

The Genus *Gearum* N. E. Brown (Araceae: Tribe *Spathicarpeae*)

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INTRODUCTION

Gearum brasiliense N. E. Br. was first collected in October 1828 by W. J. Burchell. N. E. Brown (1882) gave a very accurate description of the inflorescence and flower structure, although Burchell's specimen was heavily damaged by insect feeding, but until recently this monotypic genus remained incompletely known, due to lack of leaf material definitely attributable to *Gearum*.

The exact locality of Burchell's collection remained undiscovered until recently. Smith & Smith (1967) in their paper 'Itinerary of William John Burchell in Brazil' gave the wrong coordinates. When one of the authors (J.B.) was in Brazil ten years ago it was realized that the locality cited by Smith & Smith was incorrect because it did not look like that which Burchell described for the habitat of *Gearum brasiliense*; in fact it was a watershed and not a riverine area. The correct locality lies ca 78–80 km west (by air) of the locality given by Smith & Smith, but during the earlier visit this was not known. Some years later one of us (J.B.) tried again with more information to hand and succeeded in finding *Gearum*. In his field notebook Burchell gave the following details: "between Sapé and Santa Brizida (Serra Sta Brizida) on plains in low lying places that are often inundated (River from the ferry)" but this area could not be found in any gazetteers examined in Brazil or Europe. However, from his notebook it was possible to re-

construct roughly the route of his journey. The Rio Palma is a river in this area and there is still today a village called Sapo, which could well be Burchell's Sapé. Furthermore, Burchell himself mentioned a Rio Palma. Although there was a new bridge under construction over the Rio Palma during J.B.'s visit in 1996, the ferry was still there.

Although a second collection of *Gearum* was made by Burchell (*Burchell* 8598—leaves only), around the time of the holotype gathering, it was not until 150 years later that a third collection was made by Alfeu de Araujo Dias (*Dias* 41), a Brazilian botanist working for the Projeto RADAMBRASIL. This collection, made in 1978, remained unrecognized for several years as *Xanthosoma* cf. *pentaphyllum* (Vell.) Engl. until its identity was realized (Mayo, Bogner & Boyce, 1994). A collection by one of us (*Bogner* 2241) was made near Dias' location, just on the other side of the Rio Araguaia in the state of Goiás and another collection was made by G. Hatschbach (*Hatschbach* 56028) near Arraias. Most recently *Gearum* has been collected on three occasions in Tocantins by E. Gonçalves (*Gonçalves* 106, 108, 109).

DESCRIPTION

Gearum N. E. Br., J. Bot. 20:196, t. 231, Fig. 1 (1882); Benth. & Hook.f., Gen. Pl. 3:987–988 (1883); Engl. in Engl. & Prantl., Nat. Pflanzenfam. 2(3):144 (1887); Baillon, Hist. Pl. 13:472



Fig. 1. *Gearum brasiliense*. Pollen grain, from Bogner 2241, scale bar = 10 μm . Photo M. Hesse.

(1895); Engl. in Engl., Pflanzenr. 73 (IV.23F):52–53 (1920); Mayo *et al.*, Kew Bull. 49(4):785–788 (1994); Mayo *et al.*, The Genera of Araceae, 163–165 (1997). Type: *Gearum brasiliense* N. E. Br.

Seasonally dormant herb. Rhizome erect, with fleshy roots. Leaves 1–2 (3) ap-



Fig. 2. *Gearum brasiliense*. Seedling, growth begins with cataphylls Bogner 2241. Photo H.-J. Tillich.

pearing very soon after the inflorescence; petiole sheath about half the petiole length or shorter; preadult leaf sub-palmate, adult leaf blade pedatisect, coriaceous, with 5–13 segments and small lobes on the rachis, venation reticulate, with submarginal collective vein. Inflorescence solitary; peduncle much shorter than petiole; spathe erect, constricted, lower part convolute, globose ellipsoid, blade, erect, oblong, cuspidate; spadix shorter than spathe, sessile, fertile to the apex, female zone shorter than male and separated from it by a sterile zone of synandrodes. Flowers unisexual, perigone absent. Stamens of the male flowers connate into a synandrium, synandrium usually 4-androus, sometimes 3–6-androus, shallow, subrhombic, truncate; thecae globose to ellipsoid, dehiscing by a pore-like slit; pollen ellipsoid, inaperturate, large (ca. 56 μm), exine psilate (smooth). Sterile male flowers irregularly elongate, shallow, truncate. Female flowers densely arranged, gynoecium sur-



Fig. 3. *Beebeomyia* spec. Male. Photo M. Müller.

rounded by usually 4 obovate to subclavate (fleshy when fresh) staminodes; ovary depressed-globose to subglobose, 3–4-locular; ovule 1 per locule, orthotropous, elongate towards apex, funicle short; placenta axile at base of septum; stigma subsessile, weakly 3–4-lobed. Infructescence with depressed-globose berries; berry pale green at maturity; seed broadly ellipsoid; testa thin, smooth; embryo large, endosperm absent. Chromosomes $2n = 34$ and 68.

DISTRIBUTION

One species in central Brazil, in gallery forest, hyperseasonal savanna and cerrado vegetation, in sandy and loamy soil. Alt. ca. 450 m (only known from one locality).

ETYMOLOGY

Greek *gê* = earth and *Arum* (from Greek *Aron*).

Gearum brasiliense N. E. Br., l.c.

Type: Serra Santa Brizida, between Sapé (probably modern Sapó) and Santa Brizida, 15 Oct. 1828 (inflorescence only) *Burchell* 8111 (K, holo).

Rhizome erect, up to 14 cm deep in soil, very long, at least up to 30 cm and probably over 40 cm and 1.5–2.5 cm thick, outside light brown, inside whitish, with aromatic exudate when cut; main roots fusiform, very fleshy, 0.5–1.4 cm in diam. at the thickest part, white, other roots much thinner. Cataphylls several, often half rotten at flowering, whitish, membranaceous, soon drying, 10–13 cm long. Leaves 1–2,



Fig. 4. *Beebeomyia* spec. Female. Photo M. Müller.

rarely 3. Petiole 11–18 (–48) cm long, (0.3–) 0.4–0.7 (–0.8) cm diam., green or light reddish tinged, with whitish or dirty green vertical lines and sometimes spots; sheath distinct (5–) 6–11 cm long, mostly underground; geniculum absent. Leaf blade pedatisect, adult blade with 9–13 leaflets, rachis alate with lobes 2.5–4 cm long, 0.2–0.3 cm wide, mid-green; leaflets sessile and decurrent, oblanceolate or narrow elliptic, coriaceous, mid-green, sometimes red-edged, somewhat lighter beneath, the middle leaflet longest, 10–14 (–18) cm long, 1–3 (–5) cm wide, the other leaflets becoming progressively smaller towards the ends of the rachis, the smallest ca. 1.5 cm long, 0.4 cm wide, apex acute to cuspidate; preadult leaf sometimes subpalmate with 5 lobes, central lobes broader than basal ones, up to 10 cm long, 4.5 cm wide, apex cuspidate; first foliage leaf of

seedling tripartite; venation reticulate, middle vein of each leaflet very robust, 4–7 (–9) primary lateral veins on each side, running towards apex, secondary veins thinner, reticulate between the primaries, with submarginal collective vein on each side (sometimes inconspicuous). Inflorescence solitary, usually appearing before or with leaves, with strong spicy odor at anthesis, subtended by several cataphylls, longest longer than peduncle, of same color as those appearing with the leaves. Peduncle very short, 8–10 cm long, (0.4–) 0.8–1.3 cm diam., somewhat compressed, color as for spathe but mostly underground and then whitish. Spathe 14–20 (–24) cm long, coriaceous, constricted, lower part convolute, globose-ellipsoid to subcylindric, 4–5 cm long, 2.5–3 cm diam., blade erect, gaping 4–5 cm wide when open, apex cuspidate to acute, spathe out-



Fig. 5. *Gearum brasiliense*. Brazil, Tocantins. *Gonçalves* 109. Photo E. Gonçalves.

side light green with whitish spots or long irregular lines or whitish with purplish spots and irregular lines, or dirty whitish green with light green spots, inside upper part smooth and whitish green or light purplish when outside also purplish, lower convolute part rugose inside. Spadix always shorter than spathe; spadix (10-) 12-18 cm, sessile, fertile to apex; male zone 9.5-14 cm long, (0.8-) 1-1.8 cm diam., subcylindric, obtuse at apex, completely covered with densely arranged, cream-colored synandria; female zone adnate to spathe on one side for a short distance, 1-2.5 cm long, 1.3-1.7 cm diam.; male and female zones separated by a narrower zone of sterile male flowers (synandrodes) 1-2.5 cm long, (0.5-) 0.9-1.5 cm diam. Flowers unisexual, without perigone, densely arranged, male flowers usually 4- androus, some with up to 6 stamens or some with 3 (these near the apex), on smaller inflorescences consisting of 3 stamens, some with 2 only, all stamens of a flower connate into a subrhombic, shallow, truncate synandrium, 3-4 mm long, 2-3 mm wide, uppermost synandria short-

er (ca. 2×1.5 mm), border between the connate stamens marked by a minute groove on the upper surface of the synandrium; thecae mostly 8, but dependent on number of stamens in the synandrium (see above), globose to ellipsoid, more or less remote, laterally situated and extending to the base and to the margin of the synandrium, ca. 0.5-0.65 mm diam., dehiscing by oblique slit or pore-like opening. Pollen extruded in strands; pollen grains inaperturate, ellipsoid, 52-60 μm long, 43-49 μm wide, exine psilate (smooth). Synandrodes (of sterile flowers) irregularly elongate, shallowly truncate, 2.5-3.5 mm long, 0.8-1 mm wide, otherwise similar to synandria but lacking thecae. Female flowers usually with 4 staminodes each, rarely 3 or 5; staminodes quite fleshy when fresh, subclavate or somewhat flattened, rounded at apex, as long as ovary (staminodes partly eaten by larvae after anthesis), staminodes shrivelling after anthesis and then thinner, cream-colored, ovary depressed-globose, 1.5-2.5 mm tall, 3-4 mm diam., light green, 3-4 times furrowed (as many furrows as stig-



Fig. 6. *Gearum brasiliense*. Brazil, Tocantins. Note long, erect rhizome and fleshy roots, Gonçalves 106. Photo E. Gonçalves.



Fig. 7. *Gearum brasiliense*. Brazil, Tocantins, in habitat. Note plant on left growing submerged in water. *Gonçalves* 109. Photo E. Gonçalves.



Fig. 8. *Gearum brasiliense*. Brazil, Tocantins. Note the long petioles of plants growing in shade. *Gonçalves* 108. Photo E. Gonçalves.



Fig. 9. *Gearum brasiliense*. Brazil, Tocantins. One open inflorescence and one in bud. *Bogner 2254*. Photo J. Bogner.

ma lobes), 3–4 locular, locules 1-ovulate; ovule orthotropous, elongate and narrowing towards micropyle, funicle short; placenta axile at base of septum; style very short or stigma subsessile to sessile, style light green; stigma (2–) 3–4-lobed but mostly 4-lobed (3-lobed, occasionally 2-



Fig. 10. *Gearum brasiliense*. Brazil, Tocantins. Red spathe form. *Bogner 2254*. Photo J. Bogner.



Fig. 11. *Gearum brasiliense*. Brazil, Tocantins. Note inflated lower portion of spathe. *Bogner 2254*. Photo J. Bogner.

lobed in smaller inflorescences), 2–3 mm diam., red-brown, papillose. Infructescence with pale green berries at maturity. Berries depressed-globose, 8–9 × 6–7 mm, somewhat sunken at apex, with brownish stigma remnant, usually with 3 seeds. Seed broadly ellipsoid, 4–6 × 3–5



Fig. 12. *Gearum brasiliense*. Brazil, Tocantins. Plants in cerradão *Bogner 2254*. Photo J. Bogner.



Fig. 13. *Gearum brasiliense*. Male part of spadix, pollen extruded in strands. *Bogner* 2254. Photo J. Bogner.

mm; testa smooth, thin, whitish to light brown; embryo large, broadly ellipsoid, ca. 5×4 mm, with green chlorophyllous outer cell layer, otherwise whitish inside, plumule inconspicuous, endosperm absent. Chromosomes $2n = 34$ (from *Bogner* 2241) and $2n = 68$ (from *Bogner* 2254).

DISTRIBUTION

Brazil, in the states of Goiás, Mato Grosso and Tocantins.

COLLECTIONS SEEN

Goiás: Porto Luís Alves, ca. 45 km west of São Miguel do Araguaia, 4 Nov. 1996 (young fruits), *Bogner* 2241 (M, INPA).

Mato Grosso: Rio Araguaia, loc. 27, $13^{\circ}22'S$, $50^{\circ}40'W$, 31 Oct. 1978 (flowering), Dias 41 (HRB, RB). **Tocantins:** Serra Santa Brizida, between Sapé (probably modern Sapó) and Santa Brizida, 15 Oct. 1828 (inflorescence only) *Burchell* 8111 (K); Serra Santa Brizida, near Porto Real,



Fig. 14. *Gearum brasiliense*. Mature infructescence. *Bogner* 2241. Photo J. Bogner.

Burchell 8598 (leaves only) (K); 9 km before the Rio Palma on the road from Arraias to Conceição do Norte, 9 Nov. 1996 (flowering), *Bogner* 2254 (M, SPF, INPA); Santa Maria farm, 50 km west from Natividade, 19 Nov. 1997 (seedling), *Gonçalves* 106 (UB); Road to the 'Paraiso' waterfall, $11^{\circ}39'S$, $47^{\circ}42'W$, 20 Nov. 1997, *Gonçalves* 108 (UB); near road to Natividade, $11^{\circ}57'S$, $47^{\circ}35'W$, 20 Nov. 1997, *Gonçalves* 109 (UB); Near Arraias, 15–20 km on the road to Paranã, 10 Nov. 1991, *Hatschbach* 56028 (K, MBM).

ECOLOGY

Gearum brasiliense is a geophyte growing in gallery forest and in low-lying areas prone to seasonal riverine flooding, either in open (hyperseasonal savanna) or wooded (cerradão) habitats on loamy or yellowish sandy soils.

The collection *Bogner* 2241 was found in a forest remnant near the Rio Araguaia in deep shade and are notable in being taller with petioles much longer and leaflets much broader than those of plants (e.g. *Bogner* 2254) found in open, sunny habitats. It is interesting to note that the forest population have a diploid chromosome count of $2n = 34$.

While some of the population from which *Bogner* 2254 was gathered near the Rio Palma occurred under trees or shrubs in partial shade, more often plants grew between low grasses in full sun. Such exposed plants had short petioles and narrow leaflets. This population is tetraploid

with $2n = 68$. It is thought that this population lies with 10 km of the type locality.

RELATIONSHIPS

Gearum is quite distinct from the other genera of the tribe *Spathicarpeae*. The pedate leaf is unique in the tribe, as too are the seeds lacking endosperm. Both of these are important distinguishing characters. Also interesting is that all other genera of the *Spathicarpeae* have a chromosome count of $2n = 34$, whereas *Gearum* has counts of $2n = 34$ and $2n = 68$. Until recently no chromosome count higher than $2n = 34$ has been recorded in the tribe. The orthotropous ovule suggests a relationship with *Gorgonidium* Schott, but probably not a close one.

REMARKS

In the same areas where *Gearum brasiliense* grows there is also a *Xanthosoma* species of the *X. helleborifolium* (Jacq.) Schott complex. The latter is superficially similar in leaf shape to the *Gearum* but lacks the small lobes along the rachis and also tends to have leaflets broader than in *Gearum*.

As noted above, the leaf of *Gearum* was for a long time not known for certain since the only data were those from the Burchell 8598 collection; there was some doubt that this collection (without flowers) was really *Gearum* since it was collected at a different time and at a different place than the type and, with no other collections to compare with it was not clear that the collections represented the same species. However, now with complete collections to hand we know that Burchell was correct to add his collection 8598 to *G. brasiliense* with the note in his catalogue, next to his collection 8111, '... Folia pedata ...'. The Diaz 41 collection has a subpalmate leaf and one inflorescence. At first it was assumed that this was the mature leaf form of *G. brasiliense* (Mayo *et al.*, 1994) but, in fact, it represents the preadult leaf form as now occasionally observed in the Bogner 2254 population near Rio Palma.

Normally the seedling produces as the

first foliage leaf a tripartite leaf blade, followed by a trisect blade and later a pedatisect blade with increasingly more leaflets produced by subsequent leaves.

POLLINATION

Brown (1882) reported that the plant material (Burchell 8111) was partly destroyed by insects. This is quite normal in nature and is caused by larvae of flies of *Beebeomyia* spp. (Richardiidae).

These red-eyed flies lay their eggs on the inflorescence. The larvae appear very quickly and feed mainly on the fleshy staminodes. The development of the larvae and pupae probably takes no longer than one or two weeks. Although we have not observed the flies carrying pollen of *Gearum* from one inflorescence to another, it can be assumed that they are visiting several inflorescences and laying eggs. Fresh inflorescences packed and transported remained with their load of larvae and their larvae were later allowed to develop and to produce adult flies, from which we were able to identify the imagoes. It is known that flies of the family Richardiidae are flower visitors. All *Gearum* inflorescences collected had larvae of this fly and it may be an effective pollinator.

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