

Notes on some Indian Ustilagineae — V.

By M. J. Thirumalachar & M. S. Pavgi (Malleswaram, Bangalore, India).

With plate IV—V.

1. On a new genus of smut.

On the leaves of *Alisma* sp. a common aquatic weed, a leaf smut was collected in the vicinity of Banaras, which on examination proved to represent an undescribed genus of smut. Infection appear on the leaves as small diffuse yellow spots, often forming large patches by coalescence with each other. Sections through the infection spots reveal the presence of numerous spore balls which are permanently embedded within the mesophyll and somewhat resemble those found in the genera *Doassansia*, *Doassansiopsis* and *Burrillia* (Fig. 1). The spore balls are separate and occupy the entire space between epidermal layers in the leaf. In exsiccated material, the spore balls appear as tiny black pin points in the centre of yellowish-brown infection spot.

In sections through the sorus, the spore balls show the presence of fertile spores compacted together and inarching to a clathroid structure with a few irregular reticula (Figs. 3 & 4). Consequently, the spore balls are subspherical to stellate in outline (Fig. 2) and in the surface view, the space between the reticulum appear as labyrinthiform lacunae opening to the exterior. The marginal spores in the compact mass of fertile spores are angular, yellowish-brown in colour and closely adpressed to one another. The fertile spores inwardly disposed are spherical, somewhat paler in colour and loosely grouped (Figs. 3 to 5). The entire sorus is traversed by yellowish-brown sterile parenchymatous hyphal cells which interconnect the spore mass and fill the lacunae (Figs. 3 to 5). The space between the reticulum which is not filled up by the parenchymatous tissue appear in surface view of the spore ball as lacunae. The yellowish-brown parenchymata are not comparable in structure with the sterile cortical cells of *Doassansia* or *Doassansiopsis*, nor resemble those of *Dermatosorus* Sawada (apud Ling 1949).

The spores were teased out and germinated on slides in moist chamber. Germination was observed in a few cases after 3 days incubation in moist chamber. The promycelium developed a whorl of 4 to 6 sporidia as in the case of *Tilletiaceae* (Fig. 13). Details regarding the further behaviour of the sporidia are not known.

As regards the identity of the smut, comparative studies indicate that it is closely related to genera like *Doassansiopsis*, *Doassansia* and *Burrillia* in having permanently embedded spore balls within the host tissue and in being a member of the *Tilletiaceae*. However, in none of these and other smut genera so far known, the clathroid type of arrangement of the fertile spores exists. The presence of yellowish-brown sterile parenchymata composed of small hyphal cells, does not resemble that present in *Dermatosorus eleocharidis* Saw. An examination of the type slide of *D. eleocharidis* obtained through the kindness of Dr. Lee Ling has pointed out that the smut under study has no resemblance with *Dermatosorus*. The spores are stated to be in loose spore balls in *Dermatosorus* comparable with that in *Sorosporium*. But the examination of the type slide showed that the massing of the spores into massulae was only secondary, possibly due to the binding effect of the sterile parenchymata. The discussion given above points out that the smut under study belongs to a new genus of the *Tilletiaceae*, and the name *Narasimhania*, named in honour of Prof. M. J. Narasimhan, Mycologist, Mysore, is proposed.

Narasimhania Thirumal. & Pavgi gen. nov.

Sori in the leaves, minute, black, permanently embedded; spore balls permanent, composed of yellowish-brown fertile spores grouped into compact masses in the form of irregular clathroid structure, interconnected and traversed by yellowish-brown sterile parenchymata. Fertile spores germinating by a whorl of 4 to 6 sporidia as in the *Tilletiaceae*.

Type species: *Narasimhania alismatis* Pavgi & Thirumal.

Sori in foliis oriundi, minuti, nigri, innati; sporarum glomeruli permanentes, e sporis fertilibus, luteo-brunneis, massam compactam, quoad structuram irregulariter clathroideam formantes, parenchymate sterili luteo-brunneo conjuncti et decussati. Sporae fertiles sporidiis 4—6 verticillatim dispositis ut in *Tilletiaceis* germinantes.

Narasimhania alismatis Pavgi & Thirumal. sp. nov.

Infection spots pale yellow, 3 to 6 mm. in diameter, often coalescing to form large irregular patches. Sori in the leaves, minute, dark, permanently embedded; spore balls permanent, subglobose to spherical, often lobed along the margin and appearing stellate, composed of yellowish-brown fertile spores grouped into compact masses in the form of irregular clathroid structure, marginal spores subglobose to polygonal, yellowish-brown, closely adpressed to each other and flattened on the contiguous side smooth,

7.5—15 $\Rightarrow$ 6.6—9 μ , inner spores spherical, smooth, paler in colour, measuring 10.5 to 15 μ in diam with a mean of 12.2 μ . Sori traversed by yellowish-brown sterile parenchymatous cells which interconnect the spore masses and fill up the lacunae. Fertile spores germinating by a promycelium bearing a terminal whorl of 4 to 6 sporidia.

Hab. On the leaves of *Alisma* sp., Banaras, U.P., 12. Sept. 1951, leg. M. S. Pavgi (Type). Type deposited in Herb. Crypt. Ind. Orient. New Delhi, in Herb. C. M. I., Kew England, and in the Mycological Herb. U.S.D.A., Beltsville, Maryland, USA.

Maculae pallide luteae, 3—6 mm. diam., saepe confluentes et magnam folii partem occupantes. Sori foliicoli, minuti, omnino innati; sporarum glomeruli subglobosi vel globosi, ad marginem saepe lobati tunc fere stellati, e sporis fertilibus luteo-brunneis densissime clathroideo-aggregatis compositi; sporae marginales subglobosae, luteo-brunneae, e mutua pressione plus minusve applanatae et angulosae, leves, 7.5—15 $\Rightarrow$ 6.6—9 μ ; sporae interiores globosae, pallidiores, leves 10.5—15 μ plerumque 12.2 μ diam. Spatia inter sporas interjecta cellulis sterilibus luteo-brunneis, saepe contextum pseudoparenchymaticum formantibus complentur. Sporae fertiles promycelio sporidiis 4—6 terminalibus germinantes.

Hab. in foliis *Alsimatis* sp. Banaras, U.P., 12 Sept. 1951, leg. M. S. Pavgi (Typus).

2. *Entyloma speciosum* Schroet. & P. Henn., Hedwigia XXXV, 220. 1896.

Hab. On the leaves of *Paspalidum* (*Panicum*) *flavidum* A. Camus., Majhagawan, U.P., 6th. Oct. 1951, leg. M. S. Pavgi.

The sori appear as dull greyish linear streaks on the leaves and the sheathing leaf bases. The sori are non-erumpent, formed in the hyaline cells surrounding the bundles. The type was collected in Tubarao (Brazil) on *Panicum* species. Clinton (1906) and later on Jackson (1918) record this species on *Panicum proliferum* Lam. and *P. dichotomiflorum* Michx, in USA. Butler and Bisby (1931) recorded from Bangalore, India, what they considered to be *E. speciosum* on *Panicum* species. An examination of this material deposited in Herb. Crypt. Ind. Orient. New Delhi has revealed it to be *Melanotaenium brachiariae* Viegas, the host being *Brachiaria* (*Panicum*) *distachya* Stapf. The spores of *E. speciosum* on *Panicum flavidum* are 7 to 12.5 μ in diameter with a mean of 9.5 μ and dark reddish-brown in colour similar to *Melanotaenium* (Fig. 6) rather than *Entyloma*. Examination of this smut on *Panicum proliferum* in USA. has shown the same characters. In the absence of having the benefit of examining the type of the species, we defer transferring it under *Melanotaenium*.

3. Ovaricolous smut on *Panicum trypheron* Nees.

Tilletia narasimhanii Thirumal. & Safee and *T. narayanaraoana* Mundkur & Thirumal. have previously been reported from India on the ovaries of *Panicum trypheron*. Another ovaricolous *Tilletia* species differing from the above two species were collected on the same host near Patna, Bihar, during the months of October. The infected ovaries were slightly hypertrophied, 4 ± 2 mm. partially covered by the glumes, rupturing at maturity and exposing the brownish-black (Fig. 7) powdery spore mass. Mature spores are reddish-brown, subglobose to spherical, $16.5\text{--}23\ \mu$ in diameter with a mean of $20.5\ \mu$. The epispore is thick, covered with aculeate spines which are broad at the base (Fig. 8). The sterile cells are pale yellow, smooth, $12\text{--}16.5\ \mu$ in diameter. Comparative studies indicate that the smut should be referred to *Tilletia verrucosa* Cke. & Massee reported on species of *Panicum*. There is no previous record of this smut in India.

4. *Tilletia perotidis* Thirumal. & Pavgi sp. nov.

Sori in the ovaries, few spikelets in the panicle infected, inconspicuous, showing slight or no hypertrophy, black, 3 to 4 mm. long, 1 mm. broad, rupturing at maturity and exposing black dusty spore mass. Mature spores brownish-black, subglobose to spherical, $23\text{--}30\ \mu$ in diameter with a mean of $26.3\ \mu$; epispore thick, sculptured with blunt pyramidal processes. Sterile cells numerous, intermixed with spores, hyaline, smooth, $13\text{--}18.5\ \mu$ in diameter.

Hab. in the ovaries of *Perotis indica* L. Patna, Bihar, 21 Oct. 1951, leg. M. J. Thirumalachar & M. S. Pavgi.

Sori in ovariiis evoluti, pauci, inconspicui, nigri, $3\text{--}4 \pm 1$ mm., in maturitate disrumpentes et massam sporarum nigram pulverulentam liberantes. Sporae brunneo-nigrae, plus minusve globosae, $23\text{--}30\ \mu$, plerumque $26.3\ \mu$ diam., episporio crasso, processibus pyramidalibus obtusiusculis ornato. Cellulae steriles numerosae, sporis intermixtae hyalinae, leves, $13\text{--}18.5\ \mu$ diam.

Habitat in ovariiis *Perotidis indicae* L., Patna, Bihar, 21 Oct. 1951, leg. M. J. Thirumalachar et M. S. Pavgi.

While collecting and examining *Tilletia ahmadiana* Pavgi & Mundkur on *Perotis indica* near Patna, Bihar, the association of another *Tilletia* species which could be easily distinguished by its larger spores and different type of spore sculpturing was observed on the same host species. There were no macroscopic differences between the two bunts as regards sorus structure etc. As regards the spore structure, *T. ahmadiana* has smaller spores ($16\text{--}21\ \mu$ with a mean of $18.6\ \mu$) and the exospore is covered with irregular warts (Fig. 10). In *T. perotidis* on the other hand, the spores are larger in

size (23—30 μ with a mean of 26.3 μ) and the exospore has pyramidal processes giving a serrated appearance for the margin of the spore in the sectional view (Fig. 11).

5. *Tilletia digitaricola* Pavgi & Thirumal. sp. nov.

Sori in the ovaries, few spikelets in the panicle becoming infected, appearing as dark wrinkled bodies, 2 mm. long, slightly protruding out of the glumes; spore mass black, dusty, getting exposed at maturity; spores brownish-black to opaque, subglobose to spherical, 19—24 μ in diameter with a mean of 21.5 μ ; epispore thick, covered with flat truncate scales which impart a warty appearance to the spore; sterile cells numerous, intermixed with spores, hyaline to pale cinnamon-yellow, thick-walled, smooth, 15—22.5 μ in diameter.

Hab. in the ovaries of *Digitaria royleana* Prain, Allahabad, U.P., 17 Oct. 1951, leg. M. S. Pavgi (Type), in *Digitaria adscendens* Heus. var. *fimbriata* (Stapf) R. & S., Allahabad, 17 Oct. 1951, leg. M. S. Pavgi, and Patna, Bihar, 18 Dec. 1951, leg. M. J. Thirumalachar.

Sori ovaricoli, pauci verruculosi, fusci, 2 mm. longi e glumis parum emergentes; sporae plus minusve globosae, nigrae 19—24 μ , plerumque 21.5 μ diam.; episporio crasso, densissime verrucoso; cellulae steriles numerosae, hyalinae vel pallide cinnamomeo-luteae, crassae parietibus praeditae, leves, 15—22 μ diam.

Habitat in ovariis *Digitariae royleanae* Prain. (Figs. 14 to 17).

The sori of the smut are very inconspicuous and can be collected in the field only after considerable search. In the maturing panicles of *Digitaria royleana* and *D. adscendens* var. *fimbriata*, the healthy seeds are shed earlier than the infected ones, so that, the smutted spikelets may be located during this stage. *Tilletia digitaricola* is distinct from *T. calospora* Pass. reported on species of *Andropogon*.

6. *Sorosporium aristidae-cyananthae* (Bref.) Zundel (in litt.).

Syn. *Ustilago aristidae-cyananthae* Bref.

Sphacelotheca aristidae-cyananthae (Bref.) Pavgi & Mundkur.

Ustilago aristidae-cyananthae was described by Brefed (1895) on *Aristida cyanantha* collected from India by Cunningham. The same smut was collected by R. S. Hole in 1908 from Dehra Dun, India and was referred to *U. aristidae-cyananthae* Bref. by Sydow H. & P. and Butler (1906), and later confirmed to be identical with the type material by Pavgi and Mundkur (1948). Butler and Bisby (1931) make the remark that Magnus (in Bornmuller Iter Syriacum 1897. Fungi Verhandl. der K. K. Zool.

Bot. Ges. Wien, L. pp. 434, 1900) states that this fungus or a near ally received from Dr. Gamble in Dehra Dun as *Ustilago aristidae* Peck is really a *Sorosporium*. Pavgi and Mundkur (1948) transferred the fungus under *Sphacelotheca* as *S.aristidae-cyananthae* (Bref.) Pavgi & Mundkur. In the meanwhile Zundel independently transferred the smut to the genus *Sorosporium*, and the new combination *Sorosporium aristidae-cyananthae* (Bref.) Zundel has remained a part of his unpublished monograph. However in the notes given by Dr. J. A. Stevenson (Mycologia 43: p. 270, 1951) it is stated that Dr. Lee Ling who studied authentic material concurs with the identification of the smut as *Sphacelotheca aristidae-cyananthae* (Bref.) Pavgi & Mundkur.

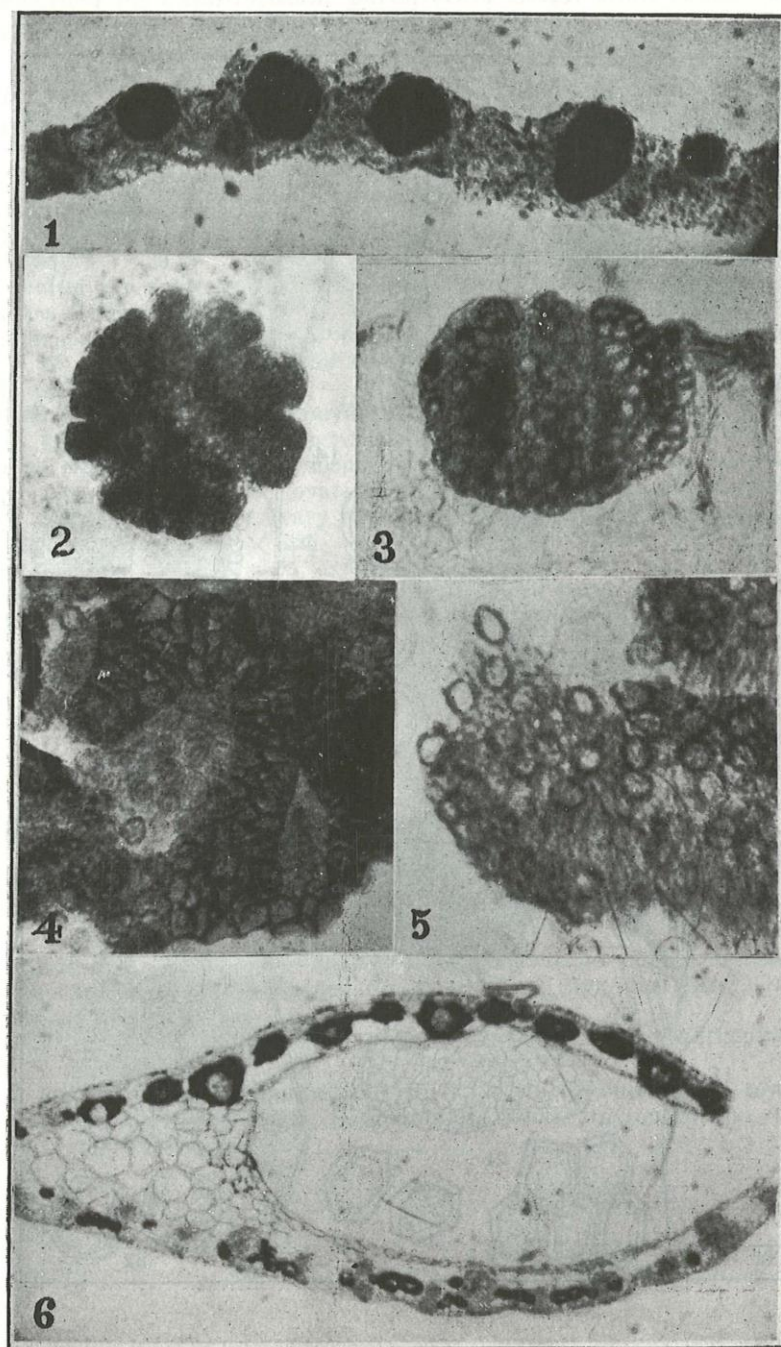
Opportunity to examine the collection of the smut made by R. H. Hole studied by Pavgi and Mundkur, and two other collections made by Dr. Gamble near Dehra Dun (F. R. I. Nos. 264 and 266) became available through the kindness of Dr. K. Bagchee, Forest Research Institute, Dehra Dun. Sori were sectioned and examination of different stages of spore development were followed. The spores are developed in firmly united spore balls, which however are flattened and discoid. The glomeruli remain firmly united in some sori even at maturity, while in others they get separated away. Observations have confirmed that the smut is a *Sorosporium* and it has no characters to warrant its inclusion under *Sphacelotheca* (Figs. 18 to 22.).

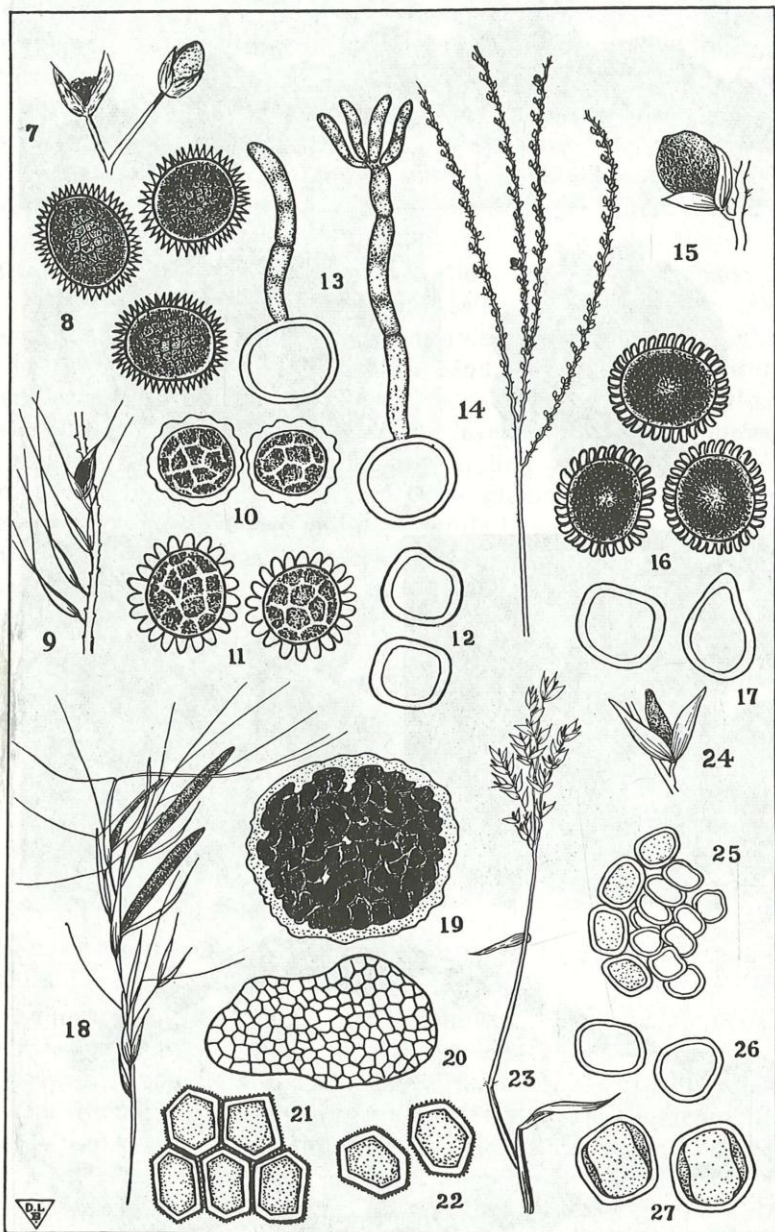
7. *Sphacelotheca mysorensis* Pavgi & Thirumal. sp. nov.

Sori destroying the ovaries in the inflorescence, 2 to 3 mm. long, covered by a false membrane light brown in colour and evanescent; spore mass reddish-brown, surrounding a central columella; sterile cells compact, often in groups, pale cinnamon-yellow, subglobose to angular. smooth, 7 to 11 μ in diameter. Spores globose to subglobose, olivaceous-brown, 10.5 to 15 μ in diameter with a mean of 12.2 μ ; episporio thick, smooth.

Hab. in the ovaries of *Capillipedium hugelii* (Hack.) A. Camus., Bedur, Shimogga, Mysore, May 1951, leg. B. T. Lingappa.

Sori ovariicoli, 2—3 mm. longi, primum in vagina nidulantes, membrana falsa dilute brunnea et evanescente tecti; sporarum massae rufo-brunneae, columellam centralem circumdantes; cellulis sterilibus saepe glomeratis, pallide cinnamomeo-flavis tecti; sporarum massae rufo-brunneae, columellam centralem circumdantes; cellulis sterilibus saepe glomeratis, pallide cinnamomeo-flavis, globosis vel angulosis, levibus, 7—11 μ diam. Sporae plus minusve globosae, olivaceo-brunneae, 10.5—15 μ , plerumque 12.2 μ diam., episporio crasso, levi.





Habitat. in ovariis *Capillipedii hugelii* (Hack.) A. Camus. (Figs. 23 to 27). The fungus is different from *S. capillipedii* Ling recorded on *Capillipedium parviflorum* Stapf. from China (Ling. 1945).

In conclusion we wish to express our gratitude to Dr. F. Petrák, for kindly translating the descriptions of the new genus and species into Latin.

Explanation of plate IV—V.

1. T. S. of the leaf of *Alisma* showing the spore balls of *Narasimhanian alismatis*. $\times 30$. — 2. Surface view of the spore ball $\times 100$. — 3. Sectional view of the spore ball $\times 300$. — 4. Showing the clathroid nature of the mass of fertile spores $\times 350$. — 5. Crushed spore ball to show the spores and parenchymata $\times 350$. — 6. Showing the sori of *Entyloma speciosum* $\times 30$. — 7. Sorus of *Tilletia verrucosa* on *Panicum trypheron* $\times 2.5$. — 8. Chlamydospores $\times 625$. — 9. Sorus of *Tilletia perotidis* on *Perotis indica* $\times 1.5$. — 10. Chlamydospores of *Tilletia ahmadiana* $\times 750$. — 11. Chlamydospores of *T. perotidis* $\times 500$. — 12. Sterile cells of *T. perotidis* $\times 500$. — 13. Chlamydospore germination in *Narasimhanian alismatis* $\times 750$. — 14. Smutted ovaries of *Digitaria adscendens* var. *fimbriata* $\times 0.5$. — 15. Infected ovary of the same $\times 5$. — 16. Chlamydospores of *Tilletia digitaricola* $\times 625$. — 17. Sterile cells of the same $\times 625$. — 18. Sori of *Sorosporium aristidae-cyananthae*. Nat. size. — 19. T. S. through the sorus $\times 15$. — 20 and 21. Spore balls $\times 400$ and 1250 . — 22. Chlamydospores $\times 1250$. — 23. Smutted inflorescence of *Capillipedium hugelii*. Nat. size. — 24. Infected ovary $\times 5$. — 25. Chlamydospores and sterile cells $\times 500$. — 26. Sterile cells $\times 500$. — 27. Enlarged view of the chlamydospores $\times 750$.

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