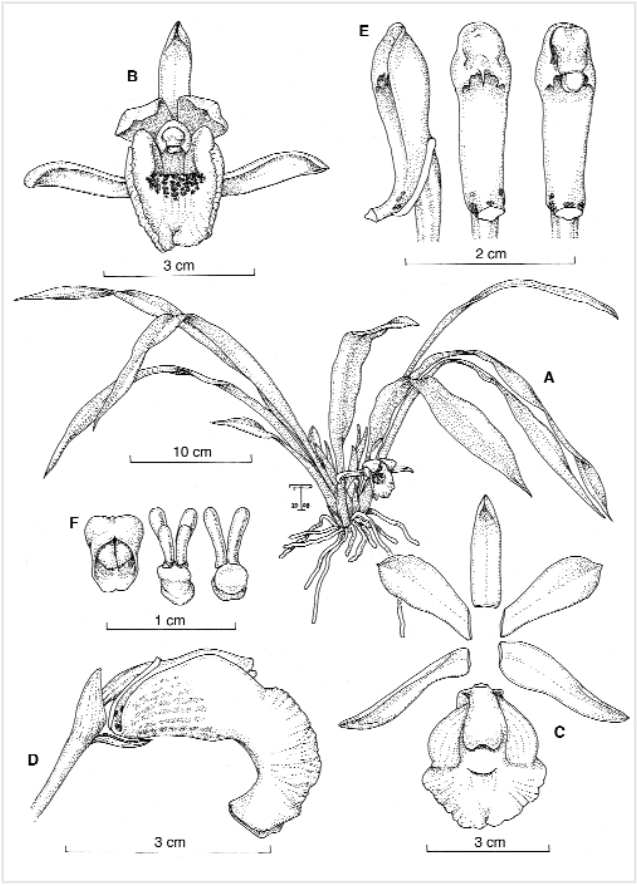

Figure 32.
Chondroscaphe eburnea. **A**, habit. **B**, flower. **C**, Perianth flattened (the right lateral sepal in natural position). **D**, column and lip, lateral view. **E**, column (lateral and 2 ventral views). **F**, anther cap and pollinarium (dorsal and ventral views). Illustration voucher: *Dressler 6826* (JBL-spirit).

C. flaveola group, a group essentially South American in distribution. Among the white-flowered species of the genus *Chondroscaphe*, it can be easily distinguished by the fimbriate midlobe of the lip, the raised, rectangular callus on the disc, and the very prominent, triangular, distal callus.

Chondroscaphe embreei was first illustrated by C.H. Dodson and P.M. Dodson in 1980 under the name of *Chondrorhyncha flaveola* Rchb.f. on the basis of an Ecuadorian specimen from the province of El Oro (Dodson & Dodson, 1980a). Dodson and Neudecker (2001) explicitly refer to this illustration in the protologue of *C. embreei*, but unfortunately the ink drawing selected to illustrate the type (Dodson & Neudecker, 2001: 86) does not correspond to this species. The plate, from Dodson and Dodson (1980b), was originally published to illustrate a specimen of *C. chestertonii* (Rchb.f.) Senghas & G. Gerlach from Ecuador, but it likely corresponds to *C. amabilis* (Linden & Rchb.f.) Senghas & G. Gerlach. Direct examination of the type of *Chondrorhyncha embreei* at SEL (*Andreetta 1209*), however, leaves no doubts about the identity of this species, which presents a basal, laminar callus raised from the base, broader at the base than at apex. The species is correctly illustrated in Dodson and Escobar (1993: 120), who also offer a color photograph of the white morph

Figure 33.
Chondroscaphe eburnea, flowering at Lankester Botanical Garden (*Dressler 6826*, JBL-spirit).

Figure 34.
Another specimen of *C. eburnea*, photographed in Panama by Kerry Dressler.

Figure 35.
The spread lip of *C. euburnea*. Note the distinclty thickened adaxial surface of the lateral lobes (*Dressler 6826*, JBL-spirit).

of *C. embreei.*

5. ***Chondroscaphe merana*** (Dodson & Neudecker) Dressler, Orquideología 22(1): 22. 2001.

Bas.: *Chondrorhyncha merana* Dodson & Neudecker, Orquideología 19(1): 83. 1993.

TYPE: ECUADOR. Pastaza: Baños de Puyo, Mera, 1500 m, 17 March 1976, *C.A. Luer et al. 891* (holotype, SEL).

Epiphytic, caespitose **herb**, to 40 cm tall. **Roots** 2-2.5 mm in diameter, produced in the axils of the lower sheaths. **Stem** short, completely surrounded by the imbricating sheaths. **Sheaths** distichous, conduplicate, provided with membranaceous margins, to 4.5 cm long, the upper one foliaceous. **Leaves** 5-8, stiff, the conduplicate base 1.5-2 cm long, the blade narrowly oblanceolate, acute-acuminate, 15-36 x 1.5-2 cm. **Inflorescence** basal, from the axils of the lower leaf-sheaths 1-flowered, peduncle to 8 cm long, with 1-2 appressed, ovate bracts. **Floral bracts** in pairs, the outer one infundibular, broadly ovate, acute, to 9 x 8 mm, the innner lanceolate, acute, 9 x 4 mm. **Ovary** and pedicel terete, to 1.4 cm long. **Flower** with sepals cream white, the petals and lip white, the throat of the lip, the callus and the column foot spotted dark purple. **Dorsal sepal** oblong-elliptic, acute, semi-erect, slightly folded at apex, to 20 x 7 mm. **Lateral sepals** oblong-ovate, acute, spreading-recurved, incurved on the margins, to 40 x 10 mm. **Petals** oblanceolate, rounded, minutely apiculate, slightly concave at apex, 22-26 x 10-12 mm. **Lip** elliptic-obovate to elliptic-flabellate, bilobed at the apex, to 25 x 25 mm; the basal margins erect, entire, tubular enfolding the column; the blade flaring and abruptly recurved, provided with deeply and irregularly undulate margins; basal callus rectangular, slightly raised from the base of the disc, bilobed, ending in 2 triangular teeth, reaching 13-15 mm from the base, the free apex 4-5 x 5 mm; distal callus a median, low thickening, running to the lip apex. **Column** terete, widest at the stigma, sulcate on the underside, 15 x 7 mm, with obscure, elliptic wings to about 3 mm below stigma, column foot 6-7 mm long, rostellar teeth narrowly triangular-acuminate, pararostellar lobes short, broadly triangular-subfalcate, acute, introrse. **Anther cap** cucullate, rectangular-subpandurate, 2-celled. **Pollinia** 4, in two superposed pairs of different size, clavate, on a small subquadrate stipe; viscidium elliptic-peltate. Fig. 37—38.

ETYMOLOGY: Named for Mera in Ecuador, the collecting locality of the type specimen.

OTHER SPECIMENS STUDIED: **Ecuador**. Tungurahua: Baños to Puyo, Río Negro, 1200 m, 4 March 1963, *C.H. Dodson 2327 & L.B. Thien* (SEL); same

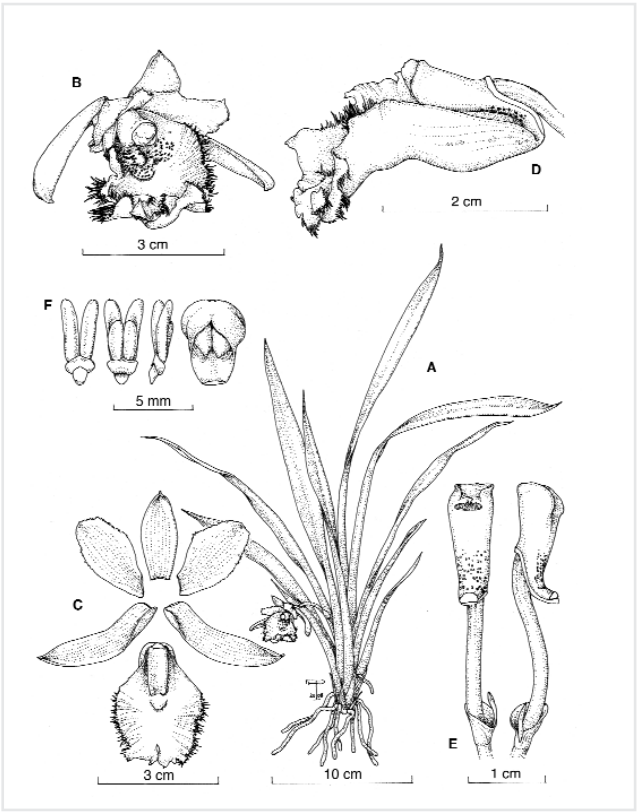

Figure 36.
Chondroscaphe embreei. **A**, habit. **B**, flower. **C**, Perianth flattened. **D**, column and lip, lateral view. **E**, column, ventral and lateral views. **F**, pollinarium (dorsal, ventral, and lateral views) and anther cap.
Illustration voucher: *Pupulin 6510* (JBL-spirit).

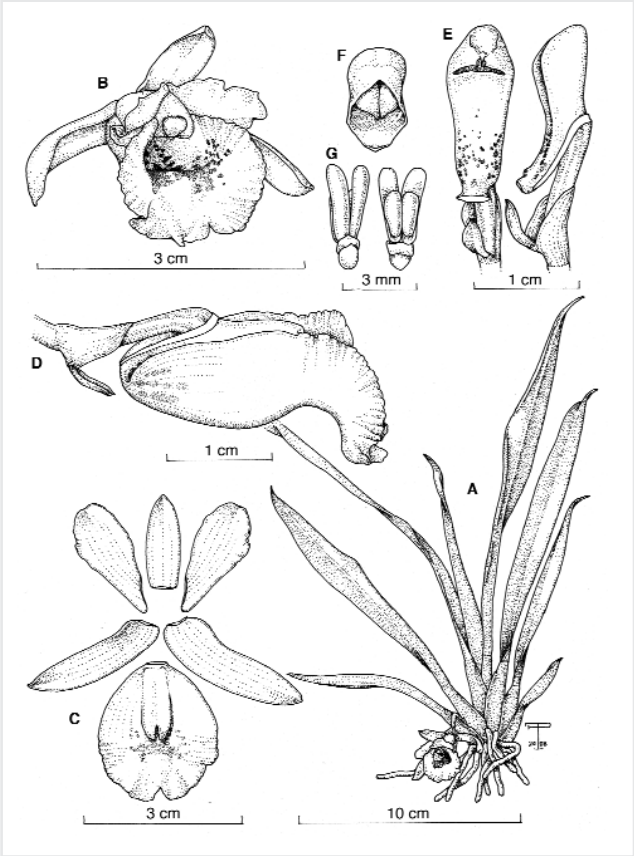

Figure 37.
Chondroscaphe merana. **A**, habit. **B**, flower. **C**, Perianth flattened (the right lateral sepal in natural position). **D**, column and lip, lateral view. **E**, column, ventral and lateral views. **F**, anther cap. **G**, pollinarium (dorsal and ventral views). Illustration voucher: *Acaro & Medina s.n.* (CIOA-spirit).

locality, March 1982, *A. Hirtz 13* (SEL). Zamora Chinchipe: Valladolid, Tapala, shores of Río Mayo and Río Loyola, where the two rivers merge, collected in 2000, flowered in cultivation in the collection of the Ángel Andreetta Research Center on Andean Orchids, accession No. CIOA-000441, 11 May 2008, *I. Acaro & H. Medina s.n.* (CIOA-spirit).

DISTRIBUTION: Endemic to Ecuador.

ECOLOGY: Epiphytic in premontane wet forest on the eastern slopes of the Andes in central and southern Ecuador at 1200-1500 m elevations. Flowering mostly occurs in March-April, but specimens have been recorded in flower also in November.

Originally recorded from Ecuador under the name of *Chondrorhyncha bicolor* (Dodson & Dodson, 1989), *C. merana* is distinguished by the elongate, rectangular, 2-toothed callus raised from the surface of the lip from the base to the apex and the absence of a distinct distal callus, substituted by a low, rounded thickening running to the lip apex (Dodson & Luer, 2005). A color photograph of *C. merana* is presented in Dodson and Escobar (1993: 117).

Figure 38.
The flower of *C. merana*, from the collection of the Ángel Andreetta Research Center on Andean Orchids, photographed by Hugo Medina (*Acaro & Medina s.n.*, CIOA-spirit).

6. ***Chondroscaphe plicata*** (D.E. Bennett & Christenson) Dressler, Orquideología 22(1): 22. 2001. Bas.: *Chondrorhyncha plicata* D.E. Bennett & Christenson, Brittonia 46: 24. 1994.

TYPE: PERU. Junín: Kivinaki, north margin of Río Perené, 1700 m, 26 Mar. 1992, *O. del Castillo ex Bennett 5507* (holotype, USM, not seen).

Epiphytic, caespitose **herb**, to 21 cm tall. **Roots** 2-2.5 mm in diameter. **Stem** short, completely hidden by the imbricating sheaths. **Sheaths** strongly conduplicate, provided with scarious margins, to 5 cm long, the upper one foliaceous. **Leaves** 3-4, stiff, the conduplicate base 1.5-2 cm long, the blade lanceolate, acuminate, 15-21 x 1.5-1.9 cm. **Inflorescence** basal, lax, 1-flowered, peduncle to 6.5 cm long. **Floral bracts** in pairs, the outer one infundibular, ovate, acuminate, to 5 x 4 mm. **Ovary** and pedicel terete, to 1.1 cm long. **Flower** with sepals and petals pale greenish white, the lip cream-white with lavender and yellow markings. **Dorsal sepal** oblong, acute, concave, 18 x 8 mm. **Lateral sepals** lanceolate, subacute, strongly concave, the margins basally involute, 26 x 7 mm. **Petals** obovate-spatulate, rounded, mucronulate, the distal margins lightly pleated, 23 x 8 mm. **Lip** elliptic-ovate when spread, tubular in natural position, unlobed, obtuse, 24 x 18 mm; the elliptic lateral lobes erect, entire, rounded, enfolding the column; the blade recurved, with many-pleated margins; basal callus of two elongate, low, broad, converging ribs, ending in two thick, triangular, acute teeth, reaching 15 mm from the base, the free apex 6 x 4 mm; distal callus a transversely elliptic, rounded, verrucose thickening. **Column** arcuate, terete-clavate, fleshy, 17.5 x 6 mm, column foot 5-7 mm long, widest aside stigma, with obscure, rounded wings to about 4 mm below stigma, the ventral surface covered with long verrucose processes. **Anther cap** cucullate, subrectangular-ovate, 2-celled. **Pollinia** 4, in two pairs of different size, oblong, curved, on a small ovate stipe; viscidium elliptic. The

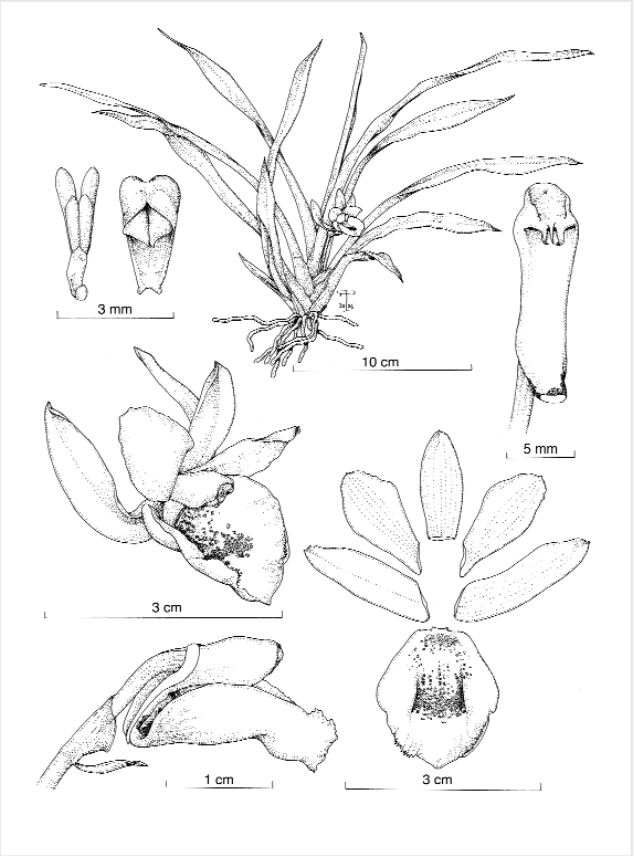

Figure 39.
Chondroscaphe venezuelana. **A**, habit. **B**, flower. **C**, Perianth flattened. **D**, column and lip, lateral view. **E**, column, ventral view. **F**, pollinarium and anther cap.
Illustration voucher: *Pupulin 5724* (VEN).

description was prepared from the original description and the accompanying illustration (Bennett & Christenson, 1994).

ETYMOLOGY: From the Latin *plicatus*, in reference to the pleated midlobe of the lip.

DISTRIBUTION: Known only from Peru.

ECOLOGY: An epiphyte from the wet montane forests of northern Peru, at 1750-1900 m elevations. Flowering in the spring months of October to November.

Like *C. merana*, *C. plicata* has a 2-ribbed, elongate callus running from the base of the lip to the disc, where the free apices converge. However, the distal callus is a transverse, verrucose thickening instead of a longitudinal, low, rounded keel. Furthermore, the ventral surface of the column presents long verrucose processes, while it is glabrous in *C. merana.*

7. ***Chondroscaphe venezuelana*** Pupulin & Dressler, *sp. nov.*

TYPE: VENEZUELA. Merida: without specific locality, collected by Sergio Mior, 1987, flowered in cultivation in the collection of Giancarlo Pozzi at Morosolo, Italy, 18 August 2005, *F. Pupulin 5724* (holotype, VEN).

Figure 40.
Photo of the flower from the plant that served as the holotype of *C. venezuelana.*

A Chondroscaphi bicolori (Rolfe) Dressler apice labelli obtuso, lobulo intermedio angustiore quam lobulis lateralis expansis, marginibus apicalibus serrulatis, stipite pollinarii elongato recedit.

Epiphytic, caespitose **herb**, to 30 cm tall. **Roots** 1.5-2 mm in diameter. **Stem** short, completely hidden by the imbricating sheaths. **Sheaths** strongly conduplicate-ancipitous, provided with scarious margins, to 5 cm long, the upper one foliaceous. **Leaves** 5-7, the conduplicate base to 8 cm long, the blade narrowly oblanceolate-ligulate, acuminate, 11-25 x 0.8-1 cm. **Inflorescence** basal, 1-flowered, suberect, peduncle to 6 cm long. **Floral bracts** in pairs, the outer one infundibular, ovate, acute, to 7 x 10 mm, the inner elliptic-lanceolate, 7 x 2 mm. **Ovary** and pedicel terete, to 1.5 cm long. **Flower** white to cream, the petals and lip white, the throat of the lip and the column foot spotted purple. **Dorsal sepal** elliptic, acute, minutely apiculate, 17 x 7 mm. **Lateral sepals** linear-oblong, slightly subfalcate, acute, minutely apiculate, the basal margins incurved, to 25 x 7 mm. **Petals** obovate, obtuse, apiculate, 20 x 8-10 mm. **Lip** broadly elliptic, 3-lobed, obtuse, 22 x 19 mm; the lateral lobes elliptic, erect, entire, partially enfolding the column; the blade broadly triangular, narrower than the spread lateral lobes, with distinctly serrulate-denticulate margins; basal callus bilobed, ending in 2 subtriangular teeth, glabrous, reaching 10-11 mm from the base, the free apex 1.5 x 7 mm; distal callus a obscure, median thickening shortly in front of the basal callus. **Column** terete, cuspidate toward apex, widest around stigma, 15-17 x 5 mm, with obscure, rounded wings to about 2 mm below stigma, column foot 6-7 mm long, rostellar teeth narrowly triangular-acuminate, pararostellar lobes ligulate, abruptly convergent apically. **Anther cap** cucullate, triangular-truncate, 2-celled. **Pollinia** 4, in two superposed pairs of different size, oblong, on a long, ligulate stipe; viscidium elliptic, small. Fig. 39—40.

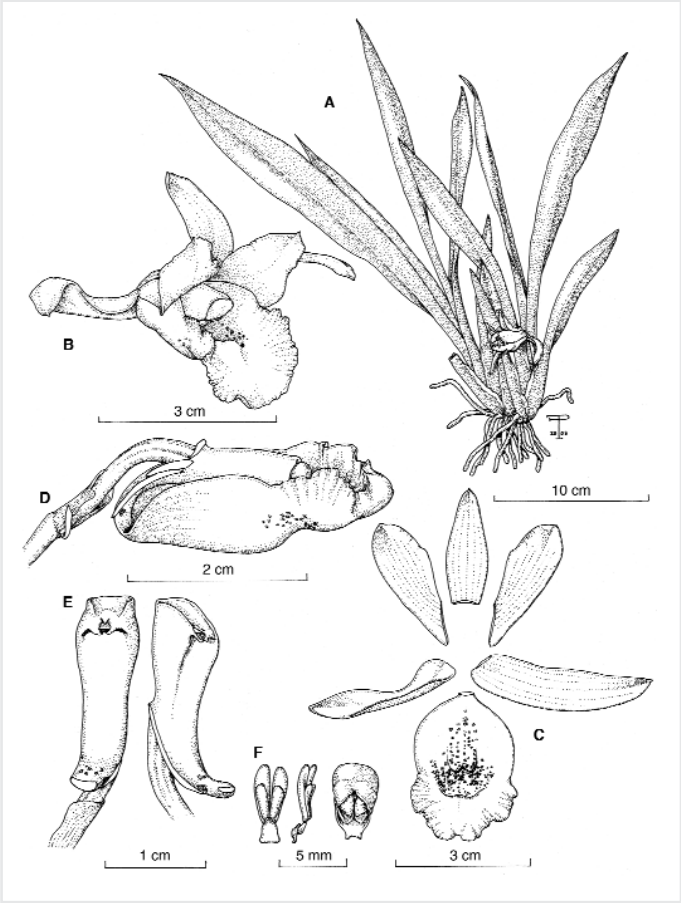

Figure 41.
Chondroscaphe yamilethiae. **A**, habit. **B**, flower. **C**, Perianth flattened (the right lateral sepal in natural position). **D**, column and lip, lateral view (the apex of lip not spread). **E**, column, ventral and three-quarters views. **F**, pollinarium (ventral and lateral views) and anther cap. Illustration voucher: *Pupulin 4701* (USJ).

ETYMOLOGY: Named from the country of origin, Venezuela.

DISTRIBUTION: Known only from Venezuela.

ECOLOGY: A supposedly rare epiphyte from the premontane wet forests of the Venezuelan Andes. Flowering in cultivation in the northern hemisphere has been recorded in August.

Chondroscaphe venezuelana is closely allied to the Costa Rican and Panamanian *C. bicolor,* with which it shares the ligulate, L-shaped pararostellar lobes. However, in *C. venezuelana* the lip is obtuse (vs. retuse-bilobed in *C. bicolor*), with the midlobe narrower than the spreading lateral lobes (vs. broader), provided with distinctly serrulate apical margins (vs. crenulate). Moreover, the stipe of the pollinarium of *C. venezuelana* is ligulate-oblong, much longer than the subtending viscidium, while the short stipe of *C. bicolor* is subquadrate and subequal to the visicidium.

8. ***Chondroscaphe yamilethiae*** Pupulin, Vanishing Beauty 1: 111. 2005.

Figure 42.
Photo of the flower from the plant that served as the holotype of *C. yamilethiae*, flowered at Lankester Botanical Garden on May 2003 (*Pupulin 4701,* JBL-Spirit). Reproduced with permission by the Editorial de la Universidad de Costa Rica.

Figure 43.
The flower on which the description of *C. yamilethiae* was based, when flowered at Lankester Botanical Garden on April 2003 (*Pupulin 4701*, USJ). Reproduced with permission by the Editorial de la Universidad de Costa Rica

Figure 44.
Another specimen of *C. yamilethiae*, from the Pacific watershed of The Cordillera de Talamanca in Costa Rica (*Pupulin 4637*, JBL-Spirit).

Figure 45.
A still undescribed Panamanian *Chondroscaphe*, probably a relative of *C. eburnea*, from the region of El Valle de Antón (photograph by Kerry Dressler).

Figure 46.
The flower of a specimen of *Chondroscaphe* photographed by Kerry Dressler in western Ecuador, perhaps allied to the Central American *C. atrilinguis.*

TYPE. COSTA RICA. Puntarenas: Buenos Aires, Holán, 1200-1300 m, collected by C. Arguedas, 2000, flowered in cultivation in the collection of J. Cambronero in San Isidro de Pérez Zeledón, 20 Apr. 2003, *F. Pupulin 4701* (holotype, USJ).

Epiphytic, caespitose **herb**, to 35 cm tall. **Roots** 2-2.5 mm in diameter. **Stem** short, completely hidden by the imbricating sheaths. **Sheaths** strongly conduplicate, provided with scarious margins, to 6.5 cm long, the upper one foliaceous. **Leaves** 5-7, the conduplicate base 4-5 cm long, the blade narrowly oblanceolate, acuminate, 10-30 x 1.8-4 cm. **Inflorescence** basal, 1-flowered, peduncle to 4 cm long. **Floral bracts** in pairs, the outer one infundibular, ovate, 9 x 6 mm, the innner ligulate, 5 x 2 mm. **Ovary** and pedicel terete, 1.8 cm long. **Flower** white, the inner part of the lip and the column foot spotted purple. **Dorsal sepal** elliptic-lanceolate, acute, minutely apiculate, 25 x 10 mm. **Lateral sepals** narrowly elliptic-ligulate, subfalcate, acute, minutely apiculate, the basal margins incurved, 38 x 9 mm. **Petals** oblong, obtuse, minutely apiculate, the distal margins crenulate, 30 x 11.5 mm. **Lip** elliptic-ovate, obscurely 3-lobed, 33 x 25 mm, shortly emarginate, deeply keeled just to the attachment of the distal lobe, the keel strongly convex in profile; the lateral lobes erect, entire, enfolding the column; the median lobe transversely elliptic, the margins crenulate-subfimbriate; basal callus bilobed, reaching 17 mm from the base, the teeth cuspidate, with free apex, sparsely glandular, 7.5 x 6.5 mm; distal callus rounded, emarginate, slightly rugose, 11 x 5 mm. **Column** terete, subquadrate toward apex, widest around stigma, 19 x 6 mm, with obscure wings to about 5 mm below stigma, column foot 7 mm long, rostellar teeth triangular, short, pararostellar lobes acicular, falcate. **Anther cap** cucullate, ovate, 2-celled. **Pollinia** 4, in two pairs of different size, oblong-subsigmoid, on a ovate-triangular stipe; viscidium suborbicular. Fig. 41—44. (Voucher: Pupulin 4701, USJ).

EPONYMY: Named in honor of Yamileth González García, then Vice-President of Research, now President, University of Costa Rica.

OTHER SPECIMENS STUDIED: Costa Rica. San José: Pérez Zeledón, camino lastreado a Las Pegas, Páramo, Los Ángeles, 9º29′01″N 83º45′16″W, 20 Apr. 2003, *F. Pupulin 4637, J. Cambronero, H. León-Páez, M. Powell, E. Salas & V. Savolainen* (JBL-Spirit); same locality, *F. Pupulin 4638, J. Cambronero, H. León-Páez, M. Powell, E. Salas & V. Savolainen* (JBL-Spirit); Dota, San Joaquín, 9º36′47″N 84º00′51″W, 26 March 2002, *F. Pupulin 3544, V. Savolainen, M. Powell & M. Flores* (JBL-Spirit).

DISTRIBUTION: Known only from Costa Rica.

ECOLOGY: A uncommon, large epiphyte from the premontane and lower montane rain forests on the Pacific slopes of the Talamanca mountain range in Costa Rica, where plants are usually found on shaded primary branches. Flowering has been mostly recorded at the beginning of the dry season in Costa Rica, during the months of December and January.

Among the species of the *C. bicolor* group, *C. yamilethiae* is distinguished by the non-reflexed lateral sepals, the deeply convex abaxial surface of the lip, in addition to the reduced size of the rostellum and the pararostellar arms.

Insufficiently Known Taxa

Today we feel that we have a better understanding of the taxonomy of white-flowered *Chondroscaphe* in those areas that have been more amply botanically sampled, as in Costa Rica, Panama, and Ecuador. The absence of documented records of species of this group in Colombia is noteworthy, where they might occur considering the genus' distribution pattern. This means that the last word about the complex taxonomy of this group has yet to be written. We have photographs of white-flowered *Chondroscaphe* species from el Valle de Antón in Panama and from Western Ecuador, taken by

Kerry Dressler over a number of years (Fig. 45—46), which apparently do not correspond to any of the already described taxa. Unfortunately, the material at hand is insufficient to verify their taxonomic identity, and we favor at this moment leaving them as unresolved problems waiting for better sampling and future, detailed observations.

Acknowledgments

We acknowledge the scientific services of Costa Rican Ministry of Environment and Energy (MINAE) and its National System of Conservation Areas (SINAC) for issuing the collecting permits under which wild species treated in this paper were collected. Gratitude is extended to José Portilla Andrade for granting access and use of the vast plant collections of Ecuagenera at Gualaceo, Ecuador, and to the Ministerio del Ambiente of Ecuador for extending the permits to manage the *ex-situ* orchid collections. Diego Bogarín helped with observations, suggestions, and field work. Gratitude is expressed to the curators and staff of K, MO, SEL, USJ, and W, for their assistance and courtesy during our research. This paper was prepared as part of the project 814-A4-068, "Descripción de especies de la familia Orchidaceae, subtribe Zygopetalinae", supported by the Vicerrectoría de Investigación, Universidad de Costa Rica.

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