

# Cycad

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## Zamia lindenii

### Taxonomy, Nomenclature, Biogeography, Morphology, Ecology, Ethnobotany, and Conservation Status of *Zamia lindenii* Regel ex André

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#### Introduction

Although *Zamia lindenii* Regel ex André was described in 1875, the name has been considered a synonym of *Z. poeppigiana* Mart. & Eichler by most recent authors. It was again elevated to specific status in 2009, but the distinctness of the species was not presented in detail at the time. This paper examines the available data and presents a more detailed framework for the species.

#### Etymology

The specific epithet honors Jean Jules Linden who cultivated the living material first collected by Benedict Roezl in Ecuador and who donated living material to the Royal Botanic Garden, Kew, in 1875. Linden (born 12 February 1817 in Luxembourg - died 12 January 1898 in Brussels) was a Belgian botanist and explorer, horticulturist and businessman, specializing in orchids, on which he wrote a number of books. Roezl (born 13 August 1824 in Prague - died 14 October 1885 in Prague) was a renowned Czech explorer, gardener, and botanist.

#### Taxonomy and Nomenclature

André (1875) stated in his type description that the species was described from living material cultivated by Linden: "*E sylvis Ecuadorensibus in hort. Linden a cl. Roezl Allata, anno 1874.*" Linden's donated material at Kew was used by André to create the illustration published in the type description and was later vouchered at Kew in 1880. In 1876 Regel reassigned the species to his new genus *Aulacophyllum* as *A. lindenii* (Regel ex André); this genus was later synonymized back into *Zamia*.

The specimen at Kew is undoubtedly material from the original cultivated plant but has no status as a type because it was collected five years after publication of the original description. In the absence of other original material, Stevenson & Sabato (1986) designated the drawing, Planche 195, in André's description as a

lectotype. Stevenson (2001) later stated that the type specimen of *Z. poeppigiana* and the *Z. lindenii* lectotype designated by Stevenson & Sabato (1986) were conspecific. Consequently, he considered *Z. lindenii* a synonym of *Z. poeppigiana*. This drawing, however, is very sketchy, and could represent a number of *Zamia* species. The voucher specimen at Kew is very likely most representative of the name as originally intended, and I consider *Z. lindenii* and *Z. poeppigiana* distinct species.

#### Biogeography

*Zamia lindenii* is known from the coastal plains and foothills of the Cordillera Occidental in Ecuador and possibly in extreme southwestern Colombia, whereas *Z. poeppigiana* is endemic to Peru. The two species are geographically and genetically isolated by the Andes. Recently collected fertile material of *Z. poeppigiana* from Amazonian Peru and *Z. lindenii* from Ecuador shows that some morphological differences exist between the two. The flattened, oblong seed shape of *Z. poeppigiana* is only shared within *Zamia* by one other unrelated species, *Z. encephalartoides* D.W. Stev. The seeds of

*Z. lindenii* are rounded and oval in shape, as are those of all other known species of *Zamia*. Ovulate strobili are pendant in *Z. lindenii* but not so in Peruvian *Z. poeppigiana*, and Peruvian material shows overall shorter pinnae length and stiffness compared to the long, often lax and drooping habit of Ecuadorian plants. Therefore, I consider *Z. lindenii* and *Z. poeppigiana* specifically distinct, but closely related and fairly recently evolved, being geographically separated by the high Andes.

#### Morphology

##### Morphological Description

Stem arborescent, to 80-1.60 m tall and 21 cm diam. Cataphylls paperaceous, cuneate basally and acuminate apically, often with single stipules on upper part of cataphyll, not at apex to 2 cm wide and 11 cm long. Leaves 14-28, 145-318 cm long; petiole with numerous small prickles, 44-83 cm long, dense rufous tomentose; rachis with prickles in lower half, dense rufous tomentose when emerging. Pinnae 25-56, sometimes paired in upper half; long-lanceolate, falcate basally only, acuminate to acute



Lectotype of *Zamia lindenii*  
(Photo by Anders Lindström)



Herbarium specimen of *Zamia lindenii*  
(Photo by Anders Lindström)

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apically, sometimes oblique, sometimes overlapping, 2.7-4.5 cm apart; median pinnae 33-49 cm long, 3.3-4.3 cm wide, attachment 5-7 mm wide; margins with 7-13 teeth above, 5-10 below, 2 mm long, strongly spinulose in upper third with serration up to 75% of pinnae length, apical spine 1.5-4.5 cm long; at least one population with pink newly emergent leaves. Microsporangiate strobili 3-6, sequential, beige to brown; erect at first, later leaning, stiff even when shedding pollen; long cylindrical, 25-38 cm long, 3-5 cm diam.; sterile apex short, slightly pointed, 10 mm tall, 10 mm in diam., distinct 2-3 mm pointed tip; peduncle 15-18 cm long, 15-19 mm wide, dense brown tomentose. Microsporophylls in 21-22 orthostichies (rows) with 29-30 in each; stiff, distinctly separated by 3-4 mm, alternated arranged; 14-16 mm long, sterile tip 6-7 mm long, 8-9 mm wide; pedicel 2 mm long, 3 mm wide, tomentose, cream colored; composed of six steeply inclined facets surrounding a central depressed terminal facet 3 mm high, 2 mm wide. Microsporangia 10-12, distributed abaxially (adaxial side lacking microsporangia), spreading to the edges, separated by a sterile area. Megasporangiate strobili 1-5, pendent, dense cream to brown tomentose, cylindrical, 28-42 cm long, 9-10 cm diam.; sterile apex blunt, indistinct, 4-5 mm high, 9-10 mm wide at base; peduncle dark green with tuberculate protrusion, covered in cream to whitish tomentum, round to sometimes slightly angled, 18-23 cm long, 3.5-4 cm wide. Megasporophylls velvety brown tomentose, distinct abaxial and adaxial lateral lobes partly covering ovules, median lobe triangular on adaxial side, seminal ridge and sagittal crest irregular, in 13-15 orthostichies with 14-19 megasporophylls in each; facets distinctly truncate-pyramidal, velvety brown tomentose, 30-35 mm wide, 20-25 mm high; sporophyll 35-40 mm long, 30-35 mm wide, pedicel 20-25 mm long, ivory white, distinct light brown tomentose at base, extending half the length of the pedicel following the center ridge; strobili axes cream with distinct light brown tomentum. Seeds red; sarcotesta, ovoid, flattened, rounded at apex, pointed

at attachment, 22-25 mm long, 15-18 mm wide, 10-14 mm high. Chromosome number  $2n = 16$  (Moretti, 1990; Norstog, 1997); differs from the genus *Ceratozamia* only by a pair of submetacentrics vs. a pair of metacentrics (Moretti, 1990).

**Distinguishing Characteristics**

The pendant female cone, with smaller, smooth, oval seeds and the light green newly-emergent leaves and later semi-glossy pinnae distinguish this species from *Zamia poeppigiana*, which undoubtedly is the closest related species. *Zamia lindenii* also often has drooping pinnae on a widely spreading crown of leaves. The depth of the median lobe on the female sporophyll is much deeper than *Z. poeppigiana*, which has a flatter facet and less depth. Female cones of *Z. lindenii* have very distinct brownish-yellow tomentum on both the central axis and the pedicels of the sporophylls, a character only seen in very few other *Zamia* species and not observed in the rather limited fresh and dried cone material of *Z. poeppigiana*. Table I presents a concise summary of the diagnostic traits of both species.

**Ecology**

**Habitat**

The habitat of *Zamia lindenii* ranges from semi-open seasonal (transitional)

evergreen rainforest to evergreen rainforest, sometimes with a thick humus cover overlaying brown clay soil. Plants often grow near streams or on flat or sloping terrain at altitudes of 50-315 m (150-1,000 ft). The associated flora is dominated by Rubiaceae, Moraceae, and Faboideae. Associated species include *Casseea* sp. (Flacortiaceae), *Swartzia litley* (Fabidaea), *Inga* sp., *Tetropolis* sp., *Chamandorea linearis*, *Phytelephas equatorialis*, *Bactris* sp., *Heliconia latispatha*, *Heliconia* sp., and *Costus* sp. (Costaceae). Average rainfall is 1,400-3,500 mm (55-135 in) annually, mostly during May to November.

**Pollinators**

Although apparently not yet collected and scientifically identified, the male



*Zamia lindenii* in habitat in Ecuador (Photo by Anders Lindström)



Drooping leaflets of *Zamia lindenii* in habitat in Ecuador (Photo by Anders Lindström)

Table I. Comparison between morphological features of *Zamia lindenii* and *Z. poeppigiana*

<i>Zamia lindenii</i>	<i>Zamia poeppigiana</i>
Crown widely spreading	Crown held fully erect
Female cone pendent	Female cone erect
Cone axis and pedicels tomentose	Cone axis and pedicels glabrous
Megasporophyll facets distinctly truncate-pyramidal	Megasporophyll facets flat
Megasporophyll median lobe 20-25 mm high, 30-35 mm wide	Megasporophyll median lobe 12-15 mm high, 25-30 mm wide
Emergent leaves light green, sometimes pink	Emergent leaves medium green
Seeds small (22-25 mm long), smooth, oval	Seeds large (33-35 mm long), edged, oblong
Median leaflets semi-glossy, lax, often drooping	Median leaflets highly glossy, stiff, flat

cones are said to contain numerous small beetles, but apparently not snout weevils (Whitelock, 2002). At pollen shedding the male cones produce a fetid smell reminiscent of humus.

Dispersal Agents

Seedlings are usually not associated with tree roots or crevices as in mice or rat dispersal. Seedlings with still attached seeds were found at a depth of approximately 10 cm (4 in) in sloping terrain usually away from the streams or river. This combined pattern suggests a ground-dwelling, burrowing animal as the dispersal agent—most likely the Central American Agouti (*Dasyprocta punctata*), which has been recorded in the area and which is the only large rodent known to exist within the distribution of the cycad.

Predators

Larvae of a small butterfly of the genus *Eumaeus* (Lepidoptera: Eumaeinae) commonly predate juvenile leaves. In deforested situations, some plants were found to be completely defoliated.

Phenology

Unlike *Zamia obliqua* and a few other rainforest *Zamia*, this species reaches sexual maturity with only 25-30 cm (10-12 in) trunk, although the species ultimately produces a tall, arborescent trunk. A female that coned in 2001 was not coning in 2002 in the habitat. Females often produce multiple (up to 5) large cones that can yield as many as 410 seeds/cone. The species has a slow seed maturation of up to 13 months. Males cone annually



Comparison of megasporophylls of *Zamia lindenii* and *Z. poeppigiana*; (left) deep median lobe and distinct pedicel tomentum of *Z. lindenii*; (right) *Z. poeppigiana* megasporophylls showing flat facets and shallow median lobes (photos by Anders Lindström)



Comparison of mature pendent female cones of *Zamia lindenii* (left) and the erect cones of *Z. poeppigiana* (right) (photo by Anders Lindström)



Views of open mature male cones of *Zamia lindenii* with microsporangia visible (photos by Craig Nazor)

with multiple (3-6) cones maturing in sequence.

#### Ethnobotany

*Zamia lindenii* is known as *palma de goma* (glue palm) by locals in Esmeraldas, Ecuador, and the sap is used as a water-soluble glue. Seeds are also ground and used as food.

#### Conservation Status

Because *Zamia lindenii* has previously been treated as a synonym of *Z. poeppigiana*, it has never been included in the IUCN Red List. However, *Z. poeppigiana* (with *Z. lindenii* as a synonym) was given a Near Threatened status in both 2003 and 2009. The Near Threatened status should be the correct designation for *Z. lindenii* based on the following assessment rationale.

Once considered a common plant of the lowland seasonal rainforest, it is now only present in widely scattered populations in degraded habitats. Even though several populations have recently been completely eradicated by deforestation, this species seems to tolerate habitat destruction and deforestation to some extent, and mature coning and reproducing plants were found in full sun in cultivated or severely disturbed secondary forest close to villages. Still existing within protected areas of a few research forest stations, no populations are, however, known to exist within officially designated protected areas. Over 30 populations have been recorded (data from herbaria), and the total area of occurrence is estimated to be as large as 93,735 km<sup>2</sup>. Population size is estimated to be between 5,000-8,000 plants.

No specific demographic data is available on this species, but population studies of other *Zamia* species suggest that some may reach maturity within ten years and have a life history with high recruitment and low persistence of adults (generation time ca. 30 years). Growth is slow, as the species must produce at least 30 cm of stem before coning, and reproduction has been shown to be infrequent, as seems to be the rule-of-thumb for rainforest cycads. These bits of information taken together suggest a generation span for this species in the range of >50 years.

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### Growing *Zamia lindenii* in Hawaii

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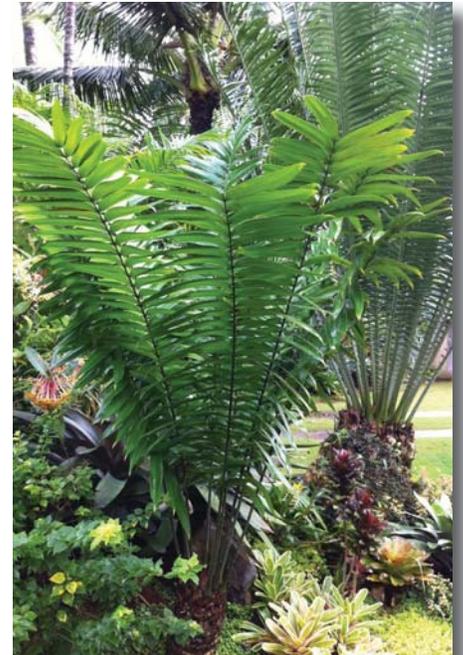
*Zamia lindenii* is an easy-to-grow species in Hawaii, but as in all cycads, it takes time to form a large trunk. I have seen two- to three-foot trunks form in 20 years. The toughest part of growing these is controlling the leaf spotting in the first two years. Most forest zamias, including *Z. lindenii*, undergo mycorrhizal inoculation at an early age, and Heritage fungicide can be used to control the leaf spotting.

A nice, rich blend of compost and live soil will help growth. At two to three years old, put these in the ground for best performance and growth. Coning starts as early as ten years at about a 10-inch diameter caudex for males and 12-inch caudex for females. This is one of the largest of the zamias in girth, smaller only than *Zamia roezlii*. These can get an 18-inch diameter trunk. Many people have seen our larger plants here in Hawaii and thought they were *Encephalartos* because of their size and their female cones, which become procumbent as they mature.

These make great landscape plants in subtropical to tropical conditions. As small plants, they do better in some shade, but as they get bigger they can handle full sun in tropical settings. What I like about this species over the larger *Zamia roezlii* is the fact that the leaves emerge and remain upright until the next leaf flush, allowing this large cycad to take up less room in the garden when trimmed to a single flush.

This cycad is for tropical and subtropical areas and enjoys rich soils with living, healthy soils. They rarely have any problems with peat in the soil, and the fungal leaf spot issues seem to disappear once they start flushing multiple large leaves. The only other problem is if you are in a windy area and a new flush emerges. One

needs to be careful to cut away anything that may rub up against the newly emerging leaves until they are hardened off.



Eight-year-old cultivated plant of *Zamia lindenii* in Hawaii



Receptive female cone of *Zamia lindenii* cultivated plant in Hawaii

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