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Stereostratum corticioides (Berk. & Broome) H. Magn. rust on *Phyllostachys bambusoides* Siebold & Zucc. from Arunachal Pradesh, India

Arunachal Pradesh, the largest of the northeastern states of India, with its many forest types[1] and large forest cover (80.43%)[2] supports a rich biodiversity of plants and animals. It is considered as one of the 200 biologically valuable eco-regions of the world[3]. However, the phytopathogenic fungal diversity of this eastern Himalayan state has not been explored to any extent. Here we report the occurrence of the culm rust fungus on a bamboo species from Ziro valley of Arunachal Pradesh.

Ziro Valley (1700 m amsl with a mean annual rainfall of 1500 mm) in the Lower Subansiri district is the home of the Apatani tribe of Arunachal Pradesh. It supports temperate forests with many plant species including the bamboo *Phyllostachys bambusoides* Siebold & Zucc. (Japanese timber bamboo, called 'Tanii-Bije' in Apatani) which is restricted to this region[4]. The Apatanis cultivate this bamboo as monoculture or with pine (*Pinus kesiya*, *Pinus roxburghii*, *Pinus wallichiana* and *Pinus merkusii*) along the periphery of their crop fields. *P. bambusoides* is a non-clump forming bamboo with creeping rhizomes. The culms are strong, slender, hollow and green and grow up to 6 m in height. The Apatanis use it for various purposes including house construction, roofing, as water pipes, thatches, for making fences, fish nets, religious altars, burial cemetery, weapons such as bows, arrows and spears and hunting traps; the tender shoots are consumed as food.

We collected the rust fungus on the culms of the bamboo from the villages of Hong, Hija, Hari, Bulla, Siiro, Salaya and Manipolyang and also from the township areas of Ziro valley such as Hapoli and old Ziro. The *Corticium*-like sori of the fungus which are red to rust brown in colour and present on the culms (Figure 1) were scrapped and collected for further examination. Microscopic examination of the large sori from the surface of bamboo culms revealed the presence of teliospores. The sori were sub-epidermal and bore numerous stalked teliospores. The teliospores were globose, two-celled, with three germ pores in each cell, hyaline, thin-walled, smooth, not constricted at the septa and without any apical thickening. They measured 20–30 × 20–25 µm (Figure 1). At a later stage, yellow urediospores were produced in striate sori. The urediospores were ellipsoid, echinulate with 2 or 3 pores and measured 16–25 × 15–20 µm. Based on these characteristics, the rust was identified as *Stereostratum corticioides* (Berk. & Br.) Magn[5].

DNA was extracted using modified cetyltrimethyl ammonium bromide (CTAB) method[6]. ITS1 and ITS4 primers were used for amplifying the nuclear ribosomal internal transcribed spacer (ITS) portion[7]. The PCR reaction mixture had 1× PCR buffer (Fermentas, USA), dNTPs (200 µM), 1.5 mM $MgCl_2$, primers (0.1 µM), *Taq* DNA polymerase (2.5 U) and template DNA (100 ng) in a final volume of 50 µl. The PCR reaction was done using a Veriti 96-well thermocycler (Applied Biosystem, USA) with denaturation at 94°C for 5 min followed by 35 cycles at 94°C for 1 min, 50°C for 1 min (annealing) and 72°C for 1 min; this was followed by a final extension of 72°C for 10 min. The size and purity of the amplified products were checked by electrophoresis on 1% agarose gel. Gel elution method was used to purify the PCR products. They were then sequenced using ITS1 and ITS4 primers. The ITS sequences were then matched with those in GenBank databases using BLAST search to find the possible homologous sequences of the newly sequenced taxa. The sequences of closely related fungi were retrieved and the phylogenetic tree was reconstructed using the MEGA6.1 software[8]. The bootstrap values were derived from 1000 replicate runs to assess the reliable level for the nodes of the tree. The sequence generated in this study was submitted to the NCBI GenBank database under the accession number MF141901.

BLASTN analysis revealed that the sequence had 99% sequence similarity (94% query coverage area) with *Stereostratum corticioides*. Phylogenetic analysis also clustered the sequence with *S. corticioides* separating other species into different lineages (Figure 2). This rust was first described by Berkeley and Broome as *Puccinia corticioides*[9]. Based on sample collected from Japan in 1899, it was later described as *Stereostratum corticioides* by Magnus[5]. A brief description of this rust fungus was made by Thirumalachar[9] from a 'small fragment of the specimen' received by him from the Natural History Museum, Stockholm.

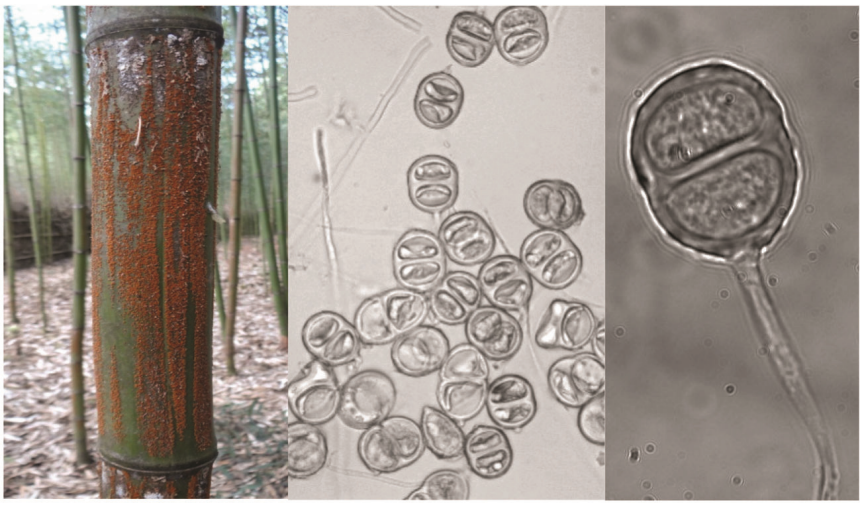

Figure 1. *Stereostratum corticioides* rust on culms of *Phyllostachys bambusoides* in Ziro valley and its two celled teliospores.

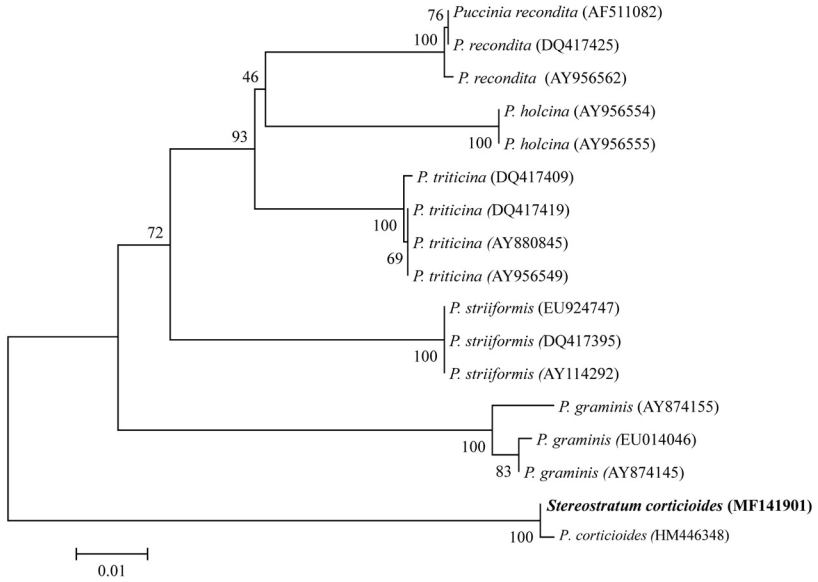

Figure 2. Neighbour-joining tree from ITS sequences showing the relationship between *Stereostratum corticioides* (previously known as *Puccinia corticioides*) of the present study and other closely related *Puccinia* species retrieved from the GenBank. Bootstrap values (1000 replicates) are shown on the branches. Bar = 1 nucleotide substitutions per 100 nucleotides.

According to Thirumalachar, the teliospores produced in very large sized sori are characteristic of this fungus[9].

Earlier studies from India have reported rusts on bamboos[10]. We describe here the occurrence of *Stereostratum corticioides*, an obligate fungal pathogen causing the culm rust disease of a bamboo in Arunachal Pradesh. This rust has been reported from China, Japan and Pakistan[11]. It causes serious culm rust disease on *P. bambusoides* in China[12] and also infects 16 other species of bamboo. It produces urediniospores and teliospores on bamboo; an alternate host is unknown for this rust[11]. In Ziro valley, the maturity of *P. bambusoides* is indicated by the shedding of its leaves and the green stem turning yellow due to the appearance of the rust fungus[13]. Locally known as *Taipona*, the rust usually begins appearing during the month of March. The sori on the culms are scrapped and chewed by the Apatanis. The current report is noteworthy since according to Hyde *et al.*[14], of the more than 1100 fungi associated with bamboo species, relatively fewer are known from India.

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Seed transmissibility of *Pepper mottle virus*: survival of virus

PepMoV was first recognized in Arizona (USA) in 1969 as a new strain of potyvirus that infected peppers. It was first reported from Palm Beach County, Delray Beach, Florida, (USA)[1–3] in *Capsicum annuum*. Recently, the virus has been reported from other pepper growing countries of the world, such as Taiwan, India, Korea, China, Japan, Cuba[4–9]. Indian chilli (*Capsicum annuum*) is infected by potyviruses such as *Potato virus Y* (PVY) and *Pepper veinal mottle virus*[10,11]. Sandhu and Chohan[12] reported PepMoV for the first time in 1979 from Punjab on serology study basis which was later molecularly characterized in 2014 (refs 5, 12). PepMoV is transmitted by insects, i.e. many species of *Aphis* namely *gossypii*, *craccivora* and *Myzus persicae* in a non-persistent manner in the field[13]. The virus belongs to most important family