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Pavonia paludicola (Malvaceae), a new record for Mexico

Pavonia paludicola (Malvaceae), un nuevo registro para México

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Abstract

Background: *Pavonia* (Malvaceae) is a morphologically diverse genus with more than 200 species in America of which 32 have been previously reported in Mexico. In a field trip to the Reserva Estatal de Dzilam de Bravo, in northern Yucatan, a population of a Malvaceae species was detected that could not be unequivocally matched with any species known previously in the country.

Questions: What is the identity of the Malvaceae species collected? Is it a new species for science or a national or regional novelty?

Species of study: Malvaceae, Malvoideae, *Pavonia*.

Study site and dates: Yucatan Peninsula**,** Mexico, 2021–2022.

Methods: Botanical specimens were collected and determined taxonomically through the use of specialized keys, and consulting of botanical collections. The conservation status was assessed using the IUCN methodology.

Results: The specimens collected at the study site do not represent an undescribed species but instead *Pavonia paludicola* Nicolson ex Fryxell, which is a new record for Mexico. The species is assessed as Least Concern (LC) along its full distributional range whereas the Yucatan population is assessed as Data Deficient (DD) at this time. Furthermore, we offer a key to the two species of *Pavonia* in the Mexican portion of the Yucatan Peninsula, the second being *P. schiedeana* Steud., whose conservation status is assessed as Least Concerned (LC).

Conclusion: With the report of *Pavonia paludicola,* thirty-three species of the genus are now recognized from Mexico, two of which occur in the Mexican portion of the Yucatan Peninsula.

Kew words: Malvoideae, Mexico, floristic novelty, Yucatan, Yucatan Peninsula.

Resumen

Antecedentes: *Pavonia* (Malvaceae) es un género morfológicamente diverso con más de 200 especies en América y 32 reportadas para México. En un viaje de campo a la Reserva Estatal de Dzilam de Bravo en el norte de Yucatán se detectó una población de Malvaceae que no pudo identificarse inequívocamente con las especies previamente conocidas para el país.

Preguntas: ¿Cuál es la identidad de esta Malvaceae? ¿Es una nueva especie para la ciencia, o una novedad taxonómica nacional o regional?

Especies de estudio: Malvaceae, Malvoideae, *Pavonia.*

Sitio y fechas de estudio: Península de Yucatán, México, 2021-2022.

Métodos: Los especímenes botánicos se determinaron taxonómicamente mediante el uso de claves especializadas y colecciones botánicas. Su estado de conservación fue determinado usando la metodología de la UICN.

Resultados: Los especímenes reportados en este estudio no representan una especie no descrita, ya que en realidad corresponden a *Pavonia paludicola* Nicolson ex Fryxell, que constituye un nuevo registro para México. La especie se evalúa como Preocupación Menor (LC) a lo largo de su distribución completa, mientras que la población de Yucatán se evalúa como Datos Insuficientes (DD) en este momento. Adicionalmente, ofrecemos una clave para ambas especies de *Pavonia* que crecen en la porción mexicana de la península de Yucatán, siendo *P. schiedeana* Steud., la otra especie, cuyo estado de conservación se evalúa también como de Preocupación Menor (LC).

Conclusión: Con el registro de *Pavonia paludicola*, se documentan treinta y tres especies del género para México, dos de ellas crecen en la porción mexicana de la Península de Yucatán.

Palabras clave: Malvoideae, México, novedad florística, Yucatán, península de Yucatán.

The flora of Mexico is one of the most diverse in the planet, including approximately 23,314 (Villaseñor 2016) to 25,077 species (Villaseñor & Meave 2022); however, there are still many taxa yet to be registered or newly described (Villaseñor & Meave 2022). The last statement is also true for a smaller region like the Yucatan Peninsula Biotic Province (Duno de Stefano *et al.* 2018). New species and new records from that region have been published even in the 21st century. Only in the year 2022, two new species were described for this region: *Gonolobus caamali* Carnevali & R. Duno (Carnevali *et. al.* 2022a), and *Heteranthera yucatana* Carnevali, J.L. Tapia & J.R. Grande (Carnevali *et al.* 2022b) and we are working in several additional novelties. The Yucatan Peninsula Biotic Province includes the three states of the peninsula in Mexico (Campeche, Quintana Roo, and Yucatan), as well as the northern portion of Guatemala and Belize (for more details, see Duno de Stefano *et al.* 2018).

In a recent, short field trip to the Reserva Estatal de Dzilam de Bravo in the northern portion of the Mexican State of Yucatan, we found an elegant, erect, sparsely branched shrub with alternate, palmately veined leaves, growing in a mangrove stand (Figure 1A, C) that we could not recognize at once. Its flowers show an epicalyx whereas the calyx shows five valvate sepals; the corolla displays five imbricate petals with the numerous stamens connate at their bases forming a tube around the pistils (Figure 1D, E). Finally, the fruit is a schizocarp. All these characters are diagnostic for the family Malvaceae, subfamily Malvoideae. To identify the genus, we used relevant taxonomic treatments (Fryxell 2001, 2009). All morphological characters (foliar nectaries absent, flower bearing an epicalyx, and schizocarp fruit with 5 carpidia) strongly suggest that the species is a member of the genus *Pavonia* Cav.

Pavonia (Malvaceae, Malvoideae, Malvavisceae), is probably one of the largest genera of the family with about 250 species worldwide and 224 species in America alone (Fryxell 1999). In Mexico, 32 species are recognized, of which 23 are endemic (Villaseñor 2016). The floristic list of the Mexican Yucatan peninsula included a single species: *P. schiedeana* Steud., which itself was only recently reported (Carnevali *et al.* 2010). The species reported herein does not match the appearance of *P. schiedeana*. Further study demonstrated it to be referable to the species *P. paludicola* Nicolson ex Fryxell.

In the present contribution we document the presence of *Pavonia paludicola* in Mexico, provide a full diagnosis, a description of its habitat, and discuss its geographical distribution. We also assess its conservation status using the IUCN methodology. Furthermore, we provide a key to the *Pavonia* species that occur wild in the Mexican Yucatan Peninsula and iconography that should allow for their identification.

Materials and methods

Field and herbarium work. The study was conducted at the Herbarium CICY of the Centro de Investigación Científica de Yucatán, A.C. (CICY), Yucatan, Mexico. Plants were obtained under scientific permits (SGPA/DGVS/01280/21 and SGPA/DGGFS/712/2913/17) issued by the Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT) to researchers at CICY. Plant material was collected during the spring of 2021 and conserved at the herbarium CICY whereas duplicates were sent to the herbaria CIQR**,** G, MEXU, MO, NY, SEL, UCAM, and UJAT.

For the morphological characterization and species identification, two monographs of the genus *Pavonia* were consulted (Fryxell 1979, 1999) as well as online databases. In addition, herbarium vouchers from CICY, MEXU, and UCAM (acronyms according to Thiers 2022) were also examined. Plant images were taken by GC using both Nikon 3300 and Sony Cybershot cameras (for *P. paludicola* and *P. schiedeana* respectively).

The conservation status of *Pavonia paludicola* and that of the Yucatan population of the species were assessed using the IUCN Red List Criteria (IUCN 2012). Because population data for these species is not available, we relied mostly on the B criteria, geographical distribution assessed both as B1 (extent of occurrence) or B2 (area of occupancy), both as implemented in GeoCAT (Bachman *et al*. 2011). We complemented these assessments with our own field experience as well as published data and iconography.

Morphological analysis. We compiled our description from living and pressed specimens, our photographs taken in the field, and spirit-preserved specimens. We rehydrated the flowers from herbarium material by boiling and then

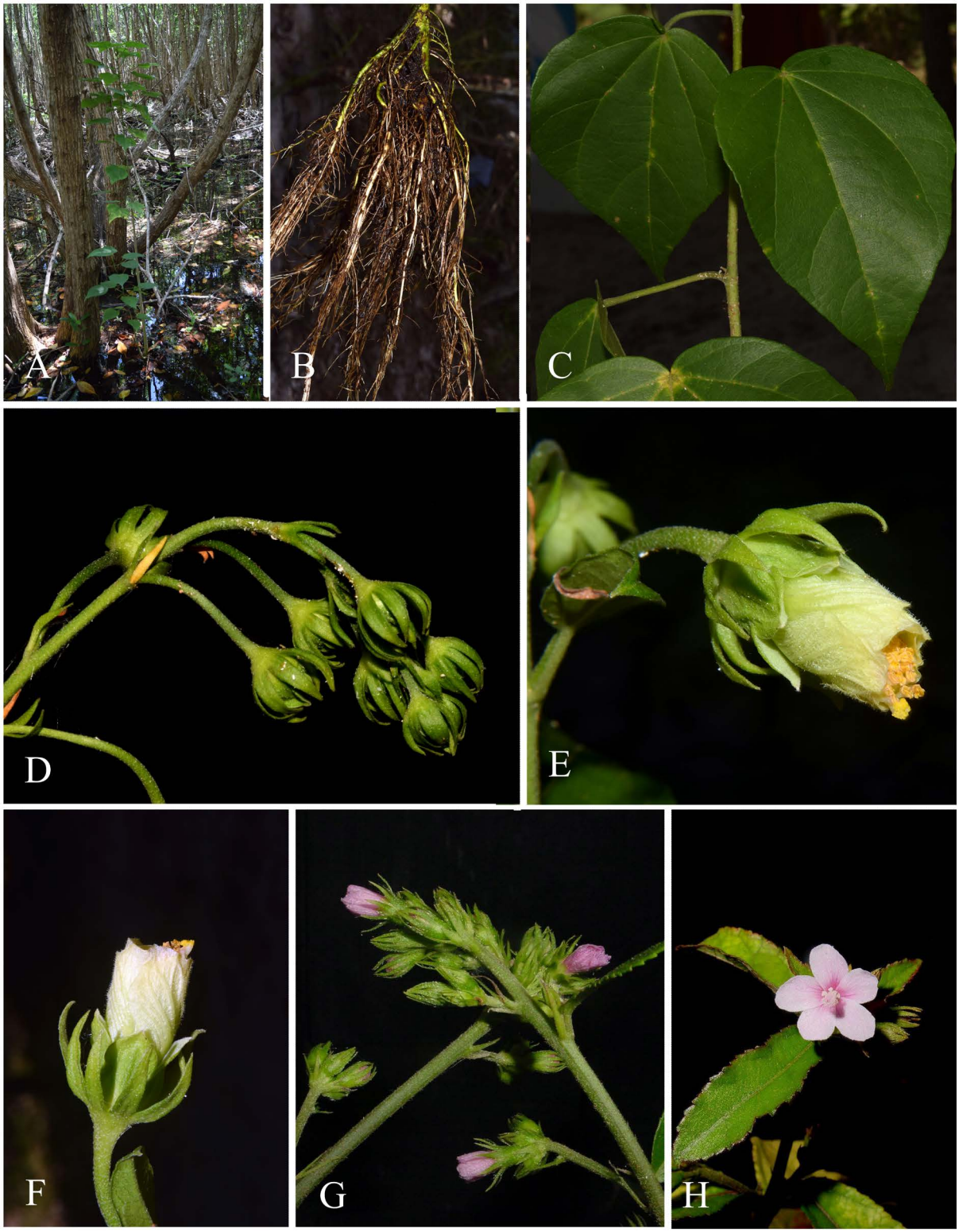

Figure 1. Morphological details of the two species of *Pavonia* Cav. (Malvaceae) that occur in the Mexican Yucatan Peninsula. A-F. *Pavonia paludicola* Nicolson ex Fryxell. G-H) *Pavonia schiedieana* Steud. A. Natural habit (cenote near Dzilam de Bravo, Yucatán). B. Root system showing whitish spongy rootlets. C. Palmately veined leaves. D. Inflorescence and flowers with epicalyx. E. Flower showing epicalyx, calyx, corolla and stamens. F. Flower before anthesis with epicalyx. G. Inflorescence. H. Plant with one inflorescence and one terminal open flower. Photos: Germán Carnevali.

soaking them in a soapy solution or, else, by soaking them in concentrated ammonium hydroxide for about one minute, then rinsing in water. We examined all material under a dissecting microscope. Furthermore, we studied digital images of *Pavonia* from several herbaria that offer such resources, including K, MEXU, MICH, and NY (acronyms follow Thiers 2022) by accessing those on the JSTOR Global Plants project database, plants.jstor.org.

Specimens were cited alphabetically by major (states) and subordinate (municipalities) administrative subdivisions. Ecological data from the labels were omitted for brevity but were relevant to assess and inform our discussions. A distribution map was prepared by plotting the locality on image data using ArcMap 10.6 (ESRI 2011). Relevant bibliography and iconography were consulted and cited.

Results

With the help of relevant bibliography (Fryxell 1979, Carnevali *et al.* 2010) and additional information sources, we concluded that the Malvaceae population from Cenote Elepetén, east of Dzilam de Bravo, did not correspond to any of the previously known species in the region (Carnevali *et al.* 2010). Thus, it was necessary to consult more general references (Fryxell 1999, 2009, 2001) to secure a reliable determination.

Upon further study, it became obvious that the schyzocarpic fruits surmounted by 5 sterile teeth or antheriferous at summit, and the possession of 10 styles and stigmas in the flower but only 5 carpels in the fruit quickly placed the species in tribe Malvaviscieae. The leaves lacking nectaries, the mericarps with 3 retrorsely barbed spines, and the solitary flower easily led to its identification as a member of *Pavonia*. Then, the shrubby growth habit and its preference for mangrove associations, with solitary terminal leafless racemes and its eight involucellar bracts, placed the species in *Pavonia* subgenus *Malache* (Vogel) Fryxel. Its unlobed, entire leaves and its woody mericarps helped placing the plant in sect. *Malache*. Within this section, the cordate-ovate, palmately 5-7 nerved leaves, the winged, apically beaked fruits, the staminal column subequal to the corolla lobes, as well as its flowers and fruits in terminal leafless racemes, eventually allowed to identify the species as *Pavonia paludicola* Nicolson ex Fryxell. It is noteworthy that the species constitutes a new record for Mexico as is not included in the last country-wide checklist of Mexico (Villaseñor 2016), nor recorded in other major floristic resources (*e.g.,* Fryxell 1979, 1999) as native from the country although it is recorded from neighboring Belize and was to be expected in southern Mexico. A general description of the Mexican population of this species is included below.

Pavonia paludicola was known from Central America as far north as northern Belize, northern South America, and the Antilles. This new record extends its distribution to Mexico. The number of species of *Pavonia* in the country is expanded to 33. Two of them grow in the Mexican Yucatan Peninsula, namely, the novelty here presented and *P. schiedeana*, which is known from the southern, more humid portions of the region (southern region of Campeche, Quintana Roo, Belize and Guatemala), and thus part of the flora of the biotic province of the Yucatan Peninsula. This botanical novelty stresses the importance of continuing with botanical explorations in protected natural areas and elsewhere in Mexico in general and in the Yucatan peninsula in particular.

The extent of occurrence (EOO) of *Pavonia paludicola* far exceeds 20.000 km^2 and its area of occupancy is larger than 500 km^2 (IUCN 2012). Thus, it should be considered as Least Concern (LC). The Yucatan population, consisting of a single known locality, has to be assessed at this time as Data Deficient (DD). The conservation status of *P. schiedeana* is assessed as Least Concern (LC).

Pavonia paludicola Nicolson ex Fryxell in Howard, R.A., Fl. Lesser Ant. 5: 241. 1989. *Malache scabra* Vogel in Trew, PI. Select. 9: 50. t. 90. 1772. ≡ *Pavonia scabra* (Vogel) Ciferri Atti Ist. Bot. Univ. Pavia, ser. 4,8: 321. 1936. (non *Pavonia scabra* C. Presl, 1835). **Type**: Trew, Pl. Select. (1772) pl. 90. Figure 1A-F, 2.

= *Pavonia racemosa* (Sw.) Sw. ≡ *Althaea racemosa* Sw.

= *Pavonia spicata* Cav. ≡ *Malache spicata* (Cav.) Kuntze

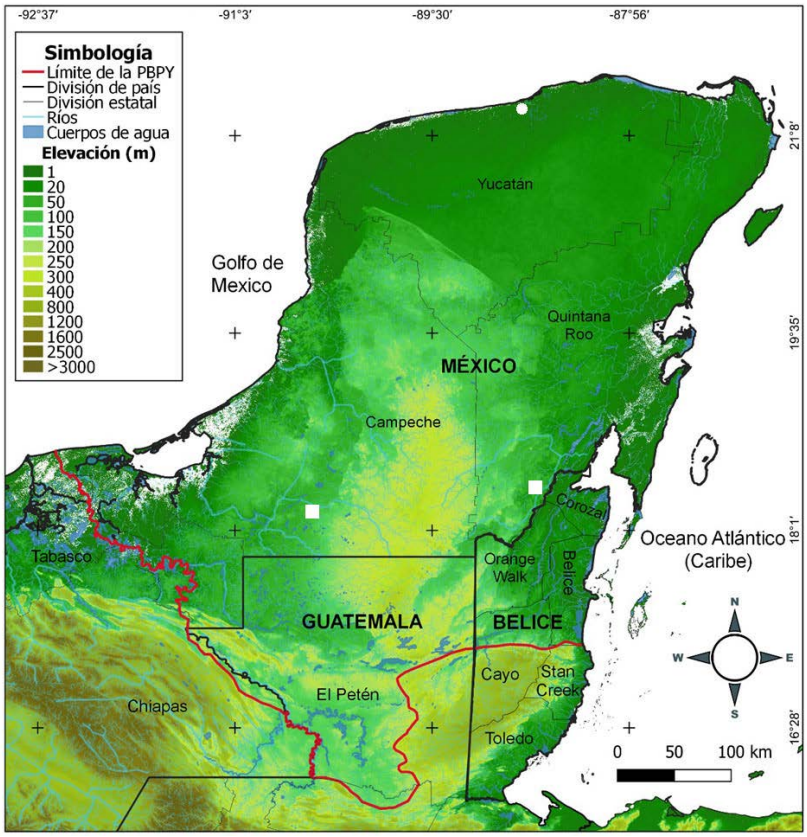

Figure 2. Distribution map of *Pavonia* Cav. in the Mexican Yucatan Biotic Province. *Pavonia paludicola* Nicolson ex Fryxell (white circle), and *Pavonia schiedeana* Steud. (white squares).

Shrubs 1-2(-3) m tall. Stems and petioles pubescent with minute stellate trichomes. Leaves broadly ovate, (6-) 13-14.5(-18.5) cm long, (6.5-)7-10.5(-13) cm wide, bicolored, upper surface dark green, indument scattered and often pubescent-stellate, lower surface light green, glabrescent, stellate-pubescent on main veins; base subcordate, apex acute to abruptly acuminate, margin inconspicuously toothed or crenulate to subentire, palmately veined, 2-3 veins on each side of main vein, at 45° angle to main vein, conspicuously marked below; petioles (4-)6.5-11(-12) cm long, sparsely stellate-pubescent; stipules foliaceous, 1-5(-7) mm long, stellate-pubescent. Inflorescence a terminal raceme, 20-30 cm long; pedicels solitary, 1.5-4.5 cm long, often stellate pubescent. Flowers 1.5-2 cm long; epicalyx bracts 8-9, basally connate, lanceolate, 8-10 mm long, 2 mm wide, apex acuminate, inconspicuously stellate-pubescent or glabrescent; calyx gamosepalous, 5-lobed, 6-8 mm diameter, lobes lanceolate, 4-6 mm long, 3-4 mm wide, apex abruptly acuminate, inconspicuously stellate-pubescent or glabrescent; petals 5, 0.5-2 cm long, obovate, apex rounded, base acute, margin crenate, veins conspicuously evident, free, erect, pale yellow to greenish-yellow to almost white, externally pubescent, 1; staminal column slightly exserted, 14-16 mm long, the filaments free towards the apex, white, 2-3 mm long; anthers reniform, dorsifixed, 2 mm long; styles 10, slightly longer than androecium, stigmas capitate; ovary superior, 5 carpelar. Fruits schizocarpous, dry, glabrous, woody, 10-12 mm in diameter, with a crown of 5 apical prominences; carpidia 5, indehiscent, 10–12 mm long, 3-4 mm wide, each with three apical prominences, the lateral ones 2-3 mm long, the central one 0.5-1 mm long; seeds solitary, 6-8 mm long.

Distribution and Ecology. *Pavonia paludicola* grows in mangrove stands and swamps along the mouth of rivers or coastal lagoons and it is widespread in the Caribbean area: S Florida (United States of America), Central America (including northern Belize), northern South America, and the Greater and Lesser Antilles. Most collections are at

or near sea level (Fryxell 1999). The Mexican population also occurs in this kind of habitat, which in this case is a "cenote" or "peten" (a freshwater spring due to the outflowing of the subterranean karstic drainage); these are locally called "ojos de agua". At the locality, the cenote Elepetén, which is about 100 m from the coast near Dzilam de Bravo in the Reserva Estatal de Dzilam de Bravo (Yucatán), the flow of water from the spring results in a slow moving river and with brackish, swampy conditions populated by a mangrove stand. Other species occurring in the area are *Bravaisia berlandieriana* (Nees) T.F. Daniel (Acanthaceae), *Rhabdadenia biflora* (Jacq.) Müller Arg. (Apocynaceae), *Ipomoea alba* L. (Convolvulaceae), *Acrostichum aureum* L. (Pteridaceae), and additional mangrove species. The single Mexican population of *P. paludicola* is at approximately 400–450 km N of the nearest known populations in northern Belize, and 800–850 km from the Cuban populations of the species. It would be interesting to look at the genetic affinities of the Mexican population to ascertain whether it represents a case of long-range dispersal from any of these sources. Alternatively, there may be additional, as yet unknown, populations of the species along the eastern coast of the Yucatan Peninsula linking in time and space these sets of apparently disjunct populations.

Specimens examined. MEXICO. Yucatán: Municipio Dzilam de Bravo, Cenote Elepetén, unos 6.3-6.4 km al este de Dzilam de Bravo por vía marina, 21° 24' 11.47" N, 88° 49' 36.10" W, 0-1 m, 30 May 2021, *G. Carnevali & I.M. Ramírez 8580* (CICY, CIQR, G, MEXU, MO, SEL, UCAM); same locality, 22 June 2021, *G. Carnevali, R. Duno & J. L. Tapia 8585* (CICY, CIQR**,** G, MEXU, MO, NY, SEL, UCAM, UJAT).

Taxonomic comment. The two species of *Pavonia* occurring in the Yucatan peninsula share apparently similar habitats (swampy forests) but are morphologically very different. *Pavonia paludicola* is a thick stemmed, few branched shrubs with fundamentally yellow to whitish flowers (*vs*. a subfrutex with white or pink flowers) and features a mericap without spines (vs. 3 apical spines). The leaves in *P. paludicola* are broadly ovate, cordate with margin inconspicuously toothed or crenulate to subentire whereas in *P. schiedeana* they are elliptic, oblong, or obovate with an obtuse to acute base and irregularly crenate-dentate margins. Furthermore, *P. schiedeana* always occurs along freshwater rivers or flooded areas, at elevations ranging from sea level up to 1,300(-1,600) m whereas *P. paludicola* is restricted to coastal habitats and brackish waters

IUCN Conservation assessment. There are near 100 occurrences of *Pavonia paludicola* at the Global Biodiversity Information Facility (GBIF www.gbif.org) and more than 90 records in the Tropicos (tropicos.org) online database. The species is far less common and widespread than *P. schiedeana* (see information below). At a global scale, however, it is to be considered not threatened (Least Concern, LC). However, in Mexico, the species is known from this single population in the Yucatan state, and it appears to be somewhat threatened because cenote Elepetén is a community tourism facility, most likely lacking a properly designed conservation program. It is necessary to make further visits to the coastal area of northern Yucatan as well as that of neighboring Quintana Roo to assess the full extent of its distribution in the region.

Pavonia schiedieana Steud., *Nomenclator Botanicus*. Editio secunda 2: 279. 1841.
Mexico: Veracruz (GOET; ILT: as photo F-9467 ex B, U) LT designated by Fryxell 1999. Figure 1G-H, 2.

Distribution and Ecology. *Pavonia schiedeana* is found in Mexico (Campeche, Chiapas, Guerrero, Oaxaca, Querétaro, Quintana Roo, Tabasco, San Luis Potosí, and Veracruz), Central America, northern South America to Brazil, and Bolivia and the Antilles. In the Yucatan Peninsula, where it is apparently rare, it grows in forests along rivers and creeks southern Campeche and Quintana Roo. Elsewhere, the species has also been recorded in mountain forest, pine-oak forest, tropical dry forests, and secondary vegetation up to 1,100(-1,600) m.

Specimens examined. MEXICO. Campeche: Municipio Escárcega, a 10 km al S de Candelaria, sobre el camino a Colonias Candelaria, 17° 57' 36" N, 91° 45' 00" W, 4 June 1983, " … flor rosa …", *E. F. Cabrera C. & H. de Cabrera*

4779 (MEXU, MO). Quintana Roo: Municipio Othón P. Blanco, Allende, orillas del río Hondo, 14 km al S de la desviación a la Unión, por la carretera Chetumal-Escárcega, 22 km a O de Chetumal, 18° 22' 48" N, 88° 32' 58" W, 5 m, 31 July 2006, " … flores rosadas …", *J. L. Tapia, G. Carnevali & R. Duno 1900* (CICY, MEXU, MO).

Taxonomic comment. For further details, see the discussion under *Pavonia paludicola*. The two species are rare in the region; possibly due to the strongly bi-seasonal climate, and the almost total lack of rivers, which are particularly important in the case of *P. schiedeana*. If we refer to the literature (Fryxell 1997, 1999), *Pavonia schiedeana* grows in various types of vegetation from sea level up to 1,600 m in tropical and subtemperate areas.

IUCN Conservation assessment. The extent of occurrence (EOO) of *Pavonia schiedeana* far exceeds 20,000 km^2 and its area of occupancy (AOO) is larger than 2,000 km^2 (IUCN 2012). There are more than 2000 occurrences at the Global Biodiversity Information Facility (GBIF) (www.gbif.org), and 182 botanical specimens at the MEXU herbarium. In some areas, the species can be frequent (Fryxell 1999). For all these reasons the species is to be considered not threatened (Least concern, LC).

Key for the Mexican species of *Pavonia* in the Mexican portion of the Yucatan Peninsula Biotic Province

1. Leaves elliptic, oblong, or obovate (at least 3 times as long as wide), truncate, crenate-dentate, acute, with acute to obtuse base, slightly discolorous, sparsely and minutely stellate-pubescent; epicalyx bracts 4-8 mm long, 1 mm wide or less, exceeding the calyx; corolla pink of purplish, more rarely white, widely spreading; stamens white; mericarps with 3 apical spines, these usually retrorsely barbed; plants often growing in flooded places or along creeks or rivers ……..……*Pavonia schiedeana*
1. Leaves broadly ovate (equal or twice as long as wide), cordate, obscurely crenulate to subentire, acuminate; epicalyx bracts 8-10 mm long, 2.5-4 wide, subequal to the calyx; corolla in various hues of yellow, subtubular or campanulate; stamens yellow; mericarps smooth, rugose, or winged but not spined; plants usually growing in mangrove associations or in brackish water ……*Pavonia paludicola*

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GCFC, field work, specimens examination, and writing analysis; JLTM, field work, specimens examination, and writing analysis; IMRM, writing analysis; RDS, field work, specimens examination, and writing analysis.