

A new species of *Zamia* from Chocó, Colombia (Cycadales, Zamiaceae)

MICHAEL CALONJE¹, DENNIS STEVENSON², CLAUDIA CALONJE¹,
YAN ARLEY RAMOS³, AND ANDERS LINDSTROM²

¹ Author for correspondence: Montgomery Botanical Center, 11901 Old Cutler Road, Miami, FL 33156, U.S.A.; e-mail: michaelc@montgomerybotanical.org

² The New York Botanical Garden, Bronx, NY 10458-5126, U.S.A.

³ Universidad Tecnológica del Chocó, Herbario CHOCO, Grupo de Investigación de la Flora Chocoana, Quibdó, Chocó, Colombia.

Abstract. *Zamia pyrophylla*, a new species from Chocó, Colombia, is described and illustrated. It is compared to *Z. amazonum*, *Z. cunaria*, and *Z. ipetiensis*. It is distinguished by its bright orange and red emerging leaves with leaflets that progressively turn green from the apex to the base as they mature, petioles with branched prickles and with ferruginous pubescence when immature, villous strobilar axes, and adaxial microsporangia.

Key Words: cycad, Chocó, *Zamia*.

Stevenson (2001) recognized 18 species of cycads in Colombia, 16 of these included in the genus *Zamia* L., and two in the endemic genus *Chigua* D. W. Stev. Calderón-Sáenz and Stevenson (2003) subsequently described *Zamia oligodonta*, bringing the total of recognized species in Colombia to 19. Six of these species (*Z. amplifolia* W. Bull. ex. Mast., *Z. chigua* Seem., *Z. disodon* D.W. Stev. & Sabato, *Z. obliqua* A. Braun, and *Z. roezlii* Linden) occur in the Chocó biogeographic region of Colombia. This region stretches across the entire Pacific coast of Colombia, including parts of the Departments of Chocó, Valle del Cauca, Cauca, Risaralda, Antioquia, Córdoba, and Nariño and is considered one of the most biologically diverse areas on the planet. In addition to the species noted above, Stevenson (2001) also listed three *Zamia* collections made in Chocó (*Bernal et al.* 1090, COL; *Juncosa* 1721, JAUM, MO, NY; *Santa et al.* 1149, HUA.) under specimens examined for *Zamia amazonum* D. W. Stev., noting that the material differed somewhat from the typical material and suggesting that further research would be necessary to confirm whether this material represented a different species.

A research expedition led by the CHOCO herbarium of the Universidad Tecnológica del Chocó in Quibdó in collaboration with Montgomery Botanical Center (Miami, Florida) took place in March of 2009 with the purpose of gaining a better understanding of this relatively unknown *Zamia* from the Chocó. Close examination of several hundred plants across five different populations, including fertile plants with ovulate and pollen strobili, led us to the conclusion that this taxon represents a new species, formally described below.

Zamia pyrophylla Calonje, D.W. Stev. & A. Lindstr. sp. nov. Type: Colombia. Chocó: Mun. Quibdó, 60–100m, *Calonje et al.* COL09–014 (holotype: CHOCO; isotypes: COL, CHOCO, CUVC, HUA). (Figs. 1, 2)

Zamia cunaria D. W. Stev. simulans, sed marginibus foliolii integerrimis et apice megasporophylli sterilis longate differt.

Stem hypogeous, rarely branching, globose to cylindrical, to 10 cm or more in diameter. *Cataphylls* chartaceous, triangular to narrowly



FIG. 1. Vegetative features of *Zamia pyrophylla*. **A.** Seedling with eophyll and apogeotropic roots. **B.** Side view of characteristic leaf. **C.** Frontal view of emergent leaf. **D.** Cataphylls. **E.** Median leaflet. **F.** Caudex of juvenile plant. All photographs taken of plants from type locality (Calonje et al. COL09-014).

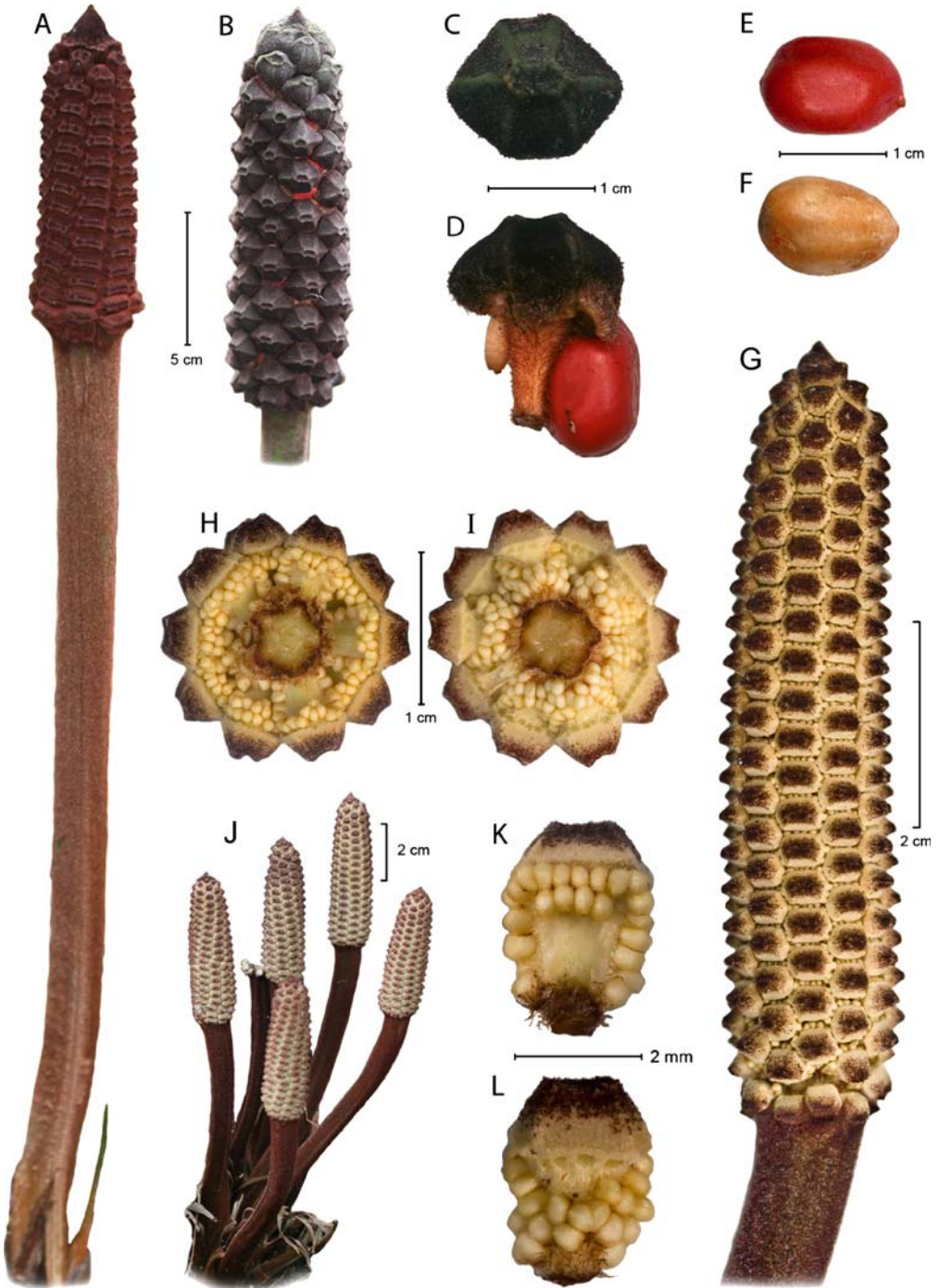


FIG. 2. Reproductive features of *Zamia pyrophylla*. **A.** Ovulate strobilus at near receptivity stage. **B.** Mature ovulate strobilus. **C.** Mature megasporophyll face, frontal view. **D.** Mature megasporophyll, abaxial view. **E.** Mature seed with sarcotesta. **F.** Sclerotesta of mature seed. **G.** Pollen strobilus at pollen shedding. **H.** Mature pollen strobilus cross-section, adaxial view. **I.** Mature pollen strobilus cross-section, abaxial view. **J.** Juvenile pollen strobili. **K.** Microsporophyll, adaxial view. **L.** Microsporophyll, abaxial view. All photographs taken of plants from type locality (Calonje et al. COL09-014).

triangular, to 8.5×3.0 cm, tan-tomentose with brown papyraceous wings. *Ptyxis* inflexed. *Leaves* 1–2, 1.1–3.4 m long; petioles 0.75–2.4 m long with abruptly swollen base to 4 cm wide, densely covered with stout, sometimes branching prickles to 5 mm long; rachis 0.3–1 m long, curved outward, with prickles in lower half, petiole and rachis brown tomentose when emerging, gradually becoming glabrous. *Leaflets* 8–16 pairs, chartaceous to coriaceous, median ones 2–5.8 cm apart, insertion on rachis 6–10 mm wide, lanceolate to oblanceolate and straight to slightly falcate, alternate to subopposite, apex acute to acuminate, margins entire, basal leaflets $28\text{--}51 \times 2.2\text{--}7.2$ cm; median leaflets $24.5\text{--}55 \times 4\text{--}7.1$ cm; apical leaflets $19\text{--}34.5 \times 2.1\text{--}6.6$ cm wide, maroon at emergence, turning to orange or reddish tones, and gradually turning green from the leaflet apex to the base as they mature. *Eophylls* with unarmed petioles 19–25 cm long, rachis to 1 cm long, typically carrying four leaflets $6.1\text{--}6.5 \times 1.7\text{--}2.2$ cm. *Pollen strobili* conical-cylindrical, erect or slightly spreading, 5–15 +, at pollen shedding $7.1\text{--}8.1 \times 1.5\text{--}1.7$ cm, strobilar axis and proximal section of microsporophyll villos with mixed white and rust-brown hairs, peduncles tomentose, emerging white to cream and maturing maroon to brown, $14\text{--}25 \times 0.8\text{--}1$ cm, microsporophylls spirally arranged in 8–10 orthostichies of 13–20 sporophylls each, obtrullate, $5.9\text{--}6.3 \times 3.5\text{--}4.3$ mm at pollen shedding, sterile apex encompassing 1/4 to 1/2 of total length of a microsporophyll, tomentose, tan to cream colored in proximal half, speckled maroon to brown in distal half, face hexagonal to oblong hexagonal, $2.7\text{--}3 \times 3.5\text{--}4$ mm, extruded downward to a narrow horizontal facet, abaxial side of microsporophyll with 15–20 microsporangia limited to the proximal half and along the margins, adaxial side with 12–15 microsporangia limited to the distal half. *Ovulate strobili* cylindrical, typically solitary but up to 3 per crown, erect at maturity, $8\text{--}15.5 \times 4\text{--}4.5$ cm, sterile apex 0.5–4 cm and acute to acuminate, strobilus axis villous with mixed rust-brown and white hairs, peduncles $15\text{--}50 \times 1.2\text{--}2.7$ cm, emerging white to cream tomentose, progressing maroon to brown tomentose, at maturity appearing green due to loss of tomentum, megasporophylls in 7–10 orthostichies of 5–11 sporophylls each, stalk 8–10 mm long, villos with mixed rust-brown

and white hairs, sterile apex 19–20 mm deep with hexagonal to oblong-hexagonal distal face $12.5\text{--}13.2 \times 15.5\text{--}16.2$ mm, extruded to a small, depressed terminal facet $2.5\text{--}3.4 \times 5.7\text{--}6.3$ mm, megasporophyll face tomentose, burnt amber in new strobili, rust colored when near receptivity, at maturity black with some exposed areas glabrous green. Seeds ovoid, $10\text{--}15.6 \text{ mm} \times 9.5\text{--}13.2$ mm, sarcotesta red and fleshy, eventually becoming evenly papyraceous at maturity.

Distribution and habitat.—This species is known only from the Atrato Valley in the Municipalities of Quibdó and Atrato, Chocó. It occurs in tropical rainforest at elevations between 10–100 m. Because it has a subterranean stem, it is able to survive initial forest clearing and can thrive and produce strobili while growing in full sun in pastures if left undisturbed. Plants were frequently observed with emergent new leaves in recently cleared fields, but were absent from older clearings, suggesting the plants may not be able to survive repeated leaf excision from pasture clearing.

The area near Quibdó is one of the wettest on earth, with an average annual precipitation of 8558 mm (West, 1957). The drier season occurs from January through March with February being the driest month, and the rainy season occurs April through December, with August being the wettest month. The temperature averages 28°C and ranges from 15°C to 41°C (Forero, 1982).

Reproductive phenology.—Very little is known about the reproductive phenology of this species. All herbarium specimens examined prior to our March 2009 expedition were sterile with no mention of reproductive structures in the label notes. During this expedition, we were fortunate to observe both seed and pollen strobili at all stages of maturity. Further research is required in order to determine whether there is any periodicity in the timing of the reproductive events of this species.

Ecology.—Larvae of a species of *Eumaeus* Hübner were observed feeding on emergent *Zamia* leaves and live butterflies were observed laying eggs on new leaves and emergent pollen strobili. Pollen strobili at pollen release stage were observed harboring numerous clavicorn beetles of the genus

Pharaxonotha Reitt., known pollinators of other *Zamia* species (Vovides, 1991; Tang, 1987; Stevenson et al., 1998).

Etymology.—The specific epithet refers to the glowing orange and red emergent leaves, which progressively turn green from the apex to the base, giving them a fiery appearance.

Conservation status.—This species has been collected only in an area covering approximately 25 km² in the Municipalities of Quibdó and Atrato. It is quite common at some localities, and evidence of seedling establishment was observed in forested areas. However, it is directly threatened by agricultural expansion and other habitat transformations. Based on its poorly known but currently restricted extent of occurrence and area of occupancy, this species should be listed as Critically Endangered (CR) based on IUCN Red List criteria B1b+2b (IUCN, 2001). Additional field work is necessary to determine the geographic range and abundance for this species.

Additional specimens examined. COLOMBIA.

Chocó: Bernal et al. 1090 (CHOCO, COL, FTG, NY); Municipio del Atrato, 80–90m, Calonje et al. COL09–001 (CHOCO, COL); Municipio de Quibdó, 80–100m, Calonje et al. COL09–021 (CHOCO); Kress & Echeverry 89–2571 (CHOCO); Santa et al. 1149 (HUA).

Collections made 100 km NW of Quibdó (*Juncosa* 1721, CHOCO, JAUM, MO, NY) differ from the type material in having leaflets with toothed margins at the distal end. In addition, the specimen label mentions that leaves of adult plants typically carry 4 leaflet pairs, whereas *Z. pyrophylla* typically carries 8–16. Further field work is required to determine if these collections represent this species or a different one.

Zamia pyrophylla most closely resembles *Zamia cunaria* D.W. Stev. and *Zamia ipetiensis* D.W. Stev. from adjacent Panama. All three species typically carry one leaf at a time, have subterranean stems, small seeds with a paper-thin sarcotesta, microsporangia present on both the abaxial and adaxial surfaces of microsporophylls, villous axes in both the pollen and ovulate strobili, and seedlings that produce long apogeotropic roots. *Zamia pyrophylla* is easily differentiated from the Panamanian species as it has leaflets with entire margins whereas the other

two species have margins that are distinctly toothed on the upper half. The petiole and rachis of *Z. pyrophylla* is densely covered with a ferruginous pubescence on young leaves and have branched prickles, whereas those of *Z. cunaria* and *Z. ipetiensis* are lightly covered with a white pubescence and have unbranched prickles. The microsporophylls of *Z. cunaria* and *Z. ipetiensis* are a uniform tan or cream color at pollen shed, whereas those of *Z. pyrophylla* are tan or cream colored on the proximal half of the sterile apex turning to maroon or brown on the distal half. The ovulate strobili of *Z. pyrophylla* typically has an acute or acuminate apex, and megasporophyll faces that are strongly extruded outward, whereas the strobili of *Z. cunaria* and *Z. ipetiensis* typically have obtuse apices and megasporophyll faces that are more or less flat or only slightly extruded. Finally, *Z. pyrophylla* has leaves attaining a maximum length of 3.4 m long, compared to those of *Z. cunaria* which reach 2.5 m in length, and those of *Z. ipetiensis*, which attain a maximum of 1.7 m in length (Alberto Taylor, pers. comm.).

Early collections of this species were discussed under *Zamia amazonum* by Stevenson (2001), who noted that additional research would be necessary to understand whether the taxon collected in Chocó belonged to a different species. *Zamia amazonum* and *Z. pyrophylla* both have hypogeous stems, carry few leaves at a time, leaflets with entire margins, densely tomentose petioles and rachises on young leaves, and stout, occasional branched prickles on the petiole. However, *Zamia amazonum* can be differentiated from *Z. pyrophylla* because it carries 2–6 leaves with up to 30 leaflet pairs, has glabrous strobilar rachises, and no microsporangia on the adaxial surface of the microsporophylls, whereas *Z. pyrophylla* carries 1–2 leaves with up to 18 leaflet pairs, has villous strobilar axes, and microsporangia present on the adaxial surface of the microsporophylls.

Villous strobilar axes are a rare feature in *Zamia*, only observed by the authors in *Z. pyrophylla*, *Z. cunaria*, and *Z. ipetiensis*. The presence of microsporangia on the adaxial surface of the microsporophylls is also uncommon, occurring in only eight of 68 recognized species of *Zamia*, namely *Z. cunaria*, *Z. encephalartoides* D.W. Stev., *Z. fairchildiana* L.D. Gómez, *Z. pyrophylla*, *Z. hymenophyllidia*

D.W. Stev., *Z. melanorrhachis* D.W. Stev., *Z. obliqua* A. Braun, and *Z. pseudomonticola* L.D. Gómez.

The bright orange and red-emergent leaflets that turn green from the apex to the base as they mature are a unique feature of *Z. pyrophylla*. In contrast, plants of *Zamia amazonum* have brown-emergent leaflets that turn green from the base to the apex, whereas *Zamia cunaria* and *Z. ipetiensis* typically have green emergent leaflets and occasionally brown-emergent leaflets that turn green from the apex to the base. Most species of *Zamia* with brown-emergent leaves have leaflets that either gradually and evenly turn green or do so from the base to the apex.

For the time being, the relationship of *Zamia pyrophylla* to other species of *Zamia* is enigmatic. However, research into a combined analysis of molecular and morphological data that is now in progress should elucidate the species relationships within *Zamia* and in turn lead to a better understanding of their historical biogeography.

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