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A New *Zamia* Species from the Panama Canal Area

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Abstract There are four terrestrial, above-ground stemmed *Zamia* taxa in Panama, the species delimitations of which have been a matter of controversy or misplacement at one time or the other (Schutzman et. al., 1998; Stevenson, 1993; Taylor, 1999a, b, 2002). All are allopatrically distributed. Two are in western Panama in Chiriquí province. One of these, *Z. pseudomonticola*, is found in the northwest of the province at altitudes above 1000 m, while the other, *Z. fairchildiana*, is found in a relatively small patch of forest in southwestern Chiriquí province. The other two taxa are found around the Canal area or farther east. The species described in this paper is found near the Canal area, and the last of the group, *Z. elegantissima,* occurs north of the Canal area in the province of Colon and also some distance to the east, including part of the Dule or Kuna aboriginal homeland known as Kuna Yala. After 16 years of research on the new taxon, we have decided to describe it as a new species, pointing out its similarity to *Z. elegantissima* and its distinctness from *Z. pseudomonticola* and *Z . fairchildiana*. The two western species are more alike in structure compared with the eastern species, and the latter are more alike between themselves compared to the western taxa. Even so, there are differences in vegetative and reproductive structures to clearly separate each species. There are even differences in the pollinators, these being, in all cases found, species of the weevil genus *Rhopalotria* and the snubbed-nosed beetle *Pharaxonotha.*

Keywords *Zamia* · Allopatry · Pollen cones · Leaflets · Pollinators · Hervibory · Emergent leaves

Introduction

Field work on the cycads of Panama over the past 20 years by Stevenson (1993), Schutzman et al. (1998), and the present authors, has led us to describe a species that has gone unnoticed or confused with both *Zamia fairchildiana* L. D. Gómez (Taylor, 1999a, b) and *Z. elegantissima* Schutzman, Vovides & Adams (Taylor, 2002). However, considering both vegetative and reproductive characteristics and growth habit, the new species is readily distinct from both. All of the species are allopatric and there is no known geographical overlap, and from the first eophylls to especially

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mature plants, the species can be separated. The cones, both pollen and ovulate, of *Z. elegantissima* and *Z. fairchildiana* are much larger than those of the new species described herein. While *Z. fairchildiana* and *Z. pseudomonticola* L. D. Gómez are found in southeastern and northeastern Chiriquí Province, respectively, *Z. elegantissima* is found in northern and western Colon Province, while our new species is found around the Panama Canal area, including near the headwaters of the Chagres River in an all-inclusive national park known as Parque Nacional Chagres, or Chagres National Park (Fig. 1).

Methods

Because the data used to describe the new species were field based, we took a very long period (more than 20 years, more than 500 plants, coning and non-coning, plus seedlings) of annotating morphometric and morphological characteristics of the new species in all known sites where it occurs (2, with 5 fragmented subsites). The morphometric characteristics included length of stem, leaves, petioles, leaflets, cones, peduncles and seeds and diameter or width of stem, leaflets, cones, peduncles and seeds. The result is the description of the new species.

Description of *Zamia stevensonii* A. S. Taylor & G. Holzman

Zamia stevensonii A.S. Taylor & G. Holzman, **sp. nov.** Type: Panama. Panama Province: on loose black soil with some dead leaves about 110 masl and near fresh

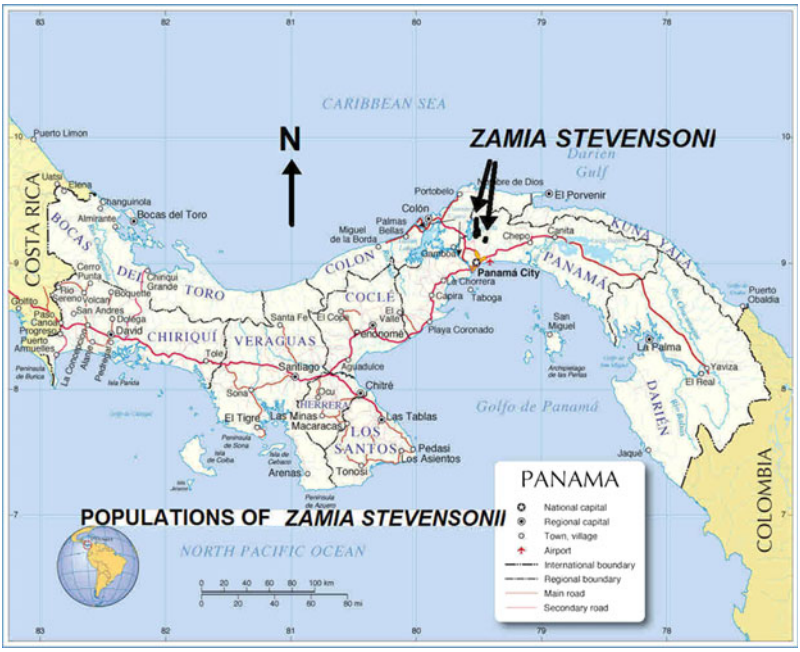

Fig. 1 Distribution of *Zamia stevensonii* in Panama

water lake, with some herbaceous and mostly shrubby vegetation with a few arborescent types, 23 May 2012 *A. S. Taylor B, & G. Holzman A. S. Taylor CCh23052012* (holotype: PMA; isotypes: NY, XAL. Figures 2(a–c). **Other specimens examined:** D.Luque, M. Calderón, N.Camacho, A.Somoza, I. Tejada, E. Núñez, P. Rojas 669 (PMA), L. Carrasquilla, N.Rivera, D. Luque no. 3522 a (PMA).

Frutex aliquando acaulis. Caudex usque ad 1.5 m altus, 2–8 cm diam., solitarius. Folia 25–120 cm longa, cum aliquot vel sine spinis, ad 27 apicem, 3–25 foliolis paribus, emergensia saepissime alba et glabra, matura viridia vel atro-viridia; petiolo 28–63 cm longo; foliolis oblongus, basis subfalcatus, acuminatis, in pagina supera plana, marginibus leviter serratis; foliolis apicalibus 7–24 cm longo, 2–5 cm lato; foliolis lateralibus 10–25 cm longo, 2–5 cm lato; foliolis basalibus 9–21 cm longo, 1.5–4 cm lato. Strobilus

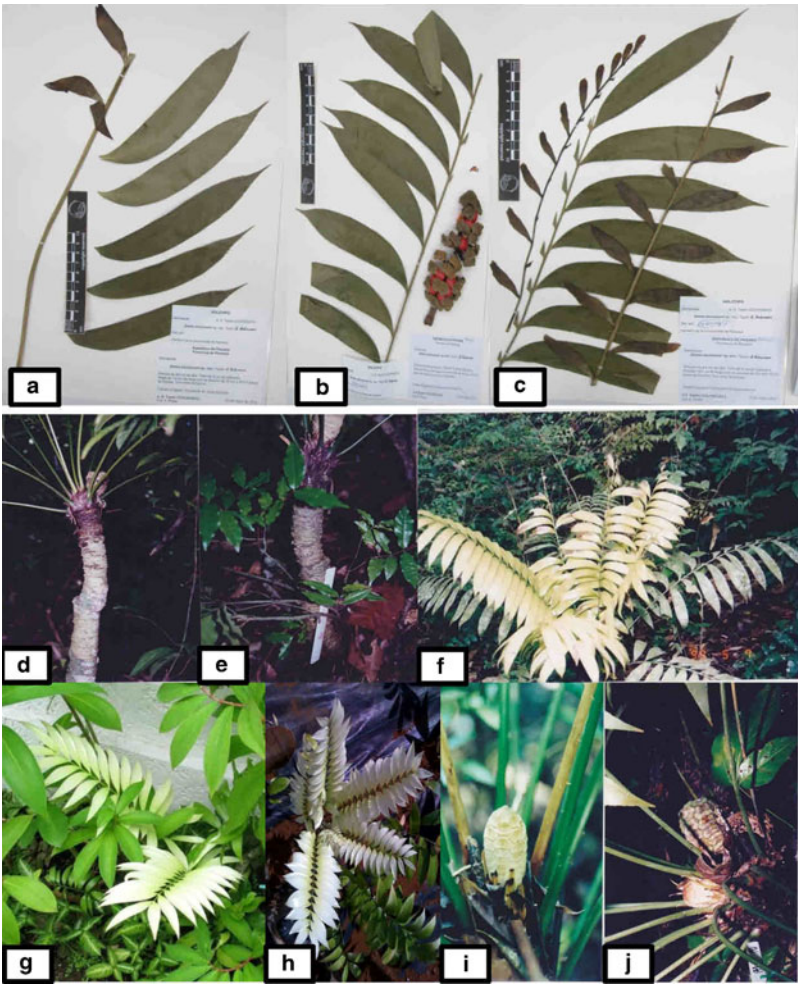

Fig. 2 Vegetative and coning structures of *Zamia stevensonii sp. nov. A.S. Taylor B. & G. Holzman*. **a**–**c**. herbarium samples of holotype. **d**–**e**. cut and resprouted stems with ovulate cones in a natural population of the species. **f**. emergent white leaves in a natural population. **g**–**h**. emergent white leaves cultivated specimens. **i**. emergent ovulate cone with pale-yellow tomentum. **j**. two ovulate cones of adjacent coning season on the same plant

pollinis 5.5–17 cm longus, 2.5–4 cm diam., emergens flavidus ad brunneolus flavidus tomentosus, cylindricus; pedunculo 4–10 cm longo, 0.5–2 cm diam.; microsporophyllis 0.7–0.8 mm lato, 0.5 mm alto, sexangularibus ad late oblongis sexangularibus, columnis sporophyllorum pollinis 13–16, seriebus 20–38, microsporangiis non nise super paginis abaxialibus.. Strobilus ovulatus 4.5–16 cm longo, 4–9 cm diam., solitarius, emergens brunneolus flavidus tomentosus, maturescens ad viridis vel olivaceis ferruginiis ad brunneis tomentosus, cylindricus ad cylindricus globosus, interdum pendus ubi maturus; pedunculo ad 10 cm longo, 0.5–3 cm diam.; megasporophyllis 1.5–2.5 cm lato, 1–1.7 cm alto, sexangularibus oblongis, columnis sporophyllorum ovulatum 3–7, seriebus 3–9. Semina 1.8–2.1 cm longa, 1.2–1.5 cm diam., ovoidea ad globosa, 24 ad 144 vel plus quam 144 ab strobilo; sarcotesta sanguinea ubi matura.

Species *Zamia elegantissimae* Schutzman, Vovides & Adams similarissimus sed caule plus angusto, foliis et foliolis minus numerosis, foliis emergentibus saepissime eburneis tum niveis, strobilo pollinifero cylindrico et strobilo ovato uterque parvis, seminibus itidem parvis differt.

Habit arborescent or sometimes acaulescent shrub. **Stem** to 1.5 m tall, 2–8 cm diam., solitary. **Leaves** 25–120 cm long, with few prickles or none, to 27 per crown (mean=11), with 3–25 leaflet pairs (mean=11.5), emerging nearly always white and glabrous, maturing glossy green to dark green; **petiole** 28–63 cm long and medium green in color, with very few or no prickles; **leaflets** oblong, subfalcate near base, acuminate, margins serrate primarily in the distal third or fourth on lower margin; apical leaflets 7–24 cm long, 2–5 cm wide; median leaflets 10–25 cm long, 2–5 cm wide; basal leaflets 9–21 cm long, 1.5–4 cm wide. **Microstrobili** 5.5–17 cm long, 2.5–4 cm diam., occurring singly or in groups of 2–3, reddish-golden to brownish-yellow tomentose, cylindrical to elongate conical-cylindrical, with round-acuminate apex of sterile sporophylls; **peduncle** 4–10 cm long, 0.5–2 cm diam.; **microsporophylls** 0.7–0.8 mm wide, 0.5 mm tall, hexagonal to oblong hexagonal, slightly protruding, arranged in 13–16 columns and 20–38 rows, microporangia only on abaxial surface. **Megastrobili** 4.5–16 cm long, 4–9 cm diam., solitary, rarely in pairs, emerging yellow-brown tomentose, maturing green or grayish-green, tan to brown tomentose, cylindrical to cylindrical-globose; **peduncle** to 10 cm long, 0.5–3 cm diam.; **megasporophylls** 1.5–2.5 cm wide, 1–1.7 cm tall, oblong hexagonal, arranged in 3–7 columns and 3–9 rows; **seeds** 1.8–2.1 cm long, 1.2–1.5 cm diam., ovoid to globose, 24 to 126 or more per cone, sarcotesta bright red when ripe.

This species is similar to *Zamia elegantissima* but differs in having a much smaller trunk, many fewer leaves and leaflets, leaves emerging white with a yellow tinge, then turning snow white, with both pollen and ovulate cones very small and also with relatively small seeds.

Etymology. The specific epithet is in honor of Dr. Dennis William Stevenson, who has a long history of systematic works with the cycads of Panama and the New World tropics (Stevenson, 1993, 2001, 2004) and was the first worker to write up a usable key for the Panamanian cycads. The white emerging leaves (Fig. 2f–h) give this species the name of "blanco" or white as it is known in the cycad trade.

Distribution, Habitat & Soil. Endemic to the Panama Canal area of the Province of Panama, the primary habitat consists of basic, humus-covered, loose or compact

forest soils in the typical low altitude humid tropical forest. It is amply distributed from about 110 masl to over 700 masl in secondary forests and near freshwater lakes and rivers (Fig. 1). The plants are very hardy, resisting dry conditions, and able to recover even from small excised parts of the stem. Maturity takes four years for pollen plants and about eight years for ovulate.

Climate. The climate of the Panama Canal region is tropical, and rainfall is relatively consistent during the "wet season" which generally extends from the beginning of April to the latter part of December.

Vegetative Traits. Trunks never attain great height, and many coning plants are practically without aerial stems (Fig. 4c). In very few cases, plants might attain heights above 1 m and up to 1.5 m (Figs. 4l–m). The plants are solitary, and quickly recover when wounded (Figs. 2d–e). The color of the emergent leaves is a very distinctive white, which is the basis for the common name "blanco" (white in Spanish) fby which it is now widely known. In shaded locations, the color can be yellowish white at first, becoming snow white in most cases. Eophylls typically have four ovate leaflets with acute tips, and most are white or nearly so when emerging (Fig. 4a).

Reproductive Traits. Both the pollen and ovulate cones show a diversity of colors from coning period to coning period and from one plant to the other. Emergent cones are generally whitish to yellowish (Figs. 2i, 4c–d), the pollen cones becoming reddish-tan to tan to grayish-brown (Figs. 2a–c, 4e–f), while the ovulate cones might turn greenish-brown to light gray (Figs. 2j, 3d–e). The ovulate strobili are usually solitary, although it is not atypical to find a new cone on the same plant with a much larger cone from the previous year (Fig. 2j) They emerge covered in pale yellow to tan tomentum, later losing some of the tomentum, and ultimately maturing to green or grayish-green (3E–F). They may reach 20 cm long and 9 cm in diam., and their peduncles (to 10 cm) are almost always covered with bracts (Figs. 2j, 3f). Mature seeds are ovoid to globose in shape (3 G–I), measure to 2.1 cm long and 1.5 cm in diameter, and may number more than 126 per cone (Figs. 3g–h).

Reproductive Phenology. The presence of numerous mature pollen and ovulate cones and many newly emerging cones observed during sixteen years of study is indicative of healthy reproductive activity. Dehiscing pollen cones and receptive ovulate cones have been observed only at one time per year, with a more or less regular cycle of 3–1/2 months for cone formation and maturity and 1–2 months of dehiscence and receptivity. Sometimes there are partheno-carpic seeds because of lack of pollen during receptivity. Depending on the intensity of the rainy season, cone formation begins in late July to early September, and dehiscence and receptivity begin in mid-November to early December. Seeds take approximately 1–2 years to mature.

Pollination. Pollination biology is similar to that of other *Zamia* species in Panama. Both wind and insect exclusion trials, plus the use of greased microslides tied to the petioles near dehiscent pollen cones and receptive ovulate cones have proven that the insects recovered from dehiscent pollen cones are the pollinators

of the species. The insects are an unknown species of erotylid beetle (genus *Pharaxonotha*, family Erotylidae) (Fig. 4j left) and another species of a *Rhopalotria*-like genus of weevils (Fig. 4j right). *Pharaxonotha* is always recovered from cones in all populations studied and, in most, the *Rhopalotria* weevils are also found. *Pharaxonotha,* then, is taken to be the primary pollinator of *Z. stevensonii* (Taylor et al., 2012).

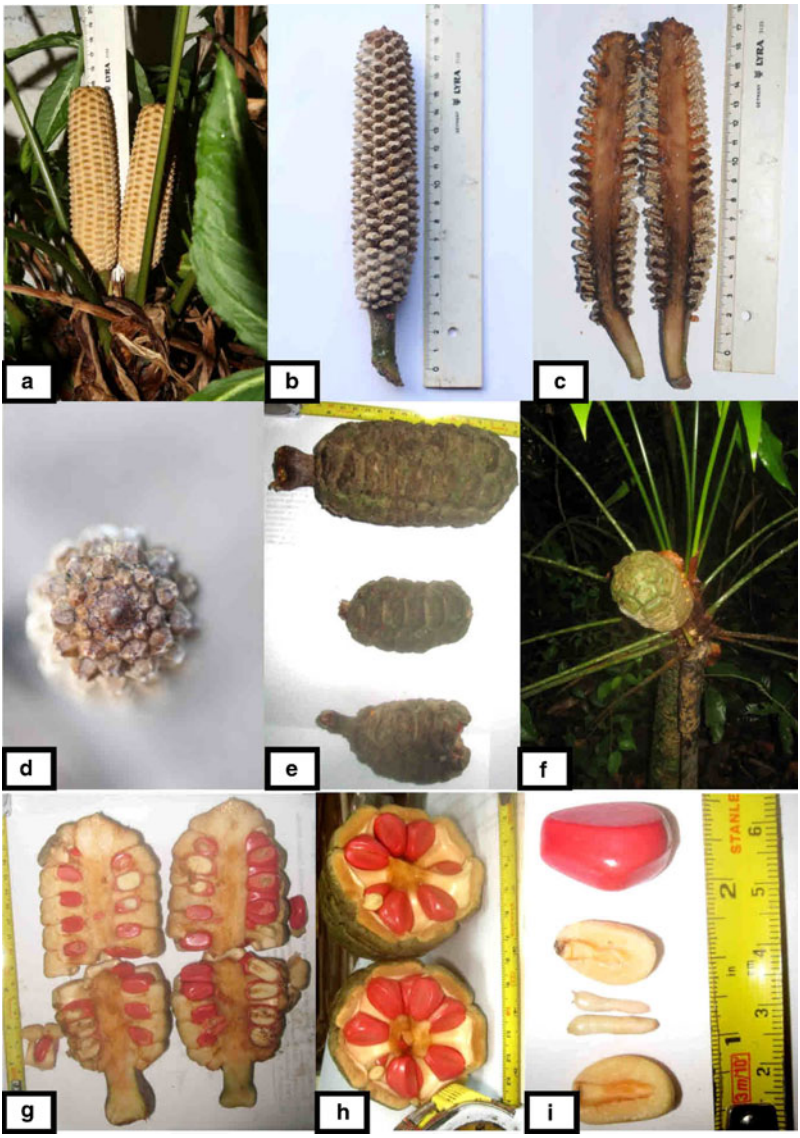

Fig. 3 Structures of pollen cone and holotype of *Zamia stevensonii sp. nov.* Taylor & Holzman. **a**–**c**. plollen cones (cultivated plants from seed). **d**. apex of pollen cone, **e**. seed cone of holotype (*top*) and isotypes (*bottom*), **f**. seed cone on plant of holotype in situ. **g**. seed cone of holotype (longitudinal section). **h**. ídem, but cross section. I. seeds with viable embryo

Pests & Diseases. Larvae of the hairstreak butterfly, *Eumaeus godarti* (Lepidoptera: Lycaenidae), were observed feeding on new and old leaves (Figs. 4h–i). The larvae, although they consume a great quantity of leaf tissue, do no serious and irreversible

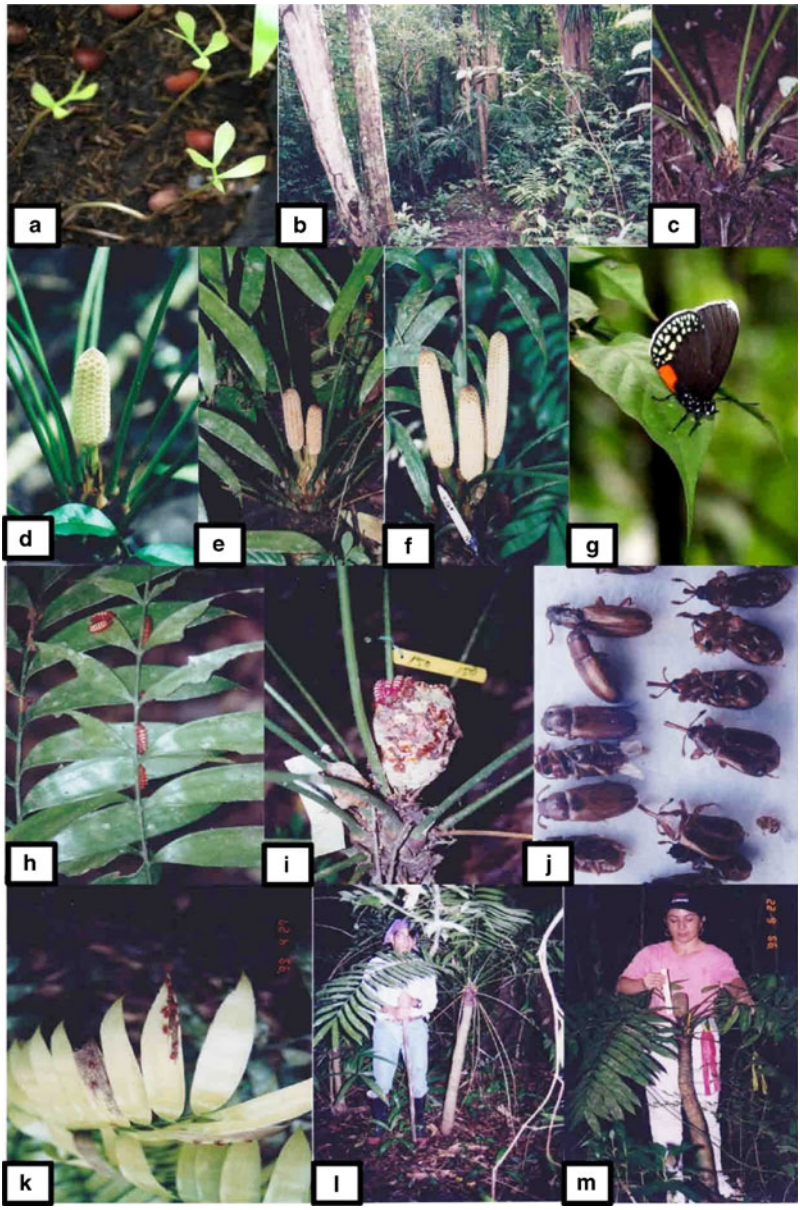

Fig. 4 *Zamia stevensonii* habit and insect relationships. **a**. germinating seeds with eophylls. **b**. habitat of a natural population with understory growth and some trees. **c**. almost stemless plant with growing pollen cone. **d**–**f**. pollen cones in natural population. **g**. *Eumaeus godarti*, Lepidotera, whose larvae are herbivore of zamias. **h**–**i**. damage to leaves and seed cone by larvae of *Eumaeus godarti*. M. *Rhopalotria*-like weevils (*right*) and *Pharoxonotha* beetle (*left*) natural pollinators of *Zamia stevensonii*. **k**. *Alacoscelis* (Chrysomelidae) attacking emergent leaves. **l**–**m**. large plants (over 1 m tall) of *Zamia stevensonii*

harm to the population. These larvae are apparently preyed upon by birds when very small (<1.5 cm), because very small larvae have been noticed disappearing in a 24-h period, and bird droppings have been observed on the leaves where the larvae were the day before.

Ethnobotanical Uses & Vernacular Names. The plants do not have any known local name and its human use is unknown or nonexistent. However it is often found in gardens or on sale in local nurseries.

Population Structure. Plants of this species are only abundant near the Panama Canal area (Fig. 1), but the total number, unknown, is not as large as in other cycad species in other countries. The most conserved site is in a national park where the U.S. Army had an outpost until a few decades ago, when the place was returned to Panamanian jurisdiction after the signing of the Torrijos-Carter Panama Canal Treaty. Most plants have been conserved, but illegal extraction and sale is ongoing, and recruitment is quite low in the populations studied.

Conservation Status. Most Panamanian cycads have received a listing of CR B1, (Taylor et al., 2012), and based on habitat destruction within a limited extent of occurrence and area of occupancy, this species also deserves a listing of critically endangered (CR) according to the most recent Guidelines for Using the IUCN Red List Categories and Criteria (IUCN Standards and Petitions Subcommittee, 2010). The complete Red List assessment is CR B1B2ab(ii v).

Key to the Non-Plicate Arboresent Species of *Zamia* in Panama

1. Leaflets entire ..... *Z. lindleyi*
1. Leaflets serrate at least in upper third 2

2. Leaflets ovate to obovate ..... *Z. obliqua*
2. Leaflets oblong to lanceolate 3

3. Petiole and rachis with very few to no prickles, leaflet surface rather flat, margins with small scattered serrations , especially in proximal end, leaflet tip acute 4

4. Emergent leaves light green to yellowish green, stem base in coning or mature plants greater tan 8 cm diam up to +21 cm diam ..... *Z. elegantissima*
4. Emergent leaves white, stem base in coning or mature plants less than 8 cm..... ..... *Z. stevensonii*
3. Petiole and rachis with obvious prickles up to base of rachis, most leaflets surfaces with obvious longitudinal crease, margins almost entire, except for small cleft at proximal end, leaflet tip acute to acuminate 5

5. Leaflets tip often less than 3 cm long ..... *Z. pseudomonticola*
5. Leaflets tip often greater than 3 cm long ..... *Z. fairchildiana*

Conclusions

In light of the preceding, we can accept that there is enough morphometric and observable morphological differences between *Zamia stevensonii*, as here presented, and the other species to which it has been compared or with which it has been mistaken to warrant its inclusion as a new species, considering the geographic range, white emergent leaves, relatively small above or below-ground stems, small number of pollen cones per plant, smaller size of ovulate and pollen cones, and having microsporangia only on the abaxial surface of the microsporophylls. In both *Z. pseudomonticola* and *Z. fairchildiana*, the microsporangia occur on both surfaces of the microsporophylls (adaxial and abaxial). Also, the leaflets of the latter two species have a longitudinal crease that is lacking in *Z. elegantissima* and *Z. stevensonii*, and most leaflets are ovoid or oblong with acuminate tips, while both *Z. elegantissima* and *Z. stevensonii* have acute tips. The eophylls of *Z. stevensonii* are very conspicuous in morphology and emergent color. Most germlings have four eophyll leaflets; while most of those of *Z. elegantissima* have six (quite a few may have four). There is a molecular biology study under way to help restructure a better systematic structure for Panamanian *Zamia* species in general and to serve as an additional source of data to help solve problems of synonymy in a few species.

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