= Gymnopilus maritimus =

Gymnopilus maritimus is a fungus species of the family Cortinariaceae first collected in northern Sardinia , Italy , in 2006 . The species produces moderately sized , sturdy mushrooms of a reddish @-@ orange colour . The cap , which can measure up to 70 millimetres (3 in) across , is covered in orange fibrils , and sometimes has small scales . The yellowish stem measures up to 110 mm (4 in) in length by 8 mm (0 @.@ 3 in) in width , and sometimes shows remnants of the partial veil . The mushrooms have thick gills of a variable colour , ranging from yellow to rust but staining darker , and the yellow flesh has a mild taste . The mushrooms leave a rusty @-@ brown spore print , while the spores themselves measure from 7 @.@ 5 ? 11 @.@ 5 micrometres (0 @.@ 00030 ? 0 @.@ 00045 in) in length . The species is most similar in appearance to G. arenophilus and G. fulgens , but can be differentiated from both morphologically . Despite the similarities , it is not closely related to either , suggesting convergent evolution . Instead , within the genus Gymnopilus , it is most closely related to the spectabilis ? imperialis clade . However , it is not particularly similar to any of its closest relatives .

The species has been found only on coastal sand dunes near Olbia , in Sardinia , where it was observed growing at the base of Juncus maritimus (the sea rush) , between the winter months of October and January . However , there is speculation that it may also grow elsewhere in Europe . Mushrooms were seen growing from both the sandy soil and decaying plants ; however , as a saprotrophic feeder , it is possible that the species would be able to grow on other substrates . The mushrooms grow in close groups or tight tufts .

= = Taxonomy = =

Gymnopilus maritimus was first described by mycologists Laura Guzmán @-@ Dávalos (a specialist in Gymnopilus) , Antonio Ortega , Marco Contu and Alfredo Vizzini in 2009 in an article in the journal Mycological Progress . The description was based on several specimens collected during field work by Contu in Sardinia between January 2006 and January 2007 ; the holotype was collected on 15 January 2006 . The discovery has contributed to Sardinia 's reputation as an area of mycological significance . The description was later published in Italian by Contu and Vizzini in the journal Micologia e Vegetazione Mediterranea , along with the description of G. purpuresquamulosus , because the original descriptions of both of these species were in English , and difficult for non @-@ specialists to obtain . The specific epithet maritimus refers to the typical habitat of coastal sand dunes , on sandy soil or decomposing Juncus maritimus . The holotype has been deposited in the University of Granada 's herbarium .

Within the genus Gymnopilus , it is located in the subgenus Gymnopilus and section Macrospori . The subgenus Gymnopilus was proposed by Henri Romagnesi as Cortinatae (while the genus was known as Fulvidula) in 1942 , though the name Gymnopilus was given later by Rolf Singer . The subgenus is characterised by mushrooms that feature either no veils , or veils that do not form rings . The section Macrospori , proposed by Guzmán @-@ Dávalos in 1995 , is made up of large @-@ spored species with ringless mushrooms . Molecular analysis revealed that G. maritimus forms a sister group to (that is , shares an immediate common ancestor with) the spectabilis ? imperialis clade , a clade that includes G. imperialis , G. spectabilis , G. junonius (often considered synonymous with G. spectabilis) , G. pampeanus , and others . G. maritimus forms a more inclusive clade along with the members of spectabilis ? imperialis ; while it produces the smallest fruit bodies , it shares with the other members strong , sturdy mushrooms , caps with fibrils (sometimes with scales) and large , warty spores that turn red in Melzer 's reagent or Lugol 's iodine .

= = Description = =

Gymnopilus maritimus mushrooms have a cap of between 15 and 70 millimetres (0 @.@ 6 and 3 in) in width that is convex to flattened @-@ convex in shape . There is sometimes a broad umbo , and in older specimens , the cap is depressed in the centre . The margin of the cap is somewhat

wavey . The cap surface is dry and dull , coloured red to red @-@ orange , and yellow towards the margin . It is covered in fibrils of an orange colour , and sometimes has minute scales . The dried cap turns blackish @-@ red when potassium hydroxide is applied . The stem is 35 to 110 mm (1 to 4 in) in length by 4 to 8 mm (0 @.@ 2 to 0 @.@ 3 in) in width . It is attached centrally to the cap , and is either completely cylindrical , with equal thickness throughout its length , or slightly narrower towards the base , where whitish or cream mycelia are sometimes visible . It is dry , with fibres and furrows . It is a yellowish colour , bruising reddish @-@ brown . Traces of the partial veil are sometimes visible on the stem , though it does not form a ring . The yellow (brown at the bottom of the stem) flesh can be up to 15 mm (0 @.@ 6 in) thick in the cap and does not bruise . It dries dark brown . There is no distinctive odour , and the taste is mild or slightly bitter . The thick gills can be adnate (connected to the stem by the entire depth of the gill) or sinuate (wavy , with the gills becoming shallower then deeper) . They are subdistant (neither close nor distant) and swollen in the middle . In colour , they are yellow in the youngest mushrooms , turning an ochre @-@ orange , while the oldest mushrooms they are rust . The gill edges are paler than the faces , and the gills stain orange @-@ brown or darker . No reference is made in the original description to the edibility of the mushrooms .

= = = Microscopic characteristics = = =

Gymnopilus maritimus leaves a rusty @-@ brown spore print . The basidiospores can measure 7 @.@ 5 ? 11 @.@ 5 micrometres (0 @.@ 00030 ? 0 @.@ 00045 in) in length , though the typical range is 8 ? 10 @.@ 5 micrometres (0 @.@ 00031 ? 0 @.@ 00041 in) . In width , they typically measure 5 @.@ 5 ? 7 @.@ 5 micrometres (0 @.@ 00022 ? 0 @.@ 00030 in) , but they can be up to 8 ?m wide . In shape , they are ellipsoid or sometimes broadly ellipsoid . The top of the spore (the side where it was once attached to the sterigma , the connection between the basidium and the spore) is rounded and blunt . The spores are covered with fairly large warts , measuring from 0 @.@ 5 ? 2 micrometres (2 @.@ 0 × 10 ? 5 ? 7 @.@ 9 × 10 ? 5 in) from the main spore in height . There is no germ pore or plage , and there is no clear depression around the hilum (the area where the spore was attached to the sterigma) . The spores turn an orange @-@ yellow to orange @-@ brown colour in potassium hydroxide , and turn reddish @-@ brown in Melzer 's reagent and in Lugol 's iodine , but they are not metachromatic .

The four @-@ spored basidia typically measure 24 ? 35 micrometres (0 @.@ 00094 ? 0 @.@ 00138 in) in length by 7 ? 9 micrometres (0 @.@ 00028 ? 0 @.@ 00035 in) in width , but can be as much as 10 @.@ 5 ?m wide . They are club @-@ shaped , but narrower in the middle . They are hyaline (translucent) and yellow to yellowish @-@ brown . The sterigmata are between 1 @.@ 6 and 7 ?m long . The cheilocystidia (cystidia on the edge of the gill) are typically 30 to 42 (though sometimes as much as 50) ?m long by 6 ? 10 @.@ 5 micrometres (0 @.@ 00024 ? 0 @.@ 00041 in) wide . They are shaped like a flask or wine @-@ skin . The top of the cell suddenly widens , and the cell as a whole is thin @-@ walled , hyaline and yellowish , and sometimes appears to contain small grains . The caulocystidia (cystidia on the stem) can be found in tufts at the top of the stem , and measure from 24 ? 60 micrometres (0 @.@ 00094 ? 0 @.@ 00236 in) by 3 ? 9 micrometres (0 @.@ 00012 ? 0 @.@ 00035 in) . They are cylindrical , or narrowly flask @-@ shaped , sometimes with a long neck . They are , again , yellow and hyaline .

The yellowish hyphae are between 15 and 13 @.@ 5 ?m wide with a wall of variable thickness . There are clamp connections at the septa (the walls dividing individual hypha cells) . The flesh in the cap is radial , and is made up of yellowish hyphae of between 2 @.@ 4 and 20 ?m wide . The pileipellis , the outermost layer of hyphae , forms a cutis , and on older specimens (and on the small scales) forms a trichoderm .

= = = Similar species = = =

There are five species similar in appearance to G. maritimus : G. arenophilus , G. decipiens , G. flavus , G. fulgens and G. pseudofulgens . G. arenophilus and particularly G. fulgens are the most

similar . Though G. maritimus and G. arenophilus show similarities in their biogeography and ecology , the typically slightly smaller G. arenophilus differs from G. maritimus morphologically . While G. maritimus has a cap covered in fibrils with small scales , G. arenophilus can sometimes be completely smooth , and spore ornamentation differs , with G. maritimus typically displaying larger warts . Like G. maritimus , G. fulgens has been recorded growing on sand @-@ dune heathland ; further , the spores are similar in appearance to those of G. maritimus . However , G. fulgens requires soil rich in peat and must grow among moss . Moreover , there are a number of morphological differences ; G. maritimus mushrooms are larger and thicker , there are never remains of the partial veil on G. fulgens stems , the shape of the top of the spores differs between the two species , and the cheilocystidia and caulocystidia are significantly larger on G. maritimus . G. fulgens var. luteicystis is even more distinct from G. maritimus than the nominate variety . Despite the similarities between the three species , the three have been shown to be in different clades within Gymnopilus , suggesting ecological convergence between G. arenophilus and G. maritimus , and morphological convergence between G. fulgens and G. maritimus .

Gymnopilus flavus , despite also appearing on land near the Mediterranean , can be differentiated from G. maritimus as it lives among grass , especially Dactylis glomerata , and it has distinctly smaller spores , typically measuring 5 to 6 by 3 @.@ 5 to 4 @.@ 2 ?m . G. pseudofulgens , also collected in Italy , shows two major morphological differences : it produces smaller mushrooms , and spores that are of a different shape with smaller warts . G. decipiens , another species that grows on sandy soil , again has spores that are markedly different . The American species G. arenicola also favours sandy soil , but has significantly smaller spores than G. maritimus . Two other species of Gymnopilus found around the Mediterranean are G. corsicus and G. spadiceus . G. corsicus has no veil remnants on the stem , and spores that do not turn red in Melzer 's reagent or Lugol 's iodine , and so can easily be differentiated from G. maritimus . G. spadiceus shows several similarities to G. maritimus , but grows only on pine wood and has rectangular spores .

Gymnopils maritimus is clearly a different species from other members of its clade , despite their close relation . All other species in the clade grow upon dead wood and have well @-@ developed rings on their stems . The spores also differ ; in the case of G. junonius and G. spectabilis (often considered synonymous) , as well as G. pampeanus , they are narrower , and in the case of G. imperialis , they are wider . Of the other members of the clade , only G. junonius and G. spectabilis also grow in Europe .

= = Habitat and distribution = =

Gymnopilus maritimus is known only from a single site in Pittulongu , an area of Olbia , in Sardinia , Italy , which is the type locality . There , mushrooms were found growing in close groups and tufts on coastal sand dunes around 10 metres (33 ft) from the high tide line . They were observed at the base of live Juncus maritimus (sea rush) plants , growing on sandy soil or decaying plants , where they were feeding as saprotrophs . As such , it is possible that the species would be able to grow on other substrates . They were observed growing from autumn to winter , between the end of October and January . In addition to the collections in Sardinia , Contu and Vizzini speculate that reports of G. fulgens growing in " sand @-@ dune heaths " on Great Britain , an unusual habitat for that species , may in fact show the presence of G. maritimus on the island .