

SEM STUDY OF EXOSPORIAL ORNAMENTATION OF BASIDIOSPORES IN GENUS *RUSSULA*, *LACTARIUS* AND *LACTIFLUUS* FROM NORTH-WEST HIMALAYA

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ABSTRACT

Morphology of basidiospore surface in Basidiomycetes is used as an important taxonomic character. Different types of ornamentations exist in basidiospores of Russulaceous mushrooms. Every species has its unique ornamentation and is used as key character to separate some closely aligned taxa in genus *Lactarius*, *Lactifluus* and *Russula*. To study the spore surface diversity Scanning Electron Microscopy (SEM) studies were conducted where basidiospores were mounted on a double sided adhesive tape pasted on a metallic specimen-stub and after gold plating, the material was scanned at different magnification in high vacuum mode to observe pattern of spore ornamentation. SEM studies were carried out with JSM6610LV GEOL scanning electron microscope in 51 taxa of russulaceous mushrooms collected from North-West Himalaya spread over three investigated genera (*Lactarius*, *Lactifluus* and *Russula*). On the basis of SEM studies spores with eight varied ornamentation type on their surface were documented. These are: tuberculate type (warts completely isolated with no inter-connections); catenulate type (isolated warts with inter connections forming chain like rows or catenulations); winged type A (broad wings around the surface with isolated warts not forming reticulum (scattered or loose arrangement of wings); winged type B (winged all around the surface forming incomplete reticulum (compact arrangement of wings); incomplete reticulate type (wart to wart connections forming reticulum but isolated warts also exist in between); complete reticulate type (no isolated warts present), ridged type (when only 2-4 warts connected forming small to large ridges on the surface, no complete wing like structures formed. Isolated warts and catenulations) and rugulose type (very low warded spores).

Keywords: russulaceous, ornamentation, basidiospores

INTRODUCTION

In 1924, Melzer for the first time discussed the importance of spore ornamentation [1]. The study of structures of basidiospores is a primary requirement for the identification and classification of fungal species [2]. Scanning electron microscopy is a valuable technique for studying spore surface. Spore ornamentation is one of the important taxonomic characters for distinguishing species within *Russula*, *Lactifluus* and *Lactarius*. Jossierand in 1940 gave a view that pattern is a molded structure inherent in spore itself [3]. Burge studied the spores in four *Russula* species using SEM [4]. Hesler and Smith studied the spore ornamentation in 59 taxa of North American *Lactarius* and described 5 basic types of ornamentation on the basis of SEM [5]. Singer recognized 12 types of exosporial ornamentations in order Agaricales [6].

MATERIALS AND METHODS

Fungal forays were undertaken to various localities of North West Himalayas between 2008- 2013 for the collection of russulaceous mushrooms. Spore prints were obtained from the fresh specimens. For scanning electron microscopic examination, the basidiospores were obtained from dry spores from the spore print that were directly mounted on a double sided adhesive tape pasted on a metallic specimen-stub and then spattered with gold coating. These gold plated spores were observed at different magnifications in high vacuum mode to observe pattern of spore ornamentation. SEM studies were carried out with JSM6610LV GEOL scanning electron microscope.

RESULTS AND DISCUSSION

In the present work SEM studies of 51 taxa of Russulaceous mushrooms spread over three genera (Table 1, 2, 3) were undertaken. On the basis of SEM studies undertaken, following eight ornamentation types have been found to occur in Russulaceous mushrooms. (Figure 1)

1. **Tuberculate type:** Warts completely isolated with no inter connections
2. **Catenulate type:** Isolated warts with inter connections forming chain like rows or catenulations
3. **Winged type A:** Broad wings around the surface with isolated warts not forming reticulum (scattered or loose arrangement of wings)
4. **Winged type B:** Winged all around the surface forming incomplete reticulum (Compact arrangement of wings)

Table 1. Basidiospore Ornamentation Types in Genus *Lactifluus*

<i>Lactifluus</i>	Subgenus	Ornamentation type
1. <i>Lf. volemus</i> var. <i>volemus</i>	<i>Lactifluus</i>	Complete Reticulum
2. <i>Lf. sainiisp.</i> nov.	“	Rugulose
3. <i>Lf. luteolus</i> var. <i>luteolus</i>	“	Catenulate
4. <i>Lf. echinatus</i>	“	Winged type A
5. <i>Lf. echinatus</i> var. <i>versicuticularis</i> var. nov	“	Winged type A
6. <i>Lf. angustifolius</i>	“	Rugulose
7. <i>Lf. piperatus</i>	“	Rugulose

Table 2. Basidiospore Ornamentation Types in Genus *Lactarius*

<i>Lactarius</i>	Subgenus	Ornamentation type
1. <i>L. subindigo</i>	<i>Piperites</i>	Incomplete reticulate
2. <i>L. salmoneus</i> var. <i>curtisii</i>	“	Incomplete reticulate
3. <i>L. rubrilacteus</i>	“	Winged type B
4. <i>L. rubrifluus</i>	“	Incomplete reticulate
5. <i>L. deliciosus</i> var. <i>areolatus</i>	“	Incomplete reticulate
6. <i>L. deterrimus</i>	“	Incomplete reticulate
7. <i>L. sanguifluus</i>	“	Incomplete reticulate
8. <i>L. sanguifluus</i> var. <i>excentristipus</i>	“	Incomplete reticulate
9. <i>L. pubescens</i>	“	Winged type B
10. <i>L. yazooensis</i>	“	Incomplete reticulate
11. <i>L. marginozonatus</i> sp. nov.	“	Incomplete reticulum
12. <i>L. eburneus</i> var. <i>eburneus</i>	<i>Plinthogalus</i>	Incomplete reticulate
13. <i>L. westii</i> var. <i>microsporus</i> var. nov.	“	Winged type B
14. <i>L. subisabellinus</i> var. <i>subisabellinus</i>	“	Incomplete reticulate
15. <i>L. subdulcis</i> var. <i>hesleri</i> var. nov.	<i>Russularia</i>	Winged type B
16. <i>L. aqueous</i> sp. nov.	“	Winged type B
17. <i>L. badiopallenscens</i>	“	Incomplete reticulate
18. <i>L. mukteshwaricus</i>	“	Winged type A

Table 3. Basidiospore Ornamentation Types in Genus *Russula*

<i>Russula</i>	Subgenus	Ornamentation type
1. <i>R. brevipes</i> var. <i>acrior</i>	<i>Compactae</i>	Incomplete reticulate
2. <i>R. romagnesianavar.acridavar. nov.</i>	“	Catenulate
3. <i>R. illota</i>	<i>Ingratula</i>	Catenulate
4. <i>R. pectinatoides</i>	“	Catenulate
5. <i>R. fertiilandica</i> var. <i>nov.</i>	“	Incomplete reticulate
6. <i>R. hetero-cuticasp. nov.</i>	<i>Heterophyllidia</i>	Ridged
7. <i>R. virescens</i>	“	Rugulose
8. <i>R. grisea</i>	“	Incomplete reticulum
9. <i>R. heterophylla</i>	“	Catenulate
10. <i>R. cyanoxanthavar.variata</i>	“	Rugulose
11. <i>R. crustosa</i>	“	Incomplete reticulate
12. <i>R. mustelina</i>	“	Incomplete to complete reticulate
13. <i>R. pleurocystidia-innumerosasp. nov.</i>	“	Catenulate
14. <i>R. cyanoxanthavar.cynaxantha</i>	“	Catenulate
15. <i>R. vesca</i>	“	Catenulate
16. <i>R. cremeoavellanea</i>	<i>Incrustatula</i>	Catenulate
17. <i>R. olivacea</i>	“	Ridged
18. <i>R. rosea</i>	“	Catenulate
19. <i>R. lilacea</i>	“	Catenulate
20. <i>R. smaragdina</i>	<i>Russula</i>	Catenulate
21. <i>R. aquosa</i>	“	Ridged
22. <i>R. persicina</i>	“	Catenulate
23. <i>R. paludosa</i>	“	Catenulate
24. <i>R. peckii</i>	“	Tuberculate
25. <i>R. brunneoviolacea</i>	“	Winged type A
26. <i>R. curtipes</i>	“	Catenulate

5. Incomplete reticulate type: Wart to wart connections forming reticulum but isolated warts also exist in between

6. Complete reticulate type: No isolated warts present

7. Ridged type: When only 2-4 warts connected, forming small to large ridges on the surface, no complete wing like structures formed. Isolated warts and catenulations prominent

8. Rugulose type: Very low warted spores

CONCLUSION

Surface details of spores is a very important and useful tool in separating some closely aligned taxa. Amongst the various ornamentation type investigated Incomplete reticulate and Catenulate types are more common whereas Tuberculate type are least represented.

ACKNOWLEDGEMENTS

The authors thank Head, Department of Botany, Punjabi University, Patiala, for providing research facilities. We are indebted to UGC & DST, New Delhi for financial assistance.

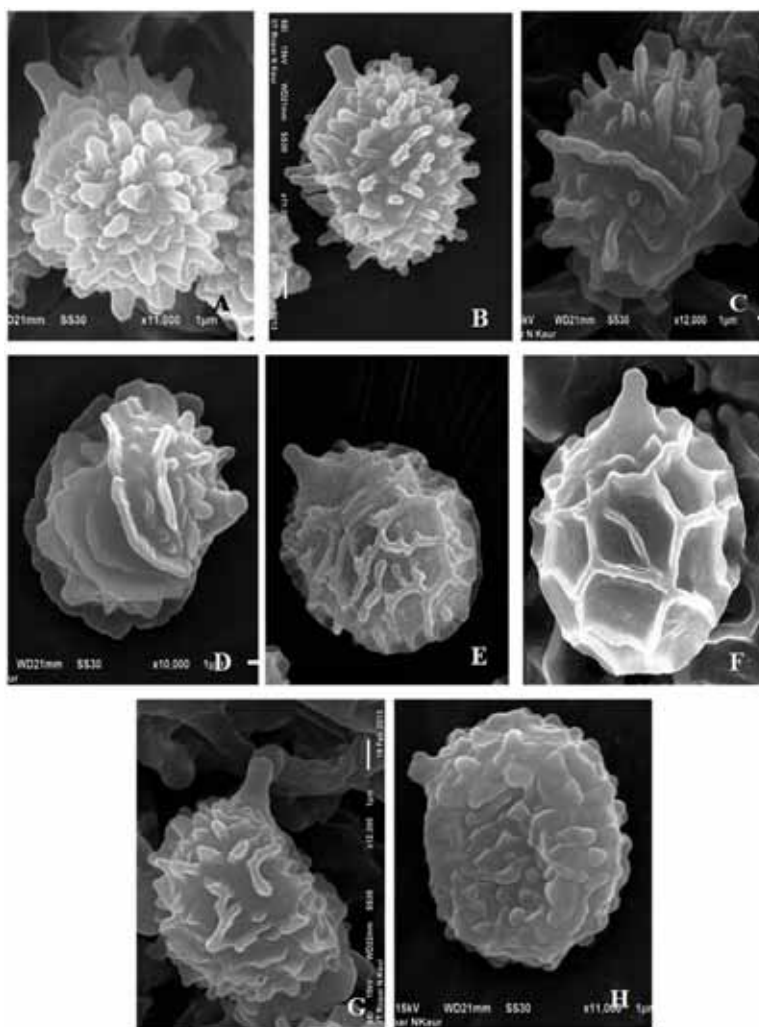


Figure 1. SEM Types: **A.** Tuberculate Type (*Russula peckii*), **B.** Catenulate Type (*R. cremeoavellanea*), **C.** Winged Type A (*Lactarius echinatus*), **D.** Winged Type B (*L. westii*), **E.** Incomplete Reticulate Type (*L. sanguifluus*), **F.** Complete Reticulate Type (*L. volemus*), **G.** Ridged Type (*R. aquosa*), **H.** Rugulose Type (*Lf. piperatus*)

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