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Abstract

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Polystichum is a nearly cosmopolitan fern genus with 31 species recognized for the Caribbean region. In Cuba, there have been from 11 to 19 taxa recorded, depending on the authors, illustrating the complexity of this group on the island. The examination of more than 2000 herbarium specimens collected in the Greater Antilles allowed the recognition of four taxa not previously recorded from Cuba: *P. platyphyllum*, *P. rhizophorum*, *P. triangulum* and *P. woodsioides*. In addition, *P. deminuens* is accepted as a species, *P. heterolepis* is reduced to the synonymy of *P. viviparum*, and *P. polystichiforme* is reduced to the synonymy of *P. platyphyllum.* Two new combinations are published: *P. triangulum* subsp. *mucronatum* (formerly treated as *P. mucronatum*) and *P. submucronatum* (formerly known under the illegitimate name, *P. woodsioides*). One name is raised from varietal to subspecific rank: *P. rhizophyllum* subsp. *cubense*.

Additional key words: taxonomy, pteridophytes, West Indies, Greater Antilles, Caribbean

Introduction

Polystichum Roth is a nearly cosmopolitan genus, most diverse in China and Japan, but also well represented in tropical America, where it has its secondary centre of diversity (Barrington 1995). The greatest species richness in the Neotropics is found in South America (N and C Andes), Central America (Mexico and Guatemala) and the Greater Antilles (Barrington 2012). The latter area is particularly distinctive because most of the species are endemic (Tryon & Tryon 1982). Of the 31 recognized species in the West Indies, 23 are confined to Cuba, Jamaica and Hispaniola, and only two are represented in continental America: *P. muricatum* (L.) Fée and *P. platyphyllum* (Willd.) C. Presl (Mickel 1997). The genus has been well studied in N-temperate regions (Wagner 1973; Wagner 1979) and Australasian regions (Perrie & al. 2003a–c), where considerable progress on the study of biogeography, evolution and taxonomy has been made. However, for tropical and other southern regions, only a small number of taxonomic (and not evolutionary) studies are known. Both areas, according to Barrington (1985), require special attention.

The first works for Cuba that refer to species currently placed in the genus *Polystichum* date from the second half of the nineteenth century (Eaton 1860; Grisebach 1866; Sauvalle 1873). These publications list only the names of the taxa and the herbarium specimens on which these names were based, without additional information. The first detailed study on Cuban *Polystichum* was made when Maxon (1909) published his revision of West Indies species. Maxon took into account new collections and the identification of materials already present in Cuban herbaria. He recognized 19 species and attributed the problems of taxon delimitation to two main factors: the great variability observed in some species, and the way existing names were inaugurated; some of them were originally based on illustrations and not on the plants

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themselves. Subsequently, Morton (1967) recognized 11 species for Cuba and included an identification key and an analysis of the taxonomic history of the types. Finally, Mickel (1997) performed the most comprehensive monograph of *Polystichum* in the Caribbean region. This author recognized 11 species and also proposed one endemic variety (*P. rhizophyllum* var. *cubense* Mickel) for Cuba.

These studies provided the starting point for the current taxonomic revision of the genus in Cuba, which began in 2000. This work has resulted in 11 species and one variety of *Polystichum* with 1-pinnate fronds (Morejón 2004, ined.), and three species and one variety with fronds 2–3-pinnate (Morejón 2008, ined.). In 2011, a survey of more than 2000 herbarium specimens and images available online from 24 herbaria in Europe and the Americas, including all species known from the Greater Antilles, resulted in publication of three species new to science (Morejón & Sánchez 2012). This research also allowed the corroboration or rejection of the existing taxonomic placement of some Cuban taxa of *Polystichum*.

This paper includes four new records for Cuba: *Polystichum platyphyllum*, *P. rhizophorum* (Jenman) Maxon, *P. triangulum* (L.) Fée and *P. woodsioides* Mickel, non Christ. It also confirms that *P. deminuens* Maxon is a "good" species. Moreover, *P. heterolepis* Fée is considered here a synonym of *P. viviparum* Fée, and *P. polystichiforme* (Fée) Maxon a synonym of *P. platyphyllum*. Three taxa have new names: *P. mucronatum* (Sw.) C. Presl becomes *P. triangulum* subsp. *mucronatum* (Sw.) Morejón & C. Sánchez, *P. rhizophyllum* var. *cubense* becomes *P. rhizophyllum* subsp. *cubense* (Mickel) Morejón & C. Sánchez, and *P. woodsioides* becomes *P. submucronatum* (Christ) Morejón & C. Sánchez.

As result of our studies the number of Cuban *Polystichum* increases, compared to Morton (1967) and Mickel (1997), to 16 taxa (nine of them endemic), with 13 species and three subspecies.

Results and Discussion

Polystichum deminuens

Polystichum deminuens is known only from the type gathering: *Wright 1057* (B, BR, G, K, MO, PH, US, YU; herbarium abbreviations following Thiers 2008+). According to Maxon (1922), it can be confused with *P. machaerophyllum* Sloss., a species that is also proliferous. However, *P. machaerophyllum* has coriaceous, markedly hastate pinnae with slightly prominent veins and conspicuously aristate auricles and apex. Mickel (1997) considered *P. deminuens* a form of *P. decoratum* Maxon.

Polystichum deminuens is here recognized as a "good" species. It differs from *P. decoratum* by having indusia, by the evident gradual reduction of the pinnae at the apex of the frond (vs. truncated apex in *P. decoratum*), and by the lanceolate medial pinnae (vs. trapezoidal in *P. decoratum*). Of all Cuban species with a proliferous apex, *P. deminuens* might be confused with *P. machaerophyllum*, as Maxon (1922) pointed out. However, *P. machaerophyllum* has conspicuously auriculate pinnae, while *P. deminuens* has pinnae practically without auricles.

Polystichum mucronatum and *P. triangulum*

Polystichum triangulum subsp. ***mucronatum*** (Sw.) Morejón & C. Sánchez, **comb. & stat. nov.** ≡ *Aspidium mucronatum* Sw. in J. Bot. (Schrader) 1800[2]: 30. 1801 ≡ *Polystichum mucronatum* (Sw.) C. Presl, Tent. Pterid. 83. 1836 ≡ *Dryopteris mucronata* (Sw.) Kuntze, Revis. Gen. Pl. 2: 813. 1891.

The name *Polystichum triangulum* was misapplied to *P. echinatum* (J. F. Gmel.) C. Chr. by Maxon (1909). This same author corrected the name in 1928, regarding *P. triangulum* as an endemic species of Hispaniola (Maxon 1928; Christensen 1937; Mickel 1997). *Polystichum triangulum* can be recognized by the high number of pinnae (45–55 pairs), the densely scaly rachis and the triangular basal pinnae (Mickel 1997).

Polystichum triangulum is a new record for Cuba, based on two collections from the eastern region: *A. Álvarez & al. HFC 64522* (B, HAJB, JE) and *C. Sánchez & Romano HFC 73650* (HAJB); herbarium series following Regalado & al. (2010). This taxon differs from other Cuban *Polystichum* by its stipe and rachis being densely covered with linear-lanceolate to linear-triangular scales, the black to brown-black indusium with a radiating cellular pattern and the cristate perispore.

The study and comparison of herbarium specimens allowed the confirmation that *Polystichum triangulum* differs from *P. mucronatum* (Sw.) C. Presl only by the dimensions of the pinnae, which are bigger in the latter species, and by the shape of the basal pinnae, which are ovate-deltoid and auriculate both acroscopically and basiscopically in *P. triangulum* vs. lanceolate and only basiscopically auriculate in *P. mucronatum*. These differences are not enough to keep the two taxa as separate species, and we consider here that *P. mucronatum* and *P. triangulum* should be regarded as a single species, *P. triangulum*, with two regional subspecies: *P. triangulum* subsp. *mucronatum*, which is endemic to Jamaica, and *P. triangulum* subsp. *triangulum*, which is restricted to Cuba and Hispaniola.

Polystichum polystichiforme and *P. platyphyllum*

Polystichum platyphyllum and *P. muricatum* are the only two species in the Antilles that are shared with continental America (Mickel 1997). *Polystichum platyphyllum* is widely distributed in the Neotropics, and has many regional variations included in a taxonomic complex that requires further study (Proctor 1985, 1989; Barrington 1995; Mickel 1997; Mickel & Smith 2004). This species

had been previously found in the Greater Antilles only in Jamaica (Maxon 1909; Proctor 1985; Mickel 1997; Mickel & Smith 2004) and Puerto Rico (Proctor 1989; Mickel 1997; Mickel & Smith 2004).

In the study of Cuban *Polystichum* with more than 1-pinnate fronds (Morejón 2008, ined.), the revision of herbarium material resulted in the recognition that some specimens of *P. polystichiforme* (*Hioram CSC 6414*, HAC, S, US; *C. Sánchez & R. Morejón HFC 81266*, HAJB; *Hioram CSC 9442*, HAC; *Clemente NSC 1283*, HAC) differ from the rest by their robustness and larger size, the 3-pinnate lamina, the lobate-spinulose pinnule margins and, at least in the basal pinnae, the basiscopic basal pinnules equally or more developed than the acroscopic basal pinnules. These characteristics were noted by Maxon (1909) and Mickel (1997) as characters for differentiating *P. platyphyllum* and *P. polystichiforme*. These differing specimens were determined to be *P. platyphyllum*, and this is the first time that its presence has been noted in Cuba.

Maxon (1909) made the change from *Phegopteris polystichiformis* Fée to *Polystichum* and placed *Polystichum tenue* Gilbert in synonymy under *P. polystichiforme* based on the similarity of this species with a gathering (*Wright 832*, B, BR, G, GH, HAC, K, L, MO, NY, P, S, UC, US, YU) previously identified by him as *P. polystichiforme*. This species is distributed throughout the Greater Antilles with different morphological variants. In Jamaica, there is a form that was previously called *P. tenue* with very narrow fronds, few free segments in the pinnae (1–4 pairs) and 1-pinnate fronds in the distal ½–¾ of the lamina. Another, rarer form is found in Cuba, Hispaniola and Puerto Rico; it is larger than the typical form and has the acroscopic basal pinnule more developed, fully divided and with the margins much more spinulose (Mickel 1997).

Historically, *Polystichum platyphyllum* has been considered to be distributed in South America, Central America and the Greater Antilles, whereas *P. polystichiforme* is restricted to the Greater Antilles. The two have been interpreted as two closely related species that together constitute a large taxonomic complex that requires further study (Proctor 1985, 1989; Barrington 1995; Mickel 1997; Mickel & Smith 2004). On the other hand, unifying the two species under the name *P. platyphyllum* has also been a possibility previously discussed (Stolze 1981), and even long before, mid-nineteenth-century authors included the two together (Mettenius 1858; Hooker 1862). In Cuba, *P. polystichiforme* is similar to specimens classified as *P. platyphyllum*, but smaller in size. Even the analysis of indumentum showed the same pattern of scales in all plants, only differing in the dimensions. Moreover, the specimens *C. Sánchez & al. HFC 75873* (HAJB), *C. Sánchez & R. Morejón HFC 81392* (HAJB) and *Morton 3540* (GH, HAC [*SV = 11931*], UC, US) all have the diagnostic character mentioned by Mickel (1997) as differentiating these two species – that in *P. polystichiforme* the basiscopic basal pinnule is less developed. However, the aspect of the plant, frond size and margin of the pinnules resemble *P. platyphyllum*. This mix of characteristics between the two taxa is reflected too in the work of Grisebach (1859–1864), where he published the new combination *Aspidium aculeatum* var. *platyphyllum* (Willd.) Griseb.

Regarding the degree of frond division, these intermediate specimens can be 3-pinnate as in *Polystichum platyphyllum* (*Morton 3540*, GH, HAC [*SV = 11931*], UC, US). The differences between basiscopic and acroscopic pinnules, used as a unique diagnostic character, are not enough to separate these two species, and separation according to the size of the plants is almost impossible. That is why *P. polystichiforme* was preliminarily considered a variety of *P. platyphyllum* (Morejón 2008, ined.). The recent opportunity to review a great number of specimens from all geographical areas where these species occur showed that plants similar to *P. polystichiforme* appear in continental America, and the mix of specimens with characteristics intermediate between the two species is not restricted to Cuban specimens. For this reason we consider *P. polystichiforme* to be a synonym of *P. platyphyllum*.

Polystichum platyphyllum can be easily differentiated from the rest of the Cuban species by the absence of an indusium, fronds more than 1-pinnate (at least basally) and by the presence of abaxial propagules distant from the apex.

Polystichum rhizophorum

Polystichum rhizophorum is based on *Aspidium viviparum* subsp. *rhizophorum* Jenman. According to Maxon (1909), the subspecies has no close relationship with *A. viviparum* (Fée) Mett., as Jenman (1895) suggested. Mickel (1997) indicated that this species is "common to Jamaica, present in south western Haiti and could be in Cuba", based on the fact that the collection *Clemente 2451* (NY, US) identified as *P. rhizophorum* has foliar dimorphism. Nevertheless, the fertile frond is regularly proliferous and the rachis is not winged, contrary to what usually happens in *P. rhizophorum*, where the fertile frond is not proliferous (Maxon 1909). The examination of specimens and recent collections made by the authors in E Cuba confirmed the presence of this species in Cuba.

Polystichum rhizophorum is closely related to *P. decoratum* based on the degree of division of the frond and the absence of indusium. However, it differs from that species primarily by having foliar dimorphism (Maxon 1909; Mickel 1997). The similarity between *P. decoratum* and *P. rhizophorum* was noted in spore characters, epidermal pattern, cell types in the scales of the stipe, absence of indusium, presence of a flagelliform and proliferous apex, and the inconspicuously winged rachis (Morejón 2004, ined.). However, the species can be separated because in *P. rhizophorum* there is a marked

difference between sterile and fertile pinnae that is not present in *P. decoratum*; the frond is lanceolate, narrowly ovate or oblong in *P. rhizophorum*, whereas in *P. decoratum* it is linear or linear-oblong-lanceolate. The type, dimensions and margins of the scales from the stem apex and stipe also differ between the two species: in *P. rhizophorum* the scales are ovate and lanceolate, 3.5–5.5 × 1.6–3 mm, and the margin is ciliate, whereas in *P. decoratum* the scales are ovate to linear-lanceolate, 4.7–9.5 × 0.4–3 mm, and the margin is irregularly sinuous and subentire. Moreover, unlike in *P. decoratum*, in *P. rhizophorum* the adaxial rachis groove is continuous with the groove on the pinnae.

Polystichum heterolepis and *P. viviparum*

Polystichum heterolepis and *P. viviparum* were described by Fée (1850–1852) based on two different plants mounted on the same sheet (*Linden 1742 p.p.*, B, G, K, NY, P, RB, US). The two names were published one after the other on consecutive pages: *P. heterolepis* on pp. 279–280 and *P. viviparum* on p. 280. Maxon (1909) accepted the name *P. heterolepis* with two synonyms: *P. viviparum* and *Aspidium viviparum*. According to him, the two species were unified under the name *P. heterolepis* by priority of the page. Morton (1967) agreed with Maxon in uniting *P. heterolepis* and *P. viviparum* under one species, but differed in selection of name, noting that *P. viviparum* has priority over *P. heterolepis* because the former had been accepted and *P. heterolepis* relegated to synonymy by Christensen (1906) when he unified the two species. This complies with Art. 11.5 of the International Code of Nomenclature for algae, fungi, and plants (McNeill & al. 2012). Although Mickel (1997) recognized that the characters differentiating *P. heterolepis* and *P. viviparum* are not exclusive, he recognized both species, albeit with doubt.

During the revision of specimens of these species, we detected plants with the characters that Fée (1850–1852) used to publish those taxa as different species. We found larger plants with concolorous and bicolorous scales on the rachis and light brown indusia, as Fée described for *Polystichum heterolepis*, and smaller plants with black to dark brown indusia, as was described for *P. viviparum*. However, the review of a large number of plants showed a mixture in those diagnostic characters, and the limits between the taxa could not be clearly demarcated. This mixture of diagnostic characters was detected in wild populations at La Gran Piedra (Sierra Maestra mountain range, E Cuba), as previously noted by Maxon (1909). In the same individual, for example, light brown indusia (typical *P. heterolepis*) and bicolorous scales in the rachis (as in *P. viviparum*) were observed (*C. Sánchez & al. HFC 71338 & 71339,* HAJB; *Clemente & Chrysogone NSC 6466*, HAC, US; *M. G. Caluff MGC 105,* BSC). Moreover, specimens were found with bicolorous indusia, i.e. black centre and light brown margins (*A. Alvarez & al. HFC 64597*, B, JE, HAJB; *Leon LS 11180*, HAC, NY; *Clemente NSC 951*, HAC, US) and a gradation in plant size and frond dissection intermediate between these two species. This lack of character consistency, previously pointed out by Mickel (1997), makes discrimination between the two species impossible.

Polystichum viviparum differs from the rest of Cuban *Polystichum* by the presence of a truncated and proliferous frond apex, the often bicolorous scales on the rachis, and the concolorous (brown or black) and bicolorous indusia.

Polystichum woodsioides renamed *P. submucronatum*

Polystichum submucronatum (Christ) Morejón & C. Sánchez, **comb. & stat. nov.** ≡ *Aspidium triangulum* var. *submucronatum* Christ in Bot. Jahrb. Syst. 24: 111. 1897 ≡ *Polystichum woodsioides* Mickel in Johns, Holttum Mem. Vol.: 142. 1997, nom. illeg. [non *Polystichum woodsioides* Christ in Bot. Gaz. 51: 354. 1911].

Mickel (1997) provided the new name *Polystichum woodsioides* when he raised the taxon described from Jamaica as *Aspidium triangulum* var. *submucronatum* to specific rank. This species is easily distinguished by the presence of abundant glandular hairs across the frond, especially at the base of the stipe (Mickel 1997). Certain Cuban specimens misclassified as *P. echinatum* belong to *P. woodsioides* based on the presence of these hairs. This species is recorded as new to Cuba based on two specimens collected in the Sierra Maestra mountain range (E Cuba): *E. L. Ekman 14600* (S) and *Linden 1866* (K).

The name *Polystichum woodsioides* Mickel (1997) is illegitimate because it is a later homonym of *P. woodsioides* Christ (1911), which applies to a different taxon from the Himalaya and China (correctly called *P. moupinense* (Franch.) Bedd. according to Zhang & Barrington 2013). Therefore, a replacement name is required if the West Indies taxon is to be recognized at specific rank. The original epithet is still available for use, and the species is accordingly here named *P. submucronatum*.

With the recent inclusion of *Adenoderris* J. Sm. in *Polystichum* (McHenry & al. in press), *P. submucronatum* could be confused with *P. glandulosum* C. Presl among the Cuban species by the presence of abundant glandular hairs on the fronds. However, the two species can be separated on account of *P. submucronatum* having coriaceous fronds and conspicuously aristate pinnae vs. thin-textured fronds and non-aristate pinnae in *P. glandulosum*.

Polystichum rhizophyllum var. *cubense* raised in rank

Polystichum rhizophyllum subsp. ***cubense*** (Mickel) Morejón & C. Sánchez, **stat. nov.** ≡ *Polystichum rhizophyllum* var. *cubense* Mickel in Johns, Holttum Mem. Vol.: 137. 1997.

Polystichum rhizophyllum (Sw.) C. Presl is one of the easiest Caribbean species to recognize because of its rosulate habit, fronds growing parallel to the ground and apiculate stem-scale apex. Moreover, the lamina is abundantly scaly, with the apex at least half as long as the lamina, and the pinnae are exauriculate, obovate and entire. In the transfer to *Polystichum* made by Presl (1836), only the new name and the synonymy of *P. rhizophyllum* were mentioned. Maxon (1909) included *P. krugii* Maxon as a synonym of the species based on one Puerto Rican specimen bearing the unpublished herbarium name "*Aspidium krugii* Kuhn". Proctor (1985, 1989) and Mickel (1997) also included in the synonymy of this species *Nephrodium rhizophyllum* (Sw.) C. Presl and *Dryopteris rhizophylla* (Sw.) Kuntze. Originally described for Jamaica, *P. rhizophyllum* has been reported from Cuba, Puerto Rico and the Lesser Antilles (Proctor 1977; Mickel 1997; Maxon 1909). Morton (1967) noted that although this species is common in Puerto Rico, it is rare in Jamaica, Cuba and Hispaniola.

In 1997, Mickel separated the Cuban specimens of this species as a new variety: *Polystichum rhizophyllum* var. *cubense*, based on its having (6–)8–13 pairs of acute pinnae and the margin of the entire portion of the apex irregularly denticulate, 4–6(–10) mm wide. These characteristics were observed in materials collected in C Cuba (*C. Sánchez HFC 74300*, HAJB; *C. Sánchez & Cuesta HFC 74298 & 74299*, HAJB). However, other plants collected in W and C Cuba (*M. G. Caluff MGC 422*, BSC; *Hno. León LS 8536*, HAC, NY) do not match these features, except for the acute pinnae. Likewise, the duplicate *Hno. León LS 8536* (US) and two duplicates of *C. G. Pringle 106* (GH, US) from W Cuba were classified as *P. rhizophyllum* var. *cubense* by Mickel in 1994. However, the characteristics of these plants do not agree with those given by Mickel for the Cuban variety, but rather with *P. rhizophyllum* var. *rhizophyllum*. These specimens have 5–7 pairs of obtuse or acute pinnae, with the margin of the entire portion of the apex irregularly undulate or subentire, 0.7–1.1 mm wide. Due to the inconsistencies observed in Cuban specimens, we previously considered that both varieties are present in Cuba (Morejón 2004, ined.). The revision of a large number specimens from Cuba and other islands of the Greater Antilles allowed for comparison of morphologically different populations across the geographical range of the species. This showed that the Cuban specimens, independent of the differences in their characteristics, differ from the plants that occur in the rest of the Caribbean. Cuban plants are larger in size and have sessile or subsessile pinnae with an acute to subacute apex, whereas plants from other islands have smaller dimensions and pinnae mostly stipitate with an obtuse to rounded apex. Because of this, we agree with Mickel (1997) that the Cuban plants constitute a separate entity, but, considering the allopatric distribution, we prefer to place them at the rank of subspecies rather than variety.

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