= Suillus spraguei =

Suillus spraguei is a species of fungus in the Suillaceae family . It is known by a variety of common names , including the painted slipperycap , the painted suillus or the red and yellow suillus . Suillus spraguei has had a complex taxonomical history , and is also frequently referred to Suillus pictus in the literature . The readily identifiable fruit bodies have caps that are dark red when fresh , dry to the touch , and covered with mats of hairs and scales that are separated by yellow cracks . On the underside of the cap are small , yellow , angular pores that become brownish as the mushroom ages . The stalk bears a grayish cottony ring , and is typically covered with soft hairs or scales .

Suillus spraguei grows in a mycorrhizal association with several pine species , particularly eastern white pine , and the fruit bodies grow on the ground , appearing from early summer to autumn . It has a disjunct distribution , and is found in eastern Asia , northeastern North America , and Mexico throughout the range of the host tree . The mushroom is edible , although opinions about its quality vary . The mushroom bears a resemblance to several other Suillus species , including the closely related S. decipiens , although the species can be differentiated by variations in color and size .

= = Taxonomy , phylogeny , and naming = =

Suillus spraguei has had a complex taxonomic history . Although the first specimen was originally collected in New England in 1856 by Charles James Sprague , a formal scientific description was not published until 1872 when Miles Joseph Berkeley and Moses Ashley Curtis called it Boletus spraguei . In a publication that appeared the following year , American mycologist Charles Horton Peck named the species Boletus pictus . Berkeley and Curtis had also described what they believed to be a new species ? Boletus murraii ? although this was later considered by Rolf Singer to be merely a younger version of their Boletus spraguei . Although Peck 's description appeared in print in 1873 , the date stamp on the original publication revealed that he had sent his documents to the printer before the appearance of the 1872 Berkeley and Curtis publication , thus establishing nomenclatural priority under the rules of fungal naming . However , in 1945 Singer reported that the name Boletus pictus was illegitimate because it was a homonym , already being used for a polypore mushroom described by Carl Friedrich Schultz in 1806 . The name was officially switched to Suillus spraguei in 1986 (Otto Kuntze had previously transferred the taxon to Suillus in 1898) .

A 1996 molecular analysis of 38 Suillus species used the sequences of their internal transcribed spacers to infer phylogenetic relationships and clarify the taxonomy of the genus . The results indicate that S. spraguei is most closely related to S. decipiens . The species S. granulatus and S. placidus lie on a branch sister to that containing S. spraguei . These results were corroborated and extended in later publications that assessed the relationships between Asian and eastern North American isolates of various Suillus , including S. spraguei . The analysis supported the hypothesis that Chinese and U.S. S. spraguei and S. decipiens were each other 's closest relatives , and the clade that contained them could be divided into four distinct subgroups : S. decipiens , U.S. S. spraguei , China (Yunnan) S. spraguei , and China (Jilin) S. spraguei .

The specific epithet spraguei is an homage to the collector Sprague , while pictus means " painted " or " colored " . Suillus spraguei is commonly known as the " painted slipperycap " , the " painted suillus " , or the " red and yellow suillus " . It is also called the " eastern painted Suillus " to contrast with the " western painted Suillus " (Suillus lakei) .

= = Description = =

The cap of the fruit body is 3 to 12 cm (1 @.@ 2 to 4 @.@ 7 in) in diameter , and depending on its age , is either conic to convex , to somewhat flattened at maturity . The cap margin is initially rolled downward before straightening out , often with hanging remnants of partial veil (appendiculate) . The cap surface is covered with densely matted filaments that are rough and scale @-@ like . The scales are pink to brownish red , fading to a pale brown @-@ gray or dull yellow in maturity . Under the scales , the cap surface is yellow to pale yellow @-@ orange . While many other Suillus species

have a sticky or slimy cap , S. spraguei is dry . The flesh is yellow .

The pores on the underside of the cap are yellowish and angular , measuring 0 @.@ 5 to 5 mm (0 @.@ 02 to 0 @.@ 20 in) wide , and formed by tubes that extend 4 to 8 mm (0 @.@ 2 to 0 @.@ 3 in) deep . These pores have a slightly decurrent attachment to the stem (extending down its length) . Young specimens have a whitish fibrous partial veil that protects the developing pores ; as the cap expands it rips the veil , which remains as a grayish ring on the stem . The stem is 4 to 12 cm (1 @.@ 6 to 4 @.@ 7 in) long , and 1 to 2 @.@ 5 cm (0 @.@ 4 to 1 @.@ 0 in) thick , roughly cylindrical in shape , or sometimes with a bulbous bottom so as to be somewhat club @-@ shaped . The stem surface is tomentose , with scales at the top , and a ring on the upper half of the stem . Below the ring the stem is fibrillose , covered with a mat of soft hairs . Its color at the top is yellow , but with wine @-@ red to reddish @-@ brown scales below , underlaid with a pale yellow to grayish color . The stem is usually solid , rarely hollow . The tissue of all parts of the fruit body ? cap , pores , and stem ? will turn brownish shortly after being bruised or injured .

In deposit , such as with a spore print , the spores of S. spraguei appear olive @-@ brown in color , although this changes to clay or tawny @-@ olive after drying . Microscopically , the spores have smooth surfaces , measuring 9 ? 11 by 3 ? 4 @.@ 5 µm ; in side profile they have asymmetrical sides and a suprahilar depression (a surface indentation formed where the spore attaches to the basidia) , while in face view they appear oblong . The spores are not amyloid , meaning that they do not absorb iodine when stained with Melzer 's reagent . The basidia (the spore @-@ bearing cells in the hymenium) are thin @-@ walled , four @-@ spored , and have dimensions of 17 ? 19 by 5 ? 7 @.@ 8 µm . In the presence of potassium hydroxide , they appear hyaline (translucent) , and they become pale yellow to nearly hyaline in Melzer 's reagent .

Various parts of the mushroom display characteristic color reactions to chemical tests commonly used in mushroom identification . The cap cuticle will turn a blackish color with the application of a drop of potassium hydroxide (KOH) , iron sulfate (FeSO4) solution , or ammonia solution . The mushroom flesh turns grayish @-@ green to greenish black with a drop of FeSO4 , and olive to greenish black with KOH or NH4OH .

= = = Edibility = = =

Suillus spraguei is an edible mushroom . Its taste is not distinctive , although the odor has been described as " slightly fruity " . Although it turns a blackish color when cooked , some consider it choice , and " among the better edibles in the genus Suillus . " In contrast , another source on mushrooms of Québec described the mushroom as a poor edible (" comestible médiocre ") , and warned of a slightly acidic taste and disagreeable flavor . Michael Kuo 's 2007 book 100 Edible Mushrooms rates the taste as mediocre , suggesting " its sluglike consistency has all the palatability of unflavored gelatin . " The book recommends frying the thinly sliced mushroom in butter or oil until it acquires a crispy texture .

= = = Similar species = = =

S. spraguei is a popular edible among novice mushroom hunters as it is readily identifiable due to both its appearance and its association with White Pine . Although this distinctiveness renders it unlikely to be confused with other species , it does share similar characteristics with several other Suillus species . S. spraguei bears some resemblance to the rosy larch bolete (S. ochraceoroseus) , but the latter species has a darker spore print , a thicker stem , and grows in association with larch . S. cavipes , another associate of larch trees , is more brownish and has a hollow stalk . S. lakei is less brightly colored than S. spraguei , has a shorter stalk , and usually grows with Douglas fir . S. decipiens has a less intensely red cap when young , but the color of older specimens fade and can resemble S. spraguei . S. decipiens generally has a smaller stature , with a cap ranging from 4 to 7 cm (1 @.@ 6 to 2 @.@ 8 in) in diameter , and stem that is typically 4 ? 7 cm (1 @.@ 6 ? 2 @.@ 8 in) long by 0 @.@ 7 ? 1 @.@ 6 cm (0 @.@ 3 ? 0 @.@ 6 in) thick . Further , its pores are irregular in shape , measuring 0 @.@ 5 ? 1 mm in diameter at maturity , and stain a shade of hazel rather

than reddish to brownish . It is found in the southeastern United States , from New Jersey south to Florida and west to Texas .

= = Ecology , habitat and distribution = =

In nature , Suillus spraguei forms ectomycorrhizal relationships with five @-@ needled pine species . This is a mutually beneficial relationship where the hyphae of the fungus grow around the roots of the trees , enabling the fungus to receive moisture , protection and nutritive byproducts of the tree , and affording the tree greater access to soil nutrients . S. spraguei produces tuberculate ectomycorrhizae (covered with wart @-@ like projections) that are described as aggregates of ectomycorrhizal roots encased in a fungal rind , and rhizomorphs that are tubular fungal cords with a hard outer sheath . The fungus has ecological host specificity , and in natural soils can only associate with white pine , a grouping of trees classified in subgenus Strobus of the genus Pinus . However , under controlled pure culture conditions in the laboratory , S. spraguei has also been shown to form associations with Red Pine , Pitch Pine , and Loblolly Pine . Asian populations have been associated with Korean Pine , Chinese White Pine , Siberian Dwarf Pine and Japanese White Pine . In North America , fruit bodies appear earlier than most other boletes , as early as June (bolete fruit bodies generally begin to appear in July ? September) , although they may be found as late as October . Mushrooms can be parasitized by the fungus Hypomyces completus . In the asexual stage of H. completus , it appears initially as patches of whitish mold on the surface of the cap or stem that rapidly spread to cover the entire mushroom surface and produce conidia (asexual spores) . In the sexual stage , the mold changes color , progressing from yellow @-@ brown to brown , greenish @-@ brown and eventually black as it makes perithecia , asci @-@ containing sexual structures that produce ascospores . The perithecia are pimply and give the surface a roughened texture .

A Japanese field study found that S. spraguei was the dominant fungus in a 21 @-@ year @-@ old stand of Korean Pine , both in terms of ectomycorrhizae (measured as percentage of biomass present in soil samples) and by fruit body production (comprising over 90 % of dry weight of total fruit bodies collected of all species) . The production of S. spraguei fruit bodies averaged about one per square meter , without much variance during the four @-@ year study period . The mushrooms appeared mostly from August to November , tended to grow in clumps , and the spatial distribution of clumps was random ? the location of the clumps was not correlatable with appearances in previous years . The density of mushrooms along a forest road was higher than average , suggesting a preference for disturbed habitat . The results also suggested that S. spraguei prefers to produce fruit bodies in areas with low litter accumulation , a finding corroborated in a later publication . This study also determined that the fungus propagates mainly by vegetative growth (extension of underground mycelia) , rather than by colonization of spores .

Suillus spraguei has a disjunct distribution and is known from several localities in Asia , including China , Japan , Korea , and Taiwan . In North America , its range extends from eastern Canada (Nova Scotia) south to the Carolinas , and west to Minnesota . It has also been collected in Mexico (Coahuila and Durango) . Furthermore , the species has been introduced to Europe (Germany , Lower Saxony ; Netherlands) .