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이 논문을 교육학 석사학위 신청 논문으로 제출함

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목 차

국 문 초 록

본 논문은 생물종 다양성 차원에서 충생자낭균류의 자원을 발굴하고 동정하여 유전자 자원 보전을 위한 신종 및 미기록종을 찾기 위하여 우리나라 전 지역을 대상으로 연구한 결과이다. 충생자낭균류는 절지동물(Arthropoda)의 체피에 기생하는 자낭균류의 일종으로 이 균류는 전 세계적으로 널리 분포하고 있고 현재 133속 2,000여종 이상이 알려져 있으며 우리나라에서는 17속 64종이 기록되어 있다.

본 연구를 통해 우리나라에서 3종의 미기록종이 채집되었다. 미기록종과 그들의 숙주를 보면 다음과 같다.

Laboulbenia borealis Spegazzini는 *Gyrinus japonicus* Sharp의 숙주곤충에 기생하였고, 경상남도 양산군 취서산 (통도사)에서 채집되었고, *Laboulbenia benjaminii* Balazuc는 *Stenolophus difficilis* Hope의 숙주곤충에 기생하였고, 전라남도 구례군 간전면 중대리 (백운산)에서 채집되었으며, *Laboulbenia humilis* Thaxter는 *Chlaenius naeviger* Morawitz의 숙주곤충에 기생하였고, 전라남도 광양시 백운산 해발 600m에서 채집되었다.

이상의 결과 우리나라의 충생자낭균류는 17속 67종이 된다.

ABSTRACT

On three species of the Laboulbeniales collected newly in Korea

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Three species under one genus of the Laboulbeniales were collected from several regions of South Korea. They are *Laboulbenia borealis* Spegazzini on *Gyrinus japonicus* Sharp (Gyrinidae, Coleoptera), *Laboulbenia humilis* Thaxter on *Chlaenius naeviger* Morawitz (Carabidae, Coleoptera), and *Laboulbenia benjaminii* Balazuc on *Stenolophus difficilis* Hope (Carabidae, Coleoptera). Occurrence of these species will be newly recorded by this paper from South Korea.

Laboulbenia borealis Spegazzini was collected from Mt. Cheuiseo (Temple Tongdo), Yangsangun, Gyeongnam, Province on August 10,

1998. The present species is characterized by the slender stalk of the receptacle and the stout upper portion united to the perithecium. The numerous filamentous branches of the receptacle are also unique to this species. Thalli grew on the sternites of back abodomen. *Laboulbenia humilis* Thaxter was collected from Mt. Baegwoon, Chungdaeri, Ganjeonmyeon, Guregun, Jeonnam Province on August 16, 2001. The main feature of this species is the remarkable pattern of the olive-brown perithecia and amber-colored, streaked or spotted receptacles, with a contrasting pale cell Ⅰ. Terada's materials (Terada, 1996) showed that cell Ⅰ and cell Ⅱ of this fungus were as shorter and stouter than those of Thaxter's (1908). Korean materials were nearly agreed with Thaxter's description. Thalli occurred on the upper side of the host's abdomen. *Laboulbenia benjaminii* Balazuc was collected under the small stones of the narrow stream surrounded by the deciduous broad-leaved forest and about 600m hight above the sea level of Mt. Baegwoon, Gwangyang City, Jeonnam Province on August 10, 1996. The hosts of *Laboulbenia benjaminii* Balazuc was so far known only from genus *Badister* Schellenberg (Balazuc 1974; Majewski 1994; Kesel 1998), but it is discovered newly from genus *Stenolophus* in Korea by this paper.

I . Introduction

The Laboulbeniales is a highly specialized fungus group of the Ascomycotina. All species of this fungus group are known as the obligate exoparasites of the Arthropoda, especially of insect, with the exception of a small number of species found from mites and milipedes. They are minute, mostly less than one milimeter long, and look like hairs or bristles of the insects own. They would be hardly utilized as a natural enemy of insects, because they do not appear to cause the death of the host insects. Members of the Laboulbeniales are widely distributed in the world and include above 2,000 known species under 133 genera, although the richest florae are found in tropical regions.

This fungus group classified in the order Laboulbeniales at present was apparently first noticed by two French entomologists, Alex Laboulbéne and August Rouget, in the 1840s. Rouget (1850) treated this fungus in a brief account on "production parasite" found on sevaral groudinhabiting beetles. Three years later, Camille Montagne and Charles Robin described the first two species of this fungus group, namely *Laboulbenia rougetti* Montagne et Robin and *L. geurinii*

Montagne et Robin(Robin, 1853). One year before this publication, however, Mayr (1853) had published the figures of *Laoulbenia* species on *Nebria* (*Coleoptera, Carabidae*), but he considered them as abnormally developed hairs of the insect.

During the next two decades after the Robin's publication, a few works relating to this fungus group appeared. Kolenati (1857) described *Arthrorhynchus* species parasitic on wingless flies (Nycteribiidae) which infest bats, but he regarded these as specialized worms.

Knoch (1868) added another species, *Laboulbenia baeri* Knoch, parasitic on the European housefly, and this was described one year later by Karsten (1869) as *Stigmatomyces muscae* Karasten. He also depicted several stages of development of this fungus, and more essentially, he recognized the sexual organs of this fungus and their resemblance to those of the Florideae (Rhodophta). Peyritsch (1873) reported this species as *Stigmatomyces baeri* (Knoch) Peyritsch. He was the first in employing the family name Laboulbeniaceae, in which he recognized only five genera among twelve species. Berlese (1889) again summarized the family with define and recognized six genera among fifteen species.

Roland Thaxter (1896), an American mycologist, published the first volume of his monumental monograph, summarizing his previous works on this fungus group, whereby a new era in the study of the Laboulbeniales started. Thaxer's works on this fungi comprised 22 unillustrated preliminary papers and the contents were recognized in an illustrated monograph published in five parts (1896, 1908, 1924, 1926, 1931). He reviewed the works of his predecessors and contemporaries so that his studies, encompassed some 128 genera (107 retained as valid) and 1,340 taxa including species and varieties.

By the early studies of Thaxter, the ascomycetous nature of the Laboulbeniales was established. The initial part of his monograph (1896) provided the first really comprehensive treatment of the morphology, development and diversity of this fungus group. During the period of Thaxter's publications, many authors started studying this fungus group collected from various areas of the world. The outstanding among them was Spegazzini who described eight new genera and about 270 new species, chiefly from Argentina and Europe (1902, 1910, 1910a, 1912, 1914, 1915, 1915a, 1917, 1918, 1924).

Subsequent to Thaxter's death in 1932, about 100 publications on the Laboulbenilaes were published. Many of these, however, are of

minor importance. Several are more or less general, nontechnical discussion intended for the nonspecialist or informed layman. However, some have provided important new data on the taxonamy, morpology, and biology of this fungus group in this period. Benjamin and Shanor (1950, 1951) observed the development of the thalli of *Laboulbenia formicarum* Thaxter and *Euzodiomyces lathrobii* Thaxter. The developmental morpology of the genus *Herpomyces* was reported by Richards and Smith (1955a, 1955b, 1956) and Tavares (1965, 1966). The taxonomical system of the Laboulbeniales was first established by Thaxter (1908) and minor changes have been added to it up to the present.

Benjamin (1971) summarized the studies on the *Laboulbeniales* by Thaxter and others. He also provided a synopsis of the genera with a key to them, cited all pertinent literatures on this fungus group, and presented a guide of the collection and techniques for study of these fungi.

Tavares (1985) published the extensive book on the morphology, development, sexuality, orgin and distribution of the Laboulbeniales. In this book, she added many own unpublished observations, proposed a new classification, presented a key for the determination of the genera

and higher taxa, and completed the bibliography of this group of fungi. At the present, the most Laboulbeniologists are utilizing the classification of the Laboulbeniales and morphological nomemclature proposed by her (1985).

On the other hand, the studies of this fungus group in Asia were repotred by Sugiyama K. (1973~), Terada (1980~) and Yong-Bo Lee (1981~). Among these Laboulbeniologists, concerning the Korean Laboulbeniales, a considerable number of species are included in Lee's papers (1981, 1982a, 1982b, 1982c, 1983, 1984a, 1984b, 1986a, 1986b, 1986c, 1990, 1991, 1992a, 1992b, 1992c 1993, 1995, 1996, 1998a, 1998b, 1999, 2000, 2002, 2003a, 2003b). He reported on this fungus group not only Korea but Papua New guinea, Malaysia, China and Tibet. Among these species and genera reported by Lee, one genus and seven species were new to science. The author surveyed for discovering the unrecorded species of Laboulbeniales, and identification of them out over South Korea. This paper will be reported of three species of *Laboulbenia* newly collected by author in South Korea.

1. Host-parasite relationship

1) Host range

The majority of the Laboulbeniales have been found on insects (Insecta) and the remaining species are known on mites (Acari) and milipedes (Diplopoda). The host insects are distributed in thirteen orders. They are Anopleura, Blattaria, Orthoptera, Thysanoptera, Acarina (Arachnida) and Juliformia (Diplopoda). Among them, Coleoptera and Diptera are the most dominent host group because more than 90% of the total species have been found on them. This fungus group is thought to be an obligate parasites of these Arthropoda though the essential organ of this fungus thallus is present on the outside of the host body. However, some rhizoidal systems inserted in host body are found in relatively small member of species.

2) Pathogenicity

Thaxter (1908) believed that this fungus group caused little or no harm to the hosts, although he noted minor tissue damage in insects parasitized by species having a penetrating rhizomycelium. However, Kamburov et al. (1967) reported an increased rate of premature mortality in a beetle, *Chiocorus bipustulatus*, presumably caused by

heavy infestation by this fungus.

Bro Larsen (1952) found high mortality among *Bledius* species infested heavily by a species of the *Laboulbeniales* in Denmark. Benjamin (1971), however, expressed some suspicion about the exact cause of mortality in these insects. In conclusion, the Laboulbeniales has the least pathogenicity on the hosts.

3) Transmisson and growth

The transmission of the Laboulbeniales from the host individuals to the other are seems to be caused by their direct contact to each other. Arwidsson (1946) and Lindroth (1948) suggested some evidence that soil plays an important role in spore transmission of a few species of *Laboulbenia*. This, however, must be confirmed by further experiments. The mating is thought to offer the good chance of contact between two host individuals (Peyritsch 1875, Benjamin & Shanor 1952).

Whisler (1968) stated that *Stigmatomyces ceratophrus* Whisler on a fly, *Fannia canicularis* Linné, was at the moment of mating. In the flying insects like flies, the chance of direct contact to each other may be limited in the moment of mating.

However, most host groups of the Laboulbeniales belong to

terrestrial insects which have more abundant chance of direct contact. Most frequent and abundant parasitization is found on the insect group which live in dense population in narrow niches.

This fungus group may be also transmitted to other parts of the body of the same individual by the movements of the legs and antennae. Richards and Smith (1955a, 1955b, 1956) found that antennae of cockroaches infected heavily by *Herpomyces styopygae* Spegazzini were very effectively served as a brush of species.

The time required for the complete maturation of an individual on its host varies in most of the species, and it is required about from 10 to 21 days (Peyrisch 1875, Thaxter 1896, Baumgartner 1923, Lindroth 1948, Richards & Smith 1955a, 1955b, 1956, Whisler 1968). However, Boyer Lefevre (1966) found that *Rhachomyces aphaenosis* Thaxter, which occurs on a cavernicolous beetle in constantly low temperatures, required nearly six months for maturation.

4) Host and position specificity

The Laboulbeniales is known to show very strict host specificity. Most all species of this fungus group are known to occur on a single host genus or on sevaral genera in a limit of a single family, though

some exceptional species are found on the host species distributed in the different families. A few *Rickia* species are very exceptional infecting both the order Coleoptera of insecta and some mites, Acarina. But these mites are eventually found on the coleopterous host insects. In this case, the parasitism on the mites is thought to be accidental. The accidental parasitism is found also in some other species of the Laboulbeniales on insect species living in the same living site.

In this fungus group, moreover, the curious restriction in the parasitism is known. This is a phenomenon called position specificity. A considerable number of fungus species are found on the only limited parts of the host body.

Sugiyama (1973) observed that *Filariomyces forficulae* Shanor occurred only on the pygidium of *Labidura japonica* De Haan and *Laboulbenia borealis* Spegazzini on the only posterior margins of elytra of *Gyrinus spp.* in Japan. Lee (1986) also observed that *Laboulbenia exigua* Thaxter in Korea parasited on the only prothorax of *Chlaenius variicornis* Bates.

This phenomenon was first reported by Peyritsch (1875) for *Stigmatomyces baeri* Petritsch. He stated that the difference in the parasitic positions of *S. baeri* were depending on the sex of the host

flies, namely, on the ventral surface of the abdomon in the male and on the dorsal surface in the female. The detailed studies of the phenomenon were made by Benjamin and Shanor (1952) in the species of *Laboulbenia*. They observed that each of six species of *Laboulbenia* occurring on one insect, *Bembidion picipes* Kirkby, grew on definite position of the host body.

They also suggested the presence of sex-of-host specifisity of some species among the fungi mentioned above, but Benjamin (1971) later stated that those facts might be accidental.

2. Development of thallus

1) Spore

The ascospores of all known Laboulbeniales are hyaline, elongate, more or less spindle-shaped and consist of two cells of unequal length separated by a transverse septum, covered wholly with gelatinous sheath. In the perithecium the spores are formed with the longer cell placed upper, and attached to the host at the top of this cell forming the base of the primary thallus. The ascospores contain usually more or less homogeneous granular protoplasm. The gelationous sheath seems to be considerably thick, thickest at the top of the longer cell. The boundary of the sheath and possible cell wall is indistinct.

In *Autoicomyces falcifer* Thaxter observed by Lee (1986), the granular protoplasm of the ascospore includes numerous, often large, oily globules as described by Thaxter (1896, 1912) in *Stigmatomyces* and *Laboulbenia* etc. Only oily globules are not stained by hematoxylin.

The ascospores are relatively uniform in size for a given species, but in dioecious species such as genus *Dioicomyces* the spores of different two sizes are formed, the larger spores give rise to the female individuals whereas the smaller ones the males (Thaxter 1908;

Benjamin 1970). Any spores formed by the asexual reproduction have never been observed in the Laboulbeniales.

2) Development of thallus

The spores germinate immediately after they adhere to the surface of the host. The basal portion of the germinating spore is blackend and formed a blackish organ of attachment, the foot.

In a few species of some genera such as *Amorphomyces, Dimorphomyces* and *Dioicomyces* (Thaxter 1896, 1931), the foot formation starts when the spores are in their perithecium. The male individuals of *Dimorphomyces muticus* Thaxter which consist of only several cells were found in mature condition in the perithecium (Thaxter 1986). The same phenomenon was observed by Sugiyama (1981) in *Eucantharomyces asiaticus* Sugiyama and by Lee (1986) in *Peyrischiella biformis* Thaxter.

The foot serves primarily as the attachment organ which combines the fungus thallus more or less elastically to the surface of the host. This organ is also thought to serve as the absorbing organ through which the nutritions are transported from the host body to the fungus thallus. However, any special rhizoidal system beneath the foot has

been demonstrated in most genera of this fungus group. In some genera, a distinct rhizoidal system at the basal end of the thallus which penatrates the body cavity of the host were observed. These fungi are limited in the parasites of soft body insects and not form the blackish foot.

After the formation of the foot, the spore cells begin to proliferate and form the vegetable body of the thallus, the receptacle. The cell divisions take place in very exact sequences and in manners typical to the given genus. Consequently, the thalli typical to the genus in cell numbers and constructions are formed.

In some genera, the receptacles are formed through a few times of the transverse and longitudinal cell divisions, and in the other, they are formed through numerous times of cell divisions of this two directions. In parallel with the completion of the receptacle, the origins of the sexual organs are formed on the definite parts of the receptacle depending on the given genus. They are those of antheridia and perithecia. Various sterile filamentous organs called appendages are also formed at some parts of the receptacle.

In many genera, the terminal portion of the receptacle forms filamentous branches. They are originated from the upper smaller cell

of the ascospore and were called primary appendages by Thaxter.

The male sexual organ in this fungus group is recognized three types of antheridia by the difference of their compositions.

The exogenous antheridia formed in the aquatic genera are produced as some small branchlets on the appendges. The sperms are formed as the released distal cells of this branchlets. The endogenous antheridia are phialide-like organ in which the sperms are formed endogenously occurring at the upper parts of the receptacle. Among them, the antheridia consisting of a single cell are called the simple antheridia and those composed of many cells are called the compound antheridia. In the latter, the antheridia are relatively large and include many cells forming sperms in the bottom. The sperms formed by these cells are once gathered in a common cavity of the distal portion of the antheridia and eventually discharged through a common nozzle at the distal end.

In most genera, the female organ is originated from a cell in the lower part of receptacle originated from the lower cell of the spore. The cell is divided into a few superposed cells and forms a lateral projection of the receptacle. Among these cells, the upper cells form the trichogyne, trichophoric cell and carpogenic cell and the lower cells

form the wall cells of the perithecium.

Sperm of spermatia released from the male organ adheres on some occasions to the trichogyne of the female organ and a male nucleus moves into the carpogentic cell. The perithecium begins to be formed centering about the fertilized carpogenic cell, the ascogenous cell. The lower cells of the carpogenis cell are proliferated to surround the ascogenous cell and become to form the perithecial wall.

The number of the ascogenous cells are definitely depending on the genus. The ascogenous cells become to give rise to many asci in the perithecial cavity. The asci form four, rarely eight spores and disappear when the spores are matured, and the spores are released in the perithecial cavity. Active discharge of ascospores does not occur in this fungus group. The ascospores are eventually leaked out through a the apical ostiole of the perithecium.

Ⅱ. Materials and Methods

There are two ways of obtaining the hosts infected with the Laboulbeniales. One way consists of the personal collection of a great number of potential hosts in the field, their preservation (preferably in ethanol), and the survey of the material for the presence of parasites. The other way involves the search for infected host specimens in zoological collections. At first glance, the latter way seems to be more promisting, since we lose no time for search in the field, and the material in the collection is often well ordered and determined. However, the author selected to collect personally the infected hosts in the field because of I have no chanced for the museum collections in Korea.

Capturing of hosts in the field calls for special equipment, including: a strainer (optimally 5㎜ inner diameter, 4㎜ mesh), an aspirater, a net for catching aquatic insects, an entomological sampler, vials with ethanol, a knife, tweezers, and small labels to be placed in the vials.

In the search for small terrestial hosts, a strainer and an aspirator are most useful. All substances containing small hosts are sifted through the strainer over a white oilcloth sheet, and the hosts clearly

visible against the white background are captured with the aspirator.

The collected hosts are immediately placed in vials with 70% ethanol. In this medium they may be preserved until inspection for the presence of thalli of the Laboulbeniales. An identification label written in pencil, giving the locality and time of collection, is placed in the vial. Moreover, detailed information on the locality and biotope, as well as all other data which may be useful later, have to be recorded in a special note-book.

The collected hosts immersed in ethanol are inspected for the presence of thalli on a depression slide, using a dissecting microscope. Selected hosts specimens with visible thalli are seperated for preparation. Thalli are transferred to a microscopic slide and enclosed in a slide mount, whereas the corresponding host has to be appropriately preserved.

For preparation of thalli of the Laboulbeniales, the present author applied the method of Benjamin (1971). The host is taken out of ethanol, and the thalli are removed using a thin needle with a sharp flat end, whereupon they are placed on a micro slide. If there are more than one species of parasite on the host, seperate slides are used for each species. During removal of thalli from the host, special attention

has to be given to small, young thalli which may be very valuable in the analysis of fungus development. Thalli from different body parts are placed on different slides.

In making slide mounts, a tiny drop of Neoshigaral medium is placed in the middle of the slide, the thalli are put into this drop and are arranged in a row with the feet of the thalli directed upwards. For prevention of thallus compression by the cover slip, one or two paper fibers are placed near the thalli.

A larger drop of the mounting medium is put in the middle of the cover slip, the slip is reversed and used to cover the thalli anchored in place in Neoshigaral medium. Subseguently the cover slip is ringed with a shellac solution, and a second application of shallac is repeated after several days.

Labels dating the serial number, information on the host, and location on host body are written on the note-book. The name of the fungus is added after its determination. Micro slides should be stored flat, preferably in wooden boxes.

Ⅲ. Results

Order LABOULBENIALES

Thallus composed of specialized cells which are limited in number; spores are spermatia and two-celled ascospores produced in perithecia; asci not persistent. External parasites of some Insecta, Acarina and Diplopoda.

Key to the *Laboulbenia*

1. Dioescious species; the primary 4-celled axis of thallus develops directly from the spore; in females, the suprabasal cell gives rise to secondary axis forming perithecia and connecting directly with host integument; the perithecial outer wall rows consist of many cells equal in height. On Blattodae ..... **HERPOMYCETINEAE**

1′. Monoecious or(rarely) dioecious species; thallus varied but not as above; most of genera from perithecia with four or five cells in outer wall cell rows; the cells are usually unequal in hight. On other arthropods ..... **LABOULBENINEAE**

2. Outer wall cells of perithecium usually 4 or 5 in each vertical row and unequal in height ..... **LABOULBENIACEAE**

3. Receptacle massive, multiseriate; small perithecia and antheridial branchlets with exogenous spermatia borne among sterile appendages in a caviry at the apex of thallus: outer wall cells of perithecia subequal in height ..... ZODIOMYCETOIDEAE

3′. Receptacle of different forms: perithecia prominent, with outer wall cells usually unequal in height; spermatia usually borne inside antheridia 4

4. Antheridia one-celled, mostly phialides ..... LABOULBENIOIDEAE

5. Receptacle forming secondary branches or suprabasal cell complex or primary axis producing lateral cells subtending perithecial stlk cells, antheridia borne on secondary axis or on secondary appendages below perithecium ..... *TERATOMYCETEAE*

5′. Receptacle uniseriate or only few vertical septa near its distal end antheridia borne above perithecium ..... *LABOULBENIEAE*

6. Thalli monoecious 7

7. Antheridia on well developed primary appendage. Usually on terrestrial insects ..... *LABOULBENINAE* ..... ***Laboulbenia***

Genus ***Laboulbenia*** Montagne et Robin

CH. ROBIN, Histoire Naturelle des Vegetaux Parasites (Paris), 622, 1853. -*Thaxteria* Giard, Compt. Rend. helbd. Seanc. Mem. soc. Biol. (Paris) 44: 156, 1892. -*Ceraiomyces* Thaxter, Proc. Amer. Acad. Arts Sci. 36: 410, 1901. -*Eumisgomyces* Spegazzini, Anales Mus. Nac. Hist. Nat. Buenos Aires 23: 176, 1912. -*Laboulbeniella* Spegazzini, 23: 188, 1912. -*Schizolaboulbenia* Middelboek, Fungus 27: 73, 1957.

Lower receptacle two-celled, the upper receptacle usually three-celled; the uppermost cell (V) may be parallel to the outer cell Ⅳ (in some species they may be subdivided, producing secondary appendages). Primay appendage well developed, usually branched, its first cell (insertion cell) typically flat and black, bearing an outer and inner appendage branch. antheridia terminal or lateral phialides, usually borne on inner branch. Perithecium more or less free, with 4 outer wall cells in each vertical row, the cells distinctly unequal in height.

Type species: *Laboulbenia rougetii* Montagne et Robin.

In the Laboulbeniales, this genus is richest in species. about 550 species and many subspecies, varieties and forms have been described. Santamaria et al. (1991) reported 92 species from Europe. The majority of the taxa of this genus parasitize *Carabidae* s. l. (Coleoptera); moreover, parasites of other beetles (e.g. *Staphylinidae, Gyrinidae, Chtysomelidae, Elateridae, Corylophidae*) as well as of diptera, Isoptera, Hemiptera, Hymenoptera, Orthoptera, Blattodea and Acarina, are known. The morphology of species, particularly of those derived from tropical countries, is greatly diversified; the above description of the genus emphasizes the traits of species of the temperate zone, especially those in Central Europe.

Owing to the abundance of diverse species, the division into subgeneric taxa of the genus *Laboulbenia* is on one hand desiderable, and on the other, difficult. *Laboulbenia* was divided into sections by Spegazzini (1917); the names of the sections indicate the morphological traits in the descriptions. However, other authors did not use this taxonomic system. Tavares (1985) distinguished in this genus 20 groups of species with morphological similarities, without, however, formally describing the taxa. There are 33 species of *Laboulbenia* in Korea.

The name of this genus commemorates Alexandre Laboulbene (1825 ~1899), M. D., professor of the history of medicine and surgery at the Academy of Medicine in Paris. He published many papers concerning ecology, anatomy and economical significance of inserts, chiefly of the coleoptera and Diptera. According to Robin (1853), he observed the thalli of Laboulbenia a long time before the fomal description of this taxon.

1. ***Laboulbenia benjaminii*** **Balazuc, Bull. mens. Soc. Linn. Lyon 43: 15, 1974; Majewski, Polish Bot. Stud. 7: 88, 1994; De Kesel, Sterbeeckia 18: 27, 1998.** **(Fig. 1)**

Total length to the top of perithecium 247.5㎛. Thallus yellowish-brown. Receptacle rather stout, composed of basal and distal portions; the basal portion consisting of five cells and insertion cell, 162.5㎛ long, 37.5㎛ thick; cell Ⅰ usually bent outwardly, up to 2 times longer than broad, 42.5㎛ long, 20㎛ thick; cell Ⅱ broader in its distal portion, septum Ⅱ/Ⅳ much longer than septum Ⅱ/Ⅲ, oblique, 50㎛ long, 37.5㎛ thick; cell Ⅲ and Ⅳ slightly elongated, cell Ⅲ 42.5㎛ long, 35㎛ thick, cell Ⅳ 45㎛ long, 35㎛ thick; cell Ⅴ small, oval, 22.5㎛ long, 15㎛ thick; insertion cell dark, thick, constricted, 5㎛ long, 17.5㎛ thick; the distal portion consisting of two appendages arranged anterior-posteriorly; the outer appendage simple, straight, composed of elongated cells, it broken in this specimen (Fig. 3); the inner appendage short, its basal cell not over half as long as the outer basal cell, giving rise to branches which are 2~3 times divided and terminating in a cluster of antheridia. Antheridia proliferate into short, evanescent branchlets.

Perithecium composed of the perithecial proper and the stalk

consisting of two cells; perithecial proper ovate, half free, usually slightly asymmertrical, with convex posterior margin and prominent, rounded posterior lips, the blackish subapical portion, 120㎛ long, 57.5㎛ thick; the basal cell (cell Ⅵ) of the perithecial stalk flattened, oblique, 25㎛ long, 32.5㎛ thick, two subbasal cells (cell Ⅶ, Ⅷ) smaller than the basal cell.

Host genus: *Badister* (Carabidae, Coleoptera).

Host species in Korea: *Stenolophus difficilis* Hope (Carabidae, Coleoptera).

Distributions: Belgium, France, Korea and Poland.

Specimen examined: Mt. Baegwoon, Gwangyang City, Jeonnam Province, August 10, 1996, L-Y-1253.

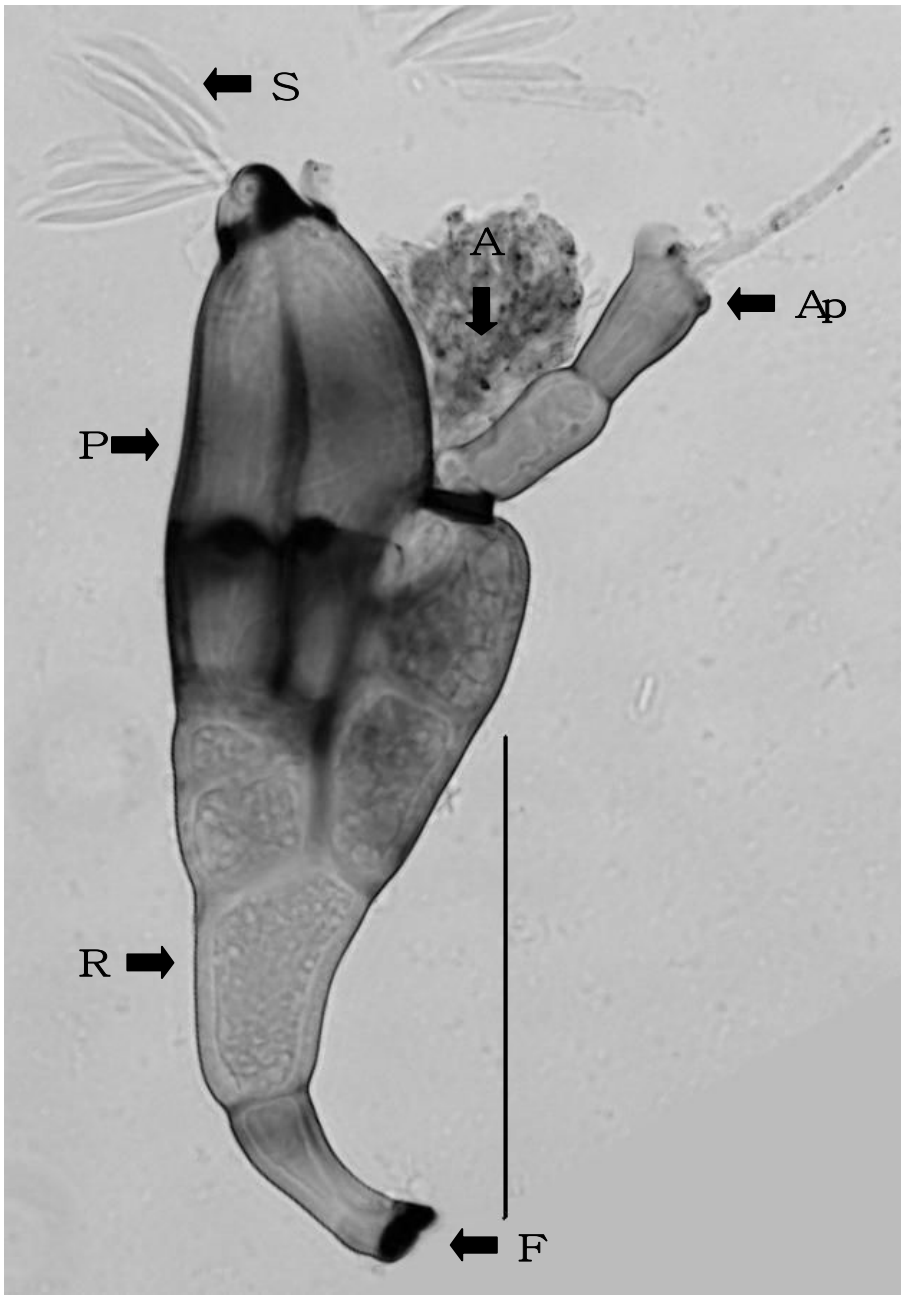


Figure 1. *Laboulbenia benjaminii* on *Stenolophus difficilis.*

A, antheridium; P, perithecium; F, foot; R, receptacle; S, spore; Ap, appendage. Scale: 100㎛.

2. ***Laboulbenia borealis*** **Spegazzini, Ann. Mus. Nac. Hist. Nat. Buenos Aires 26: 468, 1915; Sugiyama, Ginkgoana 2: 43, 1973.**

(Fig. 2 and 3)

Total length to the top of perithecium 450~480㎛. Receptacles dark yellowish brown, with fine and dense black punctations, composed of basal and distal portions; basal portion consisting of five cells, 325~350㎛ long, 45㎛ thick; cell Ⅰ and Ⅱ forming a stalk, stalk tapering evenly towards the base, forming basaly a blackish conical foot; cell Ⅰ cylindrical, 105~110㎛ long, 30㎛ thick at the distal end; cell Ⅱ 110~130㎛ long, 35㎛ in diameter; cell Ⅲ and Ⅳ stout, darker than the lower cells; cell Ⅲ 70~75㎛ long, 45㎛ thick; cell Ⅳ inflated laterally, 45~50㎛ long, 45㎛ thick; cell Ⅴ ellipsoidal, 25㎛ long, 15㎛ thick; distal portion of the receptacle composed of numerous hyaline filamentous branches, 300~325㎛ long. Perithecia concolorous with the receptacle, thickest at the base, becoming gradually thinner towards the narrowly rounded apex, more or less inflated laterally, forming a pair of short projections at the apex united to the receptacle on one lateral side of the basal half, 150~170㎛ long except the stalk, 45㎛ in diameter; apical projections pointed terminally, 4~5㎛ long; stalk thickest at the distal end, more or less tapering towards the base,

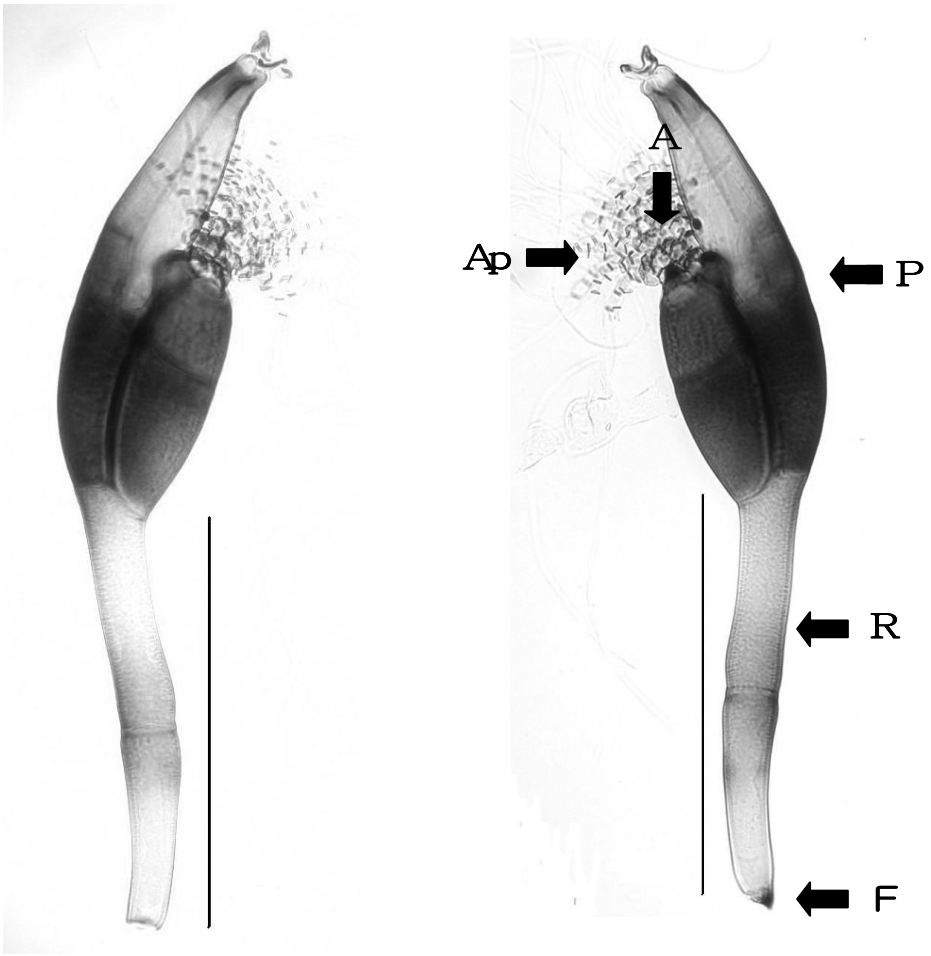
consisting of a large basal cell and a few distal cells, completely united to the third layer of the receptacle on lateral side, 90~95㎛ long, 30~40㎛ thick. Antheridium not observed.

Host genus: *Gyrinus* (Gyrinidae, Coleoptera).

Host species in Korea: *Gyrinus japonicus* Sharp (Gyrinidae, Coleoptera).

Distributions: Japan, Korea (new) and North and South America.

Specimens examined: Mt. Cheuiseo (Temple Tongdo), Yangsangun, Gyeongnam Province, August 10, 1998, L-Y-1589 and 1591.



Figures 2 and 3. *Laboulbenia borealis* on *Gyrinus japonicus.*

A, antheridium; P, perithecium; F, foot;

R, receptacle; Ap, appendage. Scale: 200㎛.

3. ***Laboulbenia humilis*** **Thaxter, Proc. Amer. Acad. Arts Sci. 38: 42, 1902; Mem. Amer. Acad. Arts Sci. 13: 334, 1908; Terada, Mycoscience 37(3): 308, 1996. (Fig. 4 & 5)**

Total length to the top of perithecium 237.5~325㎛. Receptacle amber-colored, streaked or spotted, composed of basal and distal portions; basal portion consisting of five cells and insertion cell, 152.5~175㎛ long, 27.5~30㎛ thick; cell Ⅰ contrasting pale, cylindrical, longer than the other cells, at least 4 times longer than broad, 75~87.5㎛ long, 20㎛ thick; cell Ⅱ darker than cell Ⅰ, up to 1.4 times longer than broad, 37.5㎛ long, 27.5㎛ thick; cell Ⅲ and cell Ⅳ isodiametric or slightly elongated and nearly same size, cell Ⅲ 22.5㎛ long, 20~22.5㎛ thick, cell Ⅳ 20㎛ long, 17.5~20㎛ thick; cell Ⅴ small, oval, 10~15㎛ long, 5~7.5㎛ thick; insertion cell relatively narrow, dark, thick; distal portion consisting of the outer and inner appendages arranged anterior-posteriorly; the outer appendage simple, curved outwardly, the basal three septa distinct, other above very pale, no blackening or constriction, up to 82.5~150㎛ long, 5㎛ thick; the inner appendage usually three celled the terminal cell a narrow, flask-shaped antheridium, but occasionally replaced by a short sterile branch, 37.5㎛ long, 2.5~3.75㎛ thick.

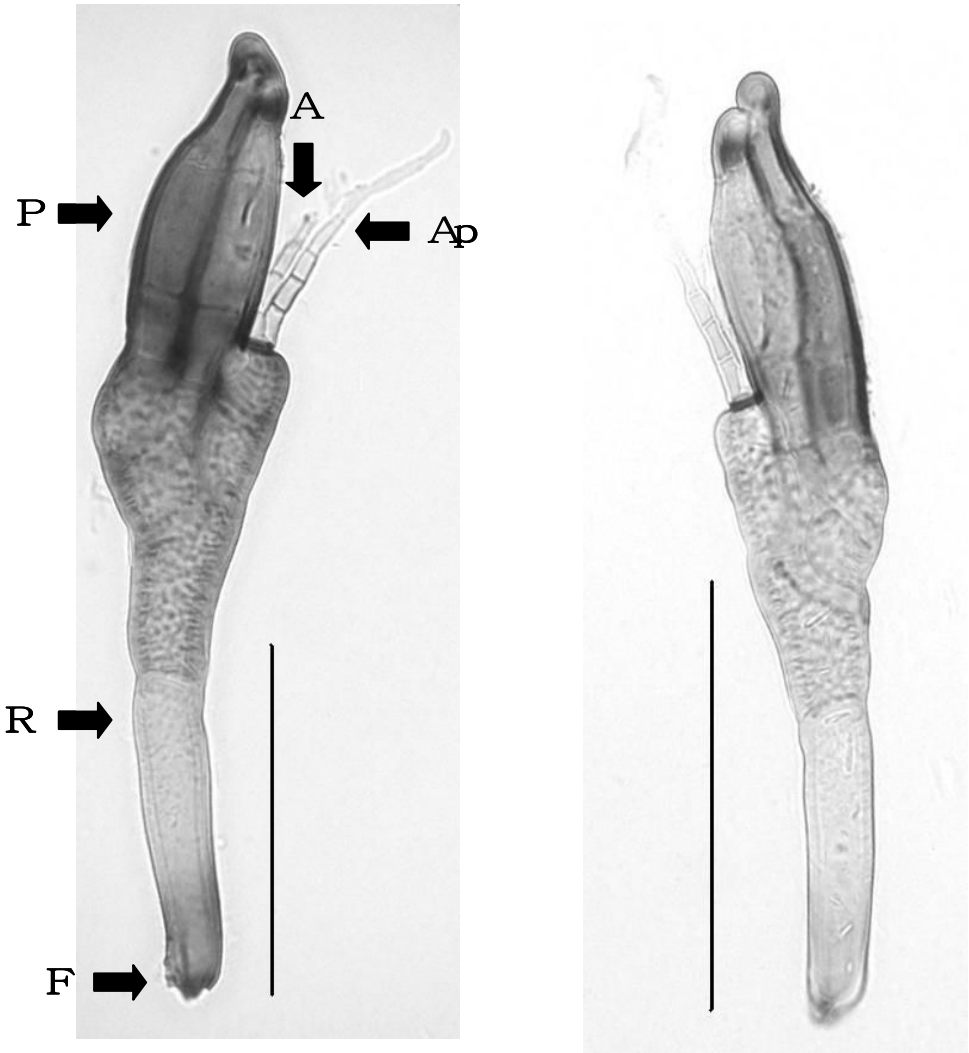
Perithecia olive-brown, convex, composed of the perithecium proper and the perithecial stalk, tapering distally towards the top, free from the receptacle at the base three fourth, outwardly oblique lips, the stalk consisting of the basal cell(cell Ⅵ) and the subbasal cell(cell Ⅶ) inflated outwardly. Antheridia 20~25㎛ long, 1.5~2㎛ thick.

Host genus: *Chlaenius* (Carabidae, Coleoptera).

Host species in Korea; *Chlaenius naeviger* Morawitz (Carabidae, Coleoptera).

Distribution: China (Hong Kong), Japan (Okinawa) and Korea (Mt. Baegwoon).

Specimens examined: Mt. Baegwoon, Chungdaeri, Ganjeonmyeon, Guryegun, Jeonnam Province, August 16, 2001, L-Y-1582.



Figures 4 and 5. *Laboulbenia humilis* on *Chlaenius naeviger.*
A, antheridium; F, foot; P, perithecium;
R, receptacle; Ap, appendage. Scale: 100㎛.

Ⅳ. Discussion

Laboulbenia benjaminii **Balazuc**: Total length to the top of perithecium 247.5㎛. Thallus yellowish-brown. Receptacle rather stout, composed of basal and distal portions. Antheridia proliferate into short, evanescent branchlets. Perithecium composed of the perithecial proper and the stalk consisting of two cells.

Korean thallus were somewhat larger than typical ones France; according to the original description by Balazuc (1971), his specimens were 175㎛ (total length), with the Perithecium 80×40㎛. The present specimen was nearly agreed with them of Majewski (1994) and Kesel (1998). Thalli grew on various parts of the host body.

This species was collected under the small stones of the narrow stream surrounded by the deciduous broad-leaved forest and about 600m hight above the sea level in the west of Mt. Baegwoon. The hosts of *Laboulbenia benjaminii* Balazuc was so far known only from genus *Badister* Schellenberg (Balazuc 1974; Majewski 1994; Kesel 1998), but they were discovered newly from genus *Stenolophus* in Korea.

Laboulbenia borealis **Spegazzini:** Total length to the top of perithecium 450~480㎛. Receptacles dark yellowish brown, with fine and dense black punctations, composed of basal and distal portions.

The present species is characterized by the slender stalk of the receptacle and the stout upper portion united to the perithecium. The numerous filamentous branches of the receptacle are also unique to this species. The most characteristic of the present species is the long umbo. Thalli were found on the outer dorsal margins of the tip of the abdomen.

This species is more closely related to *L. chaetophora* than *L. gyinidarum*, because it has the long, narrow cell Ⅰ and Ⅱ. My specimens are nearly consistent with fungi illustrated as *L. borealis* by Spegazzini (1912) and Sugiyama (1973), although they have the immature perithecia of thalli.

Laboulbenia humilis **Thaxter:** Total length to the top of perithecium 237.5~325㎛. Receptacle amber-colored, streaked or spotted, composed of basal and distal portions.

The main feature of this species is the remarkable pattern of the olive-brown perithecia and amber-colored, streaked or spotted receptacles, with a contrasting pale cell Ⅰ. Teradas materials (1996)

showed cell Ⅰ and cell Ⅱ of this fungus as shorter and stouter than Thaxters them (1908). Korean materials were nearly agreed with Thaxters description. Thalli occurred on the upper side of the hosts abdomen.

V. Summary

Three species under one genus of the Laboulbeniales were collected from several regions of south Korea. They are *Laboulbenia borealis* Spegazzini on *Gyrinus japonicus* Sharp (Gyrinidae, Coleoptera), *Laboulbenia humilis* Thaxter on *Chlaenius naeviger* Morawitz (Carabidae, Coleoptera) and *Laboulbenia benjaminii* Balazuc on *Stenolophus difficilis* Hope (Carabidae, Coleoptera). Occurrence of these species will be newly recorded in this paper from South Korea.

Laboulbenia borealis Spegazzini was collected from Mt. Cheuiseo (Temple Tongdo), Yangsangun, Gyeongnam, Province (August 10, 1998). The present species is characterized by the slender stalk of the receptacle and the stout upper portion united to the perithecium. The numerous filamentous branches of the receptacle are also unique to this species. Thalli grew on the sternites of back abodomen. *Laboulbenia humilis* Thaxter was collected from Mt. Baegwoon, Chungdaeri, Ganjeonmyeon, Guregun, Jeonnam Province (August 16, 2001). The main feature of this species is the remarkable pattern of the olive-brown perithecia and amber-colored, streaked or spotted receptacles, with a contrasting pale cell Ⅰ. Terada's materials (Terada, 1996) showed that cell Ⅰ and cell Ⅱ of this fungus were as shorter and stouter than Thaxter's them (1908). Respectively Korean materials were nearly agreed with Thaxters description. Thalli occurred on the upper side of the host's abdomen. *Laboulbenia benjaminii* Balazuc was collected under the small stones of the narrow stream surrounded by

the deciduous broad-leaved forest and about 600m hight above the sea level of Mt. Baegwoon (Gwangyang City, Jeonnam Province, August 10, 1996). The hosts of *Laboulbenia benjaminii* Balazuc was so far known only from genus *Badister* Schellenberg (Balazuc 1974; Majewski 1994; Kesel 1998), but it was discovered newly from genus *Stenolophus* in Korea.

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