Eschewing poisons: an ingenious wisdom of foraging macrofungi by Karbi ethnic group in North East India

Prila Hansepi* and Robindra Teron

Department of Life Science and Bioinformatics, Assam University – Diphu Campus, Diphu, Karbi Anglong 782 462, India

This study explores ethnomycological knowledge and management of mycetism by the Karbis of Assam, North East India. Ethnomycological data are quantitatively analysed for factors for informants' consensus, importance value and use value of 12 remedies used for the management of mycetism. Three layers of defence to avoid mycetism, viz. (i) field identification of edible and poisonous macrofungi using morpho-organoleptic features, etymology and phenology; (ii) selective cooking with various sour herbs, and (iii) use of ethnomedicine are reported here. Ethnomycological study among indigenes has benefits of documenting human culture, languages and protection of their intellectual property.

Keywords: Ethnomedicine, indigenes, macrofungi, mycetism.

MACROFUNGI are exploited traditionally as food and medicine, in rituals and as a source of dye all around the world[1–6]. However, due to the presence of poisonous macrofungi, consumption of misidentified species sometimes become fatal[7–9]. Various reports highlight the indeterminate richness of ethnomycological knowledge among indigenes of different communities[10–15]. Usually indigenes assure the safe exploitation of macrofungi by proper identification between edible and poisonous species during collection using several criteria including vision, smell, touch, taste and substrata[16–19]. Such mycological knowledge has transcended orally from generation to generation through word of mouth and has helped keep them away from mycetism to some extent.

The varied ethnic communities of the North Eastern Region (NER) of India[20] are mycophilic, and ethnomycology in Karbi Anglong district, Assam is discussed here. Collection of macrofungi is still an active process among mycophilic societies of the district. Cases of mycetism are encountered and the indigenes treat themselves with traditional remedies using local resources. The major objectives of the study are to study ethnomycological knowledge of the Karbis ethnic group, with special reference to their knowledge of poisonous and edible macrofungi, and remedies for mycetism. The literature review shows scanty information on ethnomycology of the Karbi people, and no systematic study on macrofungi has been undertaken in the district. The present study adds to the ethnobotanical database of North East India in general and the Karbi people in particular. Such a study would help document biodiversity and identify new resources for human benefit.

*For correspondence. (e-mail: prilhans@gmail.com)

Materials and methods

Ethnographic background

The Karbi Anglong district (25°33′–26°35′N and 92°10′–93°50′E) of Assam covers a geographical area of 10,434 sq. km and falls under subtropical type of climate with semi-evergreen and deciduous forest type. The region experiences monsoon from March up to September with average rainfall of about 2416 mm (ref. 21). About 41.12% of the district is covered by forests[22]. The district is inhabited by diverse ethnic people and the Karbis are dominant[23]. They belong to mongoloid race and speak a Tibeto-Burmese dialect[24]. Jhum cultivation is the chief method of crop production and paddy is the main crop grown. Inadequacy of agricultural products often compels the Karbis to collect forest resources for food security and other requirements. Long-term high dependence on forest products has probably contributed to the development of repository of a traditional knowledge, which is indispensable.

Field study and data collection

The present study was undertaken in the Karbi Anglong district (Figure 1) during March 2016 to June 2017. Field study was conducted in 16 forest villages where 120 informants comprising both male and female aged between 10 years to 70 years and above were selected using three common criteria – age, sex and involvement in macrofungal collection based on inputs provided by elders during informal group discussions (Table 1). Consent of informants to participate in data collection was obtained after explaining the purpose and objectives of the study.

The largest proportion of informants was adults (115), whereas five informants were below the age of 18 years. The adult informants were engaged in various occupations, viz. traditional healer, wild vegetable seller, magico-religious practitioner and hunter; some of the respondents were elderly persons with sound knowledge of macrofungi. Standard ethnobotanical methods were followed to collect ethnomycological data with questionnaire relevant to the objectives (Table 2)[25,26]. Samples used as remedy for mycetism were collected and preserved following the method of Jain[27]. Field data were tabulated and represented in bar and pie charts.

Quantitative analysis

To identify the most effective and potential remedy for mycetism among all the remedies recorded, factors for informants consensus (F_{ic}) and importance value (IV) were determined following the method of Trotter and Logan[28]. F_{ic} was calculated using the formula

$$F_{ic} = N_{ur} - N_t/(N_{ur} - 1),$$

where N_{ur} is the number of use-reports of informants for mycetism and N_t refers to the total number of remedies used for a particular illness category for all informants. F_{ic} values vary between 0 and 1. Species with high F_{ic} values indicate agreement of informants' on the use of a particular remedy (plant/other materials) against mycetism, while those with lower values signify disagreement among the informants. In order to confirm the healing efficiency of a particular remedy, frequency of citation, i.e. IV was calculated. It measures the proportion of informants who regard a species as most important. IV = *nis*/*n*, where *nis* is the number of informants who consider a species as most important and *n* is the total number of informants

$$IV_s = \frac{\left(\begin{array}{c}\text{No. of informants who cited the}\\ \text{species as most important}\end{array}\right)}{\text{Total no. of informants interviewed}}.$$

Use value (UV; for one species across all informants) was calculated following the method of Phillips and Gentry[29], to determine the usefulness of a sample to the community

$$UV = \left(\sum UV_{is}\right)/(n_i),$$

where n_i is the total number of informants interviewed for species *s*. UV_{is} is the sum of different uses of a species *s* mentioned by all informants.

Figure 1. Map of Karbi Anglong district, Assam, North East India.

Results and discussion

Etymology of fungi

The Karbis regard macrofungi as a group of organisms possessing distinct identity, which is collectively referred to as 'Kimu'. Karbi folk etymology describes macrofungi to have developed from soil, dead remains of plants and animals, and other organic matter. The etymology further mentions that poisonous macrofungal species originated from the vomit of animals like lion, tiger, bear, wild cat,

Table 1. Demographic profile of the participating informants (N = 120)

Demographic profile	No. of informants	Percentage
Age (years)		
10–25	10	8.33
26–40	19	15.83
41–55	25	20.83
56–70	30	25
Above 71	36	30
Gender		
Men	63	52.5
Women	57	47.5
Education		
Able to read and write	20	16.66
Elementary school	40	33.33
HSLC	5	1.73
Illiterate	55	45.82
Occupation		
Cultivation	75	62.5
Selling wild vegetables	25	20.83
Labour	20	16.66

Table 2. Questionnaire along with response of informants

Do you have knowledge about macrofungi?		How are macrofungi utilized?			Do you have rituals before collecting mushroom?		Is there any case of mushroom poisoning?		How do you cure mushroom poisoning?		Can you distinguish between edible and poisonous macrofungi?		Do you know the name of every macrofungus?	
Yes	No	Food	Medicine	Poison	Yes	No	Yes	No	Home remedy	Medication	Yes	No	Yes	No
120	0	100	20	5	4	116	114	6	73	47	75	45	0	120

snake and leopard. However, some macrofungi have different etymology. Akin to the Greeks, the Karbis also believe that every object and being has an associated myth of origin. The etymology of macrofungi decides its edibility. It is believe that fungal species that originated from harmful sources are not edible. For example, *Phallus* sp. is believed to have originated from the rotten navel of a new born baby and so it is not consumed.

Eschewing fungal poison

Avoiding spoiled food: Despite poor knowledge of microbes, the Karbis adopt strict cultural practice to avoid stale or unhygienic food using time-tested indicators. When food is kept for a long time, its edibility is checked by the presence of foam which is considered as an indicator of fermentation. In the absence of foam, degradation of food colour or release of foul odour indicate the decrease in palatability of food. When *musi* (white cottony mycelium) or powdery substance appears on food, dung, fruits or other substrates, the item is considered poisonous. To eschew microfungal or other microbial poisons, leftover food is usually warmed before consumption. Infected fruits or other items are washed and sundried to stop further microbial growth. Meat, fish, crops, pulses, etc. are smoked or kept near a fireplace to prevent microbial attack. Ethnomycological knowledge has helped these indigenous people safeguard against harmful effects of fungi and other microbes.

Edible versus poisonous macrofungi: Mushrooms refer to the fruit body of fungus which is edible, technically referred as sporophore. Women folk and children are more active in collecting mushrooms than men; they use bamboo-basket called '*ingtong*' to store and transport mushrooms. Collection is usually done during monsoon (March–October). Also, the Karbis ascribe a relationship to the time of mushroom fruiting to three phases of the moon-waxing crescent, full moon and waning crescent – as the favourable time for fruiting of macrofungi. Mushrooms are reported to appear first in the woods of jhum fields than on woods of other environments. Wood-inhabiting mushrooms appear in the first mushroom season, which is followed by fruiting of macrofungi in soil and other substrates. *Termitomyces* sp. appears first among the wild edible soil mushrooms.

Mushroom hunting poses a huge challenge and health risk as misidentification could be fatal. The Karbis employ orally inherited traditional indicators of smell, vision, colour and the substratum of fungi to distinguish edible macrofungi from poisonous species: (a) Cap with gills and good odour is considered non-poisonous. (b) Stalk with ring (annulus) that grows on soil is believed to be toxic. (c) Edible macrofungi growing on animal excreta or vomit of animals like snake, pig, elephant, tiger, wild cat, bear and pig are considered unpalatable. (d) If colour of water changes to green, yellow or black after soaking for overnight, then the macrofungus is considered non-edible. (e) In case there is no change of colour of the water but there is change of colour after cooking, the dish is considered unpalatable. (f) If the rice becomes coloured when cooked with a macrofungus, the latter is regarded poisonous. (g) Off-season edible mushroom is also suspected to be toxic. (h) When macrofungi kept in the dark illuminate under a flash of light, the mushroom is not consumed. (i) Edible macrofungi that emit unflavoured odour on maturity are collected and consumed in young stage only. Unpalatable odour is considered to be associated with toxic substances. (j) Mushrooms growing on living-trees are avoided for suspicion of accumulation of toxic substance from the host tree. (k) Macrofungi with reticulate or net-like structures under the cap or on the stalk surface are considered toxic. (l) Macrofungi with bright coloured fruiting bodies are also considered toxic. (m) Comparatively, soil macrofungi are more diverse with many look-alikes and so great caution is exercised during collection; wood macrofungi can be identified by the wood type.

The above-mentioned criteria are in agreement with reports from Meghalaya[16,17] and Nagaland[18]. Some of the criteria employed by the Karbi people are at par with modern fungal science. Features like substratum, living trees and coloured fruiting bodies mentioned above have been cited in standard books on mushrooms[30].

Remedy for mycetism

Apart from the cautions exercised during collection of mushrooms in the field, the Karbis practice selective culinary methods and utilization of local pharmacopeia to manage cases of mycetism. Mushrooms are cooked with sour herbs of *hanserong* (*Hibiscus sabdariffa*), *hanserong*

Table 3. Traditional remedies for mycetism practised among Karbi people in NE India

Antidotes	Parts used	Doses	F_{ic}	IV_s	Use value
Zea mays	Seed	200 ml approximate twice a day till recovery	0.62	0.25	0.016
Hibiscus sabdariffa	Calyx	100 ml approximate thrice a day for 3 days	0.88	0.83	0.033
Citrus sp.	Fruit	1/2 fruit is squeezed into the mouth to stop vomiting	0.89	0.87	0.025
Ipomoea batatas	Tuber	A bowl full twice a day is fed till recovery	0.82	0.91	0.033
Oryza sativa	Seed	A bowl full thrice a day is fed till recovery	0.54	0.20	0.041
Garcinia pedunculata	Fruit	50 ml approx is fed till vomiting stops	0.87	0.75	0.025
Tamarindus indica	Fruit	100 ml approx is fed periodically till vomiting stops	0.84	0.58	0.041
Soil	–	One time in the first incidence	0.62	0.25	0.05
Human excreta	Tip portion	One time in the first incidence	0.08	0.10	0.016
Copper coin	–	One bowl full twice on the first day only	0.85	0.62	0.016
Baboon flesh	Whole body	Once a day for 3–4 days	0.82	0.5	0.025
Rock mosses	Whole plant	Fed once a day for 3–4 days	0.64	0.26	0.008

ke-er (*Hibiscus acetosella*), *derot* (*Hibiscus cannabinus*), *delap* (*Polygonum chinense*), wild cherry tomato (*Solanum lycopersicum*) and brinjal (*Solanum indicum*) to neutralize the toxicity, if any. Despite the presence of many other sour leaves and fruits consumed as vegetables, the preference for *Hibiscus* and *Polygonum* probably is influenced by cultural practice and is unique and scarcely reported. In this study, 12 traditional remedies for mycetism were recorded which include plants, animals, metals and other substances (Table 3).

Maize (*Zea mays*): Sticky variety of dry-maize corn is powdered, diluted with water and about 200 ml of the mixture is given to the victim twice a day till recovery. Sometimes, fresh maize is boiled, crushed and given to the victim.

Roselle (*Hibiscus sabdariffa*): The red-calyx of the fruits of *Hibiscus* is sun-dried and preserved for dietary purpose. Such dried, one-year-old calyxes are soaked in water till the latter turns red. The extract is given to the victim to control vomiting and diarrhoea. Dose includes about 100 ml, three or more times a day to stop vomiting.

Citrus fruits: Citrus fruit of any species is cut and the juice is squeezed directly into the mouth of the victim. Lemon is the most effective among all citrus fruits; half of the fruit is taken as one dose to stop vomiting.

Sweet potato (*Ipomoea batatas*): The fresh and raw tuber of red skin variety of *Ipomoea* is crush or pounded. One bowl (about 200 ml) of the juice is fed to the victim twice a day till recovery.

Rice (*Oryza sativa*): Rice is soaked in water for sometime and the water is given to the victim. During mushroom poisoning, the victim becomes too weak to eat, so rice water is fed till he/she victim becomes strong to eat solid food.

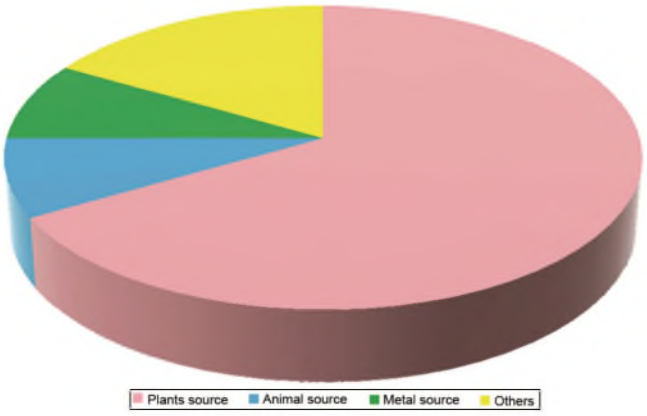

Figure 2. Proportion of different sources of remedies for mycetism.

Tamarind (*Tamarindus indica*): The ripe or raw fruits of tamarind are crushed and then mixed with water. About 100 ml of the juice is given three or more times in a day till vomiting stops. If ripe fruit is used for mycetism, the seeds are first removed and then pounded.

Garcinia pedunculata: Fresh fruit is sliced, pounded and then mixed with a small quantity of water; about 50 ml of the juice is given to the victim till vomiting stops. Often fruit is sliced, sun-dried and preserved for future use. In this case water extract of the fruit is given for mycetism.

Soil (*geophagy*): A handful of soil (usually loamy soil) from a clean area is collected and mixed with water. The mixture is taken orally during mycetism. Sandy and silty soil is avoided; informants could not offer proper explanation for this selective use of soil quality. It is given only once in the beginning of mycetism.

Human excreta: Under unusual circumstances, the tip portion of excreta of the victim is fed.

Copper coin: A magico-religious practice is invoked by the chanting of some sacred verses by a medicine man.

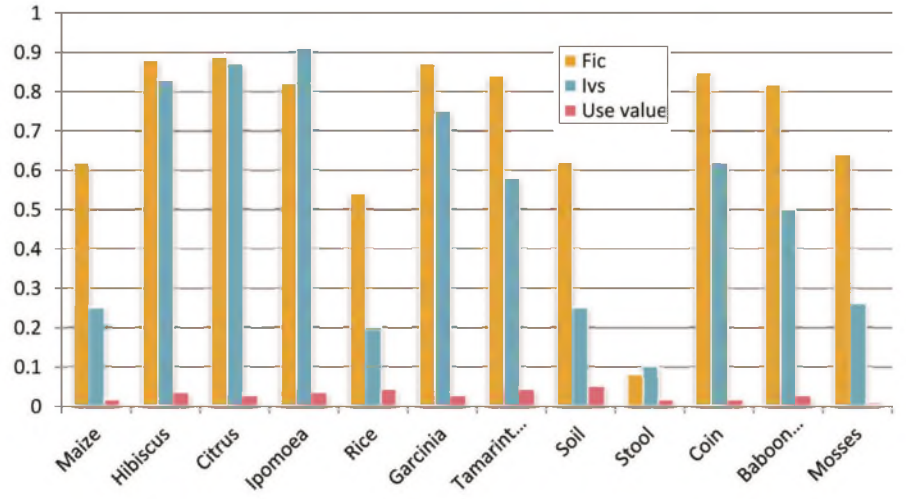

Figure 3. Quantitative analysis of remedies for mycetism showing values for F_{ic}, IV_s and use value.

During prayer, a copper coin is soaked in water (taken in a bowl) for sometime; the coin is scraped with a knife to let the powder fall in the bowl and then the water is fed to the victim after incantation. The prayers usually last for 5–10 min.

Baboon flesh: Fresh or dried meat of baboon is cooked and fed to the victim once daily for 3–4 days. The dried meat of gibbon is also preserved for future use.

Mosses: Moss growing on rocks is collected and dried, made into powder and then fed to the victim once daily for 3–4 days.

Quantitative analysis from Table 3 revealed that *Citrus* recorded highest F_{ic} value (0.89) indicating greater agreement among informants for the plant against mycetism, while human excreta showed least F_{ic} value (0.08). The response of informants regarded *Ipomoea batatas* as the most important among all remedies for mycetism with the highest UV (0.91), while baboon flesh scored the lowest UV (0.5). UV was high for rice (0.041), suggesting this plant has uses other than remedy for mycetism; rock moss scored a low value (0.008). Figure 2 shows the proportion of different sources of remedies used for the management of mycetism, while Figure 3 presents their quantitative analysis index values.

Conclusion

The Karbis practice three stages of defence to manage mycetism, an exceptional knowledge system which deserves appreciation. First, during mushroom hunting, edible species are collected using culturally accepted criteria to avoid toxic species. Second, selective cooking with sour leaves negates traces of toxic compounds, or doubts about identity of the mushroom. Third, traditionally practised ethnomedicine helps in the management of mycetism. Today, ethnomycological knowledge of the Karbis is showing signs of degradation due to their migration from the hills, destruction of potential fungal habitats, change in dietary patterns. Also, modern education has widened the divide between the Karbi people, and the once indispensable ethnomycological knowledge now remains confined to only the elders and those actively associated with mushroom hunting. Ethnomycological study has benefits of documenting biodiversity and diversification of human culture, apart from an understanding of interaction of traditional societies with fungi and pattern of transmission of knowledge. Such studies help in the selection of potential fungi for exploitation and identification of candidate plants with potential against mycetism. Indigenous people can benefit from documentation of their mycological knowledge as such research safeguards intellectual property. Being rich in nutraceuticals, mycophagy can fill the nutritional gap of economically weak people and this can be encouraged among the non-mycophilic community as well.

1. Boa, E., *Wild Edible Fungi: A Global Overview of their Use and Importance to People*, Non-Wood Forest Products, Food and Agriculture Organization of the United Nations, Rome, 2004.
2. Osemwegie, O. O., John, O. A. and Theophilus, D. A., Ethnomycological conspectus of West African mushrooms: an awareness document. *Adv. Microbiol.*, 2014, **4**, 39–54.
3. Prance, G. T., The mycological diet of the Yanomam Indians. *Mycologia*, 1973, **65**, 248–250.
4. Aryal, H. P. and Budathoki, U., Ethnomycological studies on some macrofungi in Rupandehi District, Nepal. *Banko Janakari*, 2013, **23**, 51–56.
5. Sarma, T. C., Sarma, I. and Patiri, B. N., Wild edible mushrooms used by some ethnic tribes of western Assam. *Int. Q. J. Life Sci.*, 2010, **3**, 613–625.
6. Adhikari, M., Devkota, K. S. and Tiwar, R. D., Ethnomycolgical knowledge on uses of wild mushrooms in western and central Nepal. *Our Nature*, 2005, **3**, 13–19.

7. Baniasad, N., Oghabian, Z. and Mehrpour, O., Hepatotoxicity due to mushroom poisoning: a case report. *Int. J. Med. Toxicol. Forensic Med.*, 2014, **4**, 68–73.
8. Verma, N., Bhalla, A., Kumar, S., Dhimany, R. K. and Chawlay, Y. K., Wild mushroom poisoning in North India: case series with review of literature. *J. Clin. Exp. Hepatol.*, 2014, **4**, 361–365.
9. Sharma, J., Malakar, M., Sandiguria, E. and Das, J., An expressive study of mushroom poisoning cases in Lakhimpur district of Assam. *Int. J. Adv. Res. Technol.*, 2013, **2**, 82–88.
10. Zent, E. L., Zent, S. and Iturriaga, T., Knowledge and use of fungi by a Mycophilic Society of the Venezuelan Amazon. *Econ. Bot.*, 2004, **58**, 214–226.
11. Fidalgo, O. and Prance, G. T., The ethnomycology of the Sanama Indians. *Mycologia*, 1976, **68**, 201–210.
12. Santiago, F. H. *et al.*, Traditional knowledge and use of wild mushrooms by Mixtecs or Ñuu savi, the people of the rain, from Southeastern Mexico. *J. Ethnobiol. Ethnomed.*, 2016, **12**, 1–22.
13. Shepard, G. H., Arora, D. and Lampman, A., The grace of the flood: classification and use of wild mushrooms among the highland Maya of Chiapas. *Econ. Bot. J.*, 2008, **62**, 437–470.
14. Chauhan, J., Negi, A. K., Rajasekaran, A. and Pala, N. A., Wild edible macro-fungi: a source of supplementary food in Kinnaur District, Himachal Pradesh, India. *J. Med. Plants*, 2014, **2**, 40–44.
15. Borja, W. O. R., Romero, M. E., Vera, L. P. A., Duran, P. I. H. and Reye, R. G., State of the art of mycophagy in Los Rios, Ecuador. *Adv. Environ. Biol.*, 2016, **10**, 288–296.
16. Das, K., Lamo, A., Paul, D. and Jha, L. K., Ethnomycological knowledge on wild edible mushroom of Khasi tribes of Meghalaya, North-Eastern India. *Eur. Acad. Res.*, 2014, **2**, 3433–3443.
17. Khaund, P. and Joshi, S. R., Wild edible macrofungal species consumed by the Khasi tribe of Meghalaya, India. *Indian J. Nat. Prod. Resour.*, 2013, **2**, 197–204.
18. Tanti, B., Gurung, L. and Sarma, G. C., Wild edible fungal resources used by ethnic tribes of Nagaland, India. *Indian J. Trad. Knowl.*, 2011, **10**, 512–515.
19. Barthakur, B., Mushroom poisoning, tea community and role of management in tea gardens of Assam. *Two and a Bud*, 2012, **59**, 19–21.
20. National Council of Educational Research and Training, *North East India People, History and Culture*, Pushpak Press Private Limited, New Delhi, 2017.
21. http://www.assaminfo.com/districts/15/karbi-anglong.htm (retrieved on 9 September 2017).
22. http://karbianglong.gov.in/main-web/forest.htm (retrieved on 9 September 2017).
23. Phangcho, P. C., *Karbi Anglong and North Cachar Hills – A Study on Geography and Culture*, Printwell, Diphu, 2001.
24. Bhattacharjee, T., *Sociology of the Karbis*, B.R. Publishing Corporation, Delhi, 1986.
25. Alexiades, M. N., Collecting ethnobotanical data: an introduction to basic concepts and techniques. In *Selected Guidelines for Ethnobotanical Research: A Field Manual* (eds Alexiades, M. N.), The New York Botanical Garden, New York, 1996, pp. 53–94.
26. Cunningham, A. B., *Applied Ethnobotany: People, Wild Plant Use and Conservation*, WWF, UNESCO and Royal Botanical Gardens, Kew, London and Sterling, Earthscan Publications, 2001.
27. Jain, S. K., The role of botanist in folklore research. *Folklore*, 1964, **5**, 145–150.
28. Trotter, R. T. and Logan, M. H., Informant consensus: a new approach for identifying potentially effective medicinal plants. In *Plants in Indigenous Medicine and Diet* (ed. Atkin, N. L.), Redgrave Publishing Company, New York, 1986, pp. 91–112.
29. Phillips, O. and Gentry, A. H., The useful plants of Tambopata, Peru: I. statistical hypotheses tests with a new quantitative techniques. *Econ. Bot.*, 1993, **47**, 15–32.
30. Bahl, N., *Handbook on Mushroom*, Oxford and IBH Publishing Co, New Delhi, 1984.

ACKNOWLEDGEMENT. We thank the informants for their cooperation during field survey and data collection. We also thank local guides and household heads for hospitality during the field study.

Received 13 April 2018; accepted 25 July 2018

doi: 10.18520/cs/v115/i7/1328-1333