

Schimmelmannia venezuelensis sp. nov. (Gloiosiphoniaceae, Rhodophyta) from Venezuela¹

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Schimmelmannia venezuelensis sp. nov. (Gloiosiphoniaceae, Rhodophyta) is described on the basis of sexual plants collected from the State of Vargas, Venezuela. This material had previously been identified as *Schimmelmannia plumosa* (Setch.) I.A. Abbott but has been observed to have a post-fertilization development that differs from all other species of the genus for which post-fertilization details are known. Because there is a direct fusion between the carpogonium and the auxiliary cell after fertilization (unlike the fertilized carpogonium undergoing one or more transverse divisions prior to contact with the auxiliary cell as in other *Schimmelmannia* species), the Venezuelan plants are described herein as a distinct species.

Keywords: Caribbean; Gloiosiphoniaceae; Rhodophyta; *Schimmelmannia venezuelensis* sp. nov.; Venezuela; western Atlantic.

Introduction

The genus *Schimmelmannia* Schousb. ex Kütz. is characterized by a compressed thallus, an obliquely dividing apical cell, an axial filament which is only obvious in apical regions and a terminal auxiliary cell on four to six-celled auxiliary cell branches (De Clerck *et al.* 2002). Presently, six species of *Schimmelmannia* are recognized: *S. bollei* Mont., *S. dawsonii* Acleto, *S. elegans* Baardseth, *S. frauenfeldii* Grunow, *S. plumosa* (Setch.) I.A. Abbott and *S. schousboei* (J. Agardh) J. Agardh. The species are discriminated on the basis of overall habit, branching, texture and post-fertilization details (De Clerck *et al.* 2002). The first western Atlantic report of the genus *Schimmelmannia* was by Gonzalez and de Rios (1974) based on collections in Venezuela identified as *S. plumosa*. Taylor (1976) subsequently illustrated and provided discussion of two species of the genus (based on collections from Venezuela made during 1964 through 1968), *S. plumosa* and *S. ? elegans*. Taylor (1976, p. 85) indicated that ‘until the genus is critically reviewed it seems best to assign to these Venezuelan plants the name of the best-known American species’ although *S. elegans* was previously known only from Tristan da Cunha (Baardseth 1941). *Schimmelmannia elegans* together with *S. plumosa* were included in the *Catalog of Venezuelan Algae* by Ganesan (1989). The for-

mer species has most recently been reported as a possible introduction in South Africa (De Clerck *et al.* 2002). Although Taylor (1976) provided vegetative morphological information, no examination of post-fertilization events was undertaken.

Pacific *Schimmelmannia plumosa* from California (Setchell 1912), Mexico (Aguilar-Rosas and Aguilar-Rosas 1996), Chile (Santelices and Abbott 1978, Santelices 1989) and Japan (Okamura 1927) is based on *Baylesia plumosa* Setchell (1912). Abbott (1961) transferred *Baylesia plumosa* to *Schimmelmannia*, merging the two genera based on details of the procarp. Among *Schimmelmannia* species, post-fertilization details are known only for *S. plumosa*, *S. schousboei* and *S. dawsonii*. In these species, the carpogonium divides one or more times following fertilization, and one of these division products fuses with the auxiliary cell (Kylin 1930, Abbott 1961, Acleto 1973, Sansón *et al.* 2002). Our examination of recently collected fertile male and female plants indicates a strong superficial resemblance to *Schimmelmannia plumosa*; however, details of reproductive events indicate that the Venezuelan plants represent an undescribed species.

Material and Methods

Specimens were preserved in 10 % formalin-seawater. Microscope slide preparations were stained with

¹ Submitted 6 January 2003; accepted 30 June 2003.

1% acidified aniline blue and mounted in 60% Karo® syrup. Photomicrographs using Kodak Pan Technical black and white film were taken through an Olympus BMAX 60 light microscope. Voucher specimens have been deposited in MSM, MICH, US and VEN (National Herbarium of Venezuela). Herbarium abbreviations follow Holmgren *et al.* (1990), and authority designations are according to Brummitt and Powell (1992).

Results and Observations

***Schimmelmannia venezuelensis* sp. nov.** (Figs 1–12)

Algae ad 25 cm altae, quatuor axibus eretis a singula basi discoidi artis vel axes plures e loco communi super hapteron producti; axes compressi, 2–5 mm lati, ramulis abundis pinnatis lateraliter dispositis, quibus sunt ipsi pinnatim ramosi; cellula axialis quatuor periaxialibus cellulis cincta; axis tandem magnis (usque 140 µm) parvisque cellulis rhizoidalibus obsessa; carpogonia post fecundationem putatam non dividentes; carposporophyta sphaerica, usque 190 µm diametro, immersa; carposporangia sphaerica, 20–25 µm diametro; spermatangia ab externa superficie thalli disjuncta; cellulae corticales externae spermatangiales cellulas producentes, suavice 4 vel plura spermatangia siguentes; spermatangia elongata, 5 µm longa, 2 µm lata; tetrasporophyta ignota.

Holotype: Leg. Mayra García 39, Carmen de Uria, Estado Vargas, Venezuela, [10°36' N, 66°48' W], 30.v.1998. In MICH.

Isotype: In VEN, MSM.

Additional specimens examined: *M.G.* 48, Carmen de Uria, Estado Vargas, Venezuela [10°36' N, 66°48' W], 6.vi.1998; *M.G.* 183, *ibid.*, 17.iii.1999. In MICH: *A. Parodi* 207, Playa Grande, Venezuela; *A. Parodi s.n.*, Estado Vargas, Venezuela, 10.x.1967; *Sepulvida s.n.*, *ibid.*, 15.i.1968.

Schimmelmannia venezuelensis has been collected from the State of Vargas, Venezuela, in a habitat where algae grow partially exposed on rocks in a high wave-energy environment. Plants are a deep wine-color and are lubricous to the touch. Algae are from 4 to 25 cm in height. They produce one to four erect axes from a basal discoid holdfast or additional axes generated from a common point above the holdfast. The axes are mostly simple, although occasionally variably branched (Fig. 1). Axes are compressed, to 5 mm broad, and abundantly clothed with laterally arranged pinnate determinate branchlets. First-order determinate lateral branches are typically to 1 mm, occasionally reaching 2 mm in length. They are themselves pinnately branched (Fig. 2).

Plants are uniaxial behind a prominent apical cell (Fig. 3). Axial cells cut off four periaxial cells (Fig. 4) which become radially elongate and cut off branched

files of cells extending towards the perimeter. The outermost cortical cells are spherical and highly pigmented. Uniseriate descending rhizoids are cut off by the periaxial cells and cells of the lateral filaments (Fig. 5). Mature principal axes in section are composed of large colorless medullary cells of rhizoidal origin, to 140 µm in diameter, which are surrounded by abundant smaller-diameter rhizoidal filaments (Fig. 6).

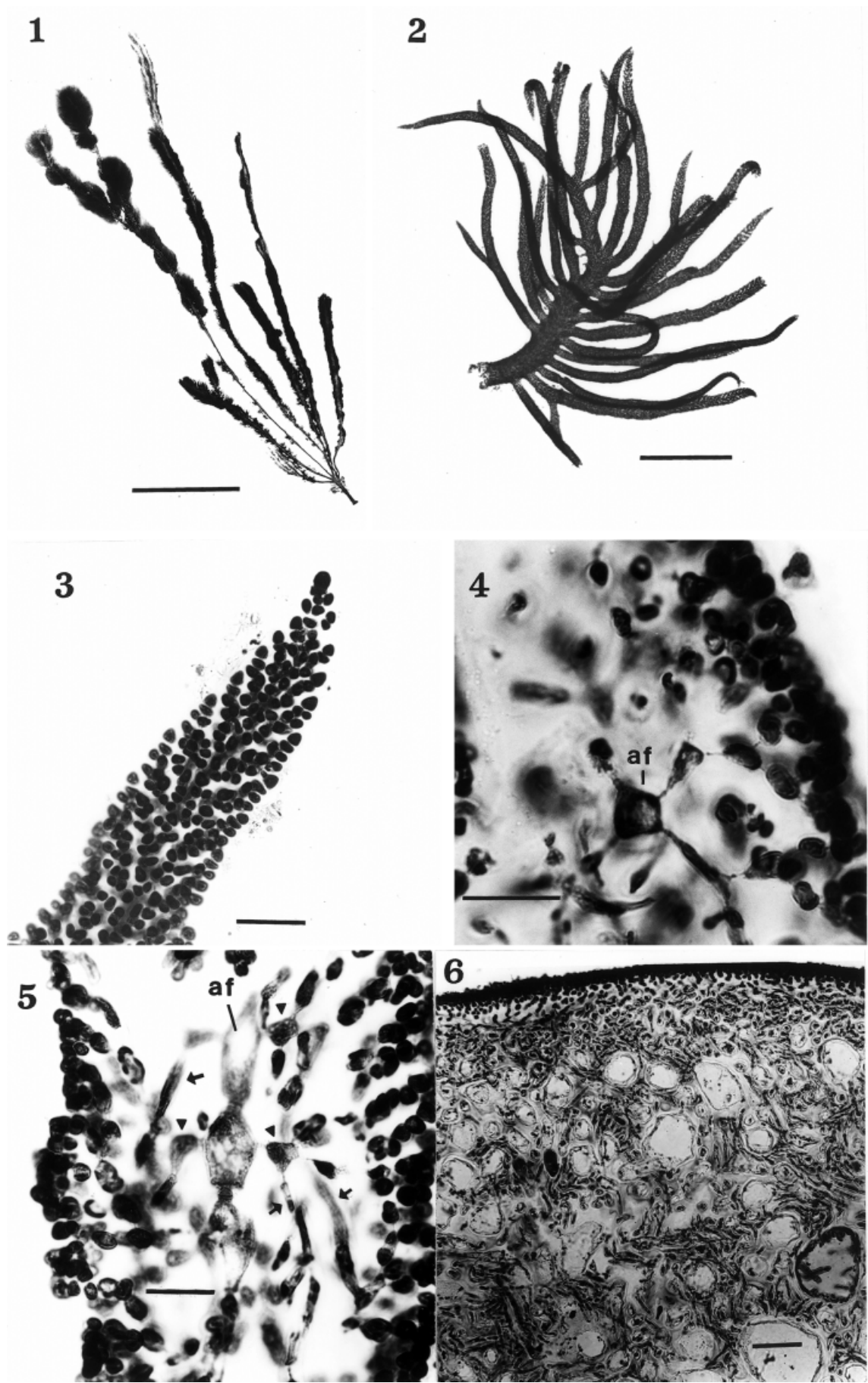
Plants are dioecious. On female plants, supporting cells are cut off from periaxial cells abaxially (Figs 7–10). The supporting cell then cuts off, also abaxially, a 4-celled carpogonial branch (Fig. 7). Procarys may be initiated from opposite periaxial cells originating from the same axial cell (Fig. 7). Carpogonial branches are curved back on themselves such that the carpogonium is in contact with the carpogonial branch cell which subtends the hypogenous cell (Fig. 8). At this time the trichogyne is swollen at the base and pinched off from the carpogonium (Fig. 8). An auxiliary cell branch (Fig. 8) is cut off from the same supporting cell as the carpogonial branch; however, it is not initiated until some point after formation of the carpogonial branch. The auxiliary cell branch, invariably five cells in length, possesses a terminal auxiliary cell which becomes enlarged in comparison with other auxiliary branch cells as it approaches the carpogonial branch (Fig. 8). The auxiliary cell continues enlargement and comes in contact with the carpogonium, and these cells presumably fuse directly (Fig. 9). The resultant fusion cell gives rise to the carposporophyte (Fig. 10). Mature carposporophytes are spherical to oblong in shape, measuring to 190 µm in diameter, and nearly all gonimoblast cells develop into carposporangia. Carposporangia measure from 20 to 25 µm in diameter. The mature carposporophytes are embedded within the female tissue, and the lateral branchlets are swollen locally around them (Fig. 11).

In male algae, spermatangia are cut off over the outer surface of the thallus. The outer cortical cells each cut off as many as 5 spermatangial mother cells. The spermatangial mother cells each cut off up to four spermatangia (Fig. 12). The spermatangia are elongate, measuring 2 × 5 µm. Tetrasporophytes were not observed.

Discussion

Our recent collections have been compared with the accounts provided by Taylor (1976) for *Schimmelmannia plumosa* and *S. ? elegans* and corresponding Venezuelan specimens deposited in MICH. The new species is clearly the same entity which Taylor referred to as *S. plumosa* and is remarkably similar vegetatively to *Schimmelmannia plumosa*. *Schimmelmannia venezuelensis* becomes the first species of the genus to be found outside of temperate waters.

De Clerck *et al.* (2002) indicated that *S. bollei*, *S.*



dawsonii and *S. plumosa* were all branched triquadripinnately. Although Taylor (1976) indicated that the latter species (based on his Venezuelan specimens) was bipinnate, Pacific specimens (Santa Cruz Island, collected by G. Hollenberg in the USA) are in fact, tripinnate. Thus the new species differs from *S. bollei*, *S. dawsonii* and *S. plumosa* in degree of branching. De Clerck *et al.* (2002) also indicated that only *S. elegans* and *S. frauenfeldii* were bipinnately branched although specimens of *S. schousboei*, the generitype, (in US and MICH) are only locally tripinnately branched. The new species differs from *Schimmelmannia elegans* in which the determinate lateral branchlets (referred to as pinnae) are secondarily branched in the second-order (Baardseth 1941, De Clerck *et al.* 2002). Vegetatively, *Schimmelmannia frauenfeldii* also differs from the new species in possessing longer and more widely spaced capillary ultimate ramelli (Baardseth 1941, Taylor 1976).

All species of *Schimmelmannia* have carpogonial branches borne on supporting cells which are cut off from the periaxial cells, and the carpogonial branch and the auxiliary cell branch are cut off from the same supporting cell. The new species differs from all other *Schimmelmannia* species for which reproductive details are known, by nature of lack of division of the carpogonium following presumed fertilization. The fertilized carpogonium in *Schimmelmannia plumosa* divides transversely, and the distal of these cells divides again (Abbott 1961). Subsequently, the

central of these division products fuses directly with the auxiliary cell. In the Peruvian *S. dawsonii*, the carpogonium also divides twice, and the central cell similarly fuses with the auxiliary cell (Acleto 1973). In *Schimmelmannia schousboei* the fertilized carpogonium divides only once, and the terminal cell formed from this division fuses with the auxiliary cell (Kylin 1930, 1956). Sansón *et al.* (2002), however, indicated that the carpogonium divides twice in this species.

The lack of division of the fertilized carpogonium in the new species is arguably a generic-level distinction. One of the distinctions between the ceramiacean genera *Aglaothamnion* and *Seirospora*, for example, is that the fertilized carpogonium divides once (prior to cutting off a connecting cell which makes contact with the auxiliary cell) in the former and does not divide in the latter genus (Kraft 1988, Aponte and Ballantine 1991, 1995). Nevertheless, given the essential vegetative identity between *S. plumosa* and the new species and the paucity of other differentiating characters, we have chosen not to erect a new genus for the Venezuelan alga.

Acknowledgements

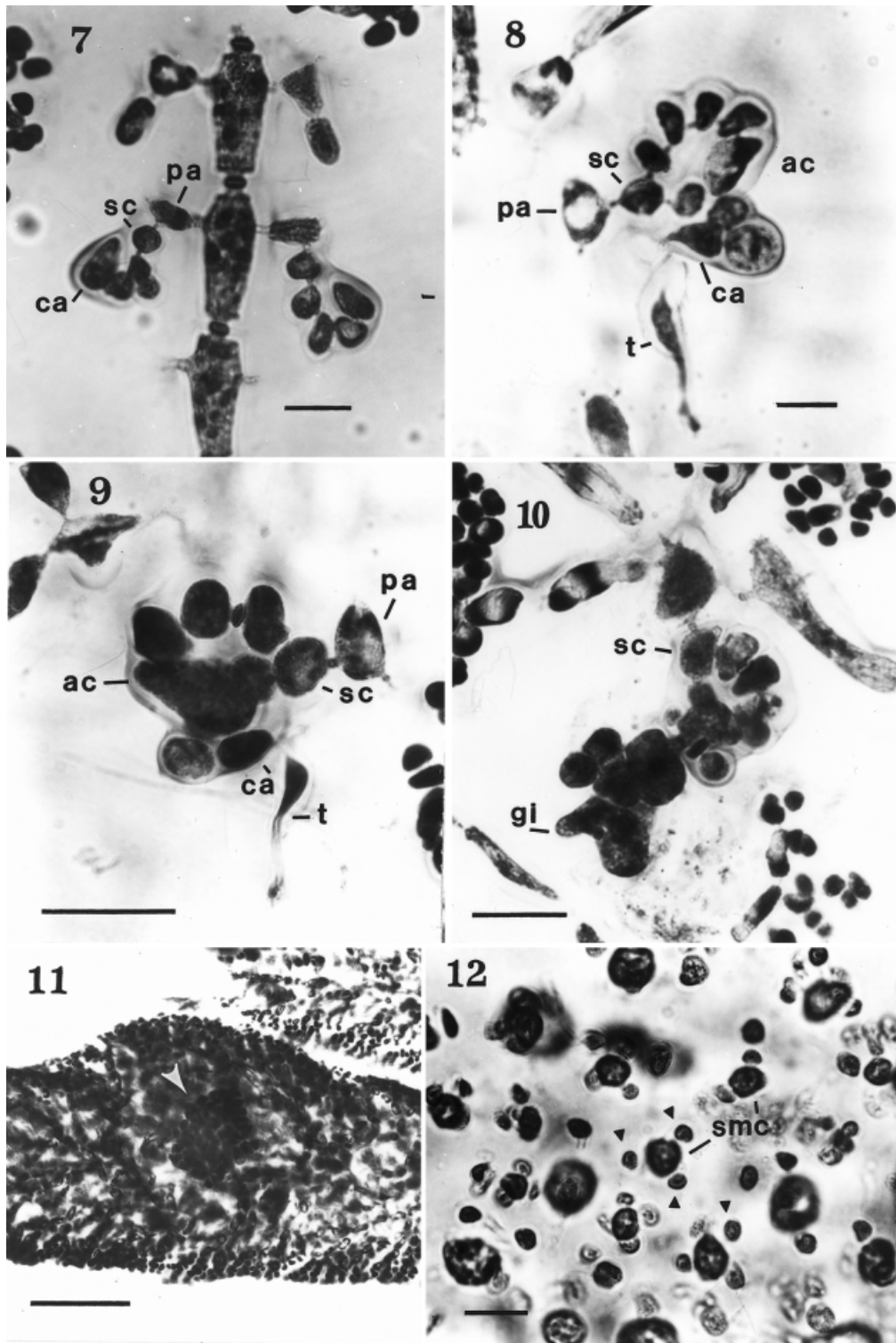
We are grateful for the loan of *Schimmelmannia* specimens from the U.S. National Herbarium. The suggestions of two anonymous reviewers improved the manuscript.

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Figs 1–6. *Schimmelmannia venezuelensis*.

Fig. 1. Habit of the holotype. Scale bar = 5.0 cm. Fig. 2. First-order determinate branchlet with second-order pinnate branching. Scale bar = 500 µm. Fig. 3. Branch apex showing prominent apical cell. Scale bar = 25 µm. Fig. 4. Transverse section through a young axis showing central axial filament and four periaxial cells. Scale bar = 25 µm. Fig. 5. Longitudinal section showing descending rhizoidal filaments (arrows) initiated from periaxial cells (arrowheads). Scale bar = 25 µm. Fig. 6. Transverse section through a mature axis showing enlarged rhizoidal cells with smaller diameter rhizoidal cells between. Scale bar = 100 µm. Figs 1–6 from Mayra García 39. Abbreviation: af = axial filament.



Figs 7–12. *Schimmelmannia venezuelensis*.

Fig. 7. Paired carpogonial branches initiated oppositely on the same axial cell prior to trichogyne formation or auxiliary cell branch initiation. Scale bar = 25 μm . Fig. 8. Procarp with carpogonial and auxiliary cell branches derived from the same supporting cell. Carpogonial branch is reflexed back on itself and the trichogyne is pinched from the carpogonium. The auxiliary cell branch is arched towards the carpogonium and the auxiliary cell has begun to enlarge. Scale bar = 10 μm . Fig. 9. Carpogonium in direct contact with auxiliary cell. Scale bar = 25 μm . Fig. 10. Gonimoblast initiation from auxiliary cell. Scale bar = 25 μm . Fig. 11. Determinate branchlet with embedded mature cystocarp (arrowhead). Scale bar = 100 μm . Fig. 12. Surface view with spermatangia (arrowheads) cut off from spermatangial mother cells. Scale bar = 10 μm .

Figs 7–10 and 12 from Mayra García 39; Fig. 11 from Mayra García 183 (= D.L.B. 5373). Abbreviations: ac = auxiliary cell; ca = carpogonium; gi = gonimolobe initial; pa = periaxial cell; sc = supporting cell; smc = spermatangial mother cell; t = trichogyne.

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