Hidrobiológica 2019, 29 (3): 197-202

UNIVERSIDAD AUTÓNOMA METROPOLITANA
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Unidad Iztapalapa

HIDROBIOLÓGICA
http:/hidrobiologica.izt.uam.mx
ISSN: 2448-7333

OPEN ACCESS
Research Article
December, 2019

NOTA CIENTÍFICA

Recent records of *Avicennia bicolor* (Acanthaceae) on the Mexican Pacific coast with notes on its distribution and conservation status

Registros recientes de *Avicennia bicolor* (Acanthaceae) en la costa del Pacífico mexicano con notas sobre su distribución y estado de conservación

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Recibido: 13 de febrero de 2017. ***Aceptado:*** 21 de octubre de 2019. ***Publicado:*** diciembre de 2019.

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To quote as:
Santamaría-Damián S., E. I. Romero-Berny, C. Tovilla-Hernández & M. E. Gallegos-Martínez. 2019. Recent records of *Avicennia bicolor* (Acanthaceae) on the Mexican Pacific coast with notes on its distribution and conservation status. *Hidrobiológica* 29 (3): 197-202.

DOI: 10.24275/uam/izt/dcbs/hidro/2020v29n3/Santamaria

ABSTRACT

Background. The mangrove *Avicennia bicolor* was first recorded in Mexico in 1946, however until now there is no basic information about its distribution supported by herbarium specimens. **Goals.** Three recent records of *A. bicolor* are provided at a new location in Mexico on the coastal wetlands of the Gulf of Tehuantepec, Chiapas; and the information about its known records on the American Pacific is summarized. **Methods.** Plant specimens were collected, which then, were dried, corroborated and deposited in four national herbaria. In the field, some structural attributes of the mangroves were determined such as density, basal area and height. A database and publications of species records were reviewed to preliminarily analyze their known distribution in the Pacific. **Results.** In Mexico, *A. bicolor* has been recorded only on the coastal wetlands of Mar Muerto and Los Patos-Solo Dios. The preliminary ecological diagnosis showed its presence in relatively dense stands (234 ± 86 trees ha^{-1}) and with high structural development (basal area: 16.1 m^2 ha^{-1}, height: 13.9 m). Although its presence is apparently conspicuous in several localities of Panama and Costa Rica, data on the species in the coastal strip between the Gulf of Fonseca and the Gulf of Tehuantepec is lacking. **Conclusions.** The importance of these records is evident, considering the scarce information available on *A. bicolor* and its restricted distribution in Mexico. We consider it appropriate to increase the ecological studies in its distribution area and give it protection through its inclusion in the Official Mexican Standard (NOM-059).

Key words: mangrove, distribution, Chiapas, Gulf of Tehuantepec, NOM-059

RESUMEN

Antecedentes. El mangle *Avicennia bicolor* fue registrado por primera vez en México en 1946, sin embargo, hasta ahora se carece de información básica sobre su distribución respaldada en ejemplares de herbario. **Objetivos.** Aportar tres registros recientes de *A. bicolor* en una nueva localidad para México en humedales costeros del Golfo de Tehuantepec, Chiapas y resumir la información sobre sus registros conocidos en el Pacífico americano. **Métodos.** Se recolectaron ejemplares botánicos, los cuales fueron herborizados, corroborados y depositados en cuatro herbarios nacionales. En campo se determinaron algunos atributos estructurales de los manglares (densidad, área basal, altura). Se revisó una base de datos y publicaciones de registros de la especie para analizar preliminarmente su distribución conocida en el Pacífico. **Resultados.** En México, *A. bicolor* se ha registrado únicamente en los humedales costeros de Mar Muerto y Los Patos-Solo Dios. El diagnóstico ecológico preliminar demostró su presencia en rodales relativamente densos (234±86 árboles ha^{-1}) y con elevado desarrollo estructural (área basal: 16.1 m^2 ha^{-1}; altura: 13.9 m). Aunque su presencia es apa-

rentemente conspicua en varias localidades de Panamá y Costa Rica, se carece de datos sobre la especie en la franja costera comprendida entre el Golfo de Fonseca y el Golfo de Tehuantepec. **Conclusiones.** Se evidencia la importancia de estos registros, considerando la escasa información disponible y su restringida distribución en México. Consideramos congruente incrementar los estudios ecológicos en su área de distribución y darle protección mediante su inclusión en la Norma Oficial Mexicana (NOM-059).

Palabras clave: manglar, distribución, Chiapas, Golfo de Tehuantepec, NOM-059

Mangroves are tree and shrub communities that occupy intertidal zones of tropical and subtropical regions. The few species that compose this group display distinctive morphological, physiological and ecological traits that make them adaptable to the coastal environment dynamics (Hogarth, 2007; Tomlinson, 1995). Mangroves are highly productive ecosystems, they provide several environmental services; including protection from coastal erosion, sediment trapping and they are efficient carbon sinks, also, they work as nursery and feeding areas for many fishery species (Sanjurjo-Rivera & Welsh-Casas, 2005; Polidoro *et al*., 2010; Donato *et al*., 2011). In Mexico four species of mangroves are widely distributed in both the Atlantic and the Pacific coasts: *Rhizophora mangle* L. (Red Mangrove; Rhizophoraceae), *Avicennia germinans* Jacq. (Black Mangrove; Acanthaceae), *Laguncularia racemosa* Gaertn. (White Mangrove; Combretaceae) and *Conocarpus erectus* L. (Button Mangrove; Combretaceae) with two varieties (*erectus* and *sericeus*) (López-Portillo & Ezcurra, 2002; Pennington & Sarukhán, 2005). Additionally, in the state of Chiapas the presence of *Rhizophora harrisonii* Leechman (considered a natural hybrid between *R. mangle* and *R. racemosa* G. Mey.) and *Avicennia bicolor* Standl. (Salty Mangrove) has been reported (Moldenke, 1960; Rico-Gray, 1981; Lot *et al.,* 2015).

Avicennia bicolor is a native mangrove of the Central American Pacific and found in the restricted areas between Buenaventura Bay in Colombia and the southern Mexican Pacific coast (Jiménez, 1990, 1994; Tomlinson, 1995; Duke, 2010). *Avicennia bicolor* and *A. germinans* can occur in mixed stands and can be easily distinguished by morphological characteristics (leaves and inflorescence arrangement) (*sensu* Gibson, 1970; Tomlinson, 1995). Microsatellite data suggests that a contemporary genetic isolation between the two species exists (Nettel *et al*., 2008).

The following is a dichotomous key to differentiate the two species of *Avicennia* present in Mexico (Tomlinson, 1995).

1. Corolla conspicuously hairy within, appreciably zygomorphic, stamens slightly to appreciably unequal..... 2

   2A. Flowers 10–15 mm long and almost as wide at anthesis, stamens excerpted and only slightly unequal; style long, excerpted from calyx when corolla is shed. Fruit distinctly beaked, glaucous, surface rough but not pitted. Leaf ovate to elliptic at most. Widely distributed from the Pacific and the Gulf of Mexico coasts..... *Avicennia germinans*

   2B. Flowers 5–6 mm long and about as wide at anthesis; stamens included and markedly unequal, with a short filament (0.5 mm) on the inner pair and a longer filament (1 mm) on the outer pair; style short, either deciduous or not excerpted from calyx when corolla is shed. Fruit blunt, globose, greenish yellow, surface irregularly pitted. Leaf blade oblong, elongate, often less than three times as long as wide. Restricted distribution in Chiapas (Mexico) and Central American Pacific coasts..... *Avicennia bicolor*

Records of *A. bicolor* in Mexico are particularly scarce. Its occurrence has been cited without location data (e.g., López-Portillo & Ezcurra, 2002; Rodríguez-Zúñiga *et al.,* 2013) or valid specimens, generating uncertainty on the actual occurrence and on its distribution in the country. The aim of this note is to report three recent records of *A. bicolor* in the state of Chiapas. Also, we provided data on the mangrove community structure with emphasis in *A. bicolor* and the general characteristics of its habitat. Additionally, information gaps of the species were determined through an analysis of its records in the Central American Pacific.

Previous records. The Japanese botanist Eizi Matuda collected the first record of *A. bicolor* in Mexico in 1946. This specimen collected in Paderón [sic], Chiapas (16° 2´ 25.5´´ N, 093° 51´ 59.91´´ W approximately) was deposited in the U.S. National Herbarium (US 1889845; we revised photographs of this specimen in April 10, 2015). A second specimen was collected after 40 years later, on the east of the Mar Muerto coastal lagoon (Chiapas state) during an ungraduated research project in 1987 (see section material examined) (Gallegos & Gómez, 1989). The information provided by the mangrove forests inventory made on the coasts of Chiapas and Oaxaca (Tovilla-Hernández *et al*., 2007; 2010) suggests that *A. bicolor* is found in some sites on the northeastern of the Gulf of Tehuantepec, Mexico (Fig. 1).

Recent records. *Avicennia bicolor* stands were in the Mangrove Priority Site Los Patos-Solo Dios, municipalities of Pijijiapan and Tonalá, Chiapas (CONABIO-PS28; Rodríguez-Zúñiga *et al*., 2013). In this new locality, forest structure parameters (DBH≥ 2.5 cm, density height, basal area) were determined in three plots (300 m^2) where *A. bicolor* was found. In April 2015 and November 2016, we collected specimens using standard field and herbarium techniques (Lot & Chiang, 1986), and for botanical determination, we used the keys of Gibson (1970) and Pool & Rueda (2001). Herbarium specimens were deposited at MEXU (National Herbarium, Universidad Nacional Autónoma de México), UAMIZ (Metropolitan Herbarium "Dr. Ramón Riba y Nava Esparza", Universidad Autónoma Metropolitana-Iztapalapa), HEM (Herbarium "Eizi Matuda", Universidad de Ciencias y Artes de Chiapas) and ECO-SC-H (El Colegio de la Frontera Sur-San Cristóbal).

Material examined. Mexico. Chiapas. Municipality of Tonalá: Mar Muerto, Estero Cinco Arrobas, ca. 7.5 km southeast of Paredón, 15° 51´ N, 093° 51´ W, 28 February 1987, A. Gómez and M. Gallegos, 268 (UAMIZ 32515); Panama. Province of Coclé: On Isla del Pozo in salinas (salt flats) of Rio Estero Salado, 8° 11´ N, 080° 30´ W, 12 February 1982, S. Knapp, K. Clary and D. Piperno, 3401 (MEXU 378957); Province of Panama: Punta Chame, 10-15 miles from Pan-American Highway, 8° 40´ N, 79° 45´ W, 17 September 1981, S. Knapp, 1244 (MEXU 382325).

Additional material from the new locality. Mexico. Chiapas. Municipality of Pijijiapan: Los Patos-Solo Dios lagoon system, ca. 120 m east of the San José estuary channel and 500 m north of the beach, 15° 43' 39.50" N, 93° 29' 50.20" W, *S. Santamaría-Damián* 001 *and E. I. Romero-Berny,* s/n (MEXU, UAMIZ. HEM, ECO-SC-H), 13 April 2015 (Fig.2). Ca. 40 m east of the San José estuary channel and 510 m north of the beach, 15° 42' 55.60" N, 093° 28' 52.70" W, *S. Santamaría-*

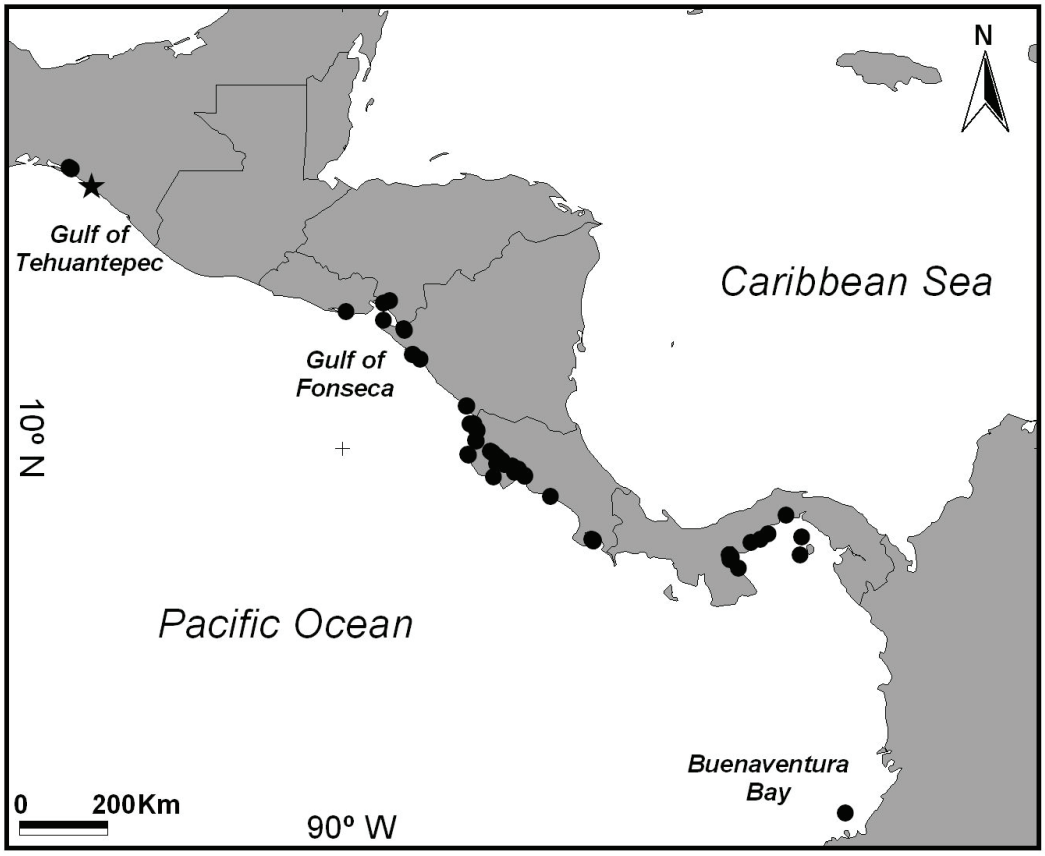

Figure 1. Map of the Pacific coast of Central America showing georeferenced localities of *Avicennia bicolor*. Multiple records in close geographic proximity may be represented by a single symbol. Area of recent records of the species in Los Patos-Solo Dios (Chiapas, Mexico) is represented by a star.

Damián 002 *and E. I. Romero-Berny,* s/n (MEXU, UAMIZ. HEM, ECO-SC-H), 15 April 2015. Municipality of Tonalá: Los Patos-Solo Dios lagoon system, ca. 50 m south of the La Ceiba fishing pier, 15° 45' 30.66" N, 093° 31' 48.74" W, *S. Santamaría-Damián* 003 and *E. I. Romero-Berny, s/n* (HEM, ECO-SC-H), 18 November 2016.

Tree community structure. In Los Patos-Solo Dios lagoon system, mean density of *A. bicolor* trees (DBH≥ 2.5 cm) was estimated at 234±86 trees ha^{-1}. Average basal area and mean height were 16.1 m^2 ha^{-1} and 13.9 m, respectively. *Avicennia bicolor* stands were observed in an intertidal creek adjacent to the main estuarine channel. These stands are located to the side of the sandbar that separates the estuary from the open ocean and it has a surface salinity of 34 psu (dry season, February 2010). *Rhizophora mangle* trees occurred at the borders of the creek (605±177 trees ha^{-1}) while the *A. germinans* stands (661±107 trees ha^{-1}) are surrounding the stands of *A. bicolor.* The composition and structure of dry climate mangroves along the Pacific of Central America show differences among stands in the inland and edge sections of the forest where the runoff seasonally modifies the patterns of local drought and salinity, which is evident in *A. bicolor- A. germinans* mixed stands (Jiménez, 1990). In general, the communities of *A. bicolor* in this new Mexican locality have a more developed forest structure in comparison to those of the Gulf of Fonseca (southeastern El Salvador), where low values of density, height and basal area are reported (Chicas-Batres *et al.,*2016).

Distribution records. To summarize the distribution records of *A. bicolor* in the Central American Pacific, we compiled locality data using the Global Biodiversity Information Facility dataset (GBIF, 2013) and literature. The search of GBIF returned 176 records with georeferenced data (including the synonym *A. tonduzii*). The species has been collected in seven countries including Mexico. Most records come from Costa Rica and Panama (Fig 1). However, there are no records north of the Gulf of Fonseca and the coast of Guatemala, with exception of those mentioned for Mexico in this note.

In Mexico, this species is restricted to a coastal stretch along the Mar Muerto lagoon to the Joaquín Amaro-La Conquista dredged channel (40.3 km). The Mar Muerto record (Paredón, Chiapas) represents the northernmost locality for this species in the Eastern Pacific, although it is necessary to intensify exploration in the northern region of the Gulf of Tehuantepec to locate a more precise distribution limit. It is also advisable to carry out a more complete characterization of its habitat to determine the environmental drivers that define its distribution and structural patterns.

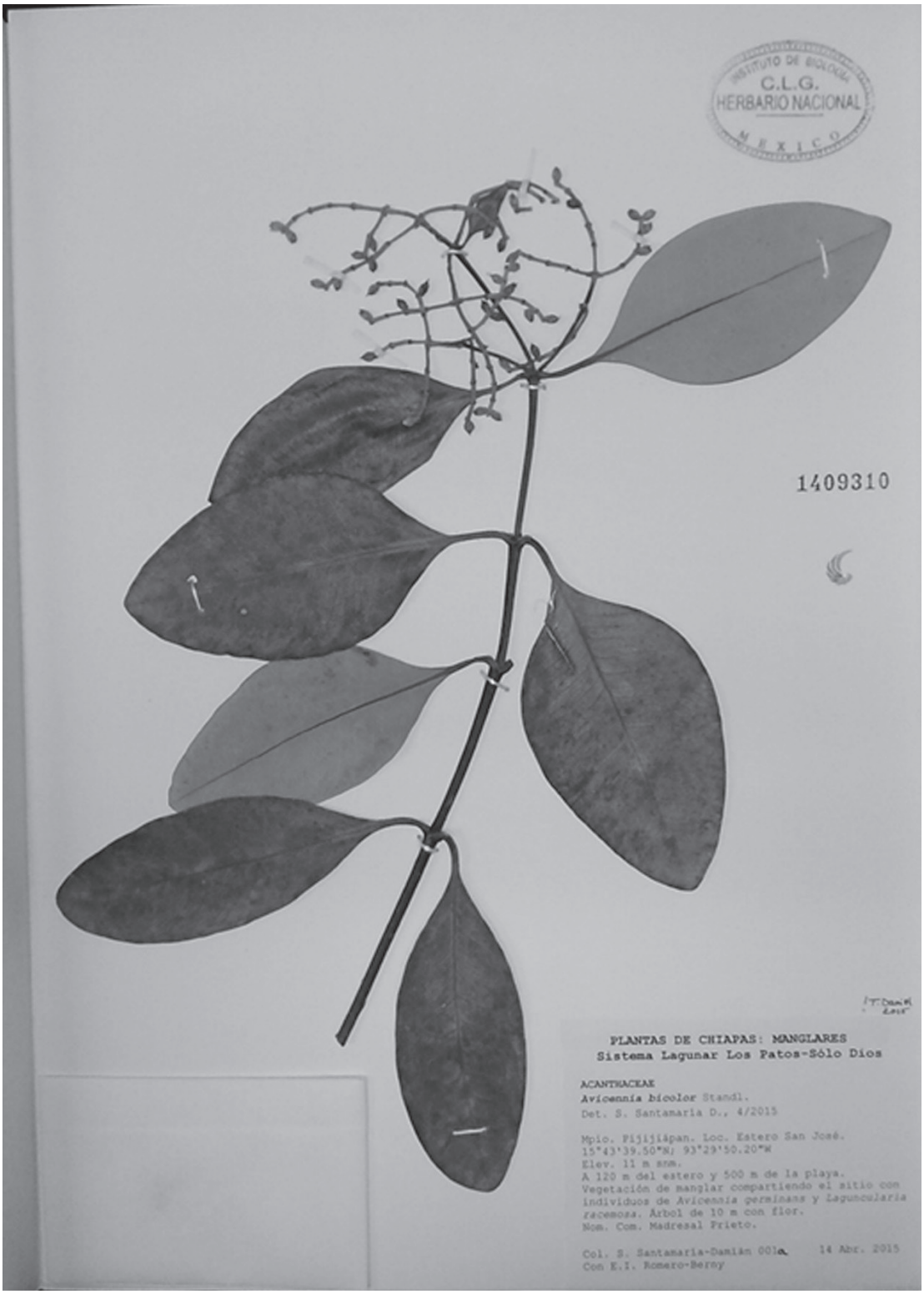

Figure 2. Herbarium specimen of *Avicennia bicolor*

Federal laws protect mangrove ecosystems in Mexico; however there is a gap with respect to *A. bicolor*, which is not listed in the Official Mexican Standard (Norma Oficial Mexicana, NOM-059-SEMARNAT-2001), although the UICN Red List categorized it as Vulnerable (Duke, 2010; SEMARNAT, 2010). Our records show that *A. bicolor* is distributed in a limited but important area in the northern Mesoamerica, in relatively dense stands with high structural development. The mangrove system of Los Patos-Solo Dios lacks conservation status and is threatened by changes in land use and selective logging (Santamaría-Damián *et al.,* 2015). Therefore, it is considered congruent to give legal protection to the site and necessary to include *A. bicolor* in the NOM-059.

ACKNOWLEDGEMENTS

We thank D. S. Gernandt and staff of the Herbario Nacional (UNAM-IB) for their invaluable assistance in several activities of this research; J. Santana Carrillo (UAMIZ), B. V. Juárez Jaimes (MEXU), H. Gómez Dominguez, M. A. Pérez Farrera (HEM), I. Vasquez Lara and M. Ishiki Ishihara (ECO-SC-H) for their assistance with database queries of collections and deposit of specimens; J. De la Presa, F. Ovalle, A. Lang and E. Serrano for field support; fishermen of S.C.P.P. El Remolino allowing access to the collecting sites; M. R. García Peña for the photographs of the specimens deposited at the National Herbarium of the Smithsonian Institute; SEMARNAT for collection permit (SGPA/DGGFS/712/2105/14). Comments on manuscript from W.A. Matamoros and two anonymous reviewers helped to substantially improve the final version.

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