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<td><strong>Issue Date</strong></td>
<td>2019</td>
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Taxonomic Study on Ten Wild Mushrooms from Loikaw Township in Kayah State

Au Au Khaing¹, Soe Soe Aung² and Ohnmar Htwe³

Abstract
The taxonomic studies on wild mushrooms from Loikaw Township, Loikaw District in Kayah State have been undertaken. The study area is located between N’ 19º 14’ 22" - 19º 59’ 45" and E’ 97º 7’ 0.9" - 97º 31’ 33". The wild mushrooms were collected from June to September, 2017. The 10 species of 9 genera belonging to 6 families and 3 order were collected, preserved, classified, identified and described. The collected species were identified as Coprinus disseminatus (Pers.) Gray, Macrolepiota konradii (Huijsman ex. P. D. Orton) M. M. Moser, Amanita caesarea (Scop.) Per., Amanitopsis vaginata (Bull.) Roze., Hygrocybe ceracea (Sowerby) P. Kumm., Termitomyces schimperi (Pat.) R. Heim, Boletus pulverulentus Opat., Lactarius clarkeae Cleland., Lactarius volemus (Fr.) Fr. and Russula virescens (Schaeff.) Fr. The growing habitats of Coprinus disseminatus (Pers.) Gray. was on the decayed woods and the others were on the soil. All species were edible. An artificial key to the studied species was constructed and presented.

Keywords: Taxonomic study, wild mushrooms, Loikaw Township, Kayah State, edible, an artificial key

Introduction
Mushrooms are fungi, generally considered to be lower forms of life, belonging to plant kingdom. There are about 45,000 known species of fungi and about 2000 of them are considered edible (Nair 1990). Mushrooms of one kind or another are to be found at almost every season but they occur in greatest abundance after showery weather in the months of July, August and September. Among the fungi, commonly known as mushrooms are the puffballs, club fungi, coral fungi, hedgehog fungi, truffles, trembling fungi, morels, stinkhorns, tube-bearing fungi and the gilled fungi or agarics. Fungi possessing no chlorophyll, must, like animals, depend for their nourishment upon living or dead organic matters (Thomas 1948).

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Fungi belong to the class of plants known as Cryptogams. The vegetable kingdom is divided into two great groups: one, flowering plants or phanerograms, which is characterized by forming seeds, the other, flowerless plants, cryptograms, which reproduced by spores (Ramsbottom 1923). Most fungi will grow between 0º and 35ºC, but optimum temperatures lies in the range of 20-30ºC. The ability of many fungi withstand extremely low temperatures (as low as -195ºC.) (Alexopoulos 1962).

Fungi are classified according to the way in which the spores are arranged. Basidiomycetes include mushrooms, toadstools, bracket fungi, fairly clubs. Basidiomycetes are characterized by having their spores borne, usually in fours, on the outside of basidia. Ascomycetes include morals, truffles, cup fungi, ergot and are characterized by having their spores usually in eights, borne within asci (Ramsbottom 1923).

The Basidiomycota contains at least 30,000 different species worldwide and includes many of our most familiar fungi. Fungi were not made of cellulose, like plants, but of chitin. They did not contain chlorophyll and could not use sunlight to convert carbon dioxide into sugars (Roberts & Evan 1950). Some basidiomycetes produce one or more other types of spore in addition to basidiospores. There are about 525 genera and 13,500 species (Smith 1979).

In Myanmar, mushrooms of Karen State was studied by Ku Yin Myint (1983). In 1987, Thida Saint presented by mushrooms of Taunggyi and Kalaw areas. In 2010, Kyi Kyi Win studied on the systematic studies of mushrooms in Pyay District and phytochemical investigation of Dictyophora indusiata (pers) Fish. In 2014, Khin Sandi Pyone Cho presented the taxonomic study on mushrooms growing in Mandalay. In 2015, Aye Aye Maw presented taxonomic studies on wild mushrooms from Monywa District. Taxonomic studies on wild mushrooms from Southern Shan State was studied by Ohnmar Htwe (2017). Although many researchers had done the wild mushrooms flora in Myanmar, the taxonomic studies on wild mushrooms have not been undertaken in Kayah State. Therefore, this study was carried out for this research work.

The aim and objectives of this study were to collect, classify and identify the morphological characteristics of the wild mushrooms from Loikaw Township, to study their detailed taxonomic characteristics and
distribution, and to fulfill the scientific information in the compilation of the mushroom flora in Myanmar.

Materials and Methods

The study areas of wild mushrooms from Loikaw Township, Kayah State were situated between 19º 14' 22" N to 19º 59' 45" N Latitude and 97º 7' 0.9" E to 97º 31' 33" E longitude. The elevation of Loikaw is 899 meter above the sea level.

The fresh specimen of wild mushrooms were collected from Htee Se Khar Waterfall, Kyauk Taung village, Padangay village and Law Pi Ta village of Loikaw Township, Kayah State from June to September, 2017. The wild mushrooms which were growing on grassland, meadows, decomposing organic matters, hollow and rotten tree trunks were collected.

All the fresh specimens were recorded with photographs to get their actual habit and noted their fruiting characteristics. The collection, preservation and the spores print technique were followed by Krieger & Schaffer (1967) and Pacionic (1981). The fleshy matured specimens were selected for the preparation of spores print. The stipe was firstly removed by cutting it off as close as possible to the point of attachment of cap. It is obtained by placing a cap with the hymenium facing down on a sheet of white, black paper or a piece of glass-slide. A blow can then serve as a cover after a few hours, a layer of the spores was deposited. Finally real colour of the spores was determined by spore print.

The collected specimens were preserved in Formalin-Acetic acid-Alcohol (FAA) by the ratio of 5: 5: 90. Some of the dried specimens were placed in plastic bags and plastic bottles. Classification and identification of the collected specimens were done by referring the literature; Bessey (1952), Krieger & Schaffer (1967), Coker & Couch (1969), Keizer (1998). An artificial key to the studied species was also constructed and presented. The herbarium specimens were numbered and deposited at the herbarium room of Department of Botany, University of Mandalay for the references and other scientific studies.
Results

Ten species of 9 genera belonging to 6 families and 3 order were collected from four study areas of Loikaw Township in Kayah State. The morphological and spores characters of those species were classified and identified. The list of collected species and their comparable morphological characteristics were presented in Table 1 and Table 2.

Table 1. List of collected wild mushroom species from Loikow Township

<table>
<thead>
<tr>
<th>Class</th>
<th>Sub-Class</th>
<th>Order</th>
<th>Family</th>
<th>No.</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basidiomycetes</td>
<td>Homobasidiomycetidae</td>
<td>Agaricales</td>
<td>Agaricaceae</td>
<td>1.</td>
<td>Coprinus disseminatus (Pers.) Gray</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.</td>
<td>Macrolepiota konradii (Hujjsman ex. P.D. Orton) M. M. Moser</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.</td>
<td>Amanita caesarea (Scop.) Per.</td>
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<tr>
<td></td>
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<td></td>
<td>4.</td>
<td>Amanitopsis vaginata (Bull.) Roze.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5.</td>
<td>Hygrocybe ceracea (Sowerby) P. Kumm.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6.</td>
<td>Termitomyces schimperi (Pat.) R. Heim</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7.</td>
<td>Boletus pulverulentus Opat.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8.</td>
<td>Lactarius clarkeae Cleland.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9.</td>
<td>Lactarius volemus (Fr.) Fr.</td>
</tr>
<tr>
<td></td>
<td>Lyophyllaceae</td>
<td></td>
<td></td>
<td>10.</td>
<td>Russula virescens (Schaeff.) Fr.</td>
</tr>
</tbody>
</table>
Table 2. Comparable morphological characteristics of wild mushrooms from Lowikaw Township

<table>
<thead>
<tr>
<th>No.</th>
<th>Scientific Name</th>
<th>Growing Habitat</th>
<th>Edible/ Inedible</th>
<th>Cap</th>
<th>Gills / Pores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Colour / Shape</td>
</tr>
<tr>
<td>1.</td>
<td><em>Coprinus disseminatus</em> (Pers.) Gray</td>
<td>decay woods</td>
<td>edible</td>
<td>white to pale grey</td>
<td>campanulate</td>
</tr>
<tr>
<td>2.</td>
<td><em>Macrolepiota konradii</em> (Huijsman ex. P.D. Orton) M. M. Moser</td>
<td>soil</td>
<td>edible</td>
<td>white</td>
<td>expanded</td>
</tr>
<tr>
<td>3.</td>
<td><em>Amanita caesarea</em> (Scop.) Per</td>
<td>soil</td>
<td>edible</td>
<td>orange-red</td>
<td>expanded</td>
</tr>
<tr>
<td>4.</td>
<td><em>Amanitopsis vaginata</em> (Bull.) Roze.</td>
<td>soil</td>
<td>edible</td>
<td>leaden-brown</td>
<td>expanded</td>
</tr>
<tr>
<td>5.</td>
<td><em>Hygrocybe ceracea</em> (Sowerby) P. Kumm.</td>
<td>soil</td>
<td>edible</td>
<td>pale-orange</td>
<td>convex</td>
</tr>
<tr>
<td>6.</td>
<td><em>Termitomyces schimperi</em> (Pat.) R. Heim</td>
<td>soil</td>
<td>edible</td>
<td>white</td>
<td>convex</td>
</tr>
<tr>
<td>7.</td>
<td><em>Boletus pulverulentus</em> Opat.</td>
<td>soil</td>
<td>edible</td>
<td>dark-brown</td>
<td>convex</td>
</tr>
<tr>
<td>8.</td>
<td><em>Lactarius clarkeae</em> Cleland.</td>
<td>soil</td>
<td>edible</td>
<td>orange-brown</td>
<td>convex to depressed</td>
</tr>
<tr>
<td>9.</td>
<td><em>Lactarius volemus</em> (Fr.) Fr.</td>
<td>soil</td>
<td>edible</td>
<td>orange-brown</td>
<td>convex with depression</td>
</tr>
<tr>
<td>10.</td>
<td><em>Russula virescens</em> (Schaeff.) Fr.</td>
<td>soil</td>
<td>edible</td>
<td>dull green</td>
<td>globose</td>
</tr>
<tr>
<td>No.</td>
<td>Scientific Name</td>
<td>Stipe</td>
<td>Spore</td>
<td></td>
<td></td>
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<tr>
<td>-----</td>
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<td>----------------</td>
<td>----------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shape</td>
<td>colour</td>
<td>hollow/ solid</td>
<td>annulus or ring</td>
</tr>
<tr>
<td>1.</td>
<td><em>Coprinus disseminatus</em> (Pers.) Gray</td>
<td>slender</td>
<td>white</td>
<td>hollow</td>
<td>absent</td>
</tr>
<tr>
<td>2.</td>
<td><em>Macrolepiota konradii</em> (Huijsman ex. P.D. Orton) M. M. Moser</td>
<td>equal</td>
<td>white</td>
<td>hollow</td>
<td>present</td>
</tr>
<tr>
<td>3.</td>
<td><em>Amanita caesarea</em> (Scop.) Per</td>
<td>unequal</td>
<td>yellow</td>
<td>hollow</td>
<td>present</td>
</tr>
<tr>
<td>4.</td>
<td><em>Amanitopsis vaginata</em> (Bull.) Roze.</td>
<td>equal</td>
<td>white</td>
<td>hollow</td>
<td>absent</td>
</tr>
<tr>
<td>5.</td>
<td><em>Hygrocybe ceracea</em> (Sowerby) P. Kumm.</td>
<td>slender</td>
<td>white</td>
<td>hollow</td>
<td>absent</td>
</tr>
<tr>
<td>6.</td>
<td><em>Termitomyces schimperi</em> (Pat.) R. Heim</td>
<td>unequal</td>
<td>white</td>
<td>solid</td>
<td>present</td>
</tr>
<tr>
<td>7.</td>
<td><em>Boletus pulverulentus</em> Opat.</td>
<td>equal</td>
<td>reddish brown</td>
<td>solid</td>
<td>absent</td>
</tr>
<tr>
<td>8.</td>
<td><em>Lactarius clarkeae</em> Clenland.</td>
<td>unequal</td>
<td>orange-brown</td>
<td>solid</td>
<td>absent</td>
</tr>
<tr>
<td>9.</td>
<td><em>Lactarius volemus</em> (Fr.) Fr.</td>
<td>equal</td>
<td>orange brown</td>
<td>solid</td>
<td>absent</td>
</tr>
<tr>
<td>10.</td>
<td><em>Russula virescens</em> (Schaeff.) Fr.</td>
<td>unequal</td>
<td>white</td>
<td>solid</td>
<td>absent</td>
</tr>
</tbody>
</table>
Figure 1. *Coprinus disseminatus* (Pers.) Gray. (A. Growing habitat, B. Fruiting body in lateral view, C. Fruiting body in longitudinal section, D. Pileus in lower view, E. Spores)

Figure 2. *Macrolepiota konradii* (Hujjsman ex. P.D. Orton) M. M. Moser. (A. Growing habitat, B. Fruiting body in lateral view, C. Fruiting body in longitudinal section, D. Pileus in lower view, E. Spores)

Figure 3. *Amanita caesarea* (Scop.) Per. (A. Growing habitat, B. Fruiting body in lateral view, C. Fruiting body in longitudinal section, D. Pileus in lower view, E. Spores)

Figure 4. *Amanitopsis vaginata* (Bull.) Roze. (A. Growing habitat, B. Fruiting body in lateral view, C. Fruiting body in longitudinal section, D. Pileus in lower view, E. Spores)

Figure 5. *Hygrocybe ceracea* (Sowerby) P. Kumm. (A. Growing habitat, B. Fruiting body in lateral view, C. Fruiting body in longitudinal section, D. Pileus in lower view, E. Spores)
Figure 6. *Termitomyces schimperi* (Pat.) R. Heim. (A. Growing habitat, B. Fruiting body in lateral view, C. Fruiting body in longitudinal section, D. Pileus in lower view, E. Spores)

Figure 7. *Boletus pulverulentus* Opat. (A. Growing habitat, B. Fruiting body in lateral view, C. Fruiting body in longitudinal section, D. Pileus in lower view, E. Spores)

Figure 8. *Lactarius clarkeae* Cleland. (A. Growing habitat, B. Fruiting body in lateral view, C. Fruiting body in longitudinal section, D. Pileus in lower view, E. Spores)

Figure 9. *Lactarius volesmus* (Fr.) Fr. (A. Growing habitat, B. Fruiting body in lateral view, C. Fruiting body in longitudinal section, D. Pileus in lower view, E. Spores)

Figure 10. *Russula virescens* (Schaeff.) Fr. (A. Growing habitat, B. Fruiting body in lateral view, C. Fruiting body in longitudinal section, D. Pileus in lower view, E. Spores)
An Artificial Key to the Studied Species

1. Stipe hollow --------------------------------------------------------------- 2
2. Stipe solid --------------------------------------------------------------- 6
2. Umbo present --------------------------------------------------------------- 3
2. Umbo absent --------------------------------------------------------------- 4
3. Cap campanulate; gills white to pale grey ----1. Coprinus disseminates
3 Cap expended; gills white -------------------9. Macrolepiota konradii
4. Ring present; stipe yellow------------------ 3. Amanita caesarea
4. Ring absent; stipe white ---------------------------------- 5
5. Spore globose; cap leaden brown --------------- 4. Amanitopsis vaginata
5. Spore elliptic; cap pale orange ------------------ 5. Hygrocybe ceracea
6. Ring present; spore elliptic -----------------6. Termitomyces schimperi
6. Ring absent; spore fusiform and globose -------------------------------- 7
7. Cap orange brown; spore rough ---------------------------------------------8
7. Cap dark-brown and dull green; spore smooth -------------------------------- 9
8. Stipe unequal; gills creamy white ---------------8. Lactarius clarkeae
8. Stipe equal; gills golden yellow brown -------4. Lactarius volemus
9. Cap convex; gills yellow, adnate -----------------7. Boletus pulverulentus
9. Cap globose; gills white, free ------------------10. Russula virescens

Discussion and Conclusion

In the present study, the taxonomic studies on ten species of wild mushrooms from Loikaw Township in Kayah State were undertaken. The fresh specimen of wild mushrooms from Loikaw Township were collected from June to September, 2017. The wild mushrooms were collected from Htee Se Khar Waterfall, Kyauk Taung village, Padangay village and Law Pi Ta village.

Among them, 9 species were gill mushrooms type and 1 species, Boletus pulverulentus Opat. was pore mushrooms type. In Loikaw Township, the 4 species collected from Htee Se Khar Waterfall were Coprinus disseminatus (Pers.) Gray, Amanita caesarea (Scop.) Pers., Lactarius volemus (Fr.) Fr. and Russula virescens (Schae. ff.). One species, Amanitopsis vaginata (Bull.) Roze. was collected from Kyauk Taung village. Hygrocybe ceracea (Sowerby) P. Kumm, Termitomyces schimperi (Pat.), R. Heim, Boletus pulverulentus Opat. and Lactarius clakeae Cleland.
were collected from Padangay village. *Macrolepiota konradii* (Hujjsman ex. P. D. Orton) M. M. Moser was collected in Law Pi Ta village.

The growing habits of the fruiting bodies vary in the studied species. The 4 species such as *Amanita caesarea* (Scop.) Pers., *Amanitopsis vaginata* (Bull.) Roze., *Lactarius clakeae* Cleland, and *Russula virecens* (Schaeff.) Fr. were growing as the single fruiting bodies. The 6 species such as *Coprinus disseminatus* (Pers.) Gray, *Macrolepiota konradii* (Hujjsman ex. P. D. Orton) M. M. Moser, *Hygrocybe ceracea* (Sowerby) P. Kumm., *Termitomyces schimperi* (Pat.) R. Heim, *Boletus pulverulentus* Opat. *Lactarius volemus* (Fr.) Fr. were growing as the aggregated fruiting bodies. The present findings were agreed with the solitary and group growing habits which mentioned by Phillips (2006).

The 9 species such as *Macrolepiota konradii* (Hujjsman ex P. D. Orton) M. M. Moser, *Amanita caesarea* (Scop.) Per., *Amanitopsis vaginata* (Bull.) Roze., *Hygrocybe ceracea* (Sowerby) P. Kumm., *Termitomyces schimperi* (Pat.) R. Heim, *Boletus pulverulentus* Opat., *Lactarius volemus* (Fr.) Fr. and *Russula virecens* (Schaeff.) Fr. were growing on the soil. One species, *Coprinus disseminatus* (Pers.) was growing on the decayed woods. These findings were agreed with Koon (1990).

Only 3 wild mushrooms species, *Coprinus disseminatus* (Pers.) Graw, *Macrolepiota konradii* (Hujjsman Ex. P. D. Orton) M. M. Moser, and *Termitomyces schimperi* (Pat.) R. Heim, were present the umbo on the cap. The others, *Amanita caesarea* (Scop.) Pers, *Amanitopsis vaginata* (Bull.) Roze., *Hygrocybe ceracea* (Sowerby) P. Kumm., *Boletus pulverulentus* Opat. and *Lactarius clakeae* Cleland., *Lactarius volemus* (Fr.) Fr. and *Russula virecens* (Schae. ff.) Fr. were absent umbo on the cap.

Two kinds of mushroom species; pore mushrooms and gills mushrooms were recorded in this study. Among them, *Boletus pulverulentus* Opat. was pore mushrooms type.

Various cap shapes were also observed in this study areas. These were campanulate in *Coprinus disseminatus* (Pers.) Gray; ovate and expanded in *Macrolepiota konrandii* (Hujjsman ex. P. D. Orton) M. M. Moser.; expanded convex in *Amanita caesarea* (Scop.) Per.; bell-shaped to expanded in *Amanitopsis vaginata* (Bull.) Roze.; convex expanded in *Termitomyces schimperi* (Pat.) R. Heim; convex in *Hygrocybe ceracea* (Sowerby) P. Kumm. and *Boletus pulverulentus* Opat., convex to centre depressed in *Lactarius clakeae* Cleland, and convex with depression in
Lactarius volemus (Fr.) Fr. and globose to convex in Russula virescens (Schaeff.) Fr. These findings were agreed with Largent (1973).

Gills were free in Coprinus disseminatus (Pers.), Gray, Macrolepiota konradii (Huijsman ex. P. D. Orton) M. M. Moser, Amanita caesarea (Scop.) Pers., Amanitopsis vaginata (Bull.) Roze., Hygrocybe ceracea (Sowerby) P. Kumm., Termitomyces schimperi (Pat.) R. Heim. and Russula virescens (Schaeff.) Fr. The pores of Boletus pulverulentus Opat. were adnate and the gills of Lactarius clarkeae Cleland. were adnate to decurrent and Lactarius volemus (Fr.) were decurrent. These findings were agreed with Phillips (2006).

The stipe shapes of 4 species were equal in Macrolepiota konradii (Huijsman ex. P. D. Orton) M. M. Moser, Amanitopsis vaginata (Bull.) Roze, Boletus purverulentus Opat. and Lactarius volemus (Fr.) Fr. The stipe shapes of Termitomyces schimperi (Pat.) R. Heim., Amanita caesarea (Scop.) Pers., Lactarius clarkeae Cleland, Russula virescens (Schaeff.) Fr. were unequal. Coprinus disseminatus (Pers.) Gray, and Hygrocybe ceracea (Sowerby) P. Kumm were slender. The hollow stipes were observed in Coprinus disseminatus (Pers.) Gray, in Macrolepiota konradii (Huijsman ex. P. D. Orton) M. M. Moser, Amanita caesarea (Scop.) Pers., Amanitopsis vaginata (Bull.) Roze. and Hygrocybe ceracea (Sowerby) P. Kumm. The remaining 5 species were solid stipes.

The spores colour were dark-brown in Coprinus disseminatus (Pers.) Gray, pink in Termitomyces schimperi (Pat.) R. Heim., olive brown in Boletus pulverulents Opat. and white in Macrolepiota konradii (Huijsman ex. P. D. orton) M. M. Moser, Amanta caesarea (Scop.) Pers, Amanitopsis vaginata (Bull.) Roze., Hygrocybe ceracea (Sowerby) P. Kumm., Lactarius clarkeae Cleland, Lactarius volemus (Fr.) Fr. and Russula virescens (Schaeff.) Fr. were white. These findings were agreed with Moore (2014). All of the studied species were edible. These findings were agreed with Groves (1979).

Some wild mushroom species from this Loikaw areas were also found in Karen State, Mon State, Southern Shan State, Mandalay area, Taungyi and Kalaw areas, Pyay District and Monywa Distinct. These are Coprinus disseminatus (Pers.) Gray, Amanita caesarea (Scop.) Per., Lactarius volemus (Fr.) Fr., Russula virescens (Schaeff.) Fr. in Karen State (Ku Yin Myint 1983); Coprinus disseminates (Pers.) Gray. and Amanitopsis vaginata (Bull.) Roze. in Thaton District, Mon State (Thandar Soe 2013); Coprinus disseminatus (Pres.) Gray, Aminta caesarea (Scop.) Per., Amanitopsis vaginata (Bull.) Roze., Lactarius volemus (Fr.) Fr. and Russula

Therefore, it would be concluded that the present study was one of the systematic records of wild mushrooms to be used by researchers in various fields of studies. This study will be provided the partial fulfillment of the information on the wild mushrooms distribution in Loikaw Township, in Kayah State and will be beneficial to accomplish the mushroom flora in Myanmar.

**Acknowledgements**

I would like to express my gratitude to Dr Nu Nu Yee, Professor and Head, Department of Botany, University of Mandalay, for her permission, invaluable advice and providing all the department facilities to do this research. I am grateful to Dr Soe Myint Aye, Pro-rector, Department of Botany, Myitkyina University, for his good suggestion and invaluable advice in this research.

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