

An endangered new catfish species of the genus *Cambeva* (*Cambeva gamabelardense* n. sp.) (Siluriformes, Trichomycteridae) from the Rio Chapecó drainage, southern Brazil

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Abstract

An endangered new catfish species of the genus *Cambeva* (*Cambeva gamabelardense* n. sp.) (Siluriformes, Trichomycteridae) from the Rio Chapecó drainage, southern Brazil. Numerous species in fast-flowing streams of southern Brazil have not been described to date. As some of these species inhabit areas under pressure due to the ongoing, intense process of environmental degradation, formal descriptions are urgently needed so as to elaborate strategies for their conservation. We describe a new species, *Cambeva gamabelardense* n. sp., found in the middle Rio Chapecó drainage, Uruguay River basin, in an area where intense deforestation and soya plantation is endangering fish species. The new species is considered closely related to *C. panthera*, a species occurring in an isolated coastal basin about 380 km from the area inhabited by the new species, as the two species share a unique jaguar-like pattern on the flank. The new species differs from *C. panthera* by having shorter barbels, a different position of the origin of the dorsal-fin, more vertebrae, and osteological features that are unique among congeners.

Key words: *Cambeva gamabelardense* n. sp., Comparative morphology, Mountain biodiversity, Osteology, Uruguay River basin

Resumen

Una nueva especie de bagre en peligro de extinción del género *Cambeva* (*Cambeva gamabelardense* sp. n.) (Siluriformes, Trichomycteridae) en la cuenca hidrográfica del río Chapecó, en el sur del Brasil. Se ha registrado una gran diversidad de especies no descritas para las corrientes rápidas del sur de Brasil, algunas de las cuales habitan zonas sometidas a un intenso proceso de degradación ambiental, lo que hace que sea urgente describir estas especies formalmente como primer paso para elaborar estrategias de conservación. La nueva especie descrita aquí, *Cambeva gamabelardense* sp. n., fue encontrada en el tramo medio del río Chapecó, en la cuenca del río Uruguay, en una zona sometida a una intensa deforestación y al cultivo de soja, lo que pone a las especies piscícolas en riesgo de extinción. Se considera que la nueva especie está estrechamente relacionada con *C. panthera*, que se encuentra en una cuenca costera aislada, a unos 380 km de la zona habitada por la nueva especie, ya que ambas especies comparten un patrón de color similar al del jaguar en el flanco. La nueva especie se diferencia de *C. panthera* en que tiene barbillas más cortas, una posición relativa diferente del origen de la aleta dorsal y más vértebras, además de tener características osteológicas únicas entre sus congéneres.

Palabras clave: *Cambeva gamabelardense* sp. n., Morfología comparada, Biodiversidad en zonas montañosas, Osteología, Cuenca del río Uruguay

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Introduction

The fast-flowing streams draining mountain ranges of south-eastern and southern Brazil support a great diversity of trichomycterine catfishes (Costa, 2021; Costa et al., 2021a, 2021b). Trichomycterines comprise the most diverse subfamily of the Trichomycteridae (i.e. Trichomycterinae), and over 260 species are found in most mountain river drainages of South America (Katz et al., 2018; Costa et al., 2021b). However, the rich diversity of trichomycterines in the upper-middle Rio Uruguai basin, Santa Catarina State, has only recently been revealed. Eight species of the genus *Cambeva* Katz, Barbosa, Mattos and Costa, 2018, endemic to this wide region, have been described in the last two years (Costa et al., 2020a, 2021b, 2022). Field studies have also shown the increasingly intense process of environmental degradation in the river drainages of the region, supporting the urgent need for descriptions of new species as a first step to elaborate strategies for their conservation.

We recently reported two new species from the middle section of the Rio Chapecó drainage, middle Rio Uruguai basin, that share a peculiar morphology (Costa et al., 2022). These species were collected during two expeditions (15 VII 2020 and 20 III 2021) to an inner plateau, about 640–900 m a.s.l. A single small specimen of a third, as yet non-described species, was collected in the second expedition. These species are endangered by the severe impact of intense deforestation and soya plantations (Costa et al., 2022). During a third expedition (5 VIII 2021), new specimens of this third species were collected. The objectives of this paper are to formally describe this new species and provide new data on environment factors threatening its survival.

Material and methods

Morphometric and meristic data were taken following Costa (1992), with modifications proposed by Costa et al. (2020b). Measurements are presented as percent of standard length (SL) except for those related to head morphology which are expressed as percent of head length. Fin-ray counts include all elements and are expressed in lower case Roman numerals for procurrent unsegmented unbranched rays of unpaired fins, upper case Roman numerals for segmented unbranched rays of any fin, and Arabic numerals for segmented branched rays of any fin (Bockmann et al., 2004; Costa et al., 2020b). Vertebra counts include all vertebrae except those participating in the Weberian apparatus, with the compound caudal centrum counted as a single element. Specimens were cleared and stained (C and S in list of specimens) for bone and cartilage following Taylor and Van Dyke (1985). In addition to morphological characters commonly used in taxonomical studies on trichomycterines, descriptions include some osteological structures that have informative variability for diagnosing species of *Cambeva* (Costa et al., 2020b, 2021a), including the mesethmoidal and cheek regions and the parurohyal morphology. Terminology for bones followed Costa (2021). Osteological illustrations were

made using a stereomicroscope Zeiss Stemi SV 6 with camera lucida. Cephalic laterosensory system terminology follows Arratia and Huaquin (1995), with modifications proposed by Bockmann et al. (2004). Comparative material is listed in Costa (2021), with the addition of *Cambeva balios* (Ferrer and Malabarba, 2013) (UFRJ 7024, 2 C and S), *Cambeva perkoso* (Datovo, Carvalho and Ferrer, 2012) (UFRJ 7025, 3 C and S), and *Cambeva tropeira* Ferrer and Malabarba, 2011) (UFRJ 6935, 2 C and S), besides specimens of congeners described more recently (Costa et al., 2021a, 2021b). Geographical names follow Portuguese terms used in the region. The material is deposited in the ichthyological collection of the Institute of Biology of the Federal University of Rio de Janeiro, Rio de Janeiro city, Brazil (UFRJ), and the ichthyological collection of the Centre of Agrarian and Environmental Sciences, Federal University of Maranhão, Campus Chapadinha, Brazil (CICCAA).

Results

Phylum Chordata Haeckel, 1874
 Class Actinopterygii Klein, 1885
 Order Siluriformes Cuvier, 1817
 Family Trichomycteridae Bleeker, 1858

Cambeva gamabelardense n. sp. (figs. 1–2)
 ZooBank LSID: <http://zoobank.org/NomenclaturalActs/03ED64B-4EBD-4C1C-80EA-52B25F781730>

Holotype

UFRJ 7003, 107.2 mm SL; Brazil: Santa Catarina State: Abelardo Luz Municipality: stream tributary to the middle section of the Rio Chapecó, close to Parque Quedas do Chapecó, Rio Uruguai basin, 26° 33' 06" S 52° 19' 17" W, about 755 m a.s.l.; C. R. M. Feltrin, 5 VIII 2021.

Paratypes

All from Brazil: Santa Catarina State: Abelardo Luz Municipality: middle Rio Chapecó drainage, Rio Uruguai basin: UFRJ 7004, 7, 35.4–111.2 mm SL; UFRJ 7005, 4 (C and S), 43.7–72.3 mm SL; CICCAA 02713, 3, 48.3–71.7 mm SL; all collected with holotype. UFRJ 7017, 5, 28.8–40.9 mm SL; stream tributary to Rio Nova Aurora, 26° 28' 15" S 52° 20' 12" W, about 860 m a.s.l.; C.R.M. Feltrin, 5 VIII 2021.

Diagnosis

Cambeva gamabelardense is distinguished from all other congeners, except *C. panthera* Costa, Feltrin and Katz, 2021, by having a jaguar-like colour pattern on the flank, consisting of irregularly shaped pale brown spots of variable size and shape, with their margins overlapped by small dark brown spots (fig. 1; vs. never a similar colour pattern). *Cambeva gamabelardense* differs from *C. panthera* by having shorter barbels, with the tip of the maxillary and rictal barbels reaching the middle portion of the interopercular patch of odontodes (vs. the tip of the maxillary barbel reaching the middle of the pectoral-fin base



Fig. 1. *Cambeva gamabelardense* n. sp., holotype, UFRJ 7003, 107.2 mm SL: A, lateral view; B, dorsal view; C, ventral view.

Fig. 1. *Cambeva gamabelardense* sp. n., holotipo, UFRJ 7003, 107,2 mm SL: A, vista lateral; B, vista dorsal; C, vista ventral.

and the tip of the rictal barbel reaching between the interopercular patch of odontodes and the pectoral-fin base) and the tip of the nasal barbel reaching between the eye and the opercular patch of odontodes (vs. the tip of the nasal barbel reaching the middle of opercular patch of odontodes); the first pectoral-fin ray terminating in a rudimentary filament, weakly extending beyond the fin membrane (vs. filament about 10–15% of the pectoral-fin length); the posterior extremity of the pelvic fin at a vertical through the anterior portion of the dorsal-fin base (vs. middle portion); the dorsal-fin origin at a vertical through the centrum of the 20th or 21st vertebra (vs. through the centrum of the 18th or 19th vertebra); and 38 or 39 vertebrae (vs. 37). *Cambeva gamabelardense* differs from all other trichomycterines examined by its long metapterygoid, its horizontal length longer than the horizontal length of hyomandibula anterior outgrowth (fig. 2B; vs. shorter) and a small lateral projection on the lateral margin of the lateral ethmoid, just posterior to the articular facet for the autopalatine (fig. 2A; vs. absence of a similar projection).

Description

General morphology

Morphometric data are shown in table 1. Body moderately slender, subcylindrical anteriorly to com-

pressed posteriorly. Greatest body depth between pectoral and pelvic fins. Dorsal and ventral profiles of head and trunk slightly convex. Skin papillae minute. Anus and urogenital papilla at vertical just anterior to middle of dorsal-fin base. Head trapezoidal to sub-rectangular in dorsal view, anterior profile of snout slightly convex. Eye small, dorsally positioned on middle portion of head. Posterior nostril located nearer anterior nostril than orbital rim. Tip of maxillary and rictal barbels reaching middle portion of interopercular patch of odontodes; tip of nasal barbel reaching between eye and opercular patch of odontodes. Mouth subterminal. Jaw teeth arranged in irregular transverse rows, slightly curved, pointed in internal to incisiform in external rows, 40–43 on premaxilla, 41–44 on dentary. Branchial membrane attached to isthmus only at its anterior point, in ventral midline. Branchiostegal rays 8 or 9.

Dorsal and anal fins subtriangular, distal margin slightly convex; total dorsal-fin rays 11–12 (ii–iii + II + 7), total anal-fin rays 10 (iii + I–II + 5–6); anal-fin origin at vertical through posterior half of dorsal-fin base, base of first procurrent anal-fin ray in vertical through base of 6th principal dorsal-fin ray. Dorsal-fin origin at vertical through centrum of 20th or 21st vertebra; anal-fin origin at vertical through centrum of 24th or 25th vertebra. Pectoral

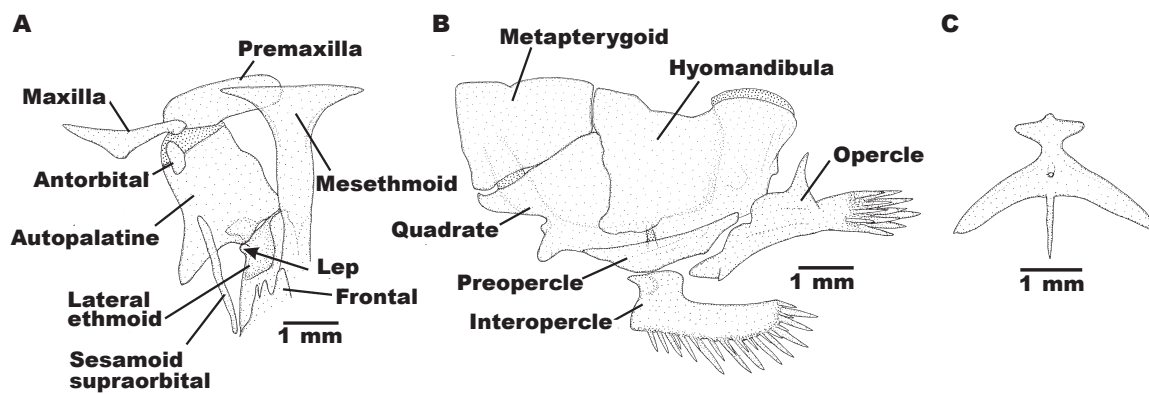


Fig. 2. Osteological features in *Cambeva gamabelardense* n. sp.: A, mesethmoidal region, middle and left portions, dorsal view; B, left suspensorium and opercular apparatus, lateral view; C, parurohyal, ventral view; Lep, lateral ethmoid projection. (Larger stippling represents cartilages).

Fig. 2. Características osteológicas de *Cambeva gamabelardense* sp. n.: A, vista dorsal de las porciones media e izquierda de la región mesetmoidal; B, vista lateral del suspensorio izquierdo y el aparato opercular; C, vista ventral del parurohial; Lep, proyección lateral del etmoides. (El punteado más claro representa los cartílagos).

fin subtriangular in dorsal view, posterior margin slightly convex, first pectoral-fin ray terminating in rudimentary filament, weakly extending beyond fin membrane; total pectoral-fin rays 7 (I + 6). Pelvic fin subtruncate, its extremity at vertical through anterior portion of dorsal-fin base; pelvic-fin bases medially in close proximity; total pelvic-fin rays 5 (I + 4). Caudal fin subtruncate, postero-dorsal and postero-ventral extremities slightly rounded; total principal caudal-fin rays 13 (I + 11 + I), total dorsal procurrent rays 22–23 (xxi–xxii + I), total ventral procurrent rays 14–15 (xiii–xiv + I). Vertebrae 38–39. Ribs 14–15. Two dorsal hypural plates, corresponding to hypurals 4 + 5 and 3, respectively; single ventral hypural plate corresponding to hypurals 1 and 2 and parhypural.

Supraorbital sensory canal continuous, connected to infraorbital sensory canal posteriorly. Supraorbital sensory canal with 3 pores: s1, adjacent to medial margin of anterior nostril; s3, adjacent to medial margin of posterior nostril; and s6, on middle part of dorsal surface of head, in transverse line just posterior to orbit; pore s6 slightly nearer orbit than its paired homologous pore. Anterior segment of infraorbital sensory canal absent; posterior segment with pore i10, adjacent to ventral margin of orbit, and pore i11, posterior to orbit. Postorbital canal with 2 pores: po1, at vertical line above posterior portion of interopercular patch of odontodes, and po2, at vertical line above posterior portion of opercular patch of odontodes. Lateral line of body short, with 2–3 pores, posterior-most pore at vertical just posterior to pectoral-fin base.

Mesethmoidal region (fig. 2A)

Mesethmoid robust, its anterior margin about straight; mesethmoid cornu subtriangular in dorsal

view, extremity pointed; narrow lateral flap on intersection between cornu and main bone axis. Small lateral projection on thickened lateral margin of lateral ethmoid, just posterior to articular facet for autopalatine. Antorbital thin, drop-shaped, short, slightly longer than wide; sesamoid supraorbital slender, its length about three or four times antorbital length. Premaxilla sub-trapezoidal in dorsal view, longer than maxilla. Maxilla boomerang-shaped, slender, slightly curved. Autopalatine sub-rectangular in dorsal view, broad, slightly longer than wide, with slightly sinuous medial margin and gently concave lateral margin; autopalatine posterolateral process subtriangular in dorsal view, short, its length about half the length of osseous portion of autopalatine, excluding postero-lateral process.

Cheek region (fig. 2B)

Metapterygoid thin, subtrapezoidal, large, its horizontal length longer than the horizontal length of the hyomandibula anterior outgrowth. Quadrate robust, dorsal process with constricted base and long posterior outgrowth, dorsoposterior margin in contact with the hyomandibula outgrowth. Hyomandibula relatively short, with well-developed anterior outgrowth, with weak to moderate dorsal concavity. Opercle relatively slender, opercular odontode patch depth shorter than dorsal hyomandibula articular facet, with 12 or 13 odontodes; odontodes pointed, straight to slightly curved, arranged in irregular transverse rows; dorsal process of opercle short; opercular articular facet for hyomandibula with small, rounded flat extension, articular facet for preopercle rounded, close to opercular facet. Interopercle moderate, about three fourths hyomandibula length, anterior margin slightly concave;

interopercular odontode patch with 25–28 pointed odontodes, arranged in irregular longitudinal rows. Preopercle compact, with short ventral extension.

Parurohyal (fig. 2C)

Robust, lateral process slender, tip slightly pointed, posterior margin slightly convex; parurohyal head well-developed, with prominent anterolateral paired process; middle foramen minute; posterior process long, its length about equal to distance between anterior margin of parurohyal and anterior insertion of lateral process.

Colouration in alcohol (fig. 1)

Flank and dorsum pale yellow; irregularly shaped pale brown spots of variable size and shape, irregularly arranged, smaller on ventral part of flank, with their margins overlapped by small dark brown spots, yielding jaguar-like pattern; similar marks but much smaller on dorsal and lateral surfaces of head. Dorsum with small black dots overlapping brown spots. Venter and ventral part of head yellowish white. Barbels pale brown. Fins pale grey to yellowish grey, with transverse rows of minute black dots, larger on distal portion of unpaired fins.

Distribution

Cambeva gamabelardense n. sp. is only known from the type locality area, in the upper Rio Chapecó drainage, Rio Uruguai basin, at altitudes between about 750 and 860 m a.s.l. (fig. 3).

Habitat

Cambeva gamabelardense n. sp. was commonly found below stones with small and medium size grain, diameter about 1–20 cm, with larger specimens above about 100 mm SL preferring larger stones, diameter about 45–70 cm. Some specimens however were also found below amphibious plants near banks, including excerpts with densely vegetated margins. A few small specimens were collected in a small tributary stream of the Rio Nova Aurora, demonstrating wide plasticity in using different habitats since in this latter location the substrate was clay, with a considerable contribution of organic matter from the riparian forest, and rhizomes and other fern structures along the bank of the stream.

Conservation

The area is highly affected by soy plantations as the municipality of Abelardo Luz is considered the national capital of soybean seed, producing 50 types of cultivars and representing approximately 50 tons/year. This agricultural activity in the area has severely reduced the extension of riparian forest, and measures required by law are frequently overlooked. Massive soy production has exacerbated the volume of siltation in rivers and especially in streams. In addition to silting, soy monoculture requires high loads of pesticides, which in turn affect the micro-basins in question. The Chapecó River has a high potential for hydroelectric power plants. Some stations have already been built and speculation into others is on-going. In short, natural habitats along the main

Table 1. Morphometric data of *Cambeva gamabelardense* n. sp.: H, holotype; P, paratypes (n = 10).

Tabla 1. Datos morfológicos de *Cambeva gamabelardense* sp. n.: H, holotipo; P, paratipos (n = 10).

	H	P
Standard length (mm)	107.2	43.7–111.2
Percent of standard length		
Body depth	14.2	14.8–16.8
Caudal peduncle depth	11.6	11.6–13.3
Body width	12.1	10.7–12.6
Caudal peduncle width	4.8	3.8–5.2
Pre-dorsal length	61.7	60.7–63.1
Pre-pelvic length	58.1	56.1–60.6
Dorsal-fin base length	11.5	10.6–13.4
Anal-fin base length	8.7	7.5–10.0
Caudal-fin length	17.3	15.5–18.0
Pectoral-fin length	10.9	11.7–14.5
Pelvic-fin length	8.9	8.1–9.7
Head length	19.1	18.6–22.0
Percent of head length		
Head depth	55.0	49.6–55.3
Head width	88.2	74.1–86.3
Snout length	45.5	42.7–48.3
Interorbital length	24.1	23.0–27.1
Preorbital length	13.0	11.4–14.4
Eye diameter	7.1	7.6–12.3

river channel are gradually disappearing, and species are becoming restricted to peripheral stream environments, habitats that are also threatened by agricultural practices such as pesticides and siltation. The type-locality is located in a tributary stream of the Chapecó River, which is in the damping zone of the Quedas do Chapecó Park, an important tourist spot in the city. The park plays the important role of displaying the natural beauty of Rio Chapecó and preserving the local environment, beneficial factors for the conservation of the type locality. However, in the areas surrounding the Park, the monoculture of soy has a tremendously negative impact on the riparian forest, often completely occupying upstream stretches, and even including their sources.

Etymology

The name *gamabelardense* (gamma, the third letter of the Greek alphabet, and abelardense, a Portu-

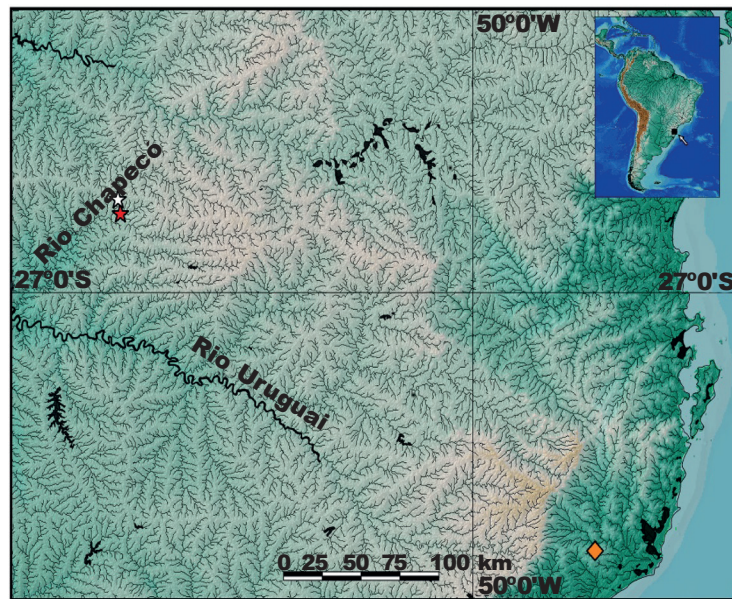


Fig. 3. Geographical distribution of *Cambeva gamabelardense* n. sp. (stars) and *C. panthera* (lozenge).

Fig. 3. Distribución geográfica de *Cambeva gamabelardense* sp. n. (estrellas) y *C. panthera* (rombo).

guese word referring to people born in Abelardo Luz municipality) is an allusion to the third new species of *Cambeva* known to occur in this area. The other two species are described in Costa et al. (2022).

Discussion

The wide diversity of colour patterns in Trichomycterines (Eigenmann, 1918) plays an important role in distinguishing species of *Cambeva* (Costa, 1992; de Pinna, 1992; Wosiacki and Garavello, 2004; Datovo et al., 2012; Ferrer and Malabarba, 2013; Costa et al., 2020a, 2021b, 2022; Reis et al., 2021). *Cambeva gamabelardense* n. sp. has a peculiar colour pattern, resembling the typical colouration of the spotted jaguar (fig. 1). Among the approximately 120 species presently included in the eastern South American trichomycterine clade comprising the genera *Cambeva*, *Scleronema* Eigenmann, 1917 and *Trichomycterus* Valenciennes, 1832, only *Cambeva panthera* has a similar colour pattern, thus suggesting that this species is the closest relative to *C. gamabelardense*. Although it is not yet possible to infer osteological characters unambiguously supporting sister group relationships between *C. gamabelardense* and *C. panthera*, the high similarity of most osseous structures, including a broad autopalatine with a short latero-posterior process (compare fig. 2A with Costa et al., 2021b: fig. 11E), a derived condition occurring in a few intrageneric lineages (Costa et al., 2020, 2021b, 2022), reinforces this hypothesis. However, in contrast with *C. gamabelardense*,

here described from an inner plateau, about 640–900 m a.s.l., drained by the middle section of the Rio Chapecó and its tributaries, *C. panthera* occurs in a lower altitude area, about 245 m a.s.l., in a small isolated coastal drainage, the Rio Tubarão basin, about 380 km from the type locality area of *C. gamabelardense* (Costa et al., 2021b).

Recent studies have reported a rich biodiversity, with numerous endemic species, in the inner plateau drained by the Rio Uruguai basin (Boldrini et al., 2009; Costa et al., 2021b), which is part of the biogeographical province known as the Araucaria plateau or Araucaria Forest (Ab'Saber, 1977; Morrone, 2006). *Cambeva gamabelardense* and two other recently described species are only known from a small area of about 80 km² originally covered by the Araucaria Forest, which is presently undergoing intense deforestation for soya monoculture (see above). The concentration of three new species in a relatively small area indicates the urgent need for additional field studies in the region to check their occurrence in neighbouring areas in order to allow consistent evaluations of the conservation status of these rare endemic species.

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