

Two new species of *Borreria* (Rubiaceae) from Brazil, with new distributional records for Pará State and a key to species with transversally sulcate seeds

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Two new species of the genus *Borreria*, *B. carajasensis* E.L. Cabral & L.M. Miguel and *B. elaiosulcata* E.L. Cabral & L.M. Miguel, are described and illustrated, based on material collected from iron outcrops in the Serra dos Carajás region, Pará State, Brazil. A key to morphologically similar species is provided; these species can be recognized by their transversally sulcate seeds. *Borreria cupularis* and *B. multiflora* are reported for the first time from the Pará State.

Introduction

The genus *Borreria* belongs to the tribe Spermacoeae of the Rubiaceae, comprising about sixty genera. The generic delimitation within the tribe was strongly modified based on molecular data by Groeninckx *et al.* (2009). *Borreria* is morphologically very similar to *Spermacoce* and the taxonomic boundaries were discussed in several works by various Rubiaceae specialists (Dessein 2003, Harwood & Dessein 2005, Dessein *et al.* 2005, Delprete 2007, Salas *et al.* 2011). Cabral *et al.* (2011) proposed to recognize these two closely related taxa at the generic level. According to Cabral *et al.* (2011), the available molecular studies are inconclusive, especially because the species sampling from the Neotropics is inadequate. In the present paper, we followed the

generic circumscription of *Borreria* of Cabral *et al.* (2011).

In the Americas, *Borreria* comprises ca. 150 species distributed from the southern United States to northern Argentina and Uruguay. In Brazil, there are 63 species, 31 of which are endemic; 15 species are known to occur in the Pará State (Cabral & Salas 2010). The new species described here have transversally sulcate seeds, as in *Borreria* ser. *Laeves* (Bacigalupo & Cabral 1996, Cabral & Bacigalupo 1999). *Borreria carajasensis* and *B. elaiosulcata* are only known from recent collections from the Carajás mountain range, apparently exclusively from the *canga* vegetation.

The present paper provides the descriptions and illustrations of these two species and a key to the South American species of *Borreria* with

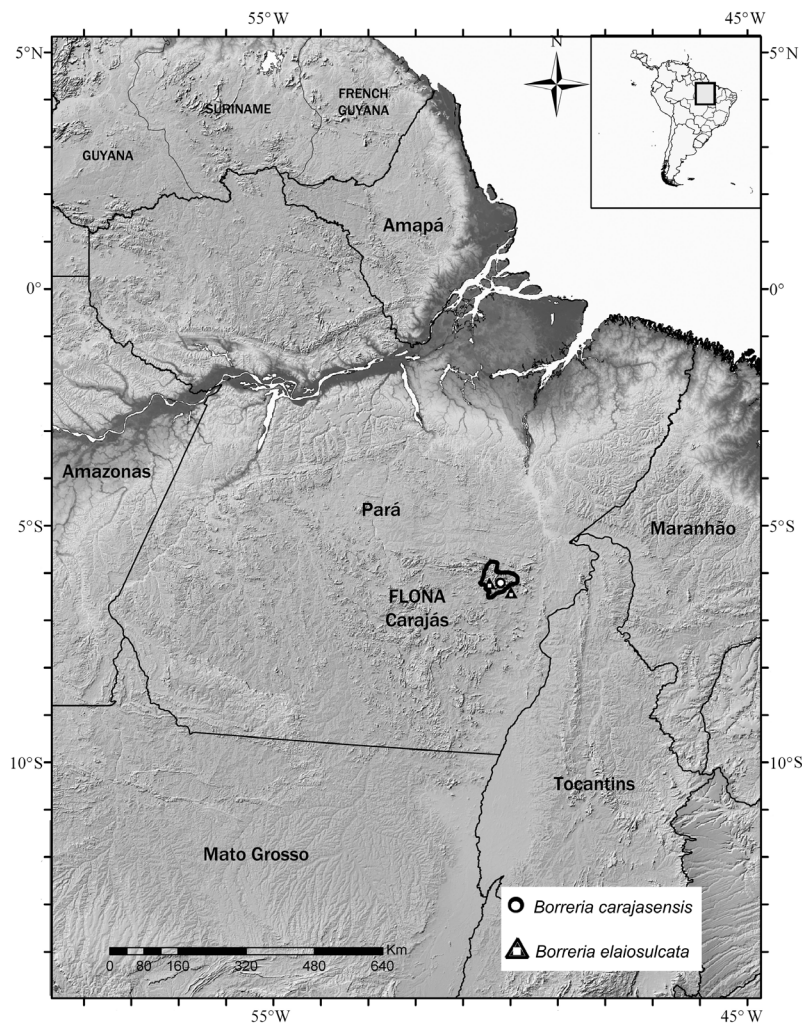


Fig. 1. Distribution of *Borreria carajasensis* and *B. elaiosulcata* in the Pará State, Brazil.

transversally sulcate seeds. *Borreria cupularis* and *B. multiflora* are reported for the first time from the State of Pará, Brazil. A brief description of the Serra of Carajás vegetation is also provided.

Characterization of the vegetation of Serra do Carajás

The Serra do Carajás is located in the southeastern portion of the Pará State in northern Brazil. It is an isolated mountain range in the eastern Amazon region. The rugged relief of the region bears a rich mosaic of vegetation types and consists of one of the most important forest remnants in the eastern Amazon. It is partially

situated within the limits of a conservation unit, the FLONA Carajás (Carajás National Forest, Fig. 1). The vegetation in the Serra do Carajás is composed essentially of evergreen, semideciduous and deciduous forests and patches of saxicolous scrubby vegetation on the iron outcrops, locally named *canga*, usually on mountain summits (Secco & Mesquita 1983).

The physiognomy of the *canga* vegetation resembles some *campos rupestres* from central Brazil. It is characterized by the presence of deciduous and semideciduous xerophytic shrubs (e.g. *Mimosa acutistipula*, *Ipomoea cavalcantei*, *I. marabensis*, *Croton* spp., *Erythroxylum nelson-rosae*), scattered perennial caespitose grasses (e.g. *Paspalum cinerascens*, *P. lanciflorum*, *Axonopus leptostachyus*), some rupicolous species,

represented by orchids (*Catasetum planiceps*, *Epidendrum nocturnum*, *E. purpurascens*), bromeliads (*Dyckia duckei*, *Ananas ananassoides*), aroids (*Anthurium lindmanianum*), and several annual plant species that bloom profusely during the rainy season, such as the endemic *Axonopus carajasensis*, *Sporobolus multiramosus*, *Paspalum carajasense*, *Perama carajensis*, *Cavalcantia glomerata* and *Monogereion carajensis*.

The diversity of endemic species of the *canga* from the Serra do Carajás region is noteworthy. Although the flora is believed to be still not satisfactorily inventoried, several endemic plant species are known from the *canga* of this region (Secco & Mesquita 1983, Morelato & Rosa 1991). This overlooked plant diversity in iron-rich environments, however, is increasingly threatened due to mining exploration in Brazil (Jacobi *et al.* 2011). The unique iron outcrops in the Serra do Carajás correspond to huge deposits of metallic ore that represents a significant amount of the total Brazilian reserves, which have been subject to intense and increasing exploration.

***Borreria* G. Mey.**

Annual or perennial herbs or sometimes shrubs, erect or decumbent, terrestrial, often weedy. Leaves opposite or pseudoverticillate; stipular sheath with setae. Glomerules axillary and/or terminal, sessile, subtended by bracts. Flowers homostylous, sessile or rarely pedicellate; calyx persistent, 4(2) lobed; corolla 4-merous, usually funnel-shaped, white, sometimes blue. Stamens 4, filaments attached to throat. Style exerted or included, stigma bifid or capitate-bilobed. Ovary 2-locular, ovules solitary in each locule, fixed to septum. Fruit capsular, ellipsoid to subglobose or obovoid, septicidal from apex, or rarely apex and valves, when loculicidal. Seeds small, reticulate, foveolate, sometimes transversally sulcate and with a strophiole on ventral surface, sometimes with elaiosome.

Key to the South American species of *Borreria* with transversally sulcate seeds

1. Plants with dense indumentum, sericeous-villous
..... *B. argentea* Cham.

1. Plants glabrous or with varied indumentum but not sericeous 2
2. Leaves filiform, linear or linear-lanceolate, 0.2–4 mm wide 3
2. Leaves elliptic, ovate, lanceolate or oblong-lanceolate, 5–45 mm wide 5
3. Seed with a white, granulose elaiosome around ventral groove and ca. 20 transverse grooves on dorsal side
..... *B. schumanniana* Taub. ex Ule
3. Seed without white excrescence on ventral side and with 13–15 transverse grooves on dorsal side 4
4. Leaves 0.5–1 mm wide, linear; stipule sheath with 3–4 filiform teeth; seed with strophiole equal in length to ventral groove *B. paraensis* E.L. Cabral & Bacigalupo
4. Leaves 2–4 mm wide, linear-lanceolate; stipule sheath with 1–3 teeth, central tooth broad at base; seed with strophiole longer than ventral groove
..... *B. carajasensis* E.L. Cabral & L.M. Miguel
5. Calyx lobes ovate or triangular 6
5. Calyx lobes linear or linear-lanceolate 7
6. Inflorescence 5–10 mm wide, 4–10 per flowering stem; calyx lobes triangular with hirtellous margins; corolla infundibuliform
..... *B. remota* (Lam.) Bacigalupo & E.L. Cabral
6. Inflorescence 10–30 mm wide, 1 or 2 per flowering stem; calyx lobes ovate, with ciliate margins; corolla cupuliform *B. brownii* (Rusby) Standl.
7. Seed with prominent, conical elaiosome covering the strophiole 8
7. Seed without elaiosome 9
8. Prostrate subshrub; leaves 5–15 mm wide; stipular sheath with 6–8 setae; involucre bracts elliptic or elliptic-ovate; calyx 4-merous; corolla white
..... *B. diamantinae* R.M. Salas & E.L. Cabral
8. Erect subshrub; leaves 0.2–2.3 mm wide; stipular sheath with 3–5 setae; involucre bracts linear; calyx 2-merous; corolla blood-red, lobes darker than tube
..... *B. elaiosulcata* E.L. Cabral & L.M. Miguel
9. Corolla infundibuliform, with an internal ring of moniliform hairs around middle portion of tube and some moniliform hairs on inner surface of lobes
..... *B. chartensis* Standl.
9. Corolla infundibuliform, with an internal ring of moniliform hairs around middle portion of the tube 10
10. Stems glabrous or puberulous, and pilose on angles; leaves 60–120 × 5–19 mm, narrowly elliptic-lanceolate, glabrous and smooth on both surfaces, except for some hairs on underneath veins, secondary veins inconspicuous; stipular sheath with 7–10 setae; involucre bracts erect to spreading, 3–4 times longer than glomerule; fruit subcylindrical or ellipsoid, 3 times longer than wide
..... *B. virgata* Cham. & Schtdl.
10. Stems pilosulous; leaves 15–40 × 5–10 mm, elliptic or ovate, pubescent or scabridulous, secondary veins impressed above, prominent below; stipular sheath 5–6; involucre bracts reflexed, 1 or rarely 2 times longer than glomerule; fruit obovoid, 2 times longer than wide
..... *B. capitata* (Ruiz & Pav.) DC.

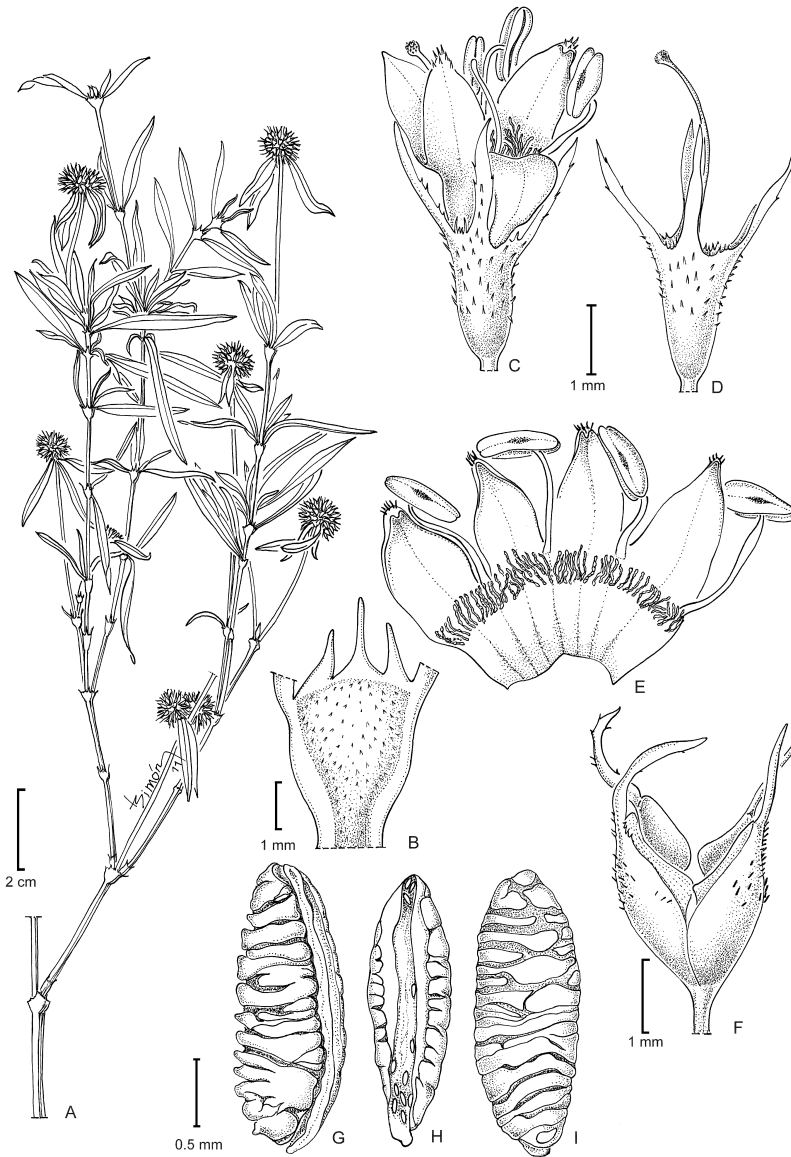


Fig. 2. *Borreria carajasensis* (drawn from the holotype). — **A:** Habit. — **B:** Detail of stipular sheath — **C:** Flower. — **D:** Calyx, style and stigma. — **E:** Corolla. — **F:** Fruit. — **G:** Lateral side of seed. — **H:** Ventral side of seed. — **I:** Dorsal side of seed.

Borreria carajasensis E.L. Cabral & L.M. Miguel, *sp. nova* (Fig. 2)

TYPE: Brazil. Pará: Canaã dos Carajás, 6°24'3''S, 50°19'4''W, alt. 753 m, 10 Oct. 2008 L. V. Costa, M. Sobral, C. Troncoso, L. García & G. Maciel 518 (holotype BHCb). — PARATYPES: Same locality as the type, 6°20'56''S, 50°26'56''W, 753 m, 12 Oct. 2008 L. V. Costa et al. 604 (BHCb); same locality as the type, 6°23'50''S, 50°20'57''W, 820 m, 12 May 2010 Pivari, M. O. et al. 1549 (BHCb).

ETYMOLOGY: The epithet is derived from the collecting locality, Serra do Carajás.

Subshrub 40–50 cm tall, branched, stems subquadrangular, glabrous. Leaves sessile, blades linear-lanceolate, 20–40 × 2–4 mm, glabrous, secondary veins inconspicuous. Stipular sheath 2.5–3 mm long, puberulous, with 1–3 setae 1–2.5 mm long, glabrous, colleter-tipped, central setae broad-based. Flowering branch with 1–2 floral glomerules. Glomerules 8–10 mm wide, multi-flowered, subtended by 2–4 bracts, twice as long as glomerule. Flowers sessile, 4-merous; hypanthium 1.8 mm long, puberulous;

calyx lobes 1.6–1.8 mm long, linear, puberulous, with intercalary teeth between lobes; corolla infundibuliform, 3–4 mm long, 4-merous, white, lobes as long as tube, glabrous outside except for some papillae at tips, internally with a fringe of moniliform hairs around mid portion of tube; anthers 4, white, oblong, 1.2 mm long, filaments 1.4–1.6 mm long; style 3.2 mm long, exerted, stigma capitate-bilobate; nectary disc bipartite. Capsules ellipsoid, 4.2 mm long, puberulous at upper half. Seeds ellipsoid, 1.5–2 mm long, dorsal side with ca. 12 transverse grooves, strophiole longer than ventral furrow.

DISTRIBUTION AND HABITAT ECOLOGY. Occurs in *canga* in the Serra do Carajás region, where it is known only from the Serra Sul mountain. Specimens with flowers and fruits were collected from September to October.

Borreria carajasensis is similar to *B. paraensis*, both being subshrubs, with apical (rarely subapical) inflorescences and transversally sulcate seeds. *Borreria paraensis* differs from *B. carajasensis* by its linear leaves 4–15(–25) × 0.5–1 mm, stipule sheath with 3–4 teeth, these 0.5–1 mm long, and by a strophiole of the same length as the ventral groove of the seed.

***Borreria elaiosulcata* E.L. Cabral & L.M. Miguel, sp. nova (Fig. 3)**

Type: Brazil. Pará: Parauapebas, Serra Sul, 6°23'1''S, 50°23'8''W, 16 Mar. 2009 V. T. Giorni, P. L. Viana, L. M. Ver-sieux, L. C. Garcia & L. V. C. Silva 177 (holotype BHCB). — PARATYPES: Brazil. Pará: Canaã dos Carajás, Floresta Nacional de Carajás, Serra Sul, 6°23'49''S, 50°20'57''W, 749 m, 6 Dec. 2007 N. F. O. Mota et al. 1084 (BHCB); Parauapebas, Serra da Bocaina, 6°18'48''S, 49°53'17''W, 711 m, 16 Dec. 2010 N. F. O. Mota et al. 1923 (BHCB).

ETYMOLOGY: The epithet refers to the transversally sulcate seeds with an elaiosome.

Subshrub 20–50 cm tall, branched, stems subquadrangular, 0.8–2 mm wide, glabrous or puberulous. Leaves sessile, blades linear or linear-lanceolate, 13–55 × 0.2–2.3 mm, glabrous, margin revolute, secondary veins inconspicuous; stipule sheath 2 mm long, puberulous, with 3–5 setae 2–3 mm long, glabrous, often with colleters among setae. Flowering branch with 1–2 flowering glomerules. Glomerules multi-

flowered, subtended by 2–6 bracts longer than glomerule. Flower sessile, hypanthium 1.5 mm long, puberulous; calyx 2-merous, lobes 0.5 mm long, linear-subulate, puberulous, with two linear teeth 0.25–0.3 mm long between lobes; corolla infundibuliform, 3–3.2 mm long, 4-merous, blood-red, lobes darker than tube, glabrous outside, internally with a ring of moniliform hairs near middle of tube and scattered short hairs on lobes; stamens exerted, filaments 1.2 mm, blood-red, anthers oblong, 1 mm long, white; style 2 mm long, exerted, stigma capitate-bilobate; nectary disc bipartite. Capsules obovoid, 3–3.5 mm long, with dehiscent mericarps, puberulous at upper half. Seeds 2–2.5 mm long, dorsal side with ca. 12–14 transverse grooves, ventral furrow partially covered by strophiole, with a prominent elaiosome protruding at apex and base.

DISTRIBUTION, HABITAT AND PHENOLOGY. This species is only known from the state of Pará, Brazil, in Serra do Carajás region, where it occurs on iron outcrops (*canga* vegetation) of Serra Sul and Serra da Bocaina mountains. Flowering and fruiting from December to March.

This species is very peculiar because of its blood-red corolla and transversally sulcate seeds with a ventral elaiosome. Due to these characters, *B. elaiosulcata* resembles *B. diamantinae*, but differs from it by the characters presented in the key.

New records of *Borreria* from the state of Pará, Brazil

Borreria cupularis DC., Prodr. 4: 543. 1830.

For description see Bacigalupo and Cabral (2007); for iconography see Cabral et al. 2011: fig. 2A–E.

GEOGRAPHICAL DISTRIBUTION: Peru, Bolivia, Paraguay, Brazil. In Brazil it was known from the States of Bahia, Minas Gerais, São Paulo and Tocantins, and in the Distrito Federal. The material studied here is the first record for Pará.

SELECTED SPECIMEN EXAMINED: Brazil. Pará: Parque Nacional do Tapajós, km 60 da estrada do Itaibu na Jacarecanga, margen esquerda do Rio Capoeira, várzea, 22 Nov. 1978 M. G. Silva et al. 3896 (INPA).

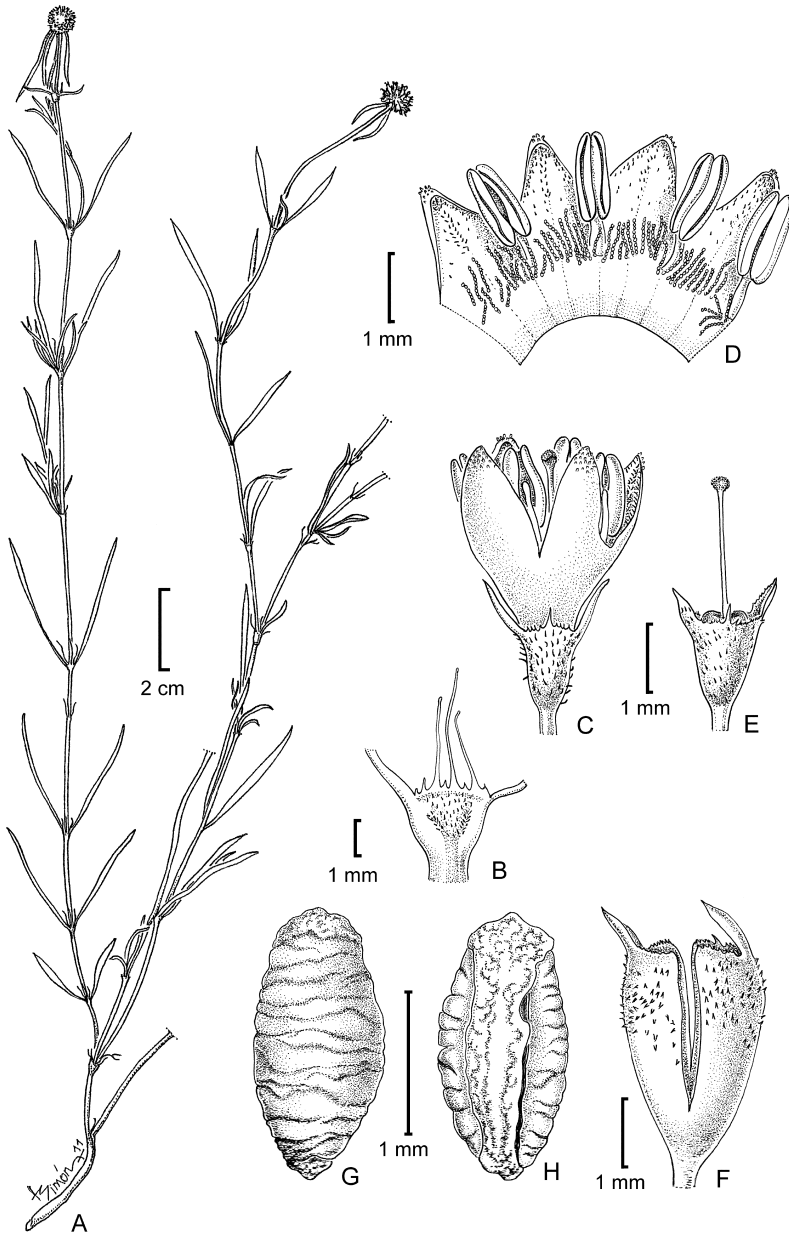


Fig. 3. *Borreria elaiosulcata* (drawn from the holotype). — **A:** Habit. — **B:** Detail of stipular sheath — **C:** Flower. — **D:** Corolla. — **E:** Calyx, style and stigma. — **F:** Fruit. — **G:** Dorsal side of seed. — **H:** Ventral side of seed.

Borreria multiflora (DC.) Bacigalupo & E.L. Cabral, *Opera Bot.* Belg. 7: 307. 1996.

Diodia multiflora DC., *Prodr.* 3: 564. 1830.

For description see Bacigalupo and Cabral (2007).

DISTRIBUTION: Venezuela, Guiana, Colombia, Bolivia, Brazil, Paraguay. In Brazil, *B. multiflora* is known from the States of Bahia, Goiás, Mato Grosso and São Paulo, and the Distrito Federal. The material cited here is the first record for Pará.

SELECTED SPECIMEN EXAMINED: Brazil. Pará: Mun. conceição do Araguaia, 8°15'S, 49°18'W, 29 Nov. 1980 *T. Plowman et al.* 9083 (INPA).

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