



The species of the genus *Staelia* (*Rubiaceae*) from Paraguay, a new species and new synonymous

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Key words

Paraguay
Rubiaceae
Staelia
Staelia nelidiae

Abstract A new species of the genus *Staelia* is described and illustrated from the Boquerón department of Paraguay: *S. nelidiae*. In total, three *Staelia* species have been recognized for Paraguay. *Staelia hassleri* is proposed as a new synonym of the widespread *S. thymoides*. A key to distinguish the new species and the remaining taxa from Paraguay is also provided. The pollen and seed morphology are also analyzed and its relevance is discussed.

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INTRODUCTION

Staelia Cham. & Schtdl. belongs to the tribe *Spermacoceae* which comprises 19 genera. The most accepted classification of *Rubiaceae* family was provided by Robbrecht (1988). In this work the tribe *Spermacoceae* was included in the subfamily *Rubioideae* with 17 other tribes. A molecular study done by Andersson & Rova (1999), confirmed the monophyly of the tribe, but with the inclusion of members of the *Hedyotideae* tribe. However, Bremer (1996) proposes to extend the definition of the tribe, including in addition to *Hedyotideae*, the tribes *Manettieae* and *Knoxieae*. In this work we follow the traditional definition of *Spermacoceae* proposed by Robbrecht (1988).

According to different authors the number of genera in America ranges between 16 and 19. The difference is mainly due to the recent changes realized in the *Borreria-Diodia-Spermacoce* complex (Bacigalupo & Cabral 1999, 2006, Cabral & Bacigalupo 1997, 2001, Dessein 2003). Some authors, such as De Candolle (1830) and Schumann (1888) have used the type of fruit dehiscence as a diagnostic character to establish the generic limit. Nevertheless, recent studies grant greater relevance to other characters like heterostylous or isostylous flowers, inflorescence pattern, chromosome number, pollen morphology, growth form and/or molecular data (Cabral & Bacigalupo 2001, Cabral 2002, Dessein et al. 2002, Dessein 2003). The genus *Staelia* can be distinguished from the remaining genera of the tribe on the basis of its fruit dehiscence. The dehiscence is longitudinal and septifragal, it starts from the apex to halfway, the fruit base and septum remaining on the short pedicel (Fig. 1e, f, 2a, b).

According to Dessein (2003) *Staelia* is a somewhat troublesome genus. Two different groups can be recognized: the *Staelia thymoides* group with very small leaves without distinct secondary veins, an ericoid habit, small seeds and small pollen grains with long colpi and the *Staelia capitata* group with larger leaves, impressed venation, a taller habit, larger ruminant seeds, and larger pollen grains with short colpi. The only character in common is the type of fruit dehiscence. The

new species described here, *S. nelidiae*, is similar to the *S. thymoides* group. No taxonomic revisions are available for the genus *Staelia*. Almost all the information is restricted to the protologues of the species and their treatment in some regional floras (Bacigalupo 1974, 1993, Kirkbride 1997, Cabral & Salas 2005, Salas & Cabral 2006a, b).

The genus *Staelia* (*Rubiaceae*, *Spermacoceae*) is distributed exclusively in South America and comprises 17 species that inhabit in Brazil (10 species, 8 of which are endemic), Argentina (3 species, 1 endemic), Paraguay (3 species, 1 endemic), Bolivia (4 species, 2 endemics) and Uruguay (2 species, 1 endemic) (De Souza & De Sales 2004, Cabral & Salas 2005, Salas & Cabral 2006a, b). The *Staelia* species grow in tropical and subtropical areas, from northern Brazil (Pará state) to Uruguay (Artigas) and north of Argentina (Entre Ríos), from approximately 1° to 32° S. *Staelia* was described by Chamisso & Schlechtendal in 1828 on the basis of one specimen from S Brazil: *S. thymoides*. Later, two new species from Goiás (Brazil) were described by De Candolle (1830): *S. galioides* DC. and *S. reflexa* DC. In that work also *Tessiera* DC. is described, a genus very close to *Staelia*. For this new genus he describes two new species: *T. lanigera* DC. (Brazil) and *T. lithospermoides* DC. (Mexico). Schumann (1888) does not accept the genus *Tessiera* including it under the synonymy of *Staelia*. In the same work, ten species of *Staelia* are recognized for the Brazilian flora, four of them are new to science (*S. aurea* K.Schum., *S. capitata* K.Schum., *S. catechosperma* K.Schum., *S. vestita* K.Schum.) and three are new combinations (*S. lanigera* (DC.) K.Schum., *S. thymbroides* (Mart. ex Mart. & Zucc.) K.Schum., *S. virgata* (Willd. ex Roem. & Schult.) K.Schum.). According to Schumann (1888) the species of *Staelia* can be grouped in three sections: *Tessiera*, *Anthospermopsis* and *Staelia*, with two, one and seven species, respectively. Chodat & Hassler (1904) recognized four species for Paraguay: *Staelia filifolia* Chodat & Hassl., *S. thymbroides*, *S. thymoides* and *S. virgata*. In this treatment, *S. filifolia* is described as a new species, however, that specific epithet was previously used by Rusby (1895) to designate a species from Bolivia. For this reason Standley (1931) proposed the new name *S. hassleri* for *S. filifolia* Chodat & Hassl. A morphological analysis of three isotypes of *S. hassleri* deposited at K, P and W, revealed that *S. hassleri* is a new synonym of the widespread *S. thymoides*. Finally, the fourth species cited by Chodat & Hassler (1904), *S. thymbroides*

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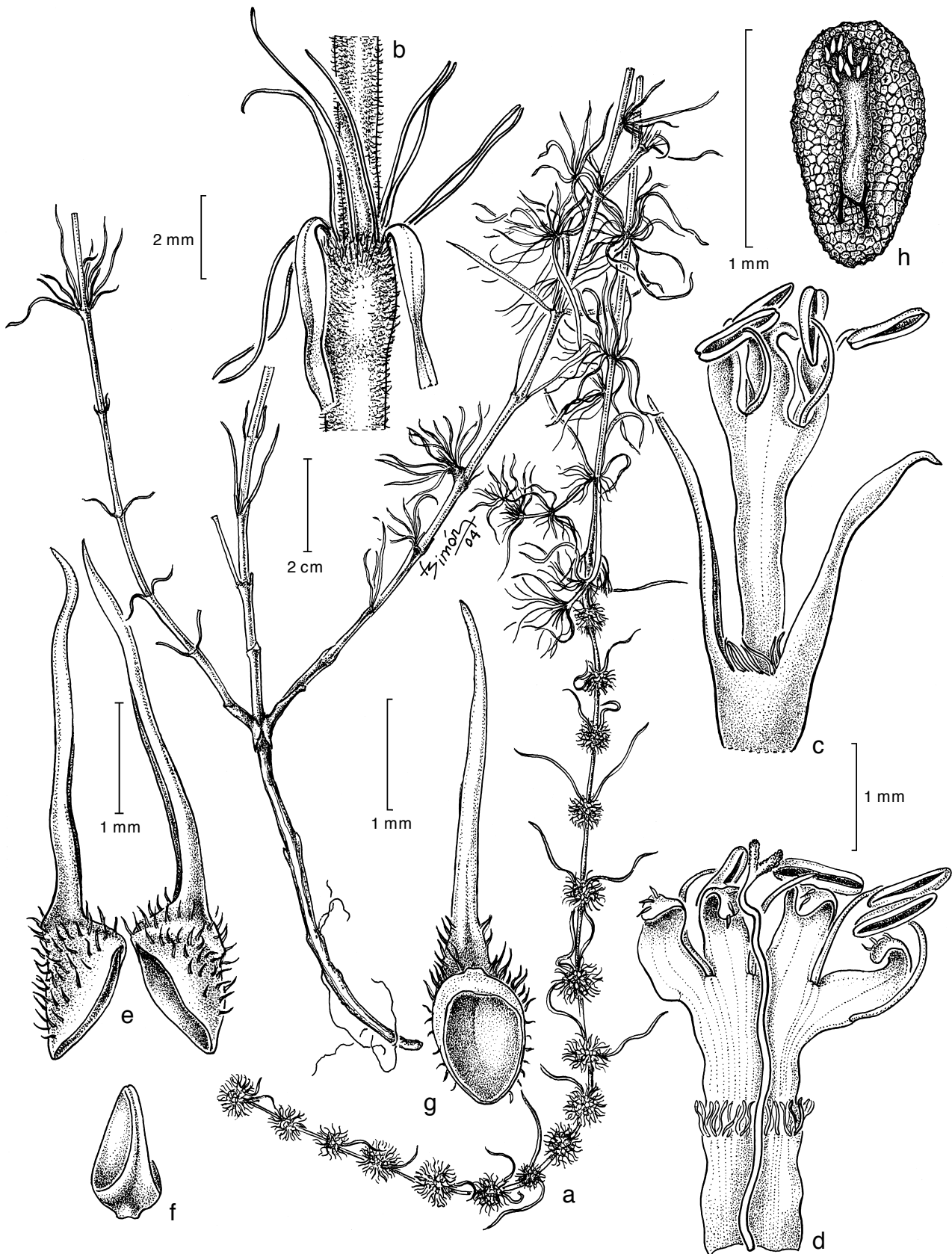


Fig. 1 *Staelia nelidae* R.M.Salas & E.L.Cabral. a. Habit; b. stipule (with 3 bristles); c. flower in anthesis; d. opened corolla with style; e–g. capsule; e. capsule, caducous valve; f. persistent basal portion; g. caducous valve, internal view; h. seed, ventral view (from *Mereles* 2663).

is an erroneous identification of one specimen collected by Hassler in the Cordillera department (*Hassler* 6126, K), which corresponds to *S. thymoides*.

During the study of the *Rubiaceae* family in Paraguay, we found some specimens collected in the Boquerón department (Para-

guay), which represents a new species endemic to this area. The present paper provides the description and illustration of the new species, *Staelia nelidae* and a key to distinguish the Paraguayan species. The pollen and seed morphology are also analysed and its relevance is discussed.

Staelia

Staelia Cham. & Schldl. (1828) 364. — Typus: *Staelia thymoides* Cham. & Schldl.

Small shrubs, subshrubs or perennial herbs. *Stipules* fimbriate, connected to the petioles. *Leaves* linear or narrowly elliptical, more rarely ovate or narrowly ovate, herbaceous or coriaceous, leaf base gradually narrowed or attenuate. *Inflorescence* multi-flowered, congested, terminal or axillary. *Flowers* sessile or pedicellate, isostylous. *Calyx* tube reduced, calyx lobes 2 or 4. *Corolla* funnel-shaped, white, 4-lobed, inside with moniliform hairs above the middle of the tube, rarely with dispersed hairs, outside glabrous or pubescent. *Stamens* and style exerted, stigma bifid, biloba or capitate. *Ovary* 2-locular with a single ovule per locule, nectary disk entire or parted. *Capsules* septifragal dehiscent in three parts, two caducous pieces and one basal persistent piece. *Seeds* ellipsoid, obovoid or dorsiventrally flattened, ventral groove shallow and wide or narrow and deep, seed coat surface finely reticulate-foveate, reticulate-areolate, rarely ruminant.

Distribution — Approximately 17 species in South America: Argentina, Bolivia, Brazil, Paraguay, Uruguay (Cabral & Salas 2005).

KEY TO THE SPECIES OCCURRING IN PARAGUAY

1. Herb or subshrub 10–30 cm tall. Inflorescences apical and 1 or 2 axillary. Nectariferous disk 2-lobed 2. *S. thymoides*
1. Subshrub 35–100 cm tall. Inflorescences apical and 5–15 (–25) axillary. Nectariferous disk entire 2
2. Stipular sheath with 3 (or 5) bristles, each 4–6 (or 8) mm long. Corollas 3.5–5 mm long. Calyx lobes 2.5–3 (or 4) mm long, larger than the corolla tube 1. *S. nelidae*
2. Stipular sheath with 3–5 (or 9) bristles, each 2–3 mm long. Corollas 5.5–6.5 (or 7) mm long. Calyx lobes 1.5–2 (–2.5) mm long, smaller than corolla tube 3. *S. virgata*

1. *Staelia nelidae* R.M.Salas & E.L.Cabral, sp. nov. — Fig. 1

Affinis *S. thymbroides* et *S. virgata*. Sed ab *S. thymbroides*, a quo imprimis differt foliis (10–)25–30(–38) mm longis, usque ad 1(–1.3) mm latis versus 5–8(–10) mm longis, 3(–3.5) mm latis, laciniis 4–6(–8) mm longis, versus laciniis 0.8–1.4 mm longis, glomeruli floralis 7–16 in ramis floriferis 10–15 mm latis versus glomeruli floralis 3–6(–8) in ramis floriferis 5–8(–10) mm latis. Ab *S. virgata* calycis segmentis differt, glabris versus pubescentis, 2.5–3(–4) mm longis versus 1.5–2.5 mm longis, corolla 3.5–5 mm longis versus 5.5–7 mm longis, laciniis 4–6(–8) mm longis versus laciniis 2–3 mm longis. — Typus: *Mereles* 2663 (holo CTES; iso FCQ, SI), Paraguay, Departamento Boquerón, 4 de mayo y Capitán Lagerenza, suelo arenoso, borde de ruta, 1 Mar. 1989.

Subshrub 35–50 cm tall. *Stem* subcylindrical to terete, hollow, pubescent. *Stipular sheath* 1.5–2 mm long, puberulous to pubescent, with 3(–5) bristles, 4–6(–8) mm long. *Leaves* opposite, (8–)10–30(–38) by 0.5–2(–2.5) mm, linear or narrowly elliptic, apex acute to acuminate, both sides glabrous. *Inflorescence* multiflorous, congested, axillary, 7–16, 10–15 mm wide; bracts 2 (or 3). *Flowers* sessile, hypanthium 0.6–0.7 mm long; calyx lobes linear-subulate, erect, glabrous, 2.6–3 (or 4) mm long, with conspicuous intercalary teeth; corolla 3.5–5 mm long, outside glabrous, inside with moniliform hairs above the middle of the tube; stamens exerted, 1.5–1.7 mm long; style 4.5–5 mm long, stigma bifid; nectary disk entire. *Fruit* capsule with puberulous to pubescent valves; seed subellipsoid, 1–1.2 mm long, reticulate-foveate, ventral furrow with strophiole.

Distribution — The new species is only known for the Boquerón department in north-western Paraguay.

Habitat & Ecology — Frequent in sandy grounds, way edges, opened forest of *Schinopsis balansae* Engl. and *Ceiba insignis*

(Kunth) P.E.Gibbs & Semir. Flowering and fruiting: February to April.

Note — *Staelia nelidae* is dedicated to Prof. Nélica Maria Bacigalupo, an important specialist in American *Rubiaceae*, by her countless contributions to floras of Argentina, Bolivia, Brazil and Paraguay. The differences between *S. nelidae* and its related species, *S. thymbroides* and *S. virgata*, are the width and length of its leaves, the bristles size, the number of glomerules per flowering branch and the calyx/corolla ratio.

Additional specimens. PARAGUAY: *Schinini & Bordas* 15100 (CTES), Boquerón, Mayor Pedro Lagerenza, 16 Apr. 1978; *Mereles* 2919 (CTES, FCQ); Boquerón, Palmar de las Islas, Puesto, 19°55'S, 60°50'W, orillas del camino, 13.03.1989; *Ramella & Mereles* 2080 (FCQ, G, SI); Boquerón, km 80, 20°25'S, 60°31'W, 30 km al norte de 4 de Mayo, 1 Mar. 1989.

2. *Staelia thymoides* Cham. & Schldl.

Staelia thymoides Cham. & Schldl. (1828) 364. — Type: *Sellow s.n.* (holo B†; iso K, W), Brasilia meridionalis.

Staelia hassleri Standl. (1931) 386. — *Staelia filifolia* Chodat & Hassler, nom. illeg. (non *Staelia filifolia* Rusby). — Type: *Hassler* 4032 (holo G n.v.; iso F photo, K, P, W), Paraguay, in campis pr. Tobaty, 1901.

Staelia thymbroides auct. non K.Schum.: Chodat & Hassler (1904) 190.

Distribution — Southern Brazil (Rio Grande do Sul), north-eastern Argentina (Misiones, Corrientes and Entre Ríos), W Uruguay and S Oriental Paraguay (Cabral & Salas 2005).

Habitat & Ecology — It grows in 'campo cerrado', savannas with *Pseudobombax* and *Acrocomia* and grasslands of *Elyonurus muticus* Kuntze. Flowering and fruiting: November to May.

Note — *Staelia thymoides* is the name most used in the identification of plants belonging to this genus. Therefore, it is very common to find erroneously identified specimens. *Staelia thymoides* displays a great variation of leaf width and length. Chodat & Hassler (1904) described *Staelia filifolia* (= *Staelia hassleri*), on the base of its filiform leaves, graceful aspect and thin branches. After the morphological analysis of three isotypes of *S. hassleri* deposited at K, P and W, we have concluded that this species and *S. thymoides* are conspecific.

3. *Staelia virgata* (Willd. ex Roem. & Schult.) K.Schum.

Staelia virgata (Willd. ex Roem. & Schult.) K.Schum. (1888) 76. — *Spermacoce virgata* Willd. ex Roem. & Schult. (1818) 281. — *Mitracarpum virgatum* (Roem. & Schult.) Cham. & Schldl. (1828) 363. — Type: *Hoffmannsegg s.n.* (B-WILLD 2634, iso BR), Brazil.

Staelia caespitosa Griseb. (1879) 158. — Lectotype (here designated): *Lorentz & Hieronymus* 390 (holo K; iso F photo, G, LE n.v.), Argentina, Provincia de Salta, La Florida en el Río del Tala, Nov. 1877.

Borreria finitima S.Moore (1922) 27. — Type: *Herzog* 1028 (holo BM), Argentina, between Embarcación and Miraflores, Nov. 1910.

Borreria exigua S.Moore (1922) 28. — *Spermacoce exigua* (S.Moore) Govaerts (1996) 16. — Type: *Herzog* 1896a (holo BM), Bolivia, Cuesta de los Monos, Mar. 1911.

Distribution — Argentina, Bolivia, almost all Brazil (except the Southern states) and Peru (De Souza & De Sales 2004). In Paraguay it has been found in Alto Paraguay, Concepción, Cordillera, Boquerón, Presidente Hayes, Ñeembucú and Paraguari departments.

Habitat & Ecology — It grows in sandy-argillaceous grounds, stony grasslands, river margins, in grasslands of *Elyonurus muticus* Kuntze with *Astronium balansae* Engl. and *Schinopsis balansae* Engl., edges of forest or ways, occasionally weeds, between 500–1100 m. Flowering and fruiting: October to May.

Note — *Staelia virgata* grows in diverse habitats throughout its distribution area, and consequently displays a wide variation in the number of bristles of stipular sheath, stem hair-covering, leaf shape and hairs and height (35–110 cm tall).

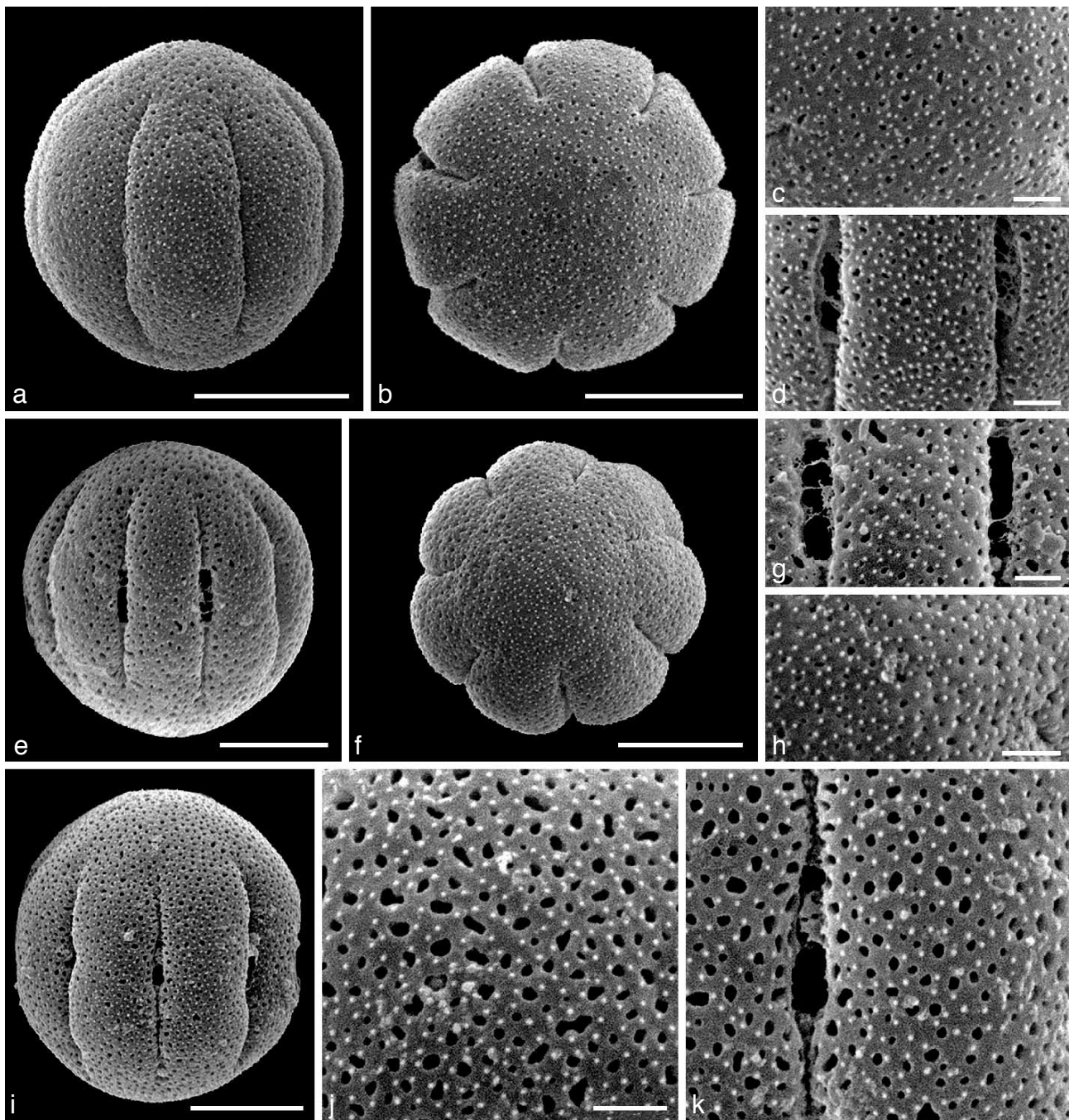


Fig. 2 Pollen grains of *Staelia* species. a–d. *Staelia nelidae* R.M.Salas & E.L.Cabral. a. Equatorial view of pollen grain; b. polar view of pollen grain; c. detail of apocolpium; d. detail of mesocolpium. — e–h. *Staelia virgata* (Willd. ex Roem. & Schult.) K.Schum. e. Equatorial view of pollen grain; f. polar view of pollen grain; g. detail of apocolpium; h. detail of mesocolpium (from *Mereles 5881*). — i–k. *Staelia thymoides* Cham. & Schltld. i. Equatorial view of pollen grain; j. detail of apocolpium; k. detail of mesocolpium (a–d: *Mereles 2663*; e–h: *Mereles 5881*; i–k: *Krapovickas 45168*). — Scale bars: a, b, e, f, i = 10 μ m; c, d, g, h, j, k = 2 μ m.

POLLEN MORPHOLOGY

Pollen grains of *Staelia* are prolate spheroidal, isopolar and radially symmetric. Medium sized (25–33 μ m), 7–10-colporate, with ectocolpi long and endoapertures lolongate. Exine 2.2–3.5 μ m thick, the sexine equal or thicker than the nexine, tectate-perforate, uniformly scabrate. Perforations circular to elongate. Scabrae 0.2 μ m, distributed over the entire surface of the grain.

Staelia nelidae — pollen grains 7- or 8-colporate, ectocolpi 14–16 μ m long, endoapertures lolongate, 4–4.5 μ m long. Medium sized, P = 25 μ m and E = 24 μ m. Exine 1.6–2 μ m thick, sexine and nexine equally thick. Perforations irregular, 0.2–0.5 μ m. Scabrae 0.1–0.2 μ m, uniformly distributed (Fig. 2a–d).

Staelia thymoides — pollen grains 8-colporate, rarely 7-colporate, ectocolpi 16–21 μ m long, endoapertures lolongate, 4.5–5.5 μ m long. Medium sized, P = 29 μ m and E = 27.5 μ m. Exine 1.4–1.6 μ m thick, sexine equally thick or thicker than nexine. Perforations subcircular or irregular, 0.2–1.2 μ m. Scabrae 0.1–0.2 μ m, uniformly distributed (Fig. 2e–h).

Staelia virgata — pollen grains 9-colporate, rarely 10-colporate, ectocolpi 14.7–17.5 μ m long, endoapertures lolongate, 4.5–5.5 μ m long. Medium sized, P = 27.8 μ m and E = 27.2 μ m. Exine 1.4–1.6 μ m thick, sexine equally thick or thicker than nexine. Perforations subcircular or irregular, 0.2–0.6 μ m. Scabrate 0.1–0.2 μ m, uniformly distributed (Fig. 2i–k).

The pollen morphology of *Staelia* sect. *Staelia* K.Schum. is rather uniform. Significant differences do not exist between

the species of Paraguay. However, some differences may be noticed in the size, number of colpi and sculpture. *Staelia nelidae* has relatively small pollen grains ($P = 25 \mu\text{m}$ and $E = 24 \mu\text{m}$), *S. virgata* has 9- or 10-colporate grains and *S. thymoides* displays relatively large perforations ($0.2\text{--}1.2 \mu\text{m}$ wide).

Staelia pollen was analyzed by Schumann (1888). He studied a single species and described the pollen grains size, shape and the number of apertures, without mentioning the aperture type and the species name.

The pollen of *S. thymoides* was studied by Galati (1988). She described it as 10-colporate, with long colpi and a perforate

tectum. Some characters were also observed in other genera of the tribe, such as the number of colpi, the long colpi and the tectate-perforate exine. Galati (1988) concludes that the pollen of *Staelia thymoides* is very close to that of two species of *Mitracarpus* Zucc. ex. Schult. & Schult.f. (*M. hirtus* (Sw.) DC. and *M. megapotamicus* (Spreng.) O.Kuntze). Both present the same morphology and the colpi are often united at the poles. However, *M. hirtus* has 5-colporate grains ((3–)7(–)9)-colporate according to Melhem et al. 2003) and *M. megapotamicus* has 8-colporate pollen grains (Galati 1988).



Fig. 3 Fruit and seed morphology of *Staelia* species. a–f. *S. nelidae* R.M. Salas & E.L. Cabral. a. Lateral view of dehiscent fruit; b. persistent portion of fruit; c. dorsal view of mature seed; d. ventral view of mature seed; e. detail of the exotesta cells; f. ventral view of seed under binocular microscope. — g, h. *S. thymoides* Cham. & Schltdl. g. Ventral view of seed; h. dorsal view of seed. — i, j. *S. virgata* (Willd. ex Roem. & Schult.) K.Schum. i. Ventral view of seed; j. dorsal view of seed (a–f: *Mereles* 2663; g, h: *Krapovickas* 45168; i, j: *Mereles* 5881). — Scale bars: a = 1 mm; b–d = 500 μm ; e = 100 μm ; f–j = 500 μm .

SEED MORPHOLOGY

Seeds of *Staelia* are light brown or dark brown, ellipsoid, subellipsoid or obovoid. The seed coat surface is reticulate-foveate, the exotesta cells are elongate, subcircular or polygonal and depressed, 22–50 µm long. At the ventral side, there are two narrow longitudinal furrows and between them rests of the placenta with numerous raphides (visible under a binocular microscope). The seeds are released by septifragal dehiscence, the fruit base and septum remaining on the short pedicel.

Seeds of *Staelia nelidae* are light brown, subellipsoid or obovoid, 0.9–1 by 0.5–0.6 mm (Fig. 3c–f), the seed coat surface is reticulate-foveate, the exotesta cells are elongate or subcircular and depressed (Fig. 3e), 22–50 µm long. The seeds of *S. thymoides* are ellipsoid and dark brown, 1.3–1.5 by 0.9–1 mm (Fig. 3g, h). *Staelia virgata* seeds are obovoid and light brown, 0.8–1 by 0.5–0.6 mm (Fig. 3i, j).

The seeds of *Staelia* species from Paraguay are uniform in seed morphology. Under binocular microscope they look very similar. The seeds of three species differ only in size and shape.

The pollen morphology of *Staelia* is similar to some species of genus *Mitracarpus* (Galati 1988), but the seed characters are very different. In *Mitracarpus* species the seeds are obovoid or spheroid, rarely ellipsoid or subellipsoid, at the dorsal side with or without cross-shaped depressions, at the ventral side with quadrangular, X- or Y-shaped inverted depressions (De Souza & De Sales 2001, Bacigalupo & Cabral 2005).

In *Staelia* both seeds are always developed, however, in some genera, as in *Diacrodon* Sprague, only one seed per fruit is developed (Sprague 1928).

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IDENTIFICATION LIST

1 = *S. nelidae* 2 = *S. thymoides* 3 = *S. virgata*

- Arbo 1685: 3 – Arenas 1717: 3; 1165: 3 – August 440: 3.
Balansa 1782: 2; 1783: 2 – Bordas 3603: 2; 4064: 2; 4398: 3.
Caballero 1559: 3.
Hassler 4032: 2; 6126: 2; 8158: 3; 12409: 2 – Herzog 1028: 3; 1896a: 3.
Krapovickas 45168: 2; 45476: 3.
Lorentz & Hieronymus 390: 3.
Mereles 2663: 1; 2919: 1; 5881: 3; 6352: 3; 6684: 3; 8055: 3.
Pedersen 9331: 2 – Pérez 2550: 3; 9285: 3; 9305: 3.
Ramella 2080: 1 – Rojas 2344: 3; 12626: 3.
Schinini 1340: 2; 2351: 3; 2704: 2; 2814: 2; 4353: 3; 14816: 3; 15100: 1.
Vanni 2057: 3.
Zardini 29335: 2; 37253: 3; 54348: 3.