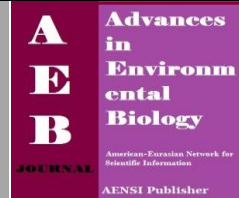




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### Eco-morphologic Aspects of Differentiation and Identification of Species *Armillaria mellea* Sensu Lato in Coppice Oakeries of Belgorod Region for the Purposes of Exploitation of Natural Resources

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#### ABSTRACT

The article deals with matters of differentiation and identification of species of the complex *Armillaria mellea sensu lato* in loco in coppice oakeries of Belgorod region in Russian Federation. On the basis of results of comparison of local ecomorphotypes descriptions and known descriptions of *Armillaria mellea* s. l. European species it was stated that in Belgorod region's oakeries there are two species belonging to the complex *Armillaria mellea* s. l.: *Armillaria cepistipes* and *Armillaria gallica*.

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## INTRODUCTION

Honey fungus *Armillaria mellea* (Vahl.) Karst., which was earlier considered as a one polymorphic species, has been divided into 5 groups, which cannot be hybridized among themselves and have the status of a biological species [1-3], with the help of a genetic test. Nowadays instead of talking about *Armillaria mellea* (Vahl.) Karst. we mention *Armillaria mellea sensu lato*, that is the *Armillaria* complex, comprising the following closely related species: *A. borealis* Marxm. & Korhonen, *A. cepistipes* Velen., *A. ostoyae* (Romagn.) Herink, *A. gallica* Marxm. & Romagn., *A. mellea* (Vahl: Fr.) Kumm. (*A. mellea sensu stricto*) [3-7]. In Russia, as earlier in Western Europe, all 5 species of *A. mellea* s. l. mentioned above were discovered and accurately identified (with the help of the genetic test) [3].

Besides genetic incompatibility, distinguished species of *A. mellea* s. l. have macromorphological (at the level of macrostructures: rhizomorph and fruit body) and ecological differences. On the basis of these differences comparative descriptions of the species *A. mellea* s. l. were elaborated [4-5, 7-9].

Importance of preliminary (before using the genetic test) differentiation and identification of the species *Armillaria* in the field can be connected with necessity for receiving source information on occurrence and confinedness of separate species in certain regions, depending on type and tempo of natural resources exploitation. The aim of our work was to detect (differentiate and identify) the species *A. mellea* s. l. according to eco-macromorphological characters in coppice oakeries of Belgorod region in Russian Federation.

##### Methods:

Object of the research is the complex *A. mellea* s. l. in coppice oakeries of Shebekinsky and Belgorod districts of Belgorod region in Russian Federation. Field studies were carried out in 2010-2013 in oak timber stands with prevailing English oak (ripening and ripe) as part of mountain, ravine and watershed oakeries. In the process of the work implementation we used methods of phytopathology and mycology [10], system analysis [11].

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**Main part:**

*General description of representants of A. mellea s. l. in coppice oakeries in Belgorod region.* Modern systematics of fungic organisms ([www.indexfungorum.org](http://www.indexfungorum.org) and <http://www.mycobank.org>) qualifies honey fungi species *A. mellea s. l.* as kingdom *Fungi* (or *Mycota*), phylum *Basidiomycota*, class *Agaricomycetes*, order *Agaricales*, family *Physalacriaceae*. They are saprotrophs and semi-saprotrophs (facultative parasites), and are characterized by polytropy, but at the same time they are distinguished by substrate specificity. They induce white sapwood rot.

Main distinctive macromorphostructures of *A. mellea s. l.* in the wild are rhizomorphs in surface soil, on trees roots and under cortex, white coat of mycelium under cortex of stressed trees and fruit bodies.

*Ecomorphotypes A. mellea s. l. in Belgorod region's oakeries.* On the basis of obtained empirical (verbal-descriptive and photo-documentary) material we discriminated 2 ecomorphotypes in the complex *A. mellea* in loco (fig. 1-2) and composed their detailed description without using biometric parameters (table 1).

**Table 1:** Description of ecomorphotype in the complex *A. mellea s. l.* in Belgorod oakeries.

Ecomorphotype #1	Ecomorphotype #2
1	2
Ecological group, pathologic role	
Saprotroph, in some cases facultative parasite on weakened trees. Often met on oaks, weakened by butt rot invaders (beefsteak fungus <i>Fistulina hepatica</i> (Schaeff.) With. and sulphur polypore <i>Laetiporus sulphureus</i> (Bull.) Murrill).	Saprophyte, in some cases facultative parasite on weakened and dying trees, secondary parasite.
Confinedness to forest sites and host plants	
Confined to maple-linden and ash oak timber stands in conditions D <sub>2</sub> . Met mainly on oaks.	Confined to oak timber stands with some aspens or cultivated oaks in aspen cutover areas in conditions D <sub>2,3</sub> , D <sub>3</sub> . Met on oaks and aspens.
Rhizomorphs	
Dark brown coming near to black, glossy, densely penetrating top soil, monopodially ramifying on roots and under cortex of stressed trees and stumps.	Black, penetrating soil with underground tree remains, monopodially ramifying.
Fruit bodies	
Formed epiphytically on rhizomorphs or laid under cortex of stressed trees and stumps.	Formed epiphytically on rhizomorphs or endophytically on subcortical mycelium.
Continuation of table 1	
1	2
Fruit bodies' macrocharacters	
<i>Cap</i> has little difference colour intensity of young and ripe fruit bodies, it is usually of reddish hues (meat-red, yellowish red, reddish brown); cap is convex spherical or campanulate in case of young bodies and pitching convex umbrella-shaped in case of ripe bodies. Cap's edge preserves white flake-like remains of partial veil. Squames of young specimens' caps are dense and big, over time they disappear on the periphery of a cap.	<i>Cap</i> of young fruit bodies is darker, grey-brown, then it lightens to buff-grey with a darker centre; at first it is convex, then almost extended, sometimes with depression and mound in the centre. Cap's edge is often flexuose and declinate. Squames are small, scarce, cover the whole cap.
<i>Stipe</i> is cylindrical, young fruit bodies are quite thick, and ripe ones are more or less thin, with a claviform thickening at the bottom; above a ring it is whitish, below a ring it has a cap's colour or is of darker, browner hues; its bottom has yellow shade. Stipe preserves flake-like remains of partial veil, yellowish on the place of disappearing ring. Stipe's flesh is stiff, white or pinkish.	<i>Stipe</i> is cylindrical, thin, sometimes with a thickening at the bottom; above a ring it has a cap's colour, below it – it is darker. Stipe's flesh may be mealy, whitish.
<i>Ring</i> is mealy, web-filmy, with uneven yellowish edge; disappears fast.	<i>Ring</i> is less mealy, filmy, with more or less even edge, greyish-white, may disappear over time.
<i>Gills</i> of young specimens are yellowish-pink, over time they darken to rusty brown, with darker spots; adnate or decurrent on to stipe. Spore print is whitish.	<i>Gills</i> of young specimens are whitish, over time they darken to flesh-brown, sometimes with darker spots; slightly decurring on to stipe. Spore print is white.
Period and peculiarities of fructification	
End of September – beginning of November; bears fruit solitarily, in small groups, rarely – acervately.	Second half of September – beginning of November; bears fruit in small groups and acervately, rarely – solitarily.

*Comparative analysis of similarity of local ecomorphotypes descriptions and A. mellea s. l. known species descriptions.* Analysis was performed according to known characters-criteria [4-9] taking into account quality of their display distinctiveness.

The most reliable macromorphological criterion for division of species in the complex *A. mellea s. l.* is peculiarities of construction of a ring on a stipe. The following three species have a stiff and solid ring which does not disappear over time: *A. borealis*, *A. ostoyae* and *A. mellea s. str.* [4-9]. A mealy, web-like ring, which disappears fast, is a distinctive feature for species *A. cepistipes* and *A. gallica* [4-9]. Also the last two species belong to the ecological group of saprotrophs [4, 6, 9]. Only in some cases they can be facultative parasites and poor pathogens. In phytopathological processes they usually play a secondary role [9]. If we refer to description of ring's construction peculiarities and ecological peculiarities of local ecomorphotypes (see table 1, fig. 1-2),

we should see that both of them belong to the grouping of species *A. cepistipes* – *A. gallica*. This conviction is reinforced also by the result of rhizomorphs macrostructure comparison: rhizomorphs of local ecomorphotypes (see table 1) and representants of *A. cepistipes* – *A. gallica* [4, 7, 9] are characterized by monopodial ramification. As for geographical information about expansion of *A. cepistipes* and *A. gallica*, it is known that these species are found everywhere, both in Western and Eastern Europe, including Belarus, Ukraine and Russia [3], and also in Siberia [4]. Besides, *A. gallica* was exactly identified in oakeries of Voronezh region [3], which share borders with Belgorod region. Thus, there is no doubt that ecomorphotypes we investigate (see table 1) belong to *A. cepistipes* – *A. gallica*.



**Fig. 1:** Fruit bodies of honey fungi *A. mellea* s. l. of ecomorphotype #1.  
 a) at the foot of a living oak                      b) in soil with underground trees remains



**Fig. 2:** Fruit bodies of honey fungi *A. mellea* s. l. of ecomorphotype #2.  
 a) at the foot of a dead aspen                      b) gathered in a bucket

The next identification stage is detection of belonging of each of two local ecomorphotypes to a certain species: *A. cepistipes* or *A. Gallica* according to colour and form of cap, stipe, size and concentration of squames on fruit bodies' caps [4].

Form of a cap of ripe fruit bodies of *A. cepistipes* is often characterized [4, 9] as a flat-convex, its colour is grey, yellow or flesh. Form of a cap of ripe fruit bodies of *A. gallica* is often characterized [4, 9] as convex with a mount in the centre, its colour is red, yellow, brown or olive. Cap's edge is striped with remains of partial veil.

Cap's squames of *A. gallica* are bigger and more dense than of *A. cepistipes* – especially it is noticeable with young fruit bodies [4]. Squames of ripe fruit bodies partially disappear [4]. Opinions on squames' concentration are discrepant [4-9], so we do not consider this character.

Stipes of both *A. cepistipes* and *A. gallica* is cylindrical, often has a claviform thickening at the bottom [4-9]. Stipe of *A. cepistipes* below a ring is usually lighter, without remains of partial veil, sometimes is of a light-yellow hue at the bottom. Ring of *A. cepistipes* is neat, whitish-grey [4, 9]. *A. gallica*'s stipe below a ring is usually darker, with remains of partial veil, yellowing at the bottom. Ring of *A. gallica* is whitish with an express yellow hue and uneven edges [4, 9], when ring disappears – a yellow print may appear on a stipe.

Gills of *A. cepistipes* are decurrent, at first white, then reddish with spots [4]. Gills of *A. gallica* are adnate or slightly decurring on to a stipe, at first white, then up to pink-brown [4].

Fruit bodies of *A. cepistipes* grow in groups, joints or separately on stumps and trunks of foliage trees [4, 9]. Fruit bodies of *A. gallica* grow separately and in solitary groups on cavings of burnt wood, on windfall and stumps of foliage species [4, 9], often at the bottom of living trees [4, 9].

#### Conclusion:

Considering above given descriptions of peculiarities of *A. cepistipes* and *A. gallica*, known from special sources, we successively compared characters of one of the known species (*A. cepistipes*) with corresponding characters of, in turn, ecomorphotype #1 and ecomorphotype #2 (see table 1, fig. 1-2). Then of another one – *A. gallica* – with corresponding characters of, in turn, ecomorphotype #1 and ecomorphotype #2 (see table 1, fig. 1-2). Results were recorded as a conditional similarity quotient, expressed in fractional form, where denominator is general number of categories of characters under comparison, and numerator is number of descriptions coinciding in essence. Ecomorphotype #1 – *A. cepistipes* (1/8), *A. gallica* (8/8). Ecomorphotype #2 – *A. cepistipes* (8/8), *A. gallica* (1/8). From this it follows that ecomorphotype #1 is most probably a species *A. gallica*, and ecomorphotype #2 – *A. cepistipes*.

#### Resume:

Thus, we can draw conclusion that in coppice oakeries of Belgorod region of Russian Federation the complex *Armillaria mellea* sensu lato is represented by two species *A. cepistipes* Velen. and *A. gallica* Marxm. & Romagn. For each of two species an eco-macromorphological description was composed; these descriptions allow to differentiate and identify them in the field with high confidence.

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