Novelties in *Chrysochlamys membranacea* (Clusiaceae: Clusieae), an Update on the Nomenclatural and Morphological Knowledge of this Species Described from Biogeographic Chocó, Colombia

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Authors' contributions

This work was carried out in collaboration among all authors. Author AVCS worked earlier on Clusiaceae studies, developed the conceptualization of the current work, and wrote the original draft of this article. Both authors FAG and AIP supervised the project and contributed to the review and editing of all previous versions. All authors read and approved the final manuscript.

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ABSTRACT

_Chrysochlamys membranacea_ Planch. & Triana is a species described as a pistillate specimen collected between Nariño and Cauca departments, in the locality of biogeographic Chocó, Colombia. In that publication the authors also provide a description of staminate flowers, however, there is no clarity about the collection related to it. During studies on the Clusiaceae family in Colombia, it was shown that _C. membranacea_ is one of the species for which clarity about its sexual dimorphism is lacking and that, additionally, the citation of collections and localities has also generated taxonomic and nomenclatural uncertainty. In this work the knowledge about the identity of _C. membranacea_ is revalued, its morphology is extensively described, emphasizing the fruits and staminate flowers, and the lectotype for this species is proposed. Finally, some notes are provided on its geographic distribution, phenology, taxonomic affinities, sexual dimorphism, and threat category according to the categories and criteria of the IUCN.

Keywords: Balboa; dioecious; malpighiales; neotropical flora; Tovomitopsis; Triana.

1. INTRODUCTION

The genus _Chrysochlamys_ Poepp. is circumscribed in the tribe Clusieae of the family Clusiaceae s.s. together with the genera _Arawakia_ L. Marinho, _Clusia_ L., _Dystovomita_ (Engl.) D'Arcy, _Tovomita_ Aubl. and _Tovomitopsis_ Planch. & Triana [1]. _Chrysochlamys_ has some 35-55 species, representing between 7-11% of the diversity of the tribe, distributed from Mexico and the Caribbean Islands to Bolivia and the North of Brazil, mainly in humid and low elevations forests, reaching ca. 2300 m a.s.l. [1,2,3,4].

All species of _Chrysochlamys_ are dioecious and usually, these are described only of pistillate or staminate specimens. This condition is frequent in the species described by Planchon & Triana [5,6], which generates problems to define the morphological limits of the species. To overcome this problem, a complement to descriptions is necessary [5,7,8]. Additionally, the names of these taxa need typification’s, notes on the type location, and the accuracy of the description to diminish taxonomic issues [9,10].

_Chrysochlamys membranacea_ is a species that has been reported in Brazil, Colombia, Ecuador, Venezuelan Guayana and, Perú [11,12,13,14,15]. However, only in the Brazil and Venezuelan Guayana flora’s is provided a critical morphology analysis of the specimens, considering mainly vegetative characters and infructescence being the last one, a structure that was not described or considered in the protologue [6,11,15].

Based on the protologue, the type collections and 19 additional specimens belonging to _C. membranacea_, a nomenclatural treatment, a morphological re-circumscription and notes on its geographical distribution, ecology, dioecious condition, and local conservation status are proposed. This work contributes to the morphological knowledge of one of the least studied genera of the Clusiaceae, additionally this is a first approach to the evaluation of the dioecious condition and its implications for the taxonomic and ecological knowledge of _Chrysochlamys_ in Northwestern of South America.

2. MATERIALS AND METHODS

Clusiaceae collections from HUA, FAUC, JAUM, MEDEL herbaria and, digital images from BM, COL, F, K, MPU, NY, P, SINCHI, UDBC and, US herbaria were revised in detail (acronyms according to [16]). In this search 39 sheets of _C. membranacea_ were found, 15 with staminate flowers, 22 pistillate flowers, and 2 with immature flower buds. Morphological descriptions follow [17,18,19,20]. The nomenclatural treatment is according to the International Code of Nomenclature for algae, fungi, and plants (ICN) [21].

The threat category analysis was carried out following the guidelines of the IUCN [22,23], and using "ConR" package [24]. Based on the coordinates of all collections examined, this software calculates the “extent of occurrence” and the “area of occupancy” of the species. A 2 km cell width was used for the area of occupancy and a radius of 5 km was applied for the number of sub-populations, the cartography of protected areas of Colombia [25], (available at: https://www.iucn.org/), and Protected planet [26],
(available at: www.protectedplanet.net) was considered. Finally, to generate the distribution map with QGIS 3.10 version [27], (available at: https://qgis.org/).

3. RESULTS AND DISCUSSION


Type (lectotype, designed here): —COLOMBIA. “Choco et Barbacoas, côtes de l’océan Pacifique, alt. 200 mètres, le long des cours d’eau, dans les forêts”, May. 1853, _Triana_ 5433-12 (BM000611594 [digital image!]; isolecotypes P00093887 [digital image!]; K000488480 [digital image!]; remanescent syntypes F00114316 [digital image!] (negative). Possible remanecent syntypes: —COLOMBIA. “Prov. del Chocó costas del pacifico, alt. 250”, Mar. 1853, _Triana_ 5433-13 (BM000939035, COL000118341 [digital image!], BM000611594 and BM000939035, see Fig. 1), the portion of the specimen on the left coincides with the locality cited in the protologue (Triana 5433-12), is designated as a lectotype in accordance with ICN Art. 9.3, Art. 9.6, Art. 9.14 and following the 9A recommendation [21].

**Nomenclatural notes:** When Planchon & Triana [6] described _Chrysochlamys membranacea_ they provide the description of a vegetative and pistillate flowers followed by the citation of unnumbered Triana collections, and “Province of Barbacoas” as the locality of the specimen. Subsequently, they describe staminate flowers without relating a collection or locality to this.

After reviewing the original material collections, it was possible to show that they have label notes with Triana’s calligraphy where, presumably numbered by him [10,28]. Nevertheless, there is uncertainty regarding the nature of this numbering. With the information provided in the protologue of the pistillate individual were found the original material in BM, K, and P herbaria. The BM voucher is mixed (BM000611594 and BM000939035, see Fig. 1), the portion of the specimen on the left coincides with the locality cited in the protologue (Triana 5433-12), is designated as a lectotype in accordance with ICN Art. 9.3, Art. 9.6, Art. 9.14 and following the 9A recommendation [21].

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**Fig. 1. Chrysochlamys membranacea** original material. A) _Triana_ 5433-12 (Lectotype) and B) _Triana_ 5433-13 in BM herbarium. C) Labels notes with Triana calligraphy in _Triana_ 5433-13 COL herbarium. D) Labels notes with Triana calligraphy in _Triana_ 5433-12 P herbarium. E) Labels notes with Triana calligraphy in _Triana_ 5433-13 BM herbarium. F) Labels notes with Triana calligraphy in _Triana_ 5433-13 BM herbarium (Lectotype)
On the other hand, BM000939035 numbered as Triana 5433-13, shares the sheet with the lectotype, their vegetative morphology coincides with the pistillate specimen, and the biogeographic region and the date agree with the route of the trips made by Triana in the Choreographic Expedition of Colombia, in the former provinces of Barbacoas and Chocó [29, 30], the same label information is present in the collections deposited in COL herbarium. Both are considered in this work as possible remanescent syntypes (see Art. 9.6, Art. 9.14, and 9C in [21]), and it is very probable that these collections correspond to the description made by the authors of the inflorescences and staminate flowers [6].

**Morphologic description:** Dioecious trees or shrubs, 2.5–15.0 m. Reddish bark. Exudate white or hyaline, viscid and abundant.

**Leaves:** Petoiles 5.0–6.3 mm long, leaf blade elliptic to oblanceolate, 10.0–37.5×4.0–17.0 cm, membranous; olive green or green grayish in sicco; base attenuate to slightly obtuse, decurrent towards petiole; apex acuminate; brochidodromous venation, prominent in the abaxial face, 19–25 pairs evenly spaced, 5.9–11.1 mm, 20°–30°; intersecondary veins non-obvious; tertiary veins forming V or branching dichotomously; slightly puberulent around midvein and secondary veins; exude canals on both sides, very abundant.

**Staminate inflorescences:** Ramiflorus thyrse, ca. 17.2 cm long, quadrangulates, without or very few irregular structures, puberulent, green; peduncle 0.4 to 2.5 cm long; internodes 0.7 to 4.5 cm long; proximal paracladia ca. 2.5 mm long.

**Staminate flowers:** Ca. 5.3×4.8 mm, globose in floral buds; pedicels 5.9–11.8 mm long, quadrangulates, puberulent, with irregular structures; bracteoles 2, ca. 0.9 mm, inserted ca. 3.7 mm from the base, triangular, coriaceous, puberulent, margin wavy, fused basally. Calyx 5-merous; outer whorl 2-merous, connate, white, occasionally with pinkish variegation, coriaceous, puberulent, non-proportional, ca. 2.6–3.2×2.7 mm, sinuous margin; inner whorl 3-merous, free parts, white, cucullate; membranous, puberulent and with visible light streaks, not proportional, ca. 3.9–5.2×3.9 mm, scarious margin. Corolla 5-merous, petals connate, yellow, pink, or white, occasionally with reddish variegation, elliptic to obovate, proportional, ca. 10.5×5.4 mm, lustrous, reflexed, margin irregular and sinuous. Staminodes in a thick uniseriate or biseriate ring, basally connate to ovary, not persistent at maturity, resinous, possible find series of epipetalous staminodes, ca. 1.8 mm long; developed anthers, globose, located in the distal portion, ca. 0.1 mm, undeveloped connective. Ovary ca. 3.9×3.9 mm, elliptic, puberulent; 4–5 locular. Stigmata 4–5; 1.3 mm long, foveolate, forming a crown.

**Fruits:** Obovate, 1.7×1.5–1.9 cm; epicarp reddish green to wine brown; deciduous sepals and staminodes; pedicels 12.7–17.3 mm long covered with verrucose protuberances. Aril orange. Seeds elliptic, ca. 0.8 cm long.

**Common name:** Sanca sanca in Chocó, Colombia (E. Rentería 59 COL, HUA ♂).

**Sexual dimorphism:** When evaluating the intraspecific sexual differences in the revised specimens, a marked collectors bias towards pistillate specimens was observed, maybe related to the duration of staminate flowers vs. fruits in several stages of development. However,
with the individuals evaluated, it can be seen sexual dimorphism in *C. membranacea* occurs at the level of inflorescences and flowers, the vegetative characters are very stable which has facilitated the generation of a hypothesis of conspecificity between the specimens (see Fig. 2).

Staminate and pistillate individuals differ in the length of the inflorescence, shape of the floral whorls, and size and number of flowers. Staminate plants have internal sepals connate, and asymmetrical petals, obovate to orbicular, shorter than in pistillate individuals. The size and number of flowers, the lengths of the inflorescences, paracladia, peduncles, internodes and pedicels also seem to be morphological characters that showed variation in the different collections, however, there are not enough data to conclude that it is an intraspecific difference related to dioeciousness.

Resins were found in the staminodes of both sexual morphs, a trait not previously reported for this species.

**Phenology:** The staminate individuals of *C. membranacea* have been collected with flowers (floral buds and anthesis) in February, March, April, May, September, and December. Pistillate individuals have been collected with flowers (floral buds and anthesis) in March, July, and November. The fruiting occurs in the months of February, April, August and with both stages in February, May, and November. However, the data provided are still insufficient to establish a precise phenological pattern or to evaluate the synchrony of flowering between both sexualities.

![Fig. 2. *Chrysochlamys membranacea*. A) Stem with leaf, staminate inflorescence, and bark. B) Details of staminate inflorescence. C) Stem with leaf, and pistillate inflorescence D) Details of staminate inflorescence. E) Detail of resins canals in the leave (adaxial face). F) Staminate flowers at anthesis, resins in central position (lateral view). G) Detail of pubescent secondary and tertiary venation (abaxial face). H) Pistillate flowers at anthesis with staminode arrangement and ovary indument (lateral view). I) Detail of pedicel in fruits with verrucose protuberances (lateral view). Figure by Cristina Pareja, based on *E. Rentería 59* (HUA) ♂, *D. Sánchez 1074* (HUA) ♂, *L. Londoño 09* (HUA) ♀, and *D. Sánchez 1081* (MEDEL) ♀.](image-url)
Table 1. Comparison between C. membranacea and its related species

<table>
<thead>
<tr>
<th>Morphologic character</th>
<th>C. membranacea</th>
<th>C. balboa</th>
<th>C. croatii</th>
<th>C. gloriosa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pubescent veins</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
</tr>
<tr>
<td>Petiole length (mm long)</td>
<td>5.0‒6.3</td>
<td>9.5‒15.8</td>
<td>12.1‒24.3</td>
<td>15‒30</td>
</tr>
<tr>
<td>Peduncle length (♂, cm long)</td>
<td>0.4‒2.5</td>
<td>ca 0</td>
<td>ca. 27.7</td>
<td>Not known</td>
</tr>
<tr>
<td>Arrangement of stamens</td>
<td>Free</td>
<td>Adelphous</td>
<td>Free</td>
<td>Not known</td>
</tr>
<tr>
<td>Staminodes (♂)</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
</tr>
<tr>
<td>Sepals color (♀)</td>
<td>White to pink</td>
<td>Not known</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Staminodes (♀)</td>
<td>Connate</td>
<td>Not known</td>
<td>Glomerate</td>
<td>Not known</td>
</tr>
<tr>
<td>Irregular structures on pedicels (♀)</td>
<td>Present</td>
<td>Not known</td>
<td>Absent</td>
<td>Absent</td>
</tr>
<tr>
<td>Stigmas</td>
<td>Foveolate</td>
<td>Not known</td>
<td>Flapped</td>
<td>Not seen</td>
</tr>
</tbody>
</table>

Fig. 3. Distribution of Chrysochlamys membranacea showing the altitudinal distribution and the EOO (extent of occurrence)
Taxonomic notes: Balboa is a monospecific genus described as a staminate specimen collected in San Pablo, a locality in the current department of Nariño, Colombia. 

Affinities: Chrysochlamys membranacea differs from the other species by the combination of short petioles (5.0–6.3 mm long), primary and secondary venation puberulent, staminate flowers with staminodes clustered, anantherous and resiniferous in the central region of the flower, pedicel in pistillate flowers with verrucose protuberances (more development in fruit), sepal whitish to pinkish, with staminodes arranged in a deciduous, leathery staminodial ring, with antherodes sessile, ovary pubescent with broad foveolate stigmas. In addition, to these characters, C. membranacea can be confused with similar species as Chrysochlamys croatii (Maguire) L. Marinho & Hammel, and Chrysochlamys gloriosa Cuatrec., a table by the differentiation of these taxa and C. balboa are provided below (see Table 1).

Distribution and habitat: Chrysochlamys membranacea was described based on specimens from two localities in Colombia, the first in the former Barbacoas Province, currently Nariño and Cauca departments; the second in the former province of Chocó, currently the department of Chocó. These locations belong to the biogeographical Chocó region. The remaining specimens seen, have been found in 17 locations in the departments of Chocó, Antioquia, Valle del Cauca, all in Colombia, and a single specimen in Ecuador, in the province of Esmeraldas (see Fig. 3 and specimens studied item). According to the specimens studied, C. membranacea occurs at elevations between 5-1750 m a.s.l. in lowland wet forests or montane cloud forests, with an annual average temperature of 26°C, and annual precipitation between 3,000–11,700 mm [31,32].

Threat category according to IUCN: Chrysochlamys membranacea grown in the Biogeographic Chocó region from Colombia and Ecuador. Historically, the region has been impacted by the highest deforestation and intensive mining [31,33], additionally, the number of protected areas in the zone in which C. membranacea is distributed is low [23,26]. Based on the extent of occurrence (EOO) of 35313.6 km² (see Fig. 3), the area of occupancy (AOO) of 68 km², that includes 14 sub-populations, close to 35% of occurrences within protected areas, and the decrease in habitat quality due to forest clearing. We suggest the “Near Threatened” (NT) [22,23].

4. CONCLUSION

Updating the dioecious species that have been described from one of the sexual morphos is necessary to fully understand the taxonomic limits, and the ecology of the species. The taxonomic study of Clusiaceae in Colombia is still necessary, especially for those genera that have been scarcely studied in the country. In response the lack information, this work constitutes a first approach to updating the knowledge of dioeciousness in Chrysochlamys from Colombia and South America.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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7. Engels ME, Marinho LC. Nomenclatural and morphological novelties in *Tovomita laurina* (Clusiaceae). *Phytotaxa*. 2018;334(1):91-94. Available: [https://doi.org/10.11646/phytotaxa.e.334.1.16](https://doi.org/10.11646/phytotaxa.e.334.1.16)


APPENDIX

Specimens Studied:

—COLOMBIA: ANTIOQUIA: Frontino. Corregimiento la Blanquita, vía Nutibara-La Blanquita, Callejas, R. 6619 (HUA, MO); Corregimiento Nutibara, cuenca alta del Río Cuevas, Sánchez, D. 1074 (COL, FAUC, HUA, MEDEL, MO), Sánchez, D. 1081 (COL, MEDEL, MO); Vereda Venados, Parque Nacional Natural Las Orquídeas. Quebrada La Manzanares, Pipoly, J. 18219 (JAUM, MO), Pipoly, J. 18241 (JAUM). Urrao. Parque Nacional Natural “Las Orquídeas”, vereda Calles, Londoño, L. 9 (HUA); Parque Nacional Natural Las Orquídeas. Sector Caliche, Palacios, C. 186 (JAUM). CHOCÓ: Cantón of San Pablo. Taridó, Rentería, E. 59 (COL, HUA). Novita. Corregimiento San Lorenzo, Quebrada Mancamo, Sánchez, D. 8878 (MEDEL). Pizarro. Bajo Baudó. Margen izquierda del río Pepé, entre Boca de Pepé y Pié de Pepé, Espina, Z. 2002 (COL, MO). Tadó. 27 km al E del Pueblo, Bernal, R. 1031 (COL); 27 km al E del Pueblo, Bernal, R. 1031 (MO). Along road between Quibdó and Medellín, at km 136.4, 63 km E of Tutunendo, 46 km W of Bolivar, Croat, T. 56341 (JAUM); Ansermanuevo-San José del Palmar rd., ca. 3-5 km E of San José del Palmar, Luteyn, J. 10443 (JAUM); “Prov. del Chocó Costas del pacífico”, Triana, J. 5433-13 (BM, COL); Quibdó-Medellín road, 39 km E of Quibdó, Gentry, A. 24526 (HUA); Río Mutatá, tributary of río El Valle, between base of Alto de Buey and mouth of river, Gentry, A. 17279 (COL, MO). NARIÑO: “Côtes de l´océan Pacifique”, Triana, J. 5433-12 (BM, F, K, P). VALLE DEL CAUCA: Costa del pacífico; río Cajambre. Barco, Cuatrecasas, J. 17166 (US); Río Calima (región del Chocó); Entre La Esperanza y Bellavista, Cuatrecasas, J. 16783 (US); Río Calima (región del Chocó); La Trojita, Cuatrecasas, J. 16386 (US).

—ECUADOR: ESMERALDAS: Parroquia de Concepción; below Playa Rica, Mexia, Y. 8484 (US).