

## Biogeography

### On the biogeographic regionalization of the Yucatán Peninsula: a nomenclatural review

#### *Acerca de la regionalización biogeográfica de la península de Yucatán: una revisión nomenclatural*

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#### Abstract

The biogeographic regionalization of the Yucatán Peninsula is examined critically. The proliferation of the names assigned to different biotic units (e.g., Yucatán Peninsula, Yucatán, Yucatanan, Yucatecan, Petén, Petén-Yucatán, Campeche, Campechean, El Petén, and Campechean-Petén) is analyzed, and different problems identified. A unified area-taxonomy is proposed recognizing 3 units: the Yucatán Peninsula province Goldman and Moore, 1945, the Yucatecan district Smith, 1941, stat. nov., and the Petén district Smith, 1941. Smaller biotic units recognized by previous authors that may eventually be considered subdistricts cannot be diagnosed by sets of endemic species, so they are treated as synonyms of the 2 districts recognized in the present proposal.

*Keywords:* Biogeographic districts; Biotic units; Mesoamerican dominion; Neotropics

#### Resumen

Se examina críticamente la regionalización biogeográfica de la península de Yucatán. Se analiza la proliferación de nombres asignados a las diferentes unidades bióticas (e.g., península de Yucatán, Yucatán, Yucatanense, Yucateca, Petén, Petén-Yucatán, Campeche, Campechanense, El Petén y Campechanense-Petén) y se identifican diferentes problemas. Se propone una taxonomía de áreas unificada reconociendo 3 unidades: la provincia de la Península de Yucatán Goldman y Moore, 1945, el distrito Yucateco Smith, 1941, stat. nov. y el distrito de El Petén Smith, 1941. Unidades bióticas menores reconocidas por los autores previos, que eventualmente podrían considerarse subdistritos, no pueden diagnosticarse por conjuntos de especies endémicas, por lo que se tratan como sinónimos de los 2 distritos reconocidos en la presente propuesta.

*Palabras clave:* Distritos biogeográficos; Unidades bióticas; Dominio Mesoamericano; Neotrópico

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## Introduction

The Yucatán Peninsula is located in southeastern Mexico, in the states of Campeche, Quintana Roo, and Yucatán, as well as in northern parts of Belize and Guatemala (Durán-García et al., 2017; Ramírez-Díaz et al., 2023). It has been assigned to the Mesoamerican dominion of the Neotropical region (Morrone, 2014, 2017, 2019). The Yucatán Peninsula corresponds to the Maya tectonic block (Gutiérrez-García & Vázquez-Domínguez, 2012), had a cratonic character during the Paleozoic, was largely emergent until the Triassic-Jurassic, and was invaded by seas during the Upper Jurassic and Lower Cretaceous (López-Ramos, 1975; Maya-Martínez et al., 2011; Suárez-Morales, 2003; Vázquez-Domínguez & Arita, 2010). The vegetation of the peninsula is tropical, with a few forest types, being predominant the medium-stature semi-evergreen and semi-deciduous forests, and also with palm groves, coastal mangroves, flooded forests, grasslands, and wetlands (Durán-García et al., 2017; Islebe et al., 2015). Some biogeographic analyses have indicated biotic relationships of the Yucatán Peninsula with the Antilles (Chiappy-Jhones et al., 2001; Suárez-Morales & Reid, 2003; Trejo-Torres & Ackerman, 2001), whereas other studies have indicated a stronger affinity with northern Central America and southeastern Mexico (Aguilar-Aguilar et al., 2003; Duno-de Stefano et al., 2012; Durán et al., 1998; Echeverry & Morrone, 2013; Escalante et al., 2003; Estrada-Lorea, 1991; Ibarra-Manríquez et al., 2002; Maya-Martínez et al., 2011; Olguín-Monroy et al., 2013; Vázquez-Miranda et al., 2007).

Since the 1940s, authors have provided biogeographic regionalizations of the Yucatán Peninsula, recognizing different biotic units named: Yucatán Peninsula, Yucatán, Yucatanan, Yucatecan, Petén, Petén-Yucatán, Campeche, Campechean, El Petén, and Campechean-Petén, among others, and categorized them as provinces, areas, districts, centers, ecoregions, and subdistricts. This nomenclatural proliferation has led to several problems, mostly when the same name has been applied to different areas, and it is very difficult to make adequate comparisons among different regionalizations. For example, Smith (1941) referred to the northern portion of the peninsula as Yucatecan province, whereas Ramírez-Pulido and Castro-Campillo (1990) used the same name for a larger area, encompassing the whole peninsula. Barrera (1962) used the name Yucatanan province for the latter unit, whereas Ferrusquía-Villafranca (1990) used the same name for the smaller one. This nomenclatural confusion should be clarified, producing a unified area-taxonomy that allows better communication among those interested in the biota of the Yucatán Peninsula.

The objective is to review the names applied to the different biotic units in the Yucatán Peninsula and to produce a unified regionalization, providing the appropriate names and listing their synonyms. The taxa endemic to such units are not analyzed, but this area-taxonomy is intended to represent a starting point for further analyses.

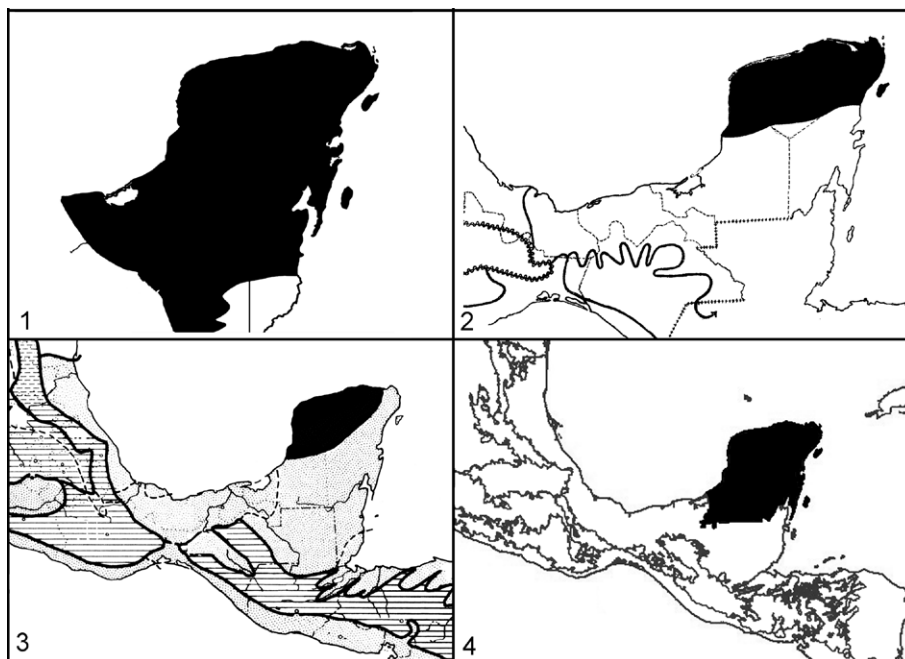
## Materials and methods

A search of specialized literature led me to identify ca. 80 works referring to the biogeography of the Yucatán Peninsula (see References). Special attention was given to the maps provided by the authors to assess the different circumscriptions of the areas recognized. Finally, a consensus is reached concerning the biotic units recognized, and a unified nomenclature is proposed applying the International Code of Area Nomenclature (Ebach et al., 2008).

## Results

The analysis of the literature allowed me to identify 2 basic problems. One is the circumscription of the Yucatán Peninsula as a biogeographic province, and the other is the identification of smaller units within it.

The largest unit recognized by several authors corresponds to southeastern Mexico (states of Campeche, Quintana Roo, Yucatán, and Tabasco) and northern Guatemala and Belize (e.g., Duno-de Stefano et al., 2018; Espadas-Manrique et al., 2003; Goldman & Moore, 1945; Morrone, 2001b, 2006, 2014; Ramírez-Barahona et al., 2009; Ramírez-Pulido & Castro-Campillo, 1990; Rzedowski, 1978; Rzedowski & Reyna-Trujillo, 1990). Carnevali Fernández-Concha et al. (2021) and Ramírez-Díaz et al. (2023) provided a map recognizing the Yucatán Peninsula as a biotic area (Fig. 1). In contrast, other authors have recognized a smaller biogeographic province, restricted to the northernmost portion of the peninsula (e.g., Smith, 1941, Fig. 2; West, 1964, Fig. 3; Arriaga et al., 1997; Brown et al., 2012; Casas-Andreu & Reyna-Trujillo, 1990; Espinosa-Organista et al., 2008; Ferrusquía-Villafranca, 1990; Udvardy, 1975). Between both extremes, a biogeographic province that is almost completely restricted to Mexico has been recognized (Morrone, 2014, 2019; Morrone et al., 2022, Fig. 4). If the latter is compared with the ecoregions of Dinerstein et al. (1995), it corresponds to the Yucatán Dry Forests and Yucatán Moist Forests ecoregions combined. The southern limit of the Yucatán Moist Forests ecoregion represents the boundary of the Yucatán Peninsula province, which differs slightly from the proposal of Morrone et al. (2022).



Figures 1-4. Alternative biogeographic regionalizations of the Yucatán Peninsula. 1, Carnevali Fernández-Concha et al. (2021); 2, Smith (1941); 3, West (1964); 4, Morrone et al. (2022).

When analyzing the units recognized by different authors within the Yucatán Peninsula province (e.g., Lundell, 1934, Fig. 5; Ibarra-Manríquez et al., 2002, Fig. 6; Espadas Manrique et al., 2003; Ramírez-Barahona et al., 2009, Fig. 7; Cortés-Ramírez et al., 2012, Fig. 8; Duno-de Stefano et al., 2012) 2 large ones correspond to the ecoregions of Dinerstein et al. (1995) and are clearly characterized by their vegetation (Islebe et al., 2015). Thus, a consensus regionalization may be achieved by recognizing these ecoregions as districts (Fig. 9). The northernmost portion of the Yucatán Peninsula province corresponds to the Yucatecan district, as recognized by Smith (1941), Udvardy (1975), Lee (1980), Olson et al. (2001), Ibarra-Manríquez et al. (2002), Espinosa-Organista et al. (2008), Ramírez-Barahona et al. (2009), Brown et al. (2012), and Duno-de-Stefano et al. (2012). The southernmost portion of the Yucatán Peninsula province corresponds to the Petén district, as recognized by Lee (1980), Olson et al. (2001), Ibarra-Manríquez et al. (2002), Espinosa-Organista et al. (2008), Ramírez-Barahona et al. (2009), Brown et al. (2012), Cortés-Ramírez et al. (2012), and Duno-de Stefano et al. (2012).

Brodkorb (1943) described a Tabascan district within Smith's (1941) Petén province, but it actually belongs to the Veracruzian biogeographic province. Dinerstein's (1995) Belizean Swamp Forests ecoregion, provisionally treated by Morrone (2014) as a district of the Yucatán

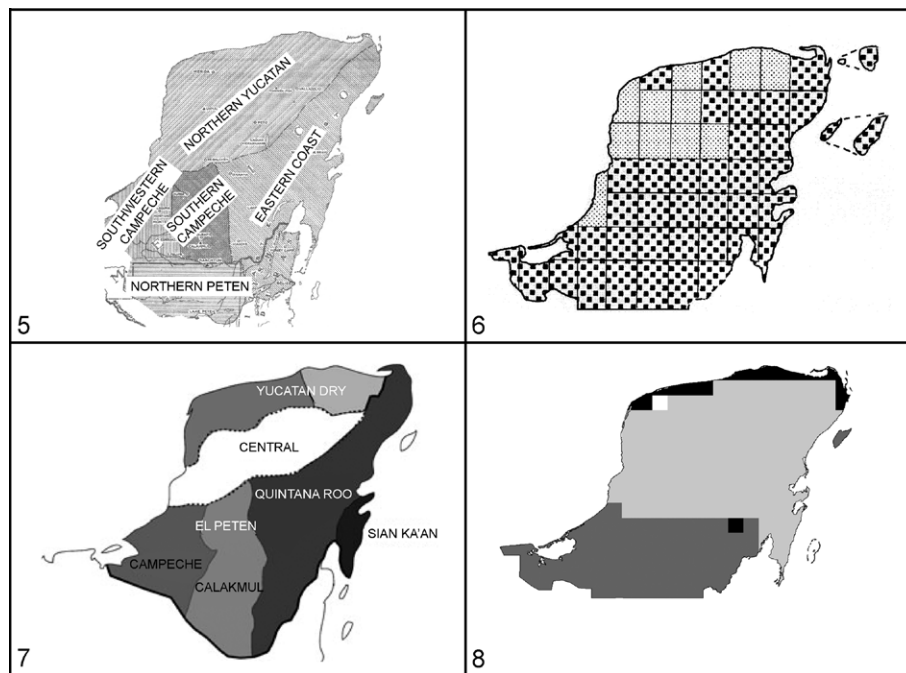
Peninsula province, is also part of the Veracruzian biogeographic province. Other smaller units recognized by Lundell (1934), Espadas-Manrique et al. (2003), Ramírez-Barahona et al. (2009), Cortés-Ramírez et al. (2012), Duno-de Stefano et al. (2012), and Morrone (2014) may be considered subdistricts; however, they cannot be diagnosed by a set of endemic species, so I prefer to treat them as synonyms of the 2 districts recognized.

#### *Area taxonomy*

Yucatán Peninsula province Goldman & Moore, 1945

Yucatán Peninsula province Goldman & Moore, 1945: 360; Ryan, 1963: 22; Stuart, 1964: 355; Rzedowski, 1978: 109; Rzedowski & Reyna-Trujillo, 1990: map; Morrone, 2001a: 43; Morrone & Márquez, 2001: 637; Ibarra-Manríquez et al., 2002: 18; Morrone et al., 2002: 98; Huber & Riina, 2003: 259; Morrone, 2006: 479; Contreras-Medina et al., 2007: 408; Mariño-Pérez et al., 2007: 79; Morrone & Márquez, 2008: 20; Ramírez-Barahona et al., 2009: 783; Maya-Martínez et al., 2011: 528; Cortés-Ramírez et al., 2012: 536; Duno-de Stefano et al., 2012: 1053; Morrone, 2014: 51; Durán-García et al., 2017: 238; Morrone, 2017: 175; Pérez-Saravia et al., 2017: 39; Duno-de Stefano et al., 2018: 515; Morrone, 2019: 59; Carnevali Fernández-Concha et al., 2021: 425; León-Tapia, 2021: 481; Ramírez-Díaz et al., 2023: 100.

Yucatanan province Barrera, 1962: 79.



Figures 5-8. Biogeographic regionalizations recognizing smaller units within the Yucatán Peninsula province. 5, Lundell (1934); 6, Ibarra-Manríquez et al. (2002); 7, Ramírez-Barahona et al. (2009); 8, Cortés-Ramírez et al. (2012).

Eastern Lowland subregion Savage, 1966: 736.

Pacific province (in part) Cabrera & Willink, 1973: 52.

Yucatán center Müller, 1973: 16.

Mexican Gulf province (in part) Samek et al., 1988: 28.

Yucatecan province Ramírez-Pulido & Castro-Campillo, 1990: map (non Smith, 1941).

Southeastern Coastal Plain province (in part) Anderson & O'Brien, 1996: 332.

Yucatán province Ayala et al., 1996: 429; Escalante et al., 1998: 285; Morrone et al., 1999: 510; Espinosa et al., 2000: 64; Morrone, 2001b: 51; Huber & Riina, 2003: 264; Espinosa Organista et al., 2008: 62.

Gulf-Caribbean Slope area (in part) Porzecanski & Cracraft, 2005: 266.

Yucatán Peninsula area Escalante et al., 2007: 155.

Eastern Lowlands area (in part) Flores-Villela & Martínez-Salazar, 2009: 820.

Yucatecan district Smith, 1941, stat. nov.

Yucatecan province Smith, 1941: 101, 1943: 228, 1949: 234; Udvardy, 1975: 41; Casas-Andreu & Reyna-Trujillo, 1990: map; Espinosa-Organista et al., 2008: 62. District I Barrera, 1962: 101.

Northern Yucatán area West, 1964: 368; Cortés-Ramírez et al., 2012: 536.

Yucatanan province Ferrusquía-Villafranca, 1990: map (non Barrera, 1962).

Yucatán Dry Forests ecoregion Dinerstein et al., 1995: 94; Olson et al., 2001: map.

Yucatán province Arriaga et al., 1997: 63; Brown et al., 1998: 31.

Northwestern district Ibarra-Manríquez et al., 2002: 24.

Yucatán area Espadas-Manrique et al., 2003: 325.

Yucatán Dry Zone area Espadas-Manrique et al., 2003: 324.

Yucatec province Maya-Martínez et al., 2009: 296.

Arid/Dry Yucatán district Ramírez-Barahona et al., 2009: 784.

Central subdistrict Ramírez-Barahona et al., 2009: 784.

Northwestern subdistrict Ramírez-Barahona et al., 2009: 784.

Yucatán district Duno-de Stefano et al., 2012: 1063.

Northern Yucatán district Morrone, 2014: 52, 2017: 178, 2019: 60, syn. nov.

Yucatán subprovince León-Tapia, 2021: 481.

Petén district Smith, 1941

Petén province Smith, 1941: 101, 1943: 228, 1949: 234; Barrera, 1962: 101; Stuart, 1964: 355; Casas-Andreu & Reyna-Trujillo, 1990: map; Arriaga et al., 1997: 63;

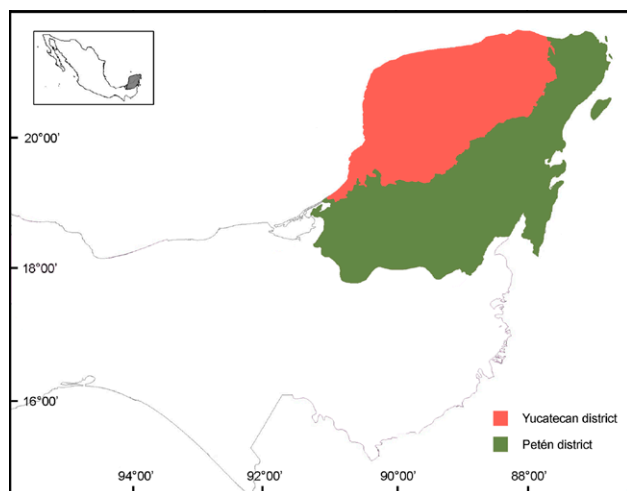


Figure 9. Biogeographic regionalization of the Yucatán Peninsula adopted herein.

Escalante et al., 1998: 285; Morrone et al., 1999: 510; Espinosa et al., 2000: 64; Huber & Riina, 2003: 261; Espinosa-Organista et al., 2008: 62; Maya-Martínez et al., 2009: 296.

District II Barrera, 1962: 101.

District III (Cozumel Island) Barrera, 1962: 101.

Petén-Yucatán Rainforest area West, 1964: 368.

Campechean province Savage, 1966: 736; Udvardy, 1975: 41; Brown et al., 1998: 31.

Campechean-Petén province (in part) Ferrusquía-Villafranca, 1990: map.

Rooan subprovince Ferrusquía-Villafranca, 1990: map.

Quintana Roo Wetlands ecoregion Dinerstein et al., 1995: 100; Huber & Riina, 2003: 157.

Yucatán Moist Forests ecoregion Dinerstein et al., 1995: 87; Olson et al., 2001: map.

Cozumel-Islas Mujeres province Escalante et al., 1998: 285.

El Petén area Espadas Manrique et al., 2003: 325.

El Petén district Ramírez-Barahona et al., 2009: 784.

Calakmul subdistrict Ramírez-Barahona et al., 2009: 783.

Campeche subdistrict Ramírez-Barahona et al., 2009: 784.

Quintana Roo subdistrict Ramírez-Barahona et al., 2009: 784.

Sian Ka'an subdistrict Ramírez-Barahona et al., 2009: 784.

Cozumel Island area Cortés-Ramírez et al., 2012: 536.

Southern Yucatán area Cortés-Ramírez et al., 2012: 536.

Petén district Duno-de Stefano et al., 2012: 1063; Morrone, 2014: 52, 2017: 179, 2019: 60.

Rooan district Morrone, 2014: 52, 2017: 179, 2019: 60, syn. nov.

Petén subprovince León-Tapia, 2021: 481.

## Discussion

The biogeographic regionalization proposed for the Yucatán Peninsula recognizes 1 province and 2 districts representing natural biotic units. Future analyses may be directed to test their naturalness and to recognize smaller units (subdistricts) within them. In particular, the areas already recognized by Lundell (1934), Espadas-Manrique et al. (2003), Ramírez-Barahona et al. (2009), Cortés-Ramírez et al. (2012), Duno-de Stefano et al. (2012), and Morrone (2014) should be examined critically with distributional data of plant and animal taxa. Additionally, phylogenetic analyses, especially those dating lineages, may contribute to analyzing the biotic diversification of the biota of the Yucatán Peninsula.

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