

= Spongiforma =

Spongiforma is a genus of sponge @-@ like fungi in the Boletaceae family . Newly described in 2009 , the genus contains two species : *S. thailandica* and *S. squarepantsii* . The type species *S. thailandica* is known only from Khao Yai National Park in central Thailand , where it grows in soil in old @-@ growth forests dominated by dipterocarp trees . The rubbery fruit bodies , which has a strong odour of coal @-@ tar similar to *Tricholoma sulphureum* , consists of numerous internal cavities lined with spore @-@ producing tissue . *S. squarepantsii* , described as new to science in 2011 , is found in Malaysia . It produces sponge @-@ like , rubbery orange fruit bodies with a fruity or musky odour . These fruit bodies will ? like a sponge ? resume their original shape if water is squeezed out . The origin of the specific name derives from its perceived resemblance to the cartoon character SpongeBob SquarePants . Apart from differences in distribution , *S. squarepantsii* differs from *S. thailandica* in its colour , odour , and spore structure .

= = Description = =

The fruit bodies of *Spongiforma* species have a brain @-@ like to sponge @-@ like form , and grow on the surface of the ground . They do not have a stalk , and lack a layer of outer skin . The small cavities (locules) of the fruit body are irregular in outline and measure between 2 and 20 mm (0 @-@ 08 and 0 @-@ 8 in) in diameter . They are lined with a smooth , greyish @-@ orange to brown or reddish brown hymenium (spore @-@ bearing tissue) , with sterile ridges that range in colour from white to cream . The columella (a column @-@ like structure extending up into the fruit body) is poorly developed , pear @-@ shaped , cream @-@ coloured , and attached at the base to white rhizomorphs . The basidiospores are brown to vinaceous @-@ brown in mass , almond @-@ shaped , bilaterally symmetrical , and finely wrinkled . Spores bear a central apiculus (a region that was once attached to the sterigmata at the end of a basidium) and a small apical pore . The spores are reddish @-@ brown in water , violet grey in 3 % potassium hydroxide , inamyloid , and cyanophilic (turning red in the stain acetocarmine) . The basidia are four @-@ spored , and do not discharge the spores forcibly . Cystidia are common on the sterile locule edges ; they are hyaline (translucent) and range in shape from cylindrical to ventricose (swollen in the middle) or rostrate (with a beaklike proboscis) . The hyphae of the flesh are gelatinous and inamyloid . Clamp connections are absent from the hyphae .

= = Taxonomy and naming = =

The type species *S. thailandica* was first described scientifically in 2009 by Egon Horak , Timothy Flegel and Dennis E. Desjardin , based on specimens collected in July 2002 in Khao Yai National Park , central Thailand , and roughly three years later in the same location . Before this , *S. thailandica* had been reported and illustrated in a 2001 Thai publication as an unidentified species of *Hymenogaster* .

S. squarepantsii was first described scientifically in 2011 in the journal *Mycologia* , authored by a team headed by Desjardin with Kabir Peay , and Thomas Bruns . The description was based on two specimens collected by Bruns in 2010 in Lambir Hills National Park , in Sarawak , Malaysia . The species was first mentioned in the scientific literature in 2010 in a study of the ectomycorrhizal mushrooms in a tropical dipterocarp rainforest in Lambir Hills , although it was not formally described in this publication .

The genus name *Spongiforma* refers to the sponge @-@ like nature of the fruit body . The specific epithet *thailandica* denotes the country in which the type species is found ; the epithet *squarepantsii* honors the well @-@ known cartoon character SpongeBob SquarePants . The unusual epithet garnered the species attention in the popular press .

= = Phylogeny and classification = =

Molecular analysis of the DNA sequences of the internal transcribed spacer (IT) region of *S. thailandica* showed that the species was part of the Boletineae , one of several lineages of Boletales recognized taxonomically at the level of suborder . The similarity between *S. thailandica* and *S. squarepantsii* was confirmed with molecular analysis , which showed a 98 % match between large subunit ribosomal DNA sequences of the two ? a value typical of many species in the same genus of Boletaceae . *Spongiforma* is sister (sharing a common ancestor) to the genus *Porphyrellus* ; *Spongiforma* and *Porphyrellus* form a clade that is sister to *Strobilomyces* . All three genera are members of the Boletaceae family .

The phylogenetic relationships determined by molecular techniques are not consistent with a classification scheme based on similarities in spore morphology . Several bolete taxa have been proposed to accommodate species with reddish @-@ brown to vinaceous @-@ brown , finely wrinkled (rugulose) to perforated or punctate spores ; these include *Boletus* subgenus *Tylopilus* , *Tylopilus* subgenus *Porphyrellus* , *Austroboletus* , or *Porphyrellus* . *Austroboletus tristis* and *A. longipes* , two species from Southeast Asia , share several spore characteristics with *Spongiforma thailandica* . All three species have spores with rugulose surfaces , sometimes with minute punctures , and the spores turn purple in potassium hydroxide . Additionally , the pores from the three species share similar surface ornamentation visible with scanning electron microscopy . In contrast to *Spongiforma* , however , *Austroboletus* spores do not have an apical pore . Genetic analysis shows that *Spongiforma* is more closely allied with the smooth @-@ spored *Porphyrellus* than with the rugulose @-@ punctate @-@ spored *Austroboletus* .

Relatively few boletes have an apical pore at the distal end of their basidiospores . The dark reddish @-@ brown , smooth spores of *Porphyrellus amylosporus* are truncate with a thin @-@ walled depression . Some species of *Heimioporus* have spores with apical pores , but molecular analyses demonstrate that *Heimioporus* is only distantly related to *Spongiforma* .

Spongiforma further resembles *Austroboletus* and *Porphyrellus* species in the cellular structure of the cap cuticle (pileipellis) . The arrangement , known as a trichodermium , features the outermost hyphae emerging roughly parallel , like hairs , perpendicular to the surface of the fruit body . The trichodermium comprises chains of short , cylindrical to somewhat moniliform cells (resembling a string of beads) with terminal (end) cells that are cylindrical to club @-@ shaped . This cellular arrangement is similar to that present in the sterile edges of the tissues that demarcate the locules in *Spongiforma* . According to Desjardins and colleagues , this may represent vestiges of what was once cap cuticle or peridial tissue in an ancestor . *Spongiforma* is the only genus of the Boletales that forms above @-@ ground fruit bodies that lack a peridium and have many exposed locules lined with basidia that do not forcibly discharge spores .

= = Ecology , habitat and distribution = =

Both species of *Spongiforma* are known only from their original collection locations . *S. thailandica* was found growing on the ground in an old growth forest in Khao Yai National Park (Nakhon Nayok Province , Thailand) , at an elevation of about 750 metres (2 @,@ 460 ft) . The fungus is thought to grow in a mycorrhizal association with *Shorea henryana* and *Dipterocarpus gracilis* , species considered to be endangered and critically endangered , respectively , by the International Union for Conservation of Nature . *Spongiforma squarepantsii* was collected from the ground where it was growing solitarily under undetermined dipterocarp trees in Lambir Hills National Park (Sarawak State , Malaysia) , northern Borneo . This tropical rainforest receives about 3 @,@ 000 mm (120 in) of rain yearly , with average temperatures ranging from 24 to 32 ° C (75 to 90 ° F) . *Spongiforma* species have lost the ability to eject their spores forcefully , and have distinctive odours , suggesting that the fungus relies on the activity of animals to help disperse spores . Because the island habitat of the genus restricts gene flow and because the two known species are separated by considerable distance geographically , the authors suggest that other unexplored , isolated tracts of dipterocarp forests between Thailand and Malaysia may contain additional species .