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OBSERVATIONS ON SOME FAIRY RING FORMING *LEPIOTA* MUSHROOMS (BASIDIOMYCOTA; AGARICALES) IN GHANA

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ABSTRACT

Mushrooms are mostly saprophytic and grow in soil, on dead wood or are found on grass, lawns, pitches and golf courses. There are about 400 species of *Lepiota* typically gilled; some are edible and other forming fairy rings in the field. Two *Lepiota* species were studied in the Greater Accra Region during the rainy season (May-July) of 2016-2018. Their morphological development, anatomy and ring-forming capacity during the 3yr cycle. *Lepiota procera* (Pers) Grays is edible and is typically without volva. The fairy ring was made up of 6 - 9 mushrooms in circle along the periphery of the circle with slight shift in the positions of the fruiting body. period. *L. procera* emerged directly from the soil without any change in the topography or color of soil in about 28 days. The second *Lepiota* sp. is not edible and completed morphological development in 2 - 3 weeks and formed full to semi-circle fairy rings. There was a distinct greening of grass (*Chrysopogon aciculatus*) along the periphery of the ring. These finding underscore the fact that fairy ring formation is not mystical but a natural phenomenon among the Basidiomycota. This is the first reported account of fairy ring formation in Ghana.

Keywords: *Lepiota procera, Lepiota* sp., fairy rings, greening of vegetation; morphological, developmental anatomical features.

Introduction

Mushrooms belong to the Phylum Basidiomycota or Order Agaricales (gilled mushrooms or eugarics) and they constitute some of the familiar edible and poisonous mushroom species. The Order Agaricales has 33 extant families, 413 genera and 13000 described species along with 6 extinct genera known only from the fossil records (Ruggiero, 2014; Hawkworth *et al.,* 1995; Kirk *et al.,* 2008). The fruiting bodies of the Agarics grow quickly, and they seem to mysteriously appear out of soil, deeply rooted in the forest and are perceived as an ominous phenomenon. The rapid growth and appearance of the fruiting bodies results in a semi to near perfect circle which in the past was attributed to the activities of witches or fairies (Piepenbring, 2015). This perfect to near perfect circles formed by the growing fungus is called 'fairy rings', because of the old superstition that mushrooms growing in a circle represent the path of dancing fairies (Alexopoulos *et al.,* 1996; Encyclopedia Britannica, 2022, Vickers, 2019). Some cultures believe that fairy circles could be the portal of an alternate supernatural world. They also have been known to signify fairy villages, where they use mushrooms as their dining tables (https://fantasticfungi.com, 2021). The associated myths of these rings is

that these magical creatures would dance and celebrate within the mushroom ring's limited space. In some cultures, it was a taboo to step into the ring and get stuck.

However, there is a scientific explanation for the magical phenomenon of fairy rings. A fairy ring starts when the fungus grows into a mycelium (spawn) of mushroom when the spore falls in a favourable spot and then sends out subterranean network of fine tubular threads called hyphae. The hyphae grows out from the spore evenly in all direction forming a circular mat underground. The mushrooms which grow out of the circular underground soil meet and form a similar pattern above ground. Gradually, the underground mycelium at the centre of the circle dies out. Its living outer edges, however, keep growing year by year and hence the diameter of the ring increases (Encyclopedia Britannica, 2022; Anon, 2022) with fruiting bodies aligned with the circle. Fairy rings are found in forests, grassy field, golf courses, city garden lawns, and many other places forming either a semi-circle/arc or complete circles. For examples, *Marasmius oreades* (Basidiomycota Agaricales) is a fairy ring mushroom on grass lawns of golf courses (Dickinson & Lucas, 1979). Another agaric, *Chlorophyllum molybdites* (a poisonous mushroom) has been found growing at Legon, Ghana (Odamtten, 2017). *Chlorophyllum molybdites* has been recorded as forming a fairy ring in North American (Alexopoulos *et al.,* 1996).

Fairy rings are of three types depending on soil type, the specific fungus involved, and environmental conditions (Aneja & Mehrotra, 2011). Firstly, the development of the basidiocarps has no effect on the vegetation e.g., *Lepiota morgani*. In the second type, there is an increased growth of the vegetation where the fungus is growing e.g., *Chlorophyllum molybdites* and *Lipsa personatum***.** In this instance, inside the circle of the mushrooms, there is a distinct zone of grass which is noticeable greener than the grass elsewhere in the vicinity. The greener colour is attributed to the nitrogenous substances which becomes available to the grass as the older hyphae of the fungus dies and disintegrate (Alexopoulos *et al.,* 1996; Aneja & Mehrotra, 2011). The third type of fairy ring does damage to the vegetation, sometimes so badly as to have effect on its aesthetic value or the vegetation is degraded to become non-existent. The fungus involved produce compounds that reduce the amount of water that the soil can absorb, leading to drought conditions that causes the grass in the ring to brown and die e.g*., Armillaria mellea, Lepiota campester, Marasmius oreades* (Blayney, Rosenkranz & Zettner, 1980; Eilers & Barnard, 1973; Nelson, 2008).

Lepiota species are typically gilled mushrooms and ground-dwelling saprotrophs in rich calcareous soils. The name is derived from the Greek meaning "scales" or ''ears" and the basidiocarps are agaricoid with whitish spores typically with scaly caps and a moving ring on the stipe. About 400 species of *Lepiota* are known worldwide but commonly in the tropics some of which are poisonous and others edible (Hawksworth *et al.,* 1995; Aneja & Melhotra 2011; Ruggiero, 2014; Wikipedia en.m.org; Encyclopedia Britannica, 2022; Anon, 2022).

Over the past decade, the rainfall patterns have been regular as predicted by the Ghana Meteorological Authority. Consequently, some moisture-loving basidiomycetous fungi belonging to the Order Agaricales have been recorded for the first time in the Accra Metropolitan Area (Legon and Achimota). This paper reports on the three years cycle of the occurrence of the phenology, morphological development and anatomy of two *Lepiota* species during the rainy season period 2016 – 2018. The formation of the two

distinct types of fairy rings within the same period is also reported.

Experimental

Two basidiomycetous agaricoid mushrooms (*Lepiota procera* (Pers) Grays or parasol mushroom, and *Lepiota* species) were observed during the minor and major rainy seasons of 2016 – 2018. *L. procera* was observed on an abandoned anthill (termitarium) at the Achimota village (5.6128°N, 0.2343°W, Accra Metropolitan Area) while other *Lepiota sp.* was found growing on the courtyard of Department of Plant and Environmental Biology University of Ghana, Legon (5.6506°N, 0.1962°W Digital address GA-490-3845) also in the Accra Metropolitan District, Greater Accra Region. The mushrooms were identified using morphological, anatomical and colour characteristic according to Alexopoulos *et al.* (1996); Dickinson & Lukas (1979), Encyclopedia Britannica (2022); Wikipedia. org; Anon, (2022)

Phenological, morphological and anatomical characteristics

The initial stages of the fruiting body of *Lepiota procera* was hidden in the subterranean soil close to the abandoned anthill. Within 25 - 28 days, the mushroom had matured to form a distinct semi-circle to a full circle. The fairy ring was photographed and illustrated and also by drawing (Fig. 1; Fig. 2 a – d). Samsung-SM-J400F camera phone was used to capture the image (Samsung camera/phone). A longitudinal section was cut through the stipe and the cap region using a dissecting knife (Fig. 3).

In the case of the second *Lepiota* species, the developmental stages were followed until maturity within 2 -3 weeks with appropriate diagrammatic illustrations (Fig. 4a) and photographs from a Samsung-SM-J400F camera phone. The fairy ring formation was also documented with the same Camera. The ring formation was repeated during the 3 yrs. study period (2016 - 2018). The morphology of the gills region of the fruitbody (basidioma) was studied using both line drawing and photographs of the longitudinal section of the stipe and cap (Fig. 6 – 7a and b).

Results and discussion

The initial stages of the typical Agaricales are subterranean arises as a monokaryotic mycelium. A second dikaryotic mycelium is formed (Alexopoulos *et al.,* 1979). The dikaryotic mycelium has the tendency to grow outward in all directions from a central point forming a large initially invisible circular colony. When the time came for sporulation and mature fruiting body formation, the tertiary mycelium (which is also dikaryotic) formed complex basidiocarps at the periphery of the circular colony (Fig. 1, Fig. 2 a-d) and thus forming a ring called fairy ring. In this present study it took about 28 days for each of the mature basidiocarps of *L. procera* to mature eventually aligned to form a distinct fairy ring (Fig. 1, Fig. 2 a-d).

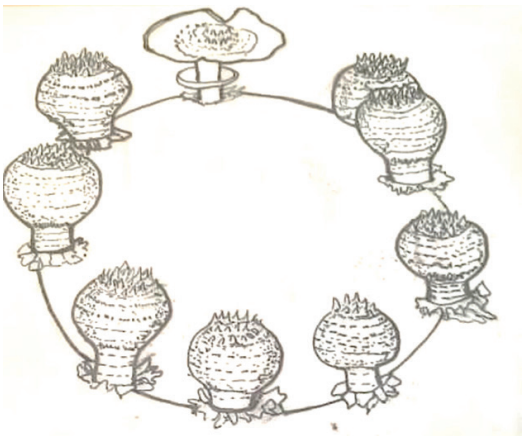

Fig. 1. Drawing of fruiting bodies of *Lepiota procera* forming a fairy ring

Fig. 2 a - d. Photograph of *L. procera* (A: top, left: growing in fairy ring formation; B: top right &: matured basidiocarps; C: bottom left: matured basidiocarps with an opened cap; D: bottom right: fully opened cap showing stipe and annulus (ring)

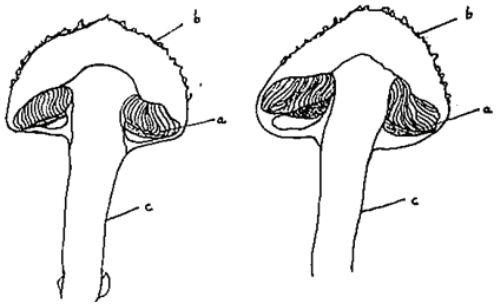

Fig. 3. Drawing of the L.S of matured unopened pileus of *Lepiota procera*

Key
a – parallel gills of trama region
b – brown shaggy scales on top of cap/pileus
c - chalky stipe

Fig. 4. Drawing of the developmental stages of *Lepiota* species from button/pin head (**a**) stage to (**e**) fully matured fruitbody and (**f**) fully opened cap

Fig. 5. Photograph of *Lepiota* species growing in a fairy ring formation with intense greening of the grass (*Chrysopogon aciculatus*) along the periphery of the ring

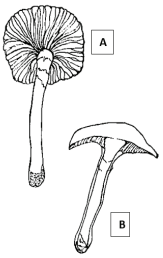

Fig. 6. Drawing of the (**A**) whole fruitbody with parallel gills and (**B**) L.S of the fruitbody of *Lepiota* species. (Note the absence of annulus and volva)

Fig. 7a & b. Photograph of (**a**) *Lepiota* species showing parallel gills and stipe devoid of annulus and volva; (**b**) enlarged portion of open parallel gills

During the three (3) years study period, the fairy rings of mushrooms appeared along the same circle with a slightly enlarge diameter of the circle and position of the fruitbodies (basidiomata). There was no vegetation on the soil and therefore the fruiting bodies emerged directly by breaking the soil without any change in topography or colour of the soil (Fig. 1; Fig. 2 a-d). Another member of the Agaricales *Lepiota morgani* also forms fairy ring without any effect on vegetation or topography of the soil (Aneja & Mehrotra, 2011). Fairy rings are of three types according to Aneja & Mehrotra (2011). The fairy ring formed by *L. procera* is the first type where the development of the basidiocarp has no effect on the vegetation akin to what existed with *Lepiota morgani*.

L. procera (Parasol Mushroom) is a delicious edible mushroom worldwide, but in Ghana, it is called "ono" by the Akan and is regarded as a delicacy for royalty. It is harvested and sold on the market in Ghana between September and November (Odamtten, 2018) particularly in the forest zone of the country. On the other hand, in susceptible persons, ingestion of either raw or cooked mushrooms e.g., *L. morgani* is poisonous causing gastrointestinal problems; with vomiting, diarrhoea and colic, occurring within one to six hours after consumption (Blayney, Rosenkranz, & Zettner, 1980; Eilers & Barnard, 1973). Eating *L. morgani* (also known as (*Chlorophyllum molybdites*) has not yet resulted in death (Davis *et al.,* 2012).

Interestingly, fairy rings are found in grassy fields and there are many such members of the Basidiomycota (Agaricales and Gasteromycetes) which also form fairy rings such as *Clitocybe maxima, C. dealbata, Marasmius oreades, Leucopaxillus giganteus, Agaricus campestris, Lycoperdon depressum, Scleroderma verrucosum, Lepista saerum, Calocybe gambosum, Lepiota rhabcodes* and *L. procera* (Encyclopedia Britannica, 2022). Formation of fairy ring by the mushroom *L. procera* is being recorded for the first time in Ghana. The longitudinal section of the basidioma of *L. procera* shows the typical movable annular rings still attached to the stipe (Fig 3) and this can also clearly be seen in Fig. 2a-d in which there was no volva. The free gills trama tissues were parallel (Fig. 3). The basidioma grew up to a height of more than 40 cm with a cap diameter of 20 – 30 cm with scaly brown squamulose cap making identification easy. The second *Lepiota* species (Basidiomycota: Order Agaricales) completed its morphological development in 2 – 3 weeks (Fig. 4). The gills were parallel and radiate. There was a distinct zone of greener grass than the grass elsewhere in the vicinity (Fig. 5). This is the second type of fairy ring formation (Aneja & Mehrotra, 2011). The greener colour is attributed to the nitrogenous substances which became available to the grass as the older hyphae of the fungus die and disintegrate

(Alexopoulos et al., 1996; Aneja & Mehrotra, 2011; Dickinson & Lucas, 1979). The intense greening increased growth of the vegetation of grass (*Chysopogon aciculatus*; Graminae) (Fig. 5). This greening of vegetation phenomenon has also been observed in *Lepiota personatum,* a gasteroid basidiomycota (Aneja & Mehrotra, 2011; Alexopoulos *et al.,* 1995). Indeed, during this present study, soil analysis for the presence of total nitrogen, available phosphorus and exchangeable potassium showed there was about twice of more of this parameter detected in the greener circumference of the fairy ring than outside the circle (Data not shown). The third type of fairy ring which has outer and inner rings in which growth of the vegetation was badly damaged was not observed in this study. However, the intense greening of the fairy ring with *Lepiota sp*. along the periphery of the circle occurred regularly during the three years observation period.

Conclusion

The morphological development, anatomy, and fair ring formation capabilities of the two *Lepiota* species were investigated over a 3-year period (2016-2018). These studies have shown that there are fairy ring forming members of the Basidiomycota; Agaricales in Ghana; a phenomenon which has not been hitherto reported in the Ghanaian pertinent scientific literature. The external morphology of *L. procera* agree with what is described in the identification manuals. The two mushroom species completed their morphological development variably. For instance, *Lepiota procera* formed matured fruit bodies and fairy ring within 28 days whereas *Lepiota* sp. completed development within 14 – 21 days. The fairy rings formed by both *Lepiota* species recorded in the present studies did not have any adverse effects on the vegetation but rather improved the nitrogenous content of soil. This is due to the nitrogenous substances that become available to the grass as the older hyphae of the fungus mycelium die and disintegrate. The grass within and at the periphery of the fair ring was greener than the grass elsewhere in the same vicinity. This is also a first record of fairy ring formation of a Ghanaian Agaricales with the greening of the grass vegetation on the periphery of the ring where the basidiomata emerge. Unlike *L. procera, Lepiota sp*. is not edible and is often mistaken for *L. procera*.

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