Taxonomy of *Neovossia horrida* (Ustilaginales)

R. A. Singh, M. D. Whitehead and M. S. Pavgi

Faculty of Agriculture, Banaras Hindu University, India.
Georgia State University, Atlanta, Georgia, U. S. A.

Summary. Morphological, cultural and cytological studies on the smut fungus inciting kernel bunt of rice (*Oryza sativa* L.) indicate that it should be correctly retained in the genus *Neovossia* as *Neovossia horrida* (Takahashi) Padwick & Azmatullah Khan.

In 1879 Körnicke described the genus *Neovossia* as having sori generally in ovaries, forming a somewhat dusty spore mass; spores simple, produced singly or in the swollen and special fertile threads (sterigmata of Magnus), which permanently invest the spores and taper into elongated hyaline appendages of large size; germination by a short promycelium producing numerous terminally clustered linear sporidia, which germinate without conjugation and in nutrient solutions give rise to a mycelium producing secondary sporidia of 2 kinds (Zundel 1953).

Neovossia horrida (Takahashi) Padwick & Khan, the incitant of kernel bunt of rice, was first described by Takahashi (1896) from Japan as *Tilletia horrida* Takahashi and independently by Anderson (1899) from the United States as *Tilletia corona* Scib. It was later transferred to the genus *Neovossia* Körnicke as *N. horrida* (Tak.) Padwick & Khan (1944). Tullis & Johnson (1952) synonimized it to *N. barclayana* Bref. Fischer & Holton (1957) and Duran & Fischer (1961) maintain the pathogen as *Tilletia barclayana* (Bref.) Sacc. & Syd. Singh & Pavgi (1972) studied the cytology of the pathogen and emphasized that the fungus should be retained in the genus *Neovossia* as *N. horrida*. The taxonomy of the fungus has since remained in dispute being transferred back and forth between *Tilletia* and *Neovossia*. This paper is an attempt to evaluate the morphological, cultural and cytological characters in the light of generic characters to determine the taxonomic position of the pathogen.

The young sorus of the pathogen enclosed between the aleuron layer, seed coat and glumes later ruptures at maturity exposing a mass of powdery teliospores. The teliospores are oval to spherical, dark brown to black, opaque, thickwalled, measuring 22.5—28.5 × 20—25 µm. The episporium is ornamented with light brown, tapering pointed awl-shaped spines. The spore remains invested in a hyaline,

gelatinous sheath to which hyphal fragments occasionally remain attached like an appendage. The teliospore germinates with a stout promycelium bearing a whorl of (32—76) terminal sporidia. Discharged *en masse* they are hyaline, acicular, curved, occasionally septate, do not fuse in compatible pairs and measure 43.7—58.7 × 1.3—1.5 μm. The primary sporidium forms a small sterigmate projection from any point, on which an allantoid, hyaline secondary sporidium (7.5—13.7 × 1.2—1.8 μm) is produced.

In culture, the fungus produces dull white mycelial and/or sporidial colonies. The septate branched mycelium bears short tapering lateral processes, resembling the sterigmata on which 2 types of sporidia, acicular and allantoid, are borne, resembling the primary and secondary sporidia respectively (Singh & Pavgi 1975).

The cytology of teliospore germination revealed that the diploid nucleus undergoes meiosis followed by an equational division in the spore after its activation. When a promycelium is formed, daughter nuclei migrate into it and continue to divide mitotically. After the formation of a terminal whorl of sporidia, one nucleus migrates into each sporidium and the sporidia become detached from the promycelium. The sporidium nucleus divides mitotically, forming a binucleate sporidium. A lateral sterigmate process is formed on the sporidium, on which a hyaline, allantoid, uninucleate, occasionally binucleate sporidium is borne. Such secondary sporidia may be produced in succession on the primary sporidia. The secondary sporidium forms an infection thread or may bud smaller, hyaline, elliptical conidia indefinitely. Conjugation between sporidia and/or secondary sporidia has not been observed at any stage of development (Singh & Pavgi 1972).

Tullis & Johnson (1952) inoculated 25 seedlings of rice and *Pennisetum* species with a culture suspension of *N. horrida* and secured infection on only 4 plants of *Pennisetum glaucum* (L.) R. Br. and 2 of *P. alopecuroides* (L.) Spreng. No infection was reported to have occurred on rice. Cross inoculations with secondary sporidia from sori of *P. glaucum* and *P. alopecuroides* failed to produce kernel infection in rice. They found that the spores produced on *Pennisetum* species were essentially identical with those of *Neovossia barclayana* Bref. except for slightly larger and more conspicuous markings on the spore of *N. horrida*. They synonimized it as *N. barclayana* on the basis of priority. Their inoculation experiment implies that the pathogen brings about seedling infection but it is now known that infection by the rice pathogen takes place in the flower, and not in the seedlings. This leaves doubt regarding validity of their results and they further confused the taxonomy of the pathogen. Duran & Fischer (1961) regarded the mature teliospores of the pathogen more representative of the genus *Tilletia* than *Neovossia*. They further asserted that

nonfusion of (homothallic) sporidia claimed for *Neovossia* also occurred in *Tilletia elymi* DIETEL & HOLWAY, *T. scrobiculata* FISCHER, *T. cerebrina* ELL. & EV. and few other species (HOLTON 1952, MEINERS 1957, SIANG 1954). In the species of *Tilletia* cited as homothallic by DURAN & FISCHER (1961), the number of primary sporidia is less than 8 and more than one nucleus migrates into each sporidium due to a lesser number of sporidia (5, 6 or 8), consequently behaving as homothallic. It is possible that 2 compatible nuclei might be passing into each sporidium, a condition construed for homothallism. As such none of the species mentioned by them is homothallic in the true sense of the term.

Differentiation of genera and/or species in the smut fungi merely on the basis of spore morphology would lead to erroneous conclusions, since the teliospore morphology in smuts is so simple that the characters often overlap between various species and between genera. FISCHER & SHAW (1953) suggested that the concept of speciation in smut fungi should be based on a practicable degree of morphological variation and on host specialization at the host family level. Dr. M. J. THIRUMALACHAR (personal communication) laid emphasis on developmental morphology of the sorus, morphology of teliospores and their germination and the biology of the smut fungus including its host specificity or range of pathogenicity and mode of dispersal of infective propagules in distinguishing members of Ustilaginales.

Regarding the large number of sporidia produced in *Neovossia* as a differentiating character, DURAN & FISCHER (1961) have mentioned that "Since spore germination is unknown in many species of *Tilletia*, it is impossible to determine the importance of primary sporidia in differentiating members of the 2 genera". This is untenable being merely based on assumptions, since no species of *Tilletia* has so far been shown to produce a large number of sporidia.

The morphological, cultural and cytological details of the rice bunt fungus conform with the generic characters of *Neovossia* and to those delineated by PADWICK & AZMATULLAH KHAN (1944). The fungus, therefore, should be correctly referred as *Neovossia horrida* (TAKAHASHI) PADWICK & AZMATULLAH KHAN.

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