BUILDING FUNGI IDENTIFICATION KEY FOR THE MAIN FUNGI OF THE GANODERMATACEAE (DONK) DONK. IN SON TRA, DANANG CITY

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Abstract - The Ganodermataceae garners considerable attention owing to its medicinal properties and ecological significance. Although numerous authors have focused on studying the Ganodermataceae in Central Vietnam, specific research on the Son Tra in Danang City still needs to be conducted. This study collected from various locations across the Son Tra. Subsequently, prompt processing and microscopic analysis of morphological and structural features were conducted. Based on these analyses, an identification key was developed to classify the mushrooms at the genus and species levels. The identification process revealed 38 species belonging to the Ganodermataceae, encompassing three genera (*Ganoderma, Amauroderma*, and *Haddowia*). Among them, the genus *Ganoderma* exhibited the highest species richness with 29 identified species, followed by *Amauroderma* with 8 species, and *Haddowia* with 1 species. Furthermore, the authors described certain biological characteristics of the common species and compared the diversity of Ganodermataceae in Vietnam and neighboring regions.

Key words - Identification key; taxonomy of Ganodermataceae; Son Tra; Danang; *Amauroderma*.

1. Introduction

The Ganodermataceae family in Central Vietnam has been the subject of research by several authors, including [1] - [4]. Studies on Ganodermataceae in the central region have primarily focused on mountainous areas, where fungal species are influenced by the mountainous region's climate, altitude, and humidity [5]. However, research on fungi in areas influenced by mountains and the sea remain lacking. Son Tra Mountain in Danang city is a peninsula that borders both the city and the sea, making it subject to a unique climate characterized by features of both mountainous and coastal regions. Specific studies focusing on the Son Tra Peninsula in the city of Danang have not been conducted yet. This region's unique ecology and biodiversity of this region make it an important area for further exploration and research.

The Ganodermataceae is a fungi family of great interest due to its medicinal properties and ecological significance [3, 4]. In Son Tra, this family exhibits unique characteristics and contributes to the overall fungal diversity in the area. The Ganodermataceae family in Son Tra contributes to the region's overall fungal biodiversity and ecosystem functioning. Additionally, these mushrooms possess potential medicinal properties and are of interest for their pharmacological applications. Ganodermataceae mushrooms in Son Tra are known for their distinct morphological features. Its fruiting bodies have different shapes and sizes. They typically have a cap that varies in shape and size, ranging from patch-shaped or cap-shaped when non-mature to fan-shaped when fully mature. These mushrooms often grow on decaying wood or tree trunks in Son Tra's forests. They are well-adapted to the local environmental conditions, including the specific climate, humidity levels, and forest ecosystems present in the region.

While the exact number of genera and species within the Ganodermataceae family in Son Tra is not specified, species of the Ganodermataceae family have been collected, their diversity determined, and their morphological characteristics and microscopic structures analyzed.

On that basis, research aim to establish the identification key for species belonging to the Ganodermataceae family collected in Son Tra Danang. It compares their morphology, anatomy, diversity with Ganodermataceae mushrooms from neighboring regions and Vietnam to help people have a scientific view of species in the Ganodermataceae family. This knowledge can contribute to conservation efforts and the sustainable management of Son Tra's unique fungal diversity.

2. Methods

2.1. Collected methodology

Samples of fungi from the Ganodermataceae family collected from Son Tra, Danang, Vietnam were stored and isolated at the University of Technology and Education, the University of Danang and the Danang Biotechnology Center. Sample collection time during 4 seasons: summer (May 2022), autumn (August 2022), winter (December 2022 and spring (February 2023).

Son Tra has high humidity during spring and autumn, so most samples are collected in these two seasons In the summer, the weather is sunny, combined with the sea breeze carrying salt water vapor, so the humidity is low, lowest in July. The mushrooms collected at this time are tropical mushrooms. In the winter, Son Tra has a lot of rain, so the road up the mountain is difficult and dangerous. Mushroom samples were collected on rainy days.

Mushroom samples were systematically collected from various locations on the Son Tra peninsula and accompanied by preliminary notes on the ecological characteristics of their respective growth locations, including coordinates and substrate information. In addition, photographs were taken of the mushrooms in their natural habitat. Each collected sample was individually packaged for further analysis. To ensure a comprehensive collection, 4-6 survey lines were established in each selected area to maximize the sample diversity (Figure 1, Table 1).

Figure 1. *Sampling areas in Son Tra peninsula*

Table 1. *Coordinate location of the sample collection area*

No	Coordinates (VN2000)
1	0550814 - 1783508
2	0551653 - 1784704
3	0552595 - 1786075
4	0554646 - 1784186
5	0555780 - 1783699
6	0556677 - 1784646
7	0558283 - 1782402
8	0553446 - 1784399

2.2. Analytical method

Upon returning to the laboratory, prompt processing and analysis of morphological characteristics and microscopic structures are conducted. A mushroom herbarium is established for documentation. Analytical methods are employed to compare morphology and microscopic structures for classification purposes.

Methods of collection, processing, analysis and classification follow the methods of authors Rolf Singer [6], Trinh Tam Kiet [7]. The list of mushrooms is arranged according to the system of Paul M. Kirk [8], and Trinh Tam Kiet [9].

The morphology method and structure identification of the Ganodermataceae family typically involve a combination of macroscopic and microscopic observations. The morphological analysis of spore bodies and microscopic structural characteristics of the species in this study were conducted using the methods described by [7], [10] and [11].

Macroscopic Morphology:

Examination of macroscopic features such as the shape, size, color, and texture of the fruiting bodies (basidiocarps).

Observation of the pore surface, which includes characteristics such as pore size, shape, color, and presence or absence of a sterile margin.

Analysis of the context (flesh) color, consistency, and any distinctive features like zonation or color changes upon bruising or aging.

Microscopic Analysis:

Preparation of thin sections or mounts of selected structures for microscopic examination.

Observation of microscopic features includes:

Spore characteristics: Shape, size, color, ornamentation, and presence of a germ pore or appendage.

Basidia: Structure, shape, and number of sterigmata (spore-bearing structures).

Cystidia: Presence, shape, size, and any unique features.

Hyphal system: Examination of the hyphae in various fungus parts, including the context, tubes, and cuticle.

In order to determine the taxonomic classification of mushroom specimens, a thorough analysis of their morphological characteristics is essential. These characteristics refer to observable traits such as the shape, size, and color of various mushroom parts. By carefully examining these features, a identification key can be constructed to assist in identifying and categorizing different mushroom species.

The first step in this process is to observe mushroom's stem. Is it attached to the side, and if so, what is its color and size. This initial characteristic helps to narrow down the potential group of species.

Next, attention is turned to the cap of the mushroom. Depending on its stage of development, the cap may exhibit different shapes. It could be patch-shaped or cap-shaped when non-mature, or fan-shaped when fully matured. This distinction is crucial for further classification.

Further analysis involves measuring the dimensions of the cap. Length, width, and thickness are recorded to establish quantitative criteria for differentiation. These measurements are compared with existing data from previous studies conducted by experts in the field.

Based on these observations, an identification key can be constructed. The key provides a step-by-step guide to identifying the mushroom species. It begins with the stem attachment and proceeds to the shape and size of the cap. The dimensions of the cap play a significant role in determining the species, with variations in size indicating potential variations within a species.

It is important to note that this classification key is based solely on the morphological characteristics of the mushroom specimens. Other factors, such as spore color, odor, and microscopic features, may need to be considered for a comprehensive and accurate taxonomic classification.

3. Results and discussion

3.1. The construction of an identification key for the Ganodermataceae family in Son Tra

Through the analysis of morphological characteristics and microscopic structures, the obtained mushroom species exhibited anatomical features that align with the characteristics of the Ganodermataceae family [12-14].

The fruiting bodies have long, short or sessile stems. The color of fruit bodies is very diverse: glossy reddish brown (*Ganoderma lucidum*), light brown (*G.lobatum*), dark brown to yellow brown (*G.capense*), black-brown (*G.brownii*), dark brown (*G.resinaceum*), purple-black (*G.sinensis*) (Figure 2), genus *Amauroderma* fruit bodies are black (*Amauroderma duris*), glossy black (*A.subresinosum*) (Figure 3).

Tubular cells: form 1 layer of hyphae, living for 1 year *(G. luteomarginatum*), 2 layers of hyphae, living for many years (*G.australe*), unclear stratification (*G.annulare*) between the tube layers there is a layer of tissue thin (*G.applanatum*), round mushroom hole.

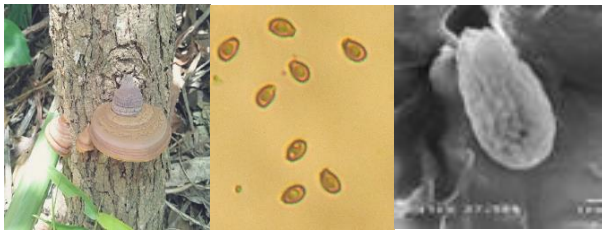

Figure 2. *Fruiting bodies, spores (100x), and SEM (3500x) of species of the genus Ganoderma*

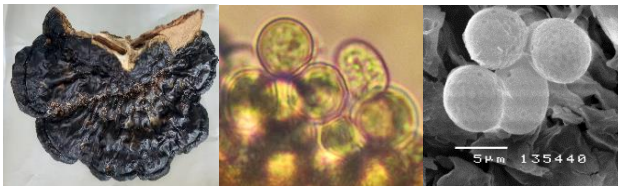

Figure 3. *Fruiting bodies, spores (100x), and SEM (3500x) of species of the genus Amauroderma*

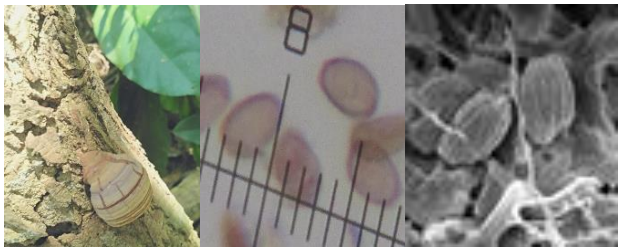

Figure 4. *Fruiting bodies, spores (100x), and SEM (3500x) of species of the genus Haddowia*

The mushroom specimens' spores corresponded to the Ganodermataceae family's spore characteristics [7, 15]. Spores have a membrane consisting of two layers: the outer layer is smooth, the inner layer has small spines. Most spores are egg-shaped without a head, have colorless appendages (genus *Ganoderma* and *Haddowia*), or are roughly round like a lemon (genus *Amauroderma*).

In the SEM images, *Ganoderma* and *Amauroderma* spores both have an inner membrane with sharp spines extending to the outer membrane, and *Haddowia* (Figure 4) spores have slits along the meridian.

Based on morphological characteristics, anatomical structures and combined with referencing the identification key construction methods by [15] - [19], the research team has built a taxonomy key to the genus and species of the Ganodermataceae family.

Identification key to the genus of the Ganodermataceae family

1. Spores two-layered, lemon-shaped ……..……1. *Amauroderma*

1. Spores have 2 layers, egg-shaped and oval-shaped……..2

2. Spores double-layered, ovoid or headless oval... ……2. *Ganoderma*

2. Spores have grooves along the parallel from top to base……...3. *Haddowia*

Based on the identification key up to the genus level within the Ganodermataceae family, three genera are identified: *Amauroderma*, *Ganoderma*, and *Haddowia*.

Next, based on the morphological anatomical characteristics of the mushrooms, including the structure of the stipe, color, shape, size, reproductive structures, and characteristics of the spores, an identification key is constructed to the genus level for *Amauroderma* and *Ganoderma*. However, since only one species is obtained for the genus *Haddowia*, a classification key is not constructed for it.

Identification key to species of genus Ganoderma

1. One-year mushroom fruiting body…….……2

1. Mushroom fruiting bodies one year to many years……..……...……13

1. The fruiting bodies of many years of mushrooms are clearly visible……..…….....16

2. Fruit bodies have shiny cuticles…….....…..…..…3

2. Fruit bodies have epidermis with little or no shine……11

3. Fruiting bodies have long stalks……....4

3. The fruit body has a large, rough stem……..6

3. Fruit bodies have short stalks or no stalks….....8

4. Fruiting bodies have lateral stems, yellow-brown, reddish brown, semicircular to nearly round shape, spores 8.5-11.5 x 5.2-6.5µm……...……...1. *Ganoderma lucidum*

4. Fruiting bodies are purple brown, spores 6.5-8 x 9-14µm……..…..2. *Ganoderma sinense*

5. Fruiting bodies have concentric patterns……6

5. Fruiting bodies with yellow edges……...……..… 3. *Ganoderma dahlia*

6. The fruit body is purple brown, the shell is hard and thick……..…4. *Ganoderma steyaertanum*

6. Nonmature fruit bodies are yellow-brown, mature are purple-brown, spores 5.5-7 x 8.5-11µm ……...5. *Ganoderma hainanense*

7. Large mushroom caps are kidney-shaped, hemispherical, and fan-shaped ……..……..……8

7. The mushroom cap has a piled shape, has protuberances, the surface of the cap is dark brown, and the skin is tough ……..……6. *Ganoderma simaoense*

8. Fruiting body with short stem, tube surface is yellow, turns brown when touched, tube 4-5l/mm, spores 5.2-6.7 x 8.5-11.5µm.....7. *Ganoderma capense*

8. Fruiting bodies are sessile, tubes are rusty brown, reddish brown, white with yellow tints….....9

9. Mushroom cap with radioactive edges, concentric rings, 2-layer fungal tissue, ovoid spores, large oil drops, 5.2-6.7 x 7.5-10.5µm……8. *Ganoderma resinaceum*

9. Mushroom cap has radioactive edges, concentric rings, non-stratified fungal tissue ……...10

10. Fruiting body surface is reddish brown, spores are ovoid 6.2-6.5 x 8.0-8.5µm……...9. *Ganoderma fulvellum*

10. Unclear radioactive ridge, closely spaced concentric rings, spores ovoid with headless head, 5.0-7.0 x 7.5-10.5µm……..….10. *Ganoderma sessile*

11. Brown mushroom cap, shiny black concentric ring……...……11. *Ganoderma amboinense*

11. Mushroom caps are light brown, black-brown, dark brown…….…… 12

12. Fruiting bodies are semicircular to nearly round, dark brown, black-brown, yellow edges, spores 8.5-11 x 5.2-7.5µm……...12. *Ganoderma luteomarginatum*

12. Fruiting bodies with slightly wavy surface, white to light brown edges, spores 5-6 x 7.5-9µm …….…….13. *Ganoderma ahmadii*

13. The fruit body is not shiny, has no stem, has clear concentric rings, is dark brown, tawny brown, has a smooth velvety layer….....….14. *Ganoderma mirivelutinum*

13. The fruit body does not have a smooth velvety layer …….14

14. Fruit body surface is dark brown, edges intact ……15

14. Fruiting body surface is black brown, red brown, blunt edge……..……15. *Ganoderma multipileum*

15. Dark cap, thick tissue, large spores 7.5-9 x 11-13.5µm……..16. *Ganoderma brownii*

15. Dark brown cap, tissue 1.3cm, spores 7-9.5 x 5-8µ…….17. *Ganoderma philippii*

16. Fruiting bodies have short, thick stems……...……...*18. Ganoderma gibbosum*

16. Fruiting bodies without stalks ……17

17. The fruit body has a hard shell…...……..…18

17. Fruiting bodies do not have a hard shell…….….24

18. Tube with unclear stratification or no stratification……..……..19

18. Stratified tubes, ovoid spores 6-10 x 9-13µm……...…… 19. *Ganoderma australe*

19. The epidermis of the mushroom cap is very hard, the tube is brown ……..…….…….20

19. The epidermis of the mushroom cap is hard, thin, easily cracked, and the tube is brown…… 21

20. Hemispherical cap, thickness sloping from edge to base……..20. *Ganoderma annulare*

20. Hemispherical cap, large and heavy, thickness from edge to base 1-3cm, long tube with thickness from edge 1cm, thickness at base 2cm……21. *Ganoderma testaceum*

21. Dark brown tube, chestnut color, 1-2cm, spores 7-9 x 4.3-6.0µm……..… 22 *Ganoderma lobatum*

21. Tube 2cm long, spores ovoid……...22

22. Tube 1cm long, yellow-white tube turns brown when injured, spores are oval, 7-9 x 10-14µm……..…. 23. *Ganoderma oroflavum*

22. Tube 1.3-2cm long, spores ovoid……23

23. Tubes brown, dark brown, red-brown, spores 7-9 x 4-6.3µm…….. 24. *Ganoderma tornatum*

23. Brown tubes, interwoven with white fibers, spores 7.5-11 x 5-7.3µm…..……25. *Ganoderma subtornatum*

24. Claw-shaped fruiting bodies……...……..….. 25

24. Hemispherical fruiting bodies…….26

25. Multi-layered mushroom tube, 1.5-2 cm thick, between the layers there is a thin layer of tissue, cross-sectionally shaped like a triangle……26. *Ganoderma triangulum*

25. The cap has small concentric rings, the base is tile-like, the tissue is thick, not layered, the tube is 2.5cm, the hole is milky white to light brown…….27. *Ganoderma rotundatum*

26. The cap is thin, easy to break when pressed, has clear concentric rings, stratified tube, thin layer of tissue in the middle, light brown spores, 7-9 x 4-6.3µm ……..……...……..28. *Ganoderma applanatum*

26. Cap surface is rough, cracked, fresh and soft, dry and hard, with clear concentric rings, stratified tubes, light brown spores, 8.5-9.5 x 5.5-6.5µm……. 29. *Ganoderma adspersum*

Identification key to species of genus Amauroderma

1. Fruiting bodies have thick caps, short, rough, or sessile stems…….2

1. The fruit body has a thin cap and a long stem …...3

2. Fruiting bodies are sessile, or short-stemmed, cap is 6-12cm, black, smooth, white tissue, has hard wood ……...…1. *Amauroderma subresinosum*

2. Fruiting bodies have short black stalks, 2 x 1.5 cm long, 3-10 cm wide caps, gray-brown, gray-white, cork material ..... 2. *Amauroderma scopulosum*

3. The stem is attached in the middle or near the middle……..……. 4

3. Back attachment stem……..5

3. The stem is attached at an angle, attached on the side .....….7

4. Stem 10-15 x 0.6-0.8cm long, black, shiny ……...……..3. *Amauroderma nigrum*

4. Stem 3-10 x 0.3-0.7cm long, black, not shiny …….4. *Amauroderma guangxiense*

5. Medium or large fruiting bodies, 4-6 x 8-15 x 0.3-0.7cm, dark gray upper surface, concentric veins, radioactive rays, stem length 10-14 x 0.5-1cm…… …….……5. *Amauroderma subrugosum*

5. The base of the stem has or does not have pseudoroots…….. 6

6. Fruiting body 4-18 x 0.4-1.5cm, with pseudo root, stem 5-18 x 0.5-2 cm long, curved, spore spherical, 8.5-10.5 x 7, 5-9.5µm……..6. *Amauroderma rugosum*

6. Fruiting bodies 7-8 x 10-12 x 0.2-1cm, stem length 14-17 x 1-1.5cm, lemon-shaped spores, 10.0-12.0 x 11.3-14 µm……...……7. *Amauroderma rude*

6. Small fruit body 4.5-6 x 1.5-2.3 x 0.2-0.3 cm, dark brown, stem 2-4 x 0.5-2.0cm long, with radioactive humps to the edge…….……8. *Amauroderma exile*

Thus, the Ganodermataceae family in Son Tra is recorded with 38 species, including 29 species of the genus *Ganoderma*, 8 species of the genus *Amautoderma*, and 1 species of the genus *Haddowia*, as presented in Table 2.

Table 2. *List of species composition of the family Ganodermataceae (Donk) Donk.*

No	Scientific name
	***1. Genus Ganoderma* Karst.**
1	*Ganoderma adspersum* (Schulzer) Donk.
2	*Ganoderma ahmadii* Steyaert.
3	*Ganoderma amboinense* (Lam.: Fr.) Pat.
4	*Ganoderma annulare* (Lam.: Fr.) Pat.
5	*Ganoderma applanatum* (Pers.) Pat.
6	*Ganoderma australe* (Fr.) Pat.
7	*Ganoderma brownii* (Murrill) Gilbertson.
8	*Ganoderma capense* (Lloyd) Teng.
9	*Ganoderma dahlii* (Henn.) Aoshima
10	*Ganoderma fulvellum* Bres.
11	*Ganoderma gibbosum* (Blume & T. Nees) Pat.
12	*Ganoderma hainanense* J.D. Zhao.
13	*Ganoderma lobatum* (Cooke.) G.F. Atk.
14	*Ganoderma lucidum* (W. Curtis.:Fr.) P. Karst.
15	*Ganoderma luteomarginatum* J.D. Zhao, L.W. Hsu & X.Q. Zhang
16	*Ganoderma mirivelutinum* J.D. Zhao
17	*Ganoderma multipileum* D. Hou, Quart.J.
18	*Ganoderma oroflavum* (Lloyd) C.J. Humphrey,
19	*Ganoderma philippii* (Bres. & Henn. ex Sacc.) Bres.
20	*Ganoderma rotundatum* J.D. Zhao, L.W. Hsu & X.Q. Zhang
21	*Ganoderma resinaceum* Boud.
22	*Ganoderma sessile* Murr.
23	*Ganoderma simaoense* J.D. Zhao
24	*Ganoderma sinense* J.D. Zhao, L.W. Hsu & X.Q. Zhang
25	*Ganoderma steyaertianum* B.J. Smith & Sivasith.
26	*Ganoderma subtornatum* Murrill.
27	*Ganoderma tornatum* (Pers.) Bres.
28	*Ganoderma testaceum* (Lev.) Pat.
29	*Ganoderma triangulum* J.D. Zhao & L.W. Hsu
	2. Genus Amauroderma (Pat.) Torrend.
30	*Amauroderma exile* (Berk.) Torrent
31	*Amauroderma guangxiense* D. Zhao & X.Q. Zhang
32	*Amauroderma nigrum* Rick
33	*Amauroderma rude* (Berk.) Torrent
34	*Amauroderma rugosum* (Blume & Ness: Fr.) Torrent
35	*Amauroderma scopulosum* (Berk.). Imazeki
36	*Amauroderma subresinosum* (Murr.) Corner
37	*Amauroderma subrugosum* (Bres. & Pat.) Torrent
	3. *Genus Haddowia* Steyaert.
38	*Haddowia sp.*

Based on the obtained results, the genus *Ganoderma* is the most dominant, with 29 identified species (76% of the identified species), followed by the genus *Amauroderma* with 8 (21% of the identified species) identified species. On the other hand, the genus *Haddowia* has only one identified species (3% of the identified species). This observation suggests that the genus *Ganoderma* is the most prevalent within the study area. In contrast, the genus *Haddowia* is relatively rare. This finding highlights the dominance and abundance of *Ganoderma* species in the study area, indicating their ecological significance and potential importance in the local mushroom biodiversity. The rarity of *Haddowia* species further emphasizes their uniqueness and potential conservation value. These results provide valuable insights into the distribution and prevalence of these genera within the research area.

3.2. Comparative Analysis of Species Diversity of Ganodermataceae Mushrooms in Son Tra and Other Regions

The comparison of species diversity among Ganodermataceae mushrooms in Son Tra and other regions provides valuable insights into the distribution and abundance of these fungi. Ganodermataceae is a diverse family of mushrooms with notable species known for their medicinal properties and ecological significance.

In Vietnam, the Ganodermataceae family has been recognized to encompass five genera [9]. In neighboring regions such as Hue [5] and Quang Nam [15], many researchers have conducted studies on the Ganodermataceae family, resulting in a relatively more significant number of genera and species compared to Son Tra, as indicated in Table 3:

Table 3. *Comparative analysis of fungal diversity within the Ganodermataceae family in Vietnam and selected neighboring regions*

Location / Family and genus	Vietnam [9]	Quang Nam [15]	Hue [5]	Son Tra, Danang
The total number of species in the Ganodermataceae family	86	50	39	38
The number of species in the genus *Ganoderma*	64	34	32	29
The number of species in the genus *Amauroderma*	18	13	6	8
The number of species in the genus *Haddowia*	2	2	1	1
The number of species in the genus *Tomophagus*	1	0	0	0
The number of species in the genus *Humphreya*	1	1	0	0

It is evident that the number of genera and species of mushrooms belonging to the Ganodermataceae family in Son Tra is significantly lower in diversity compared to the neighboring region and considerably lower compared to Vietnam as a whole. Although the diversity of this family in Son Tra is comparatively lower than in neighboring regions and Vietnam as a whole, it still plays a crucial role in the local ecosystem.

3.3. Description of some mushroom species of the Ganodermataceae family commonly found in Son Tra mountain, Danang city

Here is the representative descriptions of four species belonging to the Ganodermataceae family, namely

Ganoderma annulare, *Ganoderma applanatum*, *Ganoderma austral*, and *Amauroderma subresinosum*, collected in the research area. These species were selected for description due to their frequent occurrence during sample collection. Moreover, they play a significant role as wood decay fungi in the local ecosystem [7]. Additionally, they are valuable medicinal mushroom species that require conservation [15, 20, 21].

***Ganoderma annulare* (Lam.: Fr.) Pat.**

Fruiting bodies are perennial, sessile, cork-wood. The mushroom cap is a scalloped, flat hemisphere, 1-2 x 4-6 x 1.5-3cm. The upper surface of the shell epidermis is tough, rust-colored, and has prominent concentric rings. The edge is blunt, and intact, the asexual part has 1-3mm of thin tissue layer, dark yellow to dark brown. The underside has rust-brown holes, 4-5 holes/mm, the tube is unclearly stratified and sealed between white fungal hyphae, the layer is 1.5-2cm long. There are 3 types of fibers: primitive fibers with thin walls, transparent, 2-5µm in diameter; thick-walled stiff fibers with pointed ends; tree-like or needle-like, 3-6µm in diameter, thick-walled colorless braided fibers. Spores are truncated ovoid, 7-8 x 9-12µm, 2-layer membrane: the outer layer is transparent, smooth, inner layer has distinct spines, light brown to brown (Figure 5). These dimensions are smaller than the description provided by Trinh Tam Kiet [7] Macro fungi of Vietnam, which are reported to be 5-10 x 8-16 x 1-4 cm. It is possible that the smaller size observed in this region is influenced by abundant sunlight, constant sea breeze, and relatively low humidity at the time of sample collection.

Ecology: lives on broad-leaved trees in moist forests, saprophytes causing white rot. This species has a type location in North America, distributed in many places such as China, North America and found in some high mountainous areas of Vietnam. This species is easily recognized by its hard shell, thin tissue, and unstratified tubes.

Figure 5. *Fruiting bodies and spores of Ganoderma annulare (Lam.: Fr.) Pat.*

***Ganoderma applanatum* (Pers.) Pat**

Fruit body is perennial, sessile, cork-wood, fan-shaped cap, size 2.5-6 x 4-11 x 1-3cm, gray-brown, not shiny, with many concentric rings, covered with spores, which are relatively thick red soil. The tube is stratified, with each layer about 0.3-2.5cm thick, between the two layers there is a thin layer of tissue, the tube is nearly round, 4-5 holes/mm, dark yellow. The fiber system consists of light brown primary fibers, hard brown needle-like fibers or trees, 5-6µm in diameter, and colorless braided fibers. Spores are brown, truncated ovoid, have 2 membranes, 4.5-6.5x7.5-9µm (Figure 6). The size of the fruiting bodies according to Trinh Tam Kiet [7] for larger mushrooms in Vietnam is reported to be 6-28 x 15-53 x 3-7 cm, while according to Nguyen Phuong Dai Nguyen in 2013 [21] in the Tay Nguyen region, they measure 18-20 x 28-30 x 0.5-2 cm. Clearly, the fruiting bodies of *Ganoderma* applanatum in the Son Tra area are much smaller. This difference in size could be attributed to variations in humidity and altitude between the sampling locations of Trinh Tam Kiet and the Tay Nguyen region.

Ecology: lives on broad-leaved trees in moist forests; saprophytes cause white rot. This species has a type location in Europe, is distributed in many parts of the Northern Hemisphere and is found in some high mountainous areas of Vietnam. It is easily recognized by its thin shell, stratified tube with a layer of tissue separating it, fragile shell and tiny spores, hard shell, thin tissue, and unstratified tubes.

Figure 6. *Fruiting bodies and spores of Ganoderma applanatum (Pers.) Pat.*

***Ganoderma australe* (Fr.) Pat.**

Fruiting bodies are perennial, sessile, cork-wood, fan-shaped cap, size 1-4(5) x 1-7 x 1-3cm, upper surface dark brown or gray-brown, with concentric rings, obtuse edges. The brown tissue is about 2cm thick with a black shell. Nearly round, yellow-brown hole, 4-5 holes/mm, tube stratified, dark brown. The fiber system consists of 3 fibers: primitive fibers are transparent, thin with septa; light brown to brown stiff fibers, thick-walled, needle-like, 3-5µm, and whip-like braided fibers. Spores are ovoid, light brown in color, have 2 membrane layers, the inner layer has spines, are slightly round or broadly elliptical 6-10 x 9-13µm (Figure 7).

Figure 7. *Fruiting bodies and spores of Ganoderma australe (Fr.) Pat.*

Compared with the description provided by Trinh Tam Kiet [7], the size of the fruiting bodies is reported as 7-34 (50) x 12-80 x 2.5-9 cm. Additionally, in 2018, in the Ngoc Linh Mountain of Quang Nam province, the fruiting bodies were collected with dimensions of 10-40 (52) x 13-70 x 3-9 cm [15]. In Ngoc Linh, the sampling took place at an altitude ranging from 1600 to 2500 m, with high humidity, while in Son Tra, the sampling area ranged from 340 to 650 m with lower humidity. Therefore, there is no doubt that air humidity and altitude are determining factors in the size of the fruiting bodies.

Ecology: This species is parasitic and then saprophytic on trees, found in many places, collected many times at Son Tra mountain, Danang city, distributed in tropical and subtropical regions. Currently, the type position does not exist.

***Amauroderma subresinosum* (Murrill) Corner**

One-year mushroom fruiting body has a small, black stem attached to the side, 1-2 x 1.0-1.5cm long (according to Trinh Tam Kiet [22], it does not have a lateral attachment or a basal attachment). The caps is patch-shaped or cap-shaped when nonmature, fan-shaped when mature, (morphology varies a lot), 3-5 x 5-10 x 0.6-1.3cm. The top surface is black, glossy, radioactive, has irregular concentric rings, and is slightly wrinkled. The underside of the hole is white when nonmature, pinkish white, and then turns pinkish brown when mature, 3-4 holes/mm. Gray-white, pink-white tube, 10-15mm thick, white tissue, sometimes pinkish brown. The edge is whole, thick (pleated), occasionally thin (irregularly rolled), down to the tube, black. Spores are ovoid, nearly oval, light yellow, 9.0-12.0 x 14.0-18.0 µm, 2-layer membrane: light yellow outside, light brown inside (Figure 3).

The size of the fruiting body according to Trinh Tam Kiet [22] is reported to be 6-11 x 1-2 cm. In Le Xuan Tham [20] study in Lam Dong, this species's size fluctuated between 3.5 and 7.5 cm. There were instances where the fruiting bodies had a fan shape with dimensions of approximately 20 x 12 cm and a 1.8-2.7 cm thickness. Occasionally, individual specimens of large size ranging from 20-26 cm were collected, all of which were larger than the specimens collected in Son Tra.

Ecology: lives on broad-leaved trees in moist forests, is saprophytic.

4. Conclusion

This research has identified a total of 38 species belonging to the Ganodermataceae family, including three genera: *Ganoderma*, *Amauroderma*, and *Haddowia*. Our findings show that *Ganoderma* is the most dominant genus, comprising 76% of the identified species. *Amauroderma* follows with 21% of the identified species, while *Haddowia* represents only 3% with a single identified species. These results indicate that *Ganoderma* is the most prevalent genus in the study area, while *Haddowia* is relatively rare. The dominance of *Ganoderma* species highlights their ecological significance and potential importance in the local mushroom biodiversity. The rarity of *Haddowia* species underscores their uniqueness and potential conservation value. These findings provide valuable insights into the distribution and prevalence of these genera within the research area.

It is important to note that the diversity of genera and species within the Ganodermataceae family in Son Tra is comparatively lower than in neighboring regions and Vietnam. However, despite the lower diversity, this family still plays a crucial role in the local ecosystem.

Furthermore, in this study, an identification key was developed for the genera and species within the Ganodermataceae family, and a survey of several common biological characteristics of genera and species has been conducted.

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