TÆNIOMA J. AG. FROM INDIA

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In 1848, J. Agardh described an alga from the Pacific coast of Mexico as *Polysiphonia perpusilla*. Later, in 1863, he created the genus *Tænioma* based on this species. A second species, *T. macrourum*, was described by Thuret (in Bornet and Thuret, 1876) from Tangier, Morocco. Farlow (1877) described a third species, *T. clevelandii*, which, however, has now been transferred to the genus *Platysiphonia* (Papenfuss, 1944, p. 206). Thus, there are only two species in the genus *Tænioma* and opinion is divided on the separation of these two. Bornet (1892) included *T. macrourum* Thuret under *T. perpusillum* J. Ag., and this has been accepted by a number of workers (De Toni, 1900; Howe in Thompson, 1910; Boergesen, 1919, 1930).

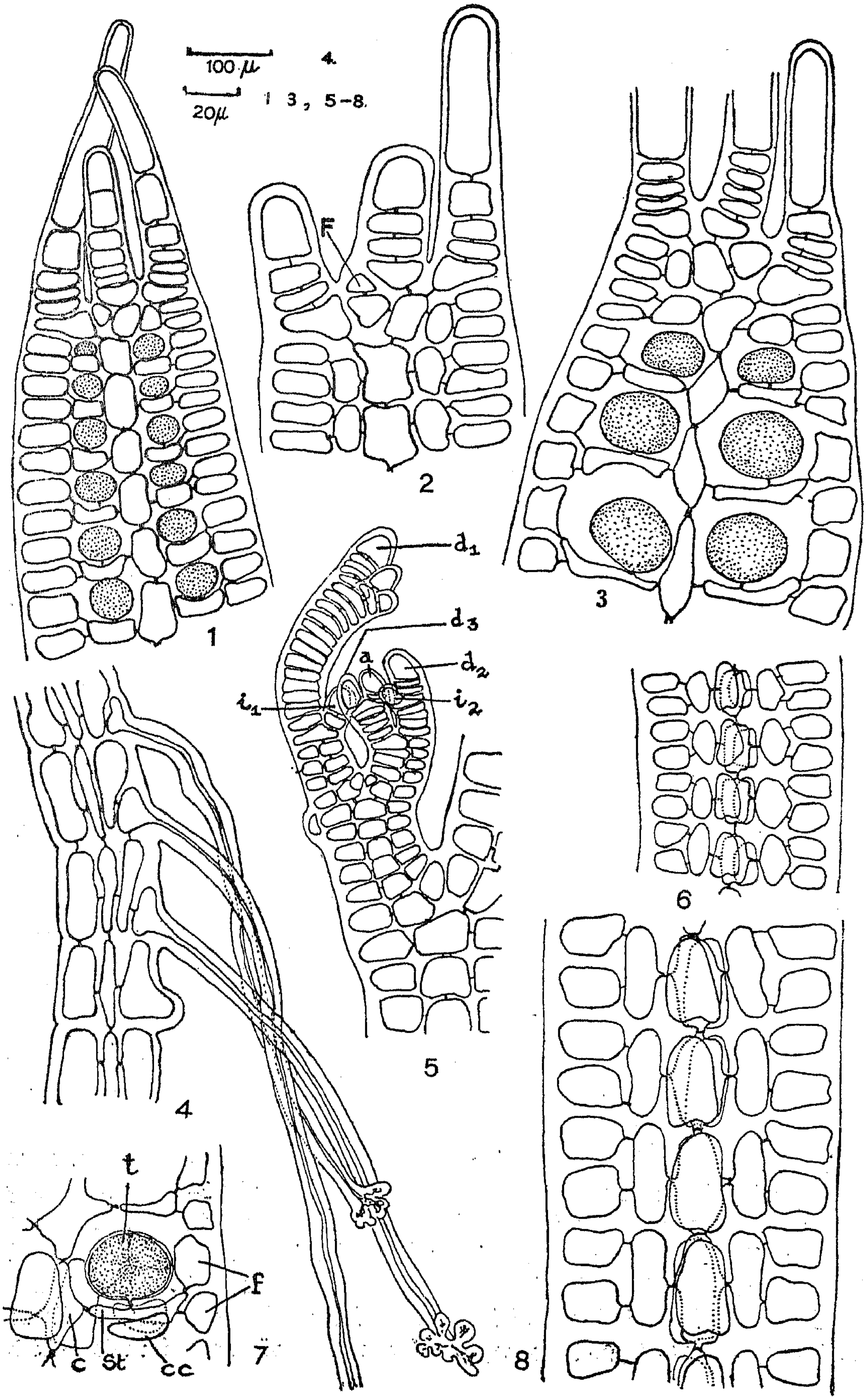
Falkenberg (1901) and Schiffner (1931) however, have kept the two separate. Recently, Papenfuss (1944) made an intensive study of *T. perpusillum* and maintained the separation of the two species (see also Tseng, 1944).

Polysiphonia nana was described by Kuetzing in 1863 and has been considered by Falkenberg (1901) and Boergesen (1919) as a synonym of *T. perpusillum*. Papenfuss (1952) examined Kuetzing's type material and transferred the species to *Tænioma* as *T. nanum* (Kuetz.) Papenfuss. He also considered *T. macrourum* and *T. nanum* identical and on the basis of priority accepted *T. nanum* as the valid binomial. Papenfuss (1944, 1952) thus recognises two species, *T. perpusillum* and *T. nanum*.

Papenfuss (1944) also gives the complete geographical distribution of these two species. It is evident that the genus has not so far been reported from India. The nearest known geographical situation is the Dirk Hartog Island (W. Australia) in the Indian Ocean and Arniston and Port Elizabeth in South Africa. The writers collected good material of this genus growing on *Laurencia* from Dwarka on the west coast of India. The material contained both the species and these are described here.

T. perpusillum

The Indian form is somewhat more robust than that described by Papenfuss. The prostrate creeping axis is anchored to the host plant by means of non-septate rhizoids (Text-Fig. 4). The erect secondary axes are produced on the dorsal side. Both the prostrate and erect axes are strictly monopodial



TEXT-FIGS. 1-8

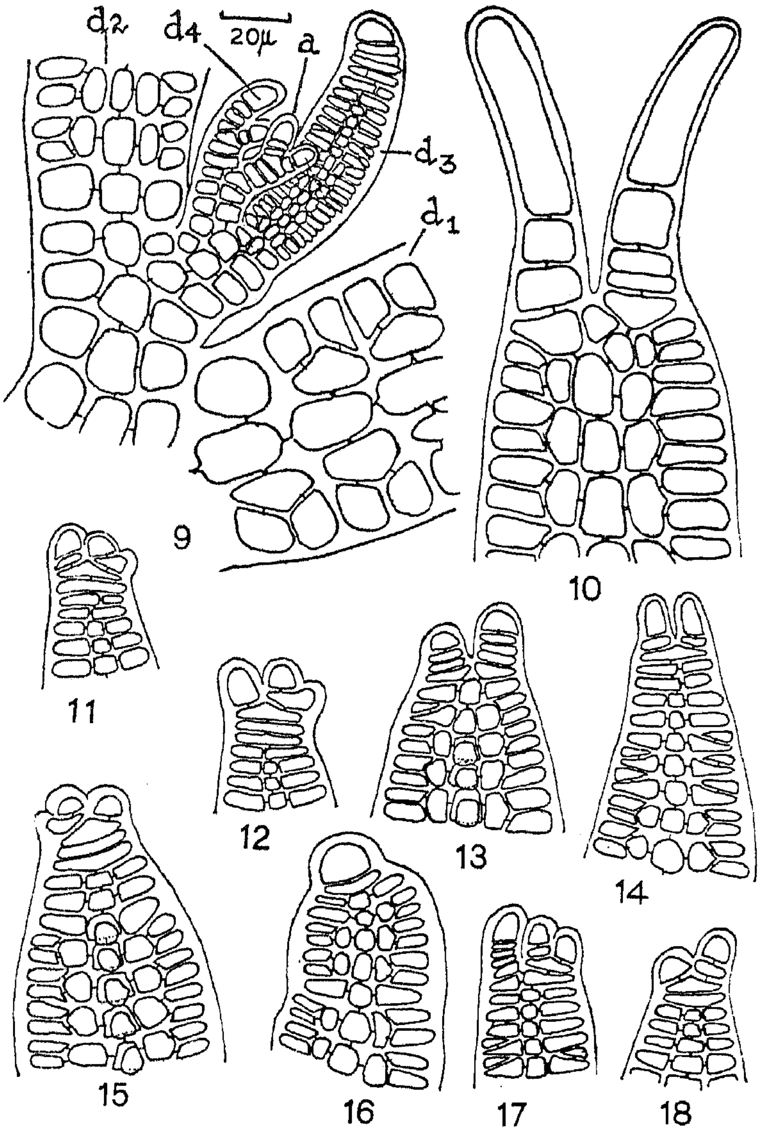
and growth is by means of an apical cell. This divides transversely and cuts off disc-shaped segments on the lower side. The indeterminate axes are polysiphonous, each segment having a central cell and four pericentral cells. The rhizoids arise as outgrowths from the ventral pericentral cells of the prostrate axes. Prostrate axes are 80–125 μ broad in the younger portions and 110–150 μ broad in the oldest portions.

The erect axes are arranged alternately at intervals of 4–8 segments on the dorsal side of the prostrate portion. In their turn, they give rise to alternate determinate laterals, starting from the 3–6 segments from the base and at intervals of 2–7 segments. In marked contrast to the indeterminate axes which are cylindrical, the determinate branches are flat and five cells in width except for the basal segments. Each determinate branch produces three, rarely two, hairs at the tip. With the initiation of these hairs, segment formation in the determinate branches ceases.

Even while quite young and only 2–3 segments long, each determinate branch initiates an indeterminate branch on the adaxial side (Text-Fig. 9). This in turn gives rise to a determinate branch of higher order which once again forms an indeterminate lateral, and so on repeatedly over and over again, so that a branch of one type gives rise always to a higher order branch of the opposite type. As a result of this frequent repetition of branching, the younger portions of the erect branches have a characteristically clustered appearance.

Branching in the prostrate and erect axes is exogenous, similar to that seen in *Polysiphonia* and other Rhodomelaceæ. The formation of a branch is initiated by an oblique division of the apical cell so that the segment formed is higher on one side. A protuberance is then formed on this higher side and this is cut off as the branch initial. Further divisions of this branch initial are transverse, giving rise to a monosiphonous filament whose segments then undergo division. The indeterminate branches produced adaxially on the determinate laterals are also likewise exogenous in origin. The erect axes as a rule produce determinate branches. The prostrate portion always gives rise to indeterminate axes.

The determinate laterals are formed alternately on the erect axes at intervals of 2–7 segments. As already stated, while only 2–3 segments long they produce exogenously indeterminate branches on the adaxial side (Text-Fig. 9). After production of these adaxial branches the apical cell of the determinate branch divides repeatedly to produce 15–23 segments. At this stage, the apical cell divides successively twice by oblique walls so that the determinate branch is topped by a set of three initials which



Text-Figs. 9–18

grow out into three monosiphonous hairs, situated at the tip of the branch (Text-Figs. 1–3). Not infrequently, the apical cell divides only once by an oblique wall. Then only two hair initials instead of three are formed and the determinate branch becomes crowned by two hairs (Text-Fig. 10). Very rarely, perhaps due to injury or other causes, even this division does not take place and we have the determinate branch crowned by a single apical cell (Text-Fig. 16).

Further segment formation in the determinate laterals ceases with the production of the hairs. Intercalary divisions of the basal cells in these hairs has not been observed (see also Papenfuss, 1944, p. 197).

After the formation of the hair initials, the other cells of the determinate branches undergo further development. Pericentral cells are produced and their formation follows the usual pattern in the Delesseriaceæ; *i.e.*, the two lateral pericentral cells are formed first. These two are not formed simultaneously. The two transverse pericentral cells are cut off later, after both the lateral pericentral cells have been formed. The transverse pericentral cells do not divide further. Each of the lateral pericentral cells cuts off two flanking cells, the upper flanking cell being always formed first (Text-Figs. 14, 17). Thus, the mature determinate branches are flat structures, five cells wide, are one layer thick at the margins and three cells thick at the midrib (Text-Figs. 6, 8). Fully mature determinate branches are 65–125 μ broad. The two hair-forming segments at the tip of the branch also divide in a fashion similar to that of other segments, but in the distal segment the lateral pericentral cell opposite to the attachment of the hair does not form flanking cells (Text-Figs. 1, 3). Rarely, however, it does divide once to form an upper flanking cell (Text-Fig. 2). Thus, in the construction of the determinate branches *Tænioma* conforms to the general pattern seen in the Delesseriaceæ. The formation of lateral organs before pericentral cell formation resembles the pattern of the Rhodomelaceæ.

The material showed abundant tetrasporangia. The development of the tetrasporangia is similar to that described by Thompson (1910) and Papenfuss (1944). The tetrasporangia are formed by the lateral pericentral cells of the determinate branches and in regular acropetal succession (Text-Figs. 1, 3). Each lateral pericentral cell of the fertile segment functions as a tetrasporangium-mother cell and divides by a concave transverse wall (Text-Fig. 20). Of the two cells thus formed, the upper cell is the tetrasporangium and the lower the stalk cell. The stalk cell remains attached to the corresponding flank cells, while the tetrasporangium is connected only to the stalk cell (Text-Figs. 1, 3, 7). The tetrasporangium enlarges and undergoes division into four tetrahedral spores. The stalk cell cuts off two cells, the cover cells, one on each side (Text-Fig. 7, *cc*). These cover cells do not divide further or even enlarge so that the tetrasporangium remains exposed throughout. The formation of cover cells subsequent to the initiation of the tetrasporangium conforms to the general pattern in the Delesseriaceæ. Fertile determinate branches become distended due to the enlargement of the tetrasporangia and measure from 100–150 μ in width. In other words, they widen to about 1½ times their original size.

Sexual plants were not seen in the material.

In the details of development and morphology, the writers' observations are in agreement with those of Papenfuss (*loc. cit.*).

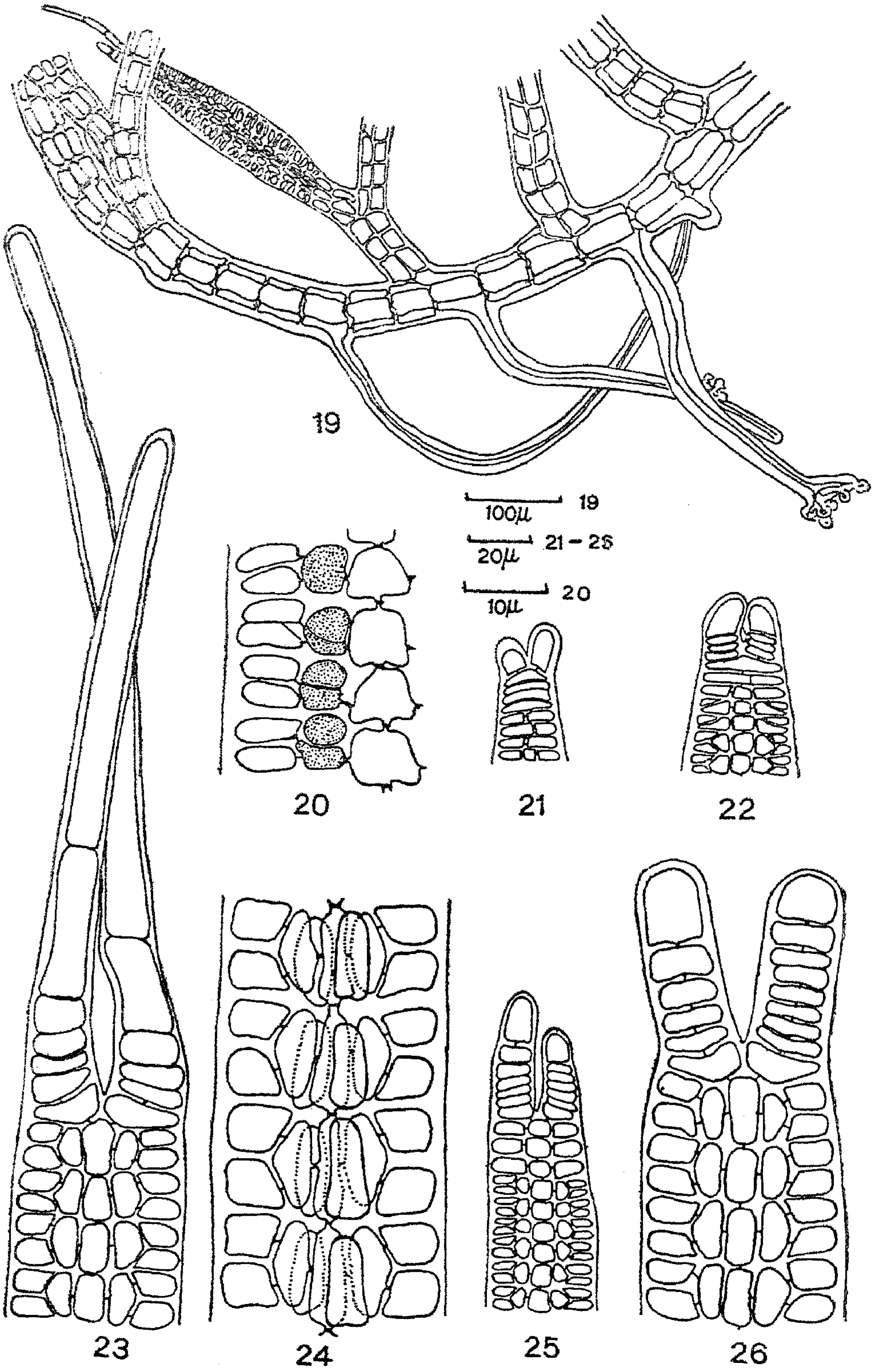
T. nanum

Only a few plants of this species were found intermixed with *T. perpusillum*. The plants are lighter in colour than those of *T. perpusillum*. The general habit is the same in the two species. The prostrate creeping axis is anchored to the host by non-septate rhizoids arising from the ventral pericentral cells. The tip alone is decumbent (Text-Fig. 19). The erect secondary indeterminate axes, similarly, are borne on the dorsal side at intervals of two to nine segments. Prostrate axes are 45 to 60 μ broad in younger parts and 60 to 100 μ in the old portions. Erect axes are 35 to 55 μ broad at the base. The construction plan of these axes is the same as in *T. perpusillum*, each segment having a central and four pericentral cells. The determinate branches are produced laterally on the erect axes starting from the fifth to the eighth segment from the base and at intervals of three to seven segments. As in *T. perpusillum*, the determinate laterals are flat, five cells in width and three cells thick in the middle (Text-Fig. 24). Pericentral cell formation in the segments is also quite similar (Text-Figs. 21, 22). Hair initiation takes place when the branch is 15–20 segments long. The apical cell divides once in an oblique fashion and the segment thus formed develops a hair on the higher side in true exogenous fashion. The apical cell grows out into the second hair (Text-Figs. 21, 22). Unlike in *T. perpusillum*, the number of hairs in this species seems very constant—there being always only two hairs, never three or one. Fully mature determinate branches are 50 to 95 μ broad.

While quite young and only two to three segments long the determinate branch forms an indeterminate branch initial on the adaxial side. This indeterminate branch develops a determinate lateral of the higher order and so on, just as in *T. perpusillum*. But while in the latter species there is a clustering at the tips owing to the frequency of this process, here the interval between the formation of successive branches is greater, leading to a general laxity in the branching. It was noted, however, that almost all the determinate branches produced adaxial branches near their base and that their production was not rare.

CONCLUSION

Tænioma is now represented by two species, *T. perpusillum* J. Agardh, 1863, and *T. nanum* (Kuetzing) Papenfuss (1952) (= *T. macrourum* Thuret in Bornet and Thuret, 1876). Bornet (1892), soon after the creation of



TEXT-FIGS. 19–26

T. macrourum reduced it to synonymy with *T. perpusillum* and this has been accepted by many workers. Falkenberg (1901) and following him Schiffner (1931) have, however, retained the two species distinct. The reasons which Falkenberg adduces for his stand are no longer tenable (see also Papenfuss, 1944). Recently Papenfuss (1944) (see also Tseng, 1944) has gone into this problem more thoroughly. He retains the two species distinct on two grounds. (1) In *T. perpusillum* the determinate branches invariably end in three hairs while in *T. nanum* (as *T. macrourum*) they end in two. (2) In *T. perpusillum* determinate branches form regularly adaxial indeterminate branches near the base while in *T. nanum* such branches are rare. Hence, the thallus is more profusely branched in *T. perpusillum* than in *T. nanum*.

The writers are in agreement with Papenfuss on the separation of the two species. Their present study confirms Papenfuss's observations on the two species. They found it easy to distinguish between the two species as the branching is much sparser in *T. nanum* than in *T. perpusillum*. Further, the prostrate and erect axes in the former species are also more slender. They have observed that in *T. perpusillum* the terminal hairs are usually three in number; but occasionally they have also seen two hairs. In *T. nanum* the hairs are always two in number and no case of formation of three hairs has been observed. Their other observations on the general features of thallus organisation are in full agreement with those of Papenfuss.

SUMMARY

Both the known species of *Tænioma, T. perpusillum* J. Ag. and *T. nanum* (Kuetz.) Papenfuss, are here reported for the first time from India. General features of thallus organisation in both species are described in detail. The development of tetrasporangia in T. *Perpusillum* is described. In general, the writers' observations are in agreement with those of Papenfuss. The taxonomy of the genus is discussed and the authors agree with Papenfuss in keeping the two species distinct.

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EXPLANATION OF TEXT-FIGURES

TEXT-FIGS. 1–8.—*Tænioma perpusillum.* Figs. 1, 3. Determinate branches showing three terminal hairs and tetrasporangia. Fig. 2. Tip of determinate branch showing production of an extra flanking cell (F) by the distal hair-forming segment. Fig. 4. Portion of prostrate axis showing rhizoids. Fig. 5. Apical portion of indeterminate branch showing two young determinate branches (d_1, d_2) each of which in turn has initiated indeterminate branches (i_1, i_2) on the adaxial side. The stem apex (a) has also initiated a determinate branch of the 3rd order (d_3) on the left. The oldest determinate branch (d_1), on the left, is in an early stage of hair formation. Figs. 6, 8. Parts of young and mature determinate branches showing the structure. Fig. 7. Part of segment of a determinate branch showing: (1) the central cell (c), (2) tetrasporangium (t), (3) the stalk cell (s), (4) the two cover cells (cc), and (5) the two flanking cells (f).

TEXT-FIGS. 9–18.—*T. perpusillum.* Fig. 9. Formation of adaxial branch by a determinate-lateral. d_1, d_2, d_3, d_4, d_5 denote determinate branches of the corresponding order. Fig. 10. Tip of determinate branch with two hairs instead of the normal three. Figs. 11, 12, 15, 17. Stages in hair initiation by determinate branches ending in three hairs. In Fig. 15 the transverse pericentral cells are also shown. Figs. 13, 14, 18. The same in determinate branches with two hairs.

In Fig. 13 transverse pericentral cells are also shown. Fig. 17. A determinate branch crowned by a single apical cell.

TEXT-FIGS. 19, 21–26.—*T. nanum.* Fig. 19. Habit showing prostrate and erect axes, rhizoids and a determinate branch. Figs. 21, 22, 25. Tips of young determinate branches showing hair formation. Fig. 23. Tip of the mature determinate branch with two hairs. Fig. 24. Part of a mature determinate branch to show organisation. Fig. 26. Upper part of mature determinate branch. TEXT-FIG. 20.—*T. perpusillum.* Part of young fertile determinate branch showing stages in the formation of tetrasporangia. Note concave wall in the lateral pericentral cells.

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