

Novelties in *Chrysochlamys membranacea* (Clusiaceae: Clusieae), an update on the nomenclatural and morphological knowledge of this species described from biogeographic Chocó, Colombia

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., *Dystovomitia* (Engl.) D'Arcy, *Tovomitia* 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 Peru [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. MATERIAL AND METHODS

Clusiaceae collections from HUA, FAUC, JAUM and 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

***Chrysochlamys membranacea* Planch. & Triana Ann. Sci. Nat., Bot., sér. 4, 14: 260. 1860 ≡ *Tovomitopsis membranacea* (Planch. & Triana) D'Arcy Ann. Missouri Bot. Gard. 67(4): 1034. 1980.**

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!]; isolectotypes P00093887 [digital image!], K000488480 [digital image!]; remanescant syntypes F00114316 [digital image!] (negative). Possible remanecent syntypes: —COLOMBIA. "Prov. del Chocó costas del pacífico, alt. 250", Mar. 1853, *Triana* 5433-13 (BM000939035 [digital image!], COL000118341 [digital image!]).

3.1 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 **FIGURE 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].



FIGURE 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 remanescant 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].

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

Leaves: Petioles 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 inverted V or branching dichotomously; slightly puberulent around midvein and secondary veins; exudate canals on both sides, very abundant.

Staminate inflorescences: Ramiflorous thyse, 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 pink variegation, coriaceous, puberulent, proportional, ca. 2.7–3.1×2.7 mm, sinuous margin; inner whorl 3–4 merous, connate, white, cucullated, membranous with the presence of thin and clear striae, not proportional. 3.8–4.8×3.4–4.8 mm, margin sinuous and scarious. Corolla 5-merous, petals connate, white, occasionally with reddish variegation, obovate to orbicular, not proportional, ca. 4.1×3.5–4.1 mm, thin lines, sinuous margin. Stamens in 2–3 verticils, 1.5–2.2 mm long; terete filaments, free in most of their length, white; anthers ca. 0.5 mm long, oval, longitudinal dehiscence, longitudinal connective. Staminodia series at 8, ca. 3.3 mm long, yellow (?), connate; undeveloped anthers, presence of resins. Pistillode absent.

Pistillate inflorescences: Ramiflorous thyse, ca. 17.2 cm long, quadrangulates, corrugated and slightly puberulent, green; peduncle 0.4–2.1 cm length; internodes 0.7–4.5 cm long; proximal paracladia ca. 2.5 mm long.

Pistillate flowers: Ca. 5.3×4.8 mm, globose in floral buds; pedicels 5.9–11.8 mm long, quadrangulate; bracteoles 2, ca. 0.9–1.6 mm long, inserted ca. 3.7 mm from the base, triangular, coriaceous, puberulent, wavy margin, basally fused. Calyx 5-merous; outer whorl 2-merous, parts connate, white occasionally with pinkish variegation, cucullate, 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.

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

3.4 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 **FIGURE 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.

3.5 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.

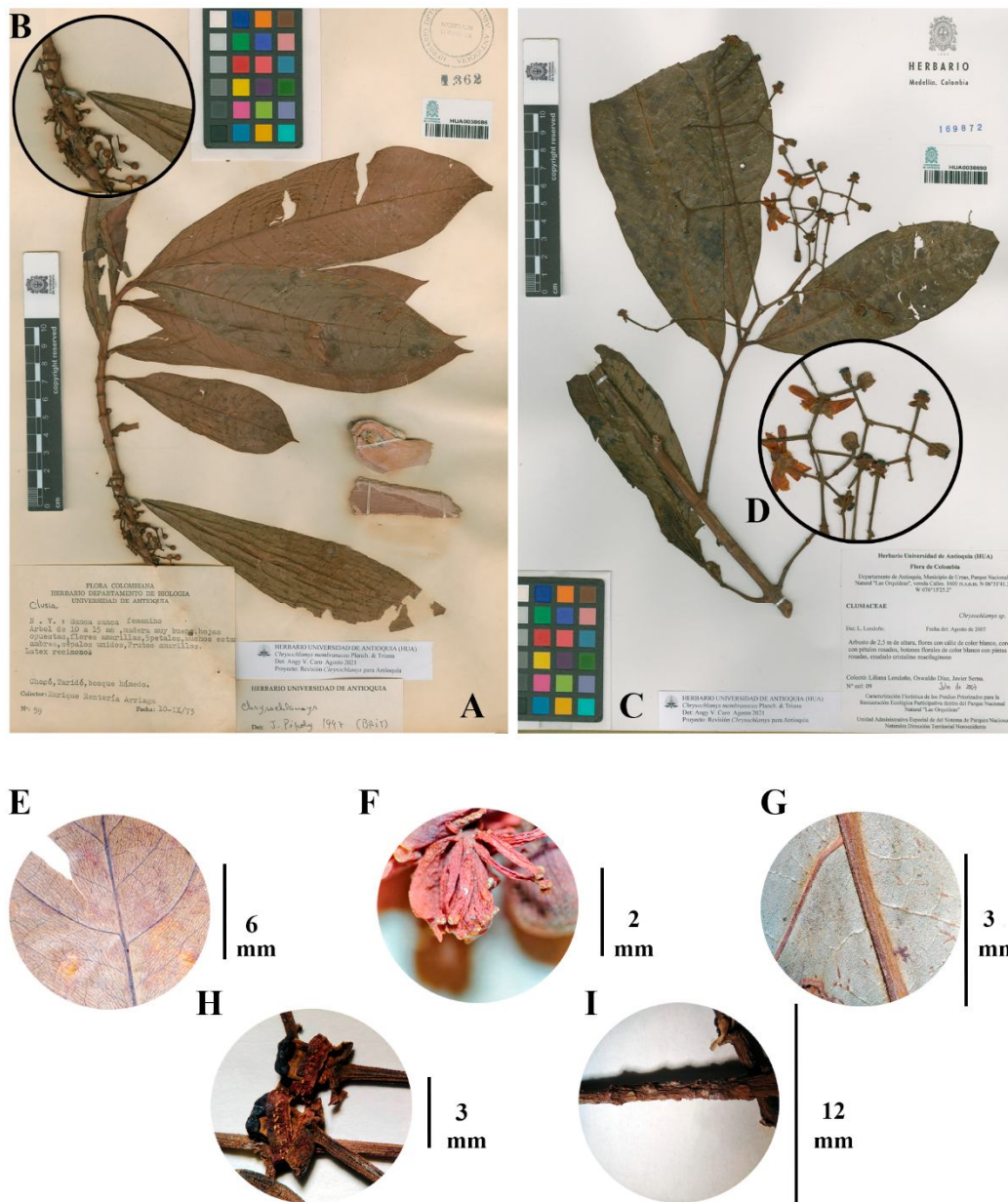


FIGURE 2. *Chrysochlamys membranacea*. **A)** Stem with leaf, staminate inflorescence, and bark. **B)** Details of staminate inflorescence. **C)** Stem with leaf, and pistillate inflorescence **D)** Details of pistillate inflorescence. **E)** Detail of resins canals in the leaf (adaxial face). **F)** 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) ♀.

3.6 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. *Balboa membranacea* Planch. & Triana was proposed as a synonym of *C. membranacea* in the treatment for Clusiaceae carried out by Guzmán-Teare *et al.* in the "Catalogue of flowering plants and gymnosperms of Peru" [12], later this synonymization was reevaluated and a new name, *Chrysochlamys balboa* Hammel, was proposed [3, 14]. In **TABLE 1.**, has provides a morphological comparison between the staminate individuals of both species, considering that the pistillate morphotype of *C. balboa* is still unknown.

3.7 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), sepals 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.**).

TABLE 1. Comparison between *C. membranacea* and its related species.

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

3.8 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 **FIGURE 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].

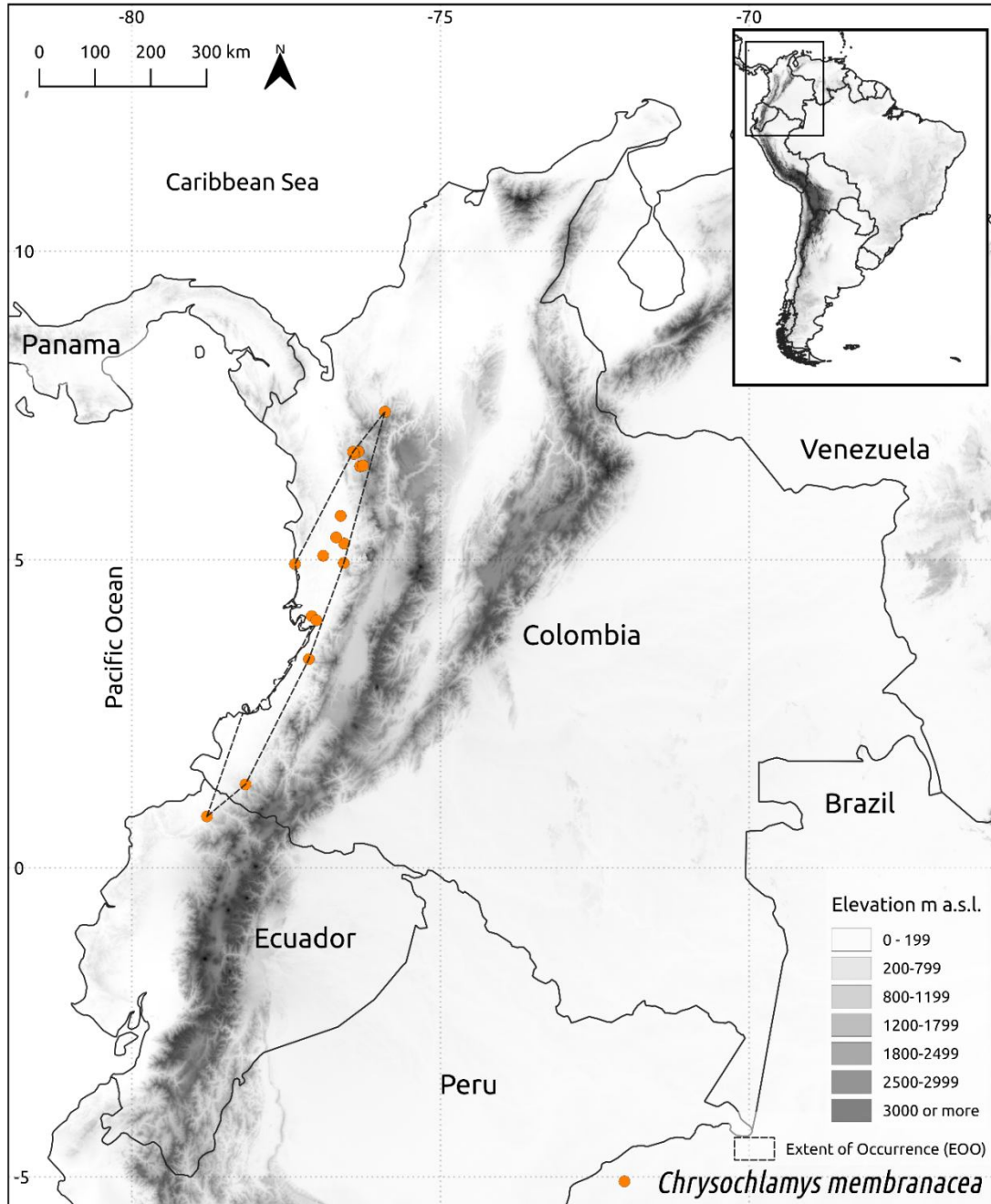


FIGURE 3. Distribution of *Chrysochlamys membranacea* showing the altitudinal distribution and the EOO (extent of occurrence).

3.9 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 **FIGURE 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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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 Bolívar, *Croat, T.* 56341 (JAUM); Ansermanuevo-San José del Palmar rd., ca. 3-5 km E of San José del Palmar, *Lutelyn, 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 **Mutató**, 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).