

= *Phellinus ellipsoideus* =

Phellinus ellipsoideus (formerly *Fomitiporia ellipsoidea*) is a species of polypore fungus in the family Hymenochaetaceae , a specimen of which produced the largest fungal fruit body ever recorded . Found in China , the fruit bodies produced by the species are brown , woody basidiocarps that grow on dead wood , where the fungus feeds as a saprotroph . The basidiocarps are perennial , allowing them to grow very large under favourable circumstances . They are resupinate , measuring 30 centimetres (12 in) or more in length , though typically extending less than a centimetre from the surface of the wood . *P. ellipsoideus* produces distinct ellipsoidal spores , after which it is named , and unusual setae . These two features allow it to be readily differentiated microscopically from other , similar species . Chemical compounds isolated from the species include several steroidal compounds . These may have pharmacological applications , but further research is needed .

The species was named in 2008 by Bao @-@ Kai Cui and Yu @-@ Cheng Dai based on collections made in Fujian Province . It was placed in the genus *Fomitiporia* , but later analysis suggests that it is more closely related to *Phellinus* species . It was revealed in 2011 that a very large fruit body , measuring up to 1 @, @ 085 cm (427 in) in length , had been found on Hainan Island . The specimen , which was 20 years old , was estimated to weigh between 400 and 500 kilograms (880 and 1 @, @ 100 lb) . This was markedly larger than the previously largest recorded fungal fruit body , a specimen of *Rigidoporus ulmarius* found in the United Kingdom that had a circumference of 425 cm (167 in) . The findings were formally published in September 2011 , but attracted international attention from the mainstream press prior to this .

= = Taxonomy and phylogenetics = =

The species was first described in 2008 by Bao @-@ Kai Cui and Yu @-@ Cheng Dai , both of the Beijing Forestry University . Five specimens of the then @-@ unknown species were collected during field work in the Wanmulin Nature Reserve (27 ° 03 ' N 118 ° 08 ' E) , Jian 'ou , Fujian Province . The pair named the species *Fomitiporia ellipsoidea* in an article in the journal *Mycotaxon* . The specific name *ellipsoidea* is from the Latin meaning " ellipsoid " , and refers to the shape of the spores . Species of the order Hymenochaetales , to which this taxon belongs , make up 25 % of the over 700 species of polypore found in China .

Phylogenetic analysis of large subunit and internal transcribed spacer DNA sequence data , the results of which were published in 2012 , concluded that the species then known as *F. ellipsoidea* was closely related to *Phellinus gabonensis* , *P. caribaeo* @-@ *quercicolus* and the newly described *P. castanopsidis* . The four species share morphological characteristics , and form a monophyletic clade . This clade resolved more closely with the *Phellinus* type species *P. igniarius* than it did with the *Fomitiporia* type species *F. langloisii* , and so the authors proposed a transference of *F. ellipsoidea* to *Phellinus* , naming the new combination *Phellinus ellipsoideus* . While the taxonomic database Index Fungorum follows the 2012 study , MycoBank continues to list *Fomitiporia ellipsoidea* as the correct binomial . Some mycologists consider *Fomitiporia* to be a synonym of *Phellinus* anyway .

= = Description = =

Phellinus ellipsoideus produces resupinate fruit bodies that are hard and woody , whether fresh or dry . The original description characterized them as measuring up to 30 centimetres (12 in) " or more " in length , 20 cm (7 @. @ 9 in) in width , and extending 8 mm (0 @. @ 3 in) from the wood on which they grow at their thickest point . The outermost layer is typically yellow to yellowish @-@ brown , measuring 2 mm (0 @. @ 08 in) in thickness . The shiny surface of the hymenium , the spore @-@ producing section of the fruit body , is covered in pores and ranges in colour from yellow @-@ brown to rust @-@ brown . There are between 5 and 8 pores per millimetre . The tubes are up to 8 mm (0 @. @ 3 in) in depth , have the same colouration as the surface of the hymenium , and

are distinctively layered . They are also hard and woody . The very thin yellow @-@ brown layer of flesh measures less than 0 @.@ 5 mm (0 @.@ 02 in) in width . As with much of the rest of the fruit body , it is firm , solid , and reminiscent of wood . The fruit bodies lack any odour or taste .

= = = Microscopic features = = =

Phellinus ellipsoideus produces basidiospores that are ellipsoidal or broadly ellipsoidal in shape . The spore shape is one of the features that makes the species readily recognisable microscopically , and the spores measure from 4 @.@ 5 to 6 @.@ 1 by 3 @.@ 5 to 5 micrometres (?m) . The average spore length is 5 @.@ 25 ?m , while the average width is 4 @.@ 14 ?m . The spores have thick cell walls , and are hyaline . They are strongly cyanophilous , meaning that the cell walls will readily absorb methyl blue stain . In addition , they are weakly dextrinoid , meaning that they will stain slightly reddish @-@ brown in Melzer 's reagent or Lugol 's solution . The spores are borne on barrel @-@ shaped basidia , with four spores per basidium , measuring 8 to 12 by 6 to 7 ?m . There are also basidioles , which are similar in shape to the basidia , but slightly smaller .

In addition to the spore shape , the species is readily identified with the use of a microscope because of its setae . Setae are a kind of unusual cystidia unique to the family Hymenochaetaceae , and , in *P. ellipsoideus* , are found in the hymenium . In shape , the setae are ventricose , with distinctive hooks on their tips . In colour , they are yellow @-@ brown , and they have thick cell walls . They measure 20 to 30 by 10 to 14 ?m . Neither more standard cystidia nor cystidioles (underdeveloped cystidia) can be found in the species , but there are a number of rhomboid crystals throughout the hymenium and the flesh .

Most of the tissue of a fungal fruit body is made up of hyphae , which can be of three forms : generative , skeletal and binding . In *P. ellipsoideus* , the tissue is dominated by skeletal hyphae , but also has generative hyphae ; it lacks binding hyphae . For this reason , the hyphal structure of *P. ellipsoideus* is referred to as " dimitic " . The hyphae are divided into separate cells by septae , and lack clamp connections . The skeletal hyphae do not react with Melzer 's reagent or Lugol 's solution , and are not cyanophilous . While the hyphae will darken when a solution of potassium hydroxide is applied (the KOH test) , they remain otherwise unchanged .

The main structure of the fruit body consists primarily of an agglutination (mass) of interwoven skeletal hyphae , which are golden- to rust @-@ brown . The hyphae are unbranched , forming long tubes 2 to 3 @.@ 6 ?m in diameter , enveloping a lumen of variable thickness . There are also hyaline generative hyphae . These hyphae have thinner walls than the skeletal hyphae , and are also septate (possessing of septa) , but are sometimes branched . They measure 2 to 3 ?m in diameter . The flesh , again , is primarily made up of skeletal hyphae with some generative hyphae . The thick @-@ walled skeletal hyphae are a yellow @-@ brown to rust brown , and are slightly less agglutinate . The hyphae in the flesh are a little smaller ; the skeletal hyphae measure 1 @.@ 8 to 3 @.@ 4 ?m in diameter , while the generative hyphae measure 1 @.@ 5 to 2 @.@ 6 ?m in diameter .

= = = Similar species = = =

A cogenetic species potentially similar to *Phellinus ellipsoideus* is *P. caribaeo* @-@ *quercicola* . The latter species shares the hooked hymenial setae and ellipsoidal to broadly ellipsoidal spores . However , details of the fruit body differ , and the spores are hyaline to yellowish , and not dextrinoid . Further , the species is known only from tropical America , where it grows on the Cuban oak . *P. castanopsidis* , newly described in 2013 , is not perennial , and has a pale greyish @-@ brown pore surface . The spores are also slightly larger than those of *P. ellipsoideus* .

Phellinus ellipsoideus differs from species of *Fomitiporia* in two key respects . Its spores are less dextrinoid than those of the genus and their shape is atypical . Other than this , it is typical of the genus , according to the original description . Five species of *Fomitiporia* , *F. bannaensis* , *F. pseudopunctata* , *F. sonorae* , *F. sublaevigata* and *F. tenuis* , share with *P. ellipsoideus* the resupinate fruit bodies and the setae in the hymenium . Despite this , all of them but *P. ellipsoideus*

have straight hymenial setae , and all of them have spores that are spherical or almost spherical , which is much more typical of the genus . *F. uncinata* (formerly *Phellinus uncinatus*) has hooked hymenial setae , and the spores are , as with *P. ellipsoideus* , thick @-@ walled and dextrinoid . The species can be differentiated by the fact the spores are spherical or nearly so , and somewhat larger than those of *P. ellipsoideus* , measuring 5 @.@ 5 to 7 by 5 to 6 @.@ 5 ?m . The species is also known only from tropical America , where it grows on bamboo .

= = Distribution and ecology = =

Phellinus ellipsoideus has been recorded growing on the fallen wood of oaks of the subgenus *Cyclobalanopsis* , as well as the wood of other flowering plants . The species favours the trunks of trees , where it feeds as a saprotroph , causing white rot . *P. ellipsoideus* fruit bodies are perennial growers , allowing them to , in the correct circumstances , grow very large . The species is found in the tropical and subtropical areas of China ; it has been recorded in Fujian Province and Hainan Province . It is not a common species , and fruit bodies are only occasionally encountered .

= = Largest fruit body = =

In 2010 , Cui and Dai were performing field work in tropical woodland on Hainan Island , China , studying wood @-@ rotting fungi . The pair uncovered a very large *P. ellipsoideus* fruit body on a fallen *Quercus asymetrica* log , which turned out to be the largest fungal fruit body ever documented . The fruit body was found at an altitude of 958 metres (3 @,@ 143 ft) , in old @-@ growth forest . They were initially unable to identify the specimen as *P. ellipsoideus* , because of its large size , but tests revealed its identity after samples were taken for analysis . After their initial encounter with the large fruit body , Cui and Dai returned to it on two subsequent occasions , so that they could study it further . Nicholas P. Money , executive editor of *Fungal Biology* , in which the findings were published , praised the pair for not removing the fruit body , thereby allowing it " to continue its business and to marvel visitors to Hainan Island " . The discovery was formally published in *Fungal Biology* in September 2011 , but gained attention in the mainstream press worldwide prior to this .

The fruit body was 20 years old , and up to 1 @,@ 085 cm (35 @.@ 60 ft) long . It was between 82 and 88 cm (32 and 35 in) wide , and between 4 @.@ 6 and 5 @.@ 5 cm (1 @.@ 8 and 2 @.@ 2 in) thick . The total volume of the fruit body was somewhere between 409 @,@ 000 and 525 @,@ 000 cubic centimetres (25 @,@ 000 and 32 @,@ 000 in³) . It was estimated to weigh between 400 and 500 kilograms (880 and 1 @,@ 100 lb) , based on three samples from different areas of the fruit body . The specimen had an average of 49 pores per square millimetre , roughly equivalent to 425 million pores . Money estimated that , based on spore output from other polypore species , the fruit body would be able to release a trillion spores a day .

Prior to this discovery , the largest recorded fruit body of any fungus was a specimen of *Rigidoporus ulmarius* , found in Kew Gardens , United Kingdom . It measured 150 by 133 cm (59 by 52 in) in diameter , and had a circumference of 425 cm (167 in) . While the largest individual fruit bodies belong to polypores , individual organisms belonging to certain *Armillaria* species can grow extremely large . In 2003 , a large specimen of *A. solidipes* (synonymous with *A. ostoyae*) was recorded in the Blue Mountains , Oregon , covering an area of 965 hectares (2 @,@ 380 acres) . At the time , the organism was estimated to be 8650 years old . Prior to this , an *A. gallica* (synonymous with *A. bulbosa*) organism was the largest recorded , covering 15 hectares (37 acres) , weighing approximately 9 @,@ 700 kilograms (21 @,@ 400 lb) . However , whilst these organisms cover a large area , the individual fruit bodies (the mushrooms) are not remarkably large , typically with stems of up to 10 centimetres (3 @.@ 9 in) in height and caps less than 15 centimetres (5 @.@ 9 in) in diameter , weighing from 40 to 100 grams (1 @.@ 4 to 3 @.@ 5 oz) each .

= = Medicinal uses and biochemistry = =

The fruit bodies of both *Phellinus* and *Fomitiporia* species have seen use in traditional medicine for gastrointestinal cancer and heart disease . *P. ellipsoideus* fruit bodies are used for medicinal purposes as " sanhhuang " (a name which typically refers to *P. linteus*) in the north of Fujian Province .

In 2011 , research into the chemistry of *P. ellipsoideus* was published in the journal *Mycosystema* by Cui , along with Hai @-@ Ying Bao and Bao @-@ Kai Liu of the Jilin Agricultural University . The research discussed how several chemical compounds could be isolated from *P. ellipsoideus* with petroleum ether and (after defatting) chloroform . The nine compounds isolated from these extracts included the common ergosterol and its derivative ergosterol peroxide . Two of the compounds , ergosta @-@ 7 @,@ 22 @,@ 25 @-@ triene @-@ 3 @-@ one and benzo [1 @,@ 2 @-@ b : 5 @,@ 4 @-@ b '] difuran @-@ 3 @,@ 5 @-@ dione @-@ 8 @-@ methyl formate , were new to science . All of these chemicals were steroidal ; such compounds play important physiological roles in cell membranes . *P. ellipsoideus* has been used as a source of ergosterol for biochemical research .

Steroidal compounds , like those isolated from *P. ellipsoideus* , can have pharmacological or taxonomical applications ; for instance , some can act as anti @-@ inflammatories (including ergosterol) or inhibit tumour growth . The 2011 study concluded that , as *P. ellipsoideus* contained a large number of diverse steroidal compounds , there may be comparatively high pharmacological activity in the fungus ; however , more research would be needed to confirm this . Later publications echoed this research , claiming that the fungus has " potential medicinal functions " . Research published in 2012 named fomitiporiaester A , a natural furan derivative isolated from methanolic extract of *P. ellipsoideus* fruit bodies . The chemical , methyl 3 @,@ 5 @-@ dioxa @-@ 1 @,@ 3 @,@ 5 @,@ 7 @-@ tetrahydrobenzo [1 @,@ 2 @-@ c : 4 @,@ 5 @-@ c '] difuran @-@ 4 @-@ carboxylate , displayed significant antitumour ability in a mouse model .