

## New records of the carabidicolous Laboulbeniales (Ascomycetes) of Japan

Katsuyuki Terada

1–2–20–203, Omiya, Nishi-ku, Hiroshima 733–0007, Japan

Accepted for publication 29 January 1998

Six carabidicolous species of Laboulbeniales are reported as new for the Japanese mycoflora. They are *Dixomyces stomonaxi*, *Laboulbenia picardii*, *L. tenera*, *L. slackensis*, *L. aristata* and *L. kwangjuensis*. Two forms of *D. stomonaxi* are distinguished, one form of which resembles *D. nigromarginatus*. A remarkable ornamentation consisting of a coil-like pattern occurs on the receptacle of *L. picardii*. In *L. tenera* and *L. slackensis*, the outer appendage has somewhat constricted, blackened septa near the base. *Laboulbenia aristata* and *L. kwangjuensis* have spirally arranged outer wall cells. Antheridia were observed in *L. tenera*, *L. slackensis*, *L. aristata* and *L. kwangjuensis*.

Key Words—Carabidae; *Dixomyces*; Japan; *Laboulbenia*; new records.

The dominant hosts of the Laboulbeniales are insects, among which the Carabidae (Coleoptera) are frequently parasitized. As part of an extensive study of the carabidicolous Laboulbeniales of Japan, the present paper deals with one species of *Dixomyces* and five species of *Laboulbenia*, all of which are new for the Japanese mycoflora. Both fungus and host specimens are preserved in the K. Terada Herbarium.

1. *Dixomyces stomonaxi* (Thaxter) I. I. Tav., Mycologia Memoir 9: 208. 1985. Basionym: *Misgomyces stomonaxi* Thaxter, Proc. Amer. Acad. Arts Sci. 35: 443. 1900. Type: On *Caelostomus* sp. (erroneously listed as *Stomonaxus striaticollis* Dej.), China.

Figs. 1, 2

Specimens examined: On *Caelostomus picipes japonicus* Tschitschérine, Pterostichini. KT-1178, 1311, 27-VII-1992, Yugawara, Kanagawa; KT-1318 (collected by I. Okamoto), 12-XII-1992, Oku-Dogo, Matsuyama, Ehime.

Measurements: Total length to tip of perithecium 350–380  $\mu\text{m}$  (slender form) or ca. 290  $\mu\text{m}$  (broader form); perithecium ca. 100  $\times$  32  $\mu\text{m}$ .

The thalli of this fungus are almost colorless, whereas Thaxter (1900, under the name *Misgomyces stomonaxi*) described them as “hyaline or pale straw colored.” The receptacle is composed of a triseriate series of cells. The specimens in my collection include three slender, young thalli with a large number of receptacle cells and two broader thalli with fewer cells. One slender thallus has a receptacle with 15 superposed anterior cells including cells I and II, 17 posterior cells and 8 cells in the middle row (Fig. 1). Such a cell composition and a thallus form agree well with those of *D. stomonaxi*. No mature perithecia were found on the slender thalli. On the other hand, one broader thallus has a receptacle

with 10 superposed anterior cells including cells I and II, 10 posterior cells and 8 cells in the middle row (Fig. 2); the posterior walls of the receptacle are thicker than the anterior walls. The fungus resembles *D. nigromarginatus* (Thaxter) I. I. Tav. (Thaxter, 1931; Tavares, 1985), although *D. nigromarginatus* has deeply blackened posterior walls of the receptacle and the thallus has a brownish tinge. One mature perithecium was seen on a broad thallus (Fig. 2); it is abruptly narrowed from the subapical region to the blunt apex and resembles that of *D. spiralis* (Thaxter) I. I. Tav. Thaxter’s illustrations of *D. spiralis* and *D. stomonaxi* (Thaxter, 1908, pl. LXX, figs. 7, 8; 1931, pl. XLVIII, fig. 4) indicate that the two species have perithecia similar to each other. Both the slender and broad specimens in my collection were obtained from the body of a single host.

The host species, *Caelostomus* sp., was originally listed by Thaxter (1900) as *Stomonaxus striaticollis* Dej. However, the species is known to occur only in tropical Africa (Balazuc, 1982).

The genus *Dixomyces* is characterized by the division of the vertical rows of the receptacle into three rows. In *D. stomonaxi*, each row consists of several cells.

2. *Laboulbenia picardii* Maire, Bull. Soc. Hist. Nat. Afrique N. 7: 28, 30. 1916. Type: On *Tachys (Porotachys) bisulcatus* Nicolai, Morocco. Figs. 3–8

Specimens examined: On *Macrotachys recurvicollis* (Andrewes), Bembidiini. KT-1125, 1179, 1310, 1323, 28-VIII-1982, Hesaka, Hiroshima, Hiroshima; KT-1313, 31-VII-1993, Hurukawa, Hiroshima, Hiroshima; KT-1324, (collected by I. Okamoto), 12-XII-1993, Oku-Dogo, Matsuyama, Ehime.

Measurements: Total length to tip of perithecium 300–470  $\mu\text{m}$ ; perithecia 90–120  $\times$  40–45  $\mu\text{m}$ ; outer ap-

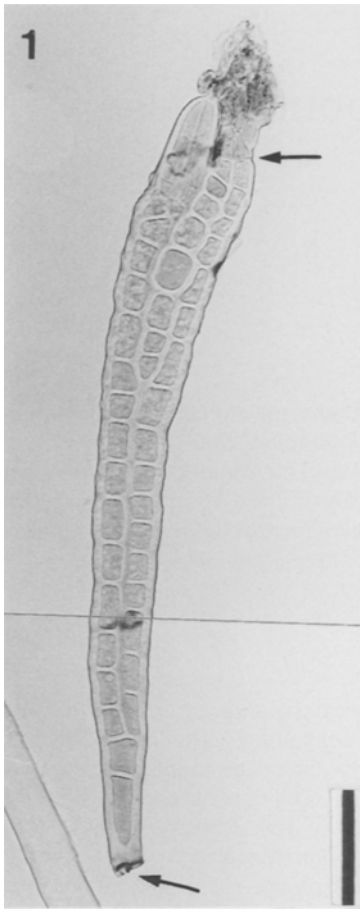


Fig. 1. *Dixomyces stomonaxi*.  
Young thallus with slender receptacle. Original spore septum is indicated by upper arrow. Arrow at base indicates broken foot. Acetocarmine staining. KT-1178. Bar=50  $\mu$ m.

pendages ca. 85  $\mu$ m long and inner appendages ca. 50  $\mu$ m long.

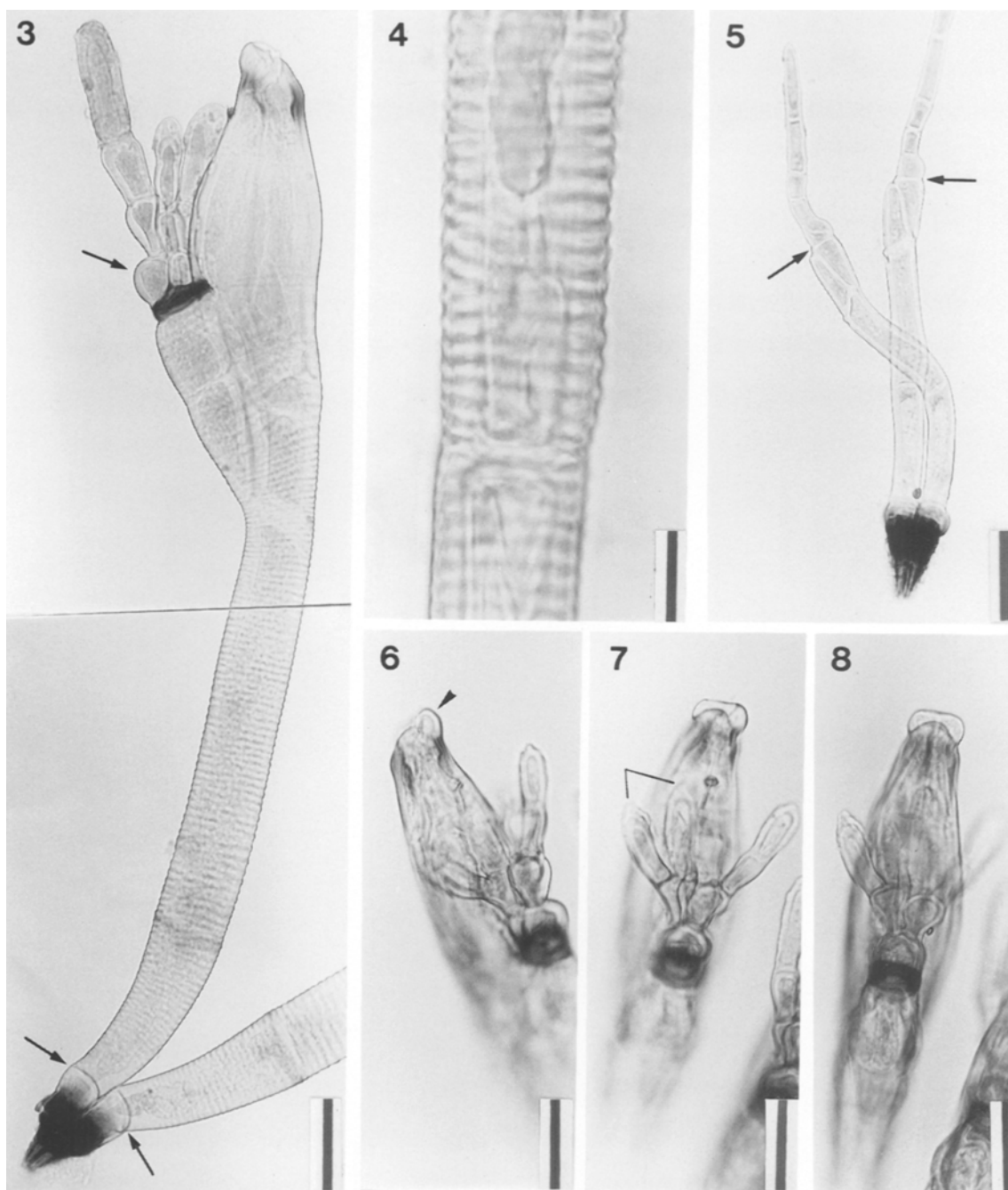
This is a striking species having a coil-like ornamentation, which was not clearly shown by Maire (1916). Annuli cover the whole receptacle, whose surface is grooved at regular intervals (Figs. 3, 4). The foot is acute-triangular and the receptacle is abruptly bent just above the foot. Therefore, a crease is sometimes formed above the foot, as shown in Fig. 3, depending on the orientation of the receptacle when pressed under a coverglass. The septum between cells IV and V is oblique and never reaches cell III. The black insertion cell is adnate to the basal portion of the perithecium. The outer appendage is simple and short. The outer basal cell is almost cubical or rounded on the outer side (Fig. 3). The inner appendage is composed of right and left axes. Each axis is short, stout and branched dichotomously in most cases (Fig. 7). The inner basal cell is equal in height to the outer basal cell. The perithecium is nearly ovoid, lip-shaped at the apex, and very weakly pigmented just below the apex. The truncate posterior apex of the perithecium is taller than the rounded anterior apex (Figs. 6–8). No black septa are formed in the appendage of the



Fig. 2. *Dixomyces stomonaxi*.  
Mature thallus with broad receptacle. Original spore septum is indicated by arrow. Posterior walls of receptacle are thicker than anterior walls. Acetocarmine staining. KT-1178. Bar=25  $\mu$ m.

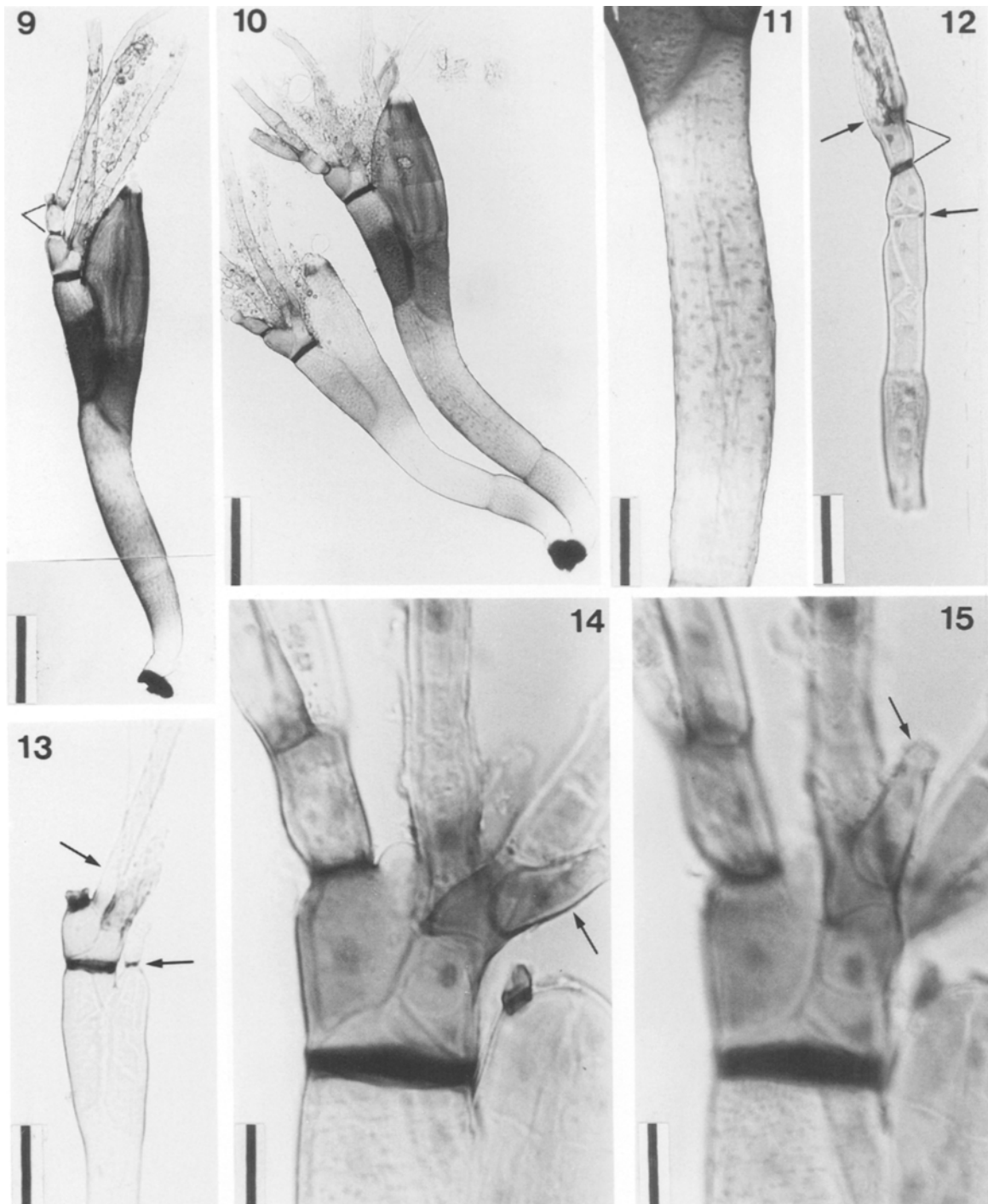
sporeling (Fig. 5). The color of the thallus is near amber or “jaune-ambre” as recognized by Maire (1916).

3. *Laboulbenia tenera* Majewski, Polish Bot. Stud. 7: 112. 1994. Type: On *Bembidion (Eupetedromus) den-*



Figs. 3–8. *Laboulbenia picardii*.

3. Mature thallus with coil-like ornamentation of receptacle. Upper arrow indicates basal cell of outer appendage with conspicuous outer protrusion. Each arrow at base indicates crease above foot. Acetocarmine staining. KT-1324. Bar=25  $\mu$ m. 4. Middle portion of receptacle showing coil-like ornamentation. KT-1310. Bar=10  $\mu$ m. 5. Two sporelings. Each original spore septum is indicated by arrow. Lowermost cell of primary appendage at left has divided into two cells by oblique septum, whereas it has not yet divided in the appendage at right. No black septa are formed in appendages. Acetocarmine staining. KT-1313. Bar=25  $\mu$ m. 6. Mature thallus in free condition (no coverglass) showing perithecium and appendages. Arrowhead indicates in lateral view the posterior apex, which is taller than the anterior apex. KT-1323. Bar=25  $\mu$ m. 7. Mature thallus in free condition (no coverglass) showing perithecium and appendages. V-line indicates dichotomously branched left axis of inner appendage. One branch of right axis is out of focus. KT-1323. Bar=25  $\mu$ m. 8. Mature thallus in free condition (no coverglass) showing nearly horizontal posterior apex in antero-posterior view. KT-1323. Bar=25  $\mu$ m.



Figs. 9–15. *Laboulbenia tenera*.

9. Mature thallus. V-line indicates black, constricted septa of suprabasal cell of outer appendage. Cell III and perithecial base including cell VI are suffused with dark color. KT-1294. Bar = 50  $\mu\text{m}$ . 10. Mature thallus at right and almost mature thallus at left. KT-1294. Bar = 50  $\mu\text{m}$ . 11. Middle portion of receptacle showing dark pigment spots. KT-1321. Bar = 25  $\mu\text{m}$ . 12. Sporeling. Original spore septum is indicated by arrow at right. Lowermost cell of primary appendage is divided into three small cells just above original spore septum. Cell above is separated by blackened, slightly constricted upper and lower septa (V-line). Formation of subterminal branch (arrow at left) has begun. Acetocarmine staining. KT-1320. Bar = 25  $\mu\text{m}$ . 13. Young thallus with immature perithecium. Arrow at right indicates black septum of trichogyne base. Left arrow indicates straight subterminal branch of outer appendage. KT-1294. Bar = 25  $\mu\text{m}$ . 14. Basal portion of appendages showing one antheridium (arrow) on lateral side of inner appendage. Acetocarmine staining. KT-1320. Bar = 10  $\mu\text{m}$ . 15. Same portion of thallus in another focus. One antheridium (arrow) is on another axis of inner appendage. Acetocarmine staining. KT-1320. Bar = 10  $\mu\text{m}$ .

tellum (Thunberg), Poland.

Figs. 9–15

Specimens examined: On *Bembidion (Eupetedoromus) inouyei* Habu, Bembidiini. KT-1294, 6-IX-1974, KT-1296, 1320-1322, 13-VIII-1993, Nopporo, Ebetsu, Hokkaido.

Measurements: Total length to tip of perithecium 310–380  $\mu\text{m}$ ; perithecia 95–100  $\times$  38–45  $\mu\text{m}$ ; appendages ca. 200  $\mu\text{m}$ ; ascospores ca. 35  $\times$  3  $\mu\text{m}$  (excluding cell wall).

This species has been recently described from Europe. In color it is dark olivaceous brown or “olive-brownish” (Majewski, 1994). However, the appendages usually lack an olive tinge. Dark spots are scattered on the surface of the receptacle (Fig. 11). The septum between cells IV and V is slightly oblique and reaches cell III. The black insertion cell is adnate to the middle portion of the perithecium (Figs. 9, 10). The outer appendage consists of 3 or 4 more-or-less slender branches; each of the basal and suprabaasal cells bears a subterminal branch on the inner side. The basal cell of the outer appendage is about two times taller than the inner basal cell. The inner appendage is composed of right and left axes. Each axis bears laterally a persistent antheridium (Figs. 14, 15). The perithecium is ovoid, lip-

shaped at the apex, and blackened in the subapical region. The simple short trichogyne bears a blackish septum at the base (Fig. 13).

Two black septa are clearly formed in the sporeling (Fig. 12). In Fig. 12, the lowermost cell of the primary appendage divides into three small cells, subtended by the original spore septum; the suprabaasal cell of the outer appendage begins to form a subterminal branch. The ascospores are relatively small and narrow, but not as slender as in the group of *Laboulbenia exigua* Thaxter (see comments under *Laboulbenia kwangjuensis* Y.-B. Lee in the present paper).

*Laboulbenia tenera* is undoubtedly related to *L. pedicellata* Thaxter, in which cell V reaches the septum of cell III, cell II is long, whereas cell I is short, and the outer appendage bears black septa near the base. *Laboulbenia pedicellata* has been reported on a wide range of hosts and seems to be variable in form. The species of the host of the type is not known (Thaxter, 1992). The range of morphological variation in *L. pedicellata* should be studied for a wide range of hosts.

According to Morita (1990), *B. inouyei* may be synonymous with *B. sibiricum* Dej., regarded as a variety of *B. dentellum*, the host species of the type collection.



Figs. 16–18. *Laboulbenia slackensis*.

16. Two mature thalli. Each arrow indicates black septum of outer appendage. KT-1325. Bar=50  $\mu\text{m}$ . 17. Almost mature thallus. Two antheridia (arrowheads) are separately located on lateral side of inner appendage. Basal cell of outer appendage bears black septum (arrow). KT-1279. Bar=25  $\mu\text{m}$ . 18. Perithecium showing bluntly rounded posterior apex and somewhat acute anterior apex in antero-posterior view (indicated by three arrowheads). KT-1280. Bar=25  $\mu\text{m}$ .

4. *Laboulbenia slackensis* Cépède et Picard, Compt. Rend. 36ème session Assoc. Fr. Avanc. Sci. Reims, 1907(2): 780. 1907. Type: On *Pogonus chaldeus* (Marsham), France. Figs. 16–18

Specimens examined: On *Pogonus itoshimaensis* Habu, Pogonini. KT-1247, 1279, 1280, 30-IV-1995, Azisu, Yamaguchi. On *Pogonus japonicus* Bates, Pogonini. KT-1325, 30-IV-1995, Azisu, Yamaguchi.

Measurements: Total length to tip of perithecium 250–300  $\mu\text{m}$ ; appendages 180–200  $\mu\text{m}$ ; perithecia 115  $\times$  55  $\mu\text{m}$ ; ascospores 48–53  $\times$  5  $\mu\text{m}$  (excluding cell wall).

This species is well known in Europe. The thallus is brownish yellow and gradually turns yellowish brown, or “assez transparente, faiblement colorée en jaune” (quite hyaline, slightly yellow colored) or “jaune paille” (straw yellow) as described by Cépède and Picard (1907, 1908). The receptacle of the thallus has a vertical septum between cells IV and V, which reaches cell III (Figs. 16, 17). The black insertion cell is adnate to the basal portion of the perithecium. The outer appendage is composed of the terminal and subterminal axes, each arising from the outer basal cell; the terminal axis has a constricted, black septum at the base (Figs. 16, 17), and branches once or twice. The inner appendage is composed of right and left axes arising from the inner basal cell; each axis usually bears two persistent antheridia arising separately near the base (Fig. 17). The inner basal cell is shorter than the outer basal cell. The perithecium is ovoid, lip-shaped at the apex, and blackened in the subapical region. The posterior apex of the perithecium is bluntly rounded in antero-posterior view (Fig. 18).

5. *Laboulbenia aristata* Thaxter, Proc. Amer. Acad. Arts Sci. 35: 158. 1899. Type: On a carabid near *Pericalus*, East Indies. Fig. 19

Specimens examined: On *Colpodes (Loxocrepis) rubriolus* Bates, Platynini. KT-540 (provided by M. Mori), 11-VII-1970, Hatsuno, Amami-Oshima, Kagoshima.

Measurements: Total length to tip of perithecium 210–280  $\mu\text{m}$ ; perithecia 100–130  $\times$  35–52  $\mu\text{m}$ ; appendages ca. 300  $\mu\text{m}$ .

This species has a rather simple appendage structure. The thallus is yellowish brown, becoming darker especially on the perithecium. The top of cell I also has darker shades, though Thaxter (1899) described the thallus as “pale amber-yellow” in color. The septum between cells IV and V is very oblique and does not reach cell III. Cell IV has a rounded outer protrusion (Fig. 19). The black insertion cell is adnate to the middle portion of the perithecium. The outer appendage is simple and slightly inclined toward the perithecium. The inner appendage is also simple, consisting of a basal cell and a persistent antheridium. However, Thaxter (1908) described the inner appendage as “...consisting of a small basal cell bearing a very short one- or two-celled branch on either side.” The outer wall cells of the perithecium are spirally arranged. The bluntly rounded posterior apex is clearly seen in lateral view. The arrangement of

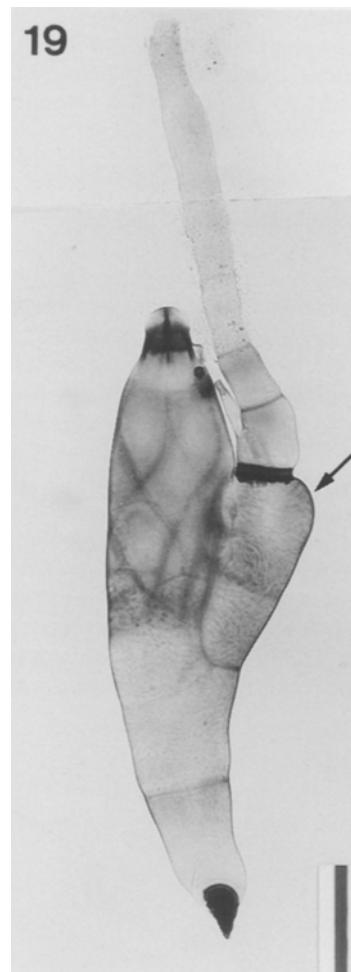


Fig. 19. *Laboulbenia aristata*.

Mature thallus more or less flattened because of pressure of coverglass, showing perithecium with spirally arranged outer wall cells. Arrow indicates distinct outer protrusion of cell IV. KT-540. Bar = 50  $\mu\text{m}$ .

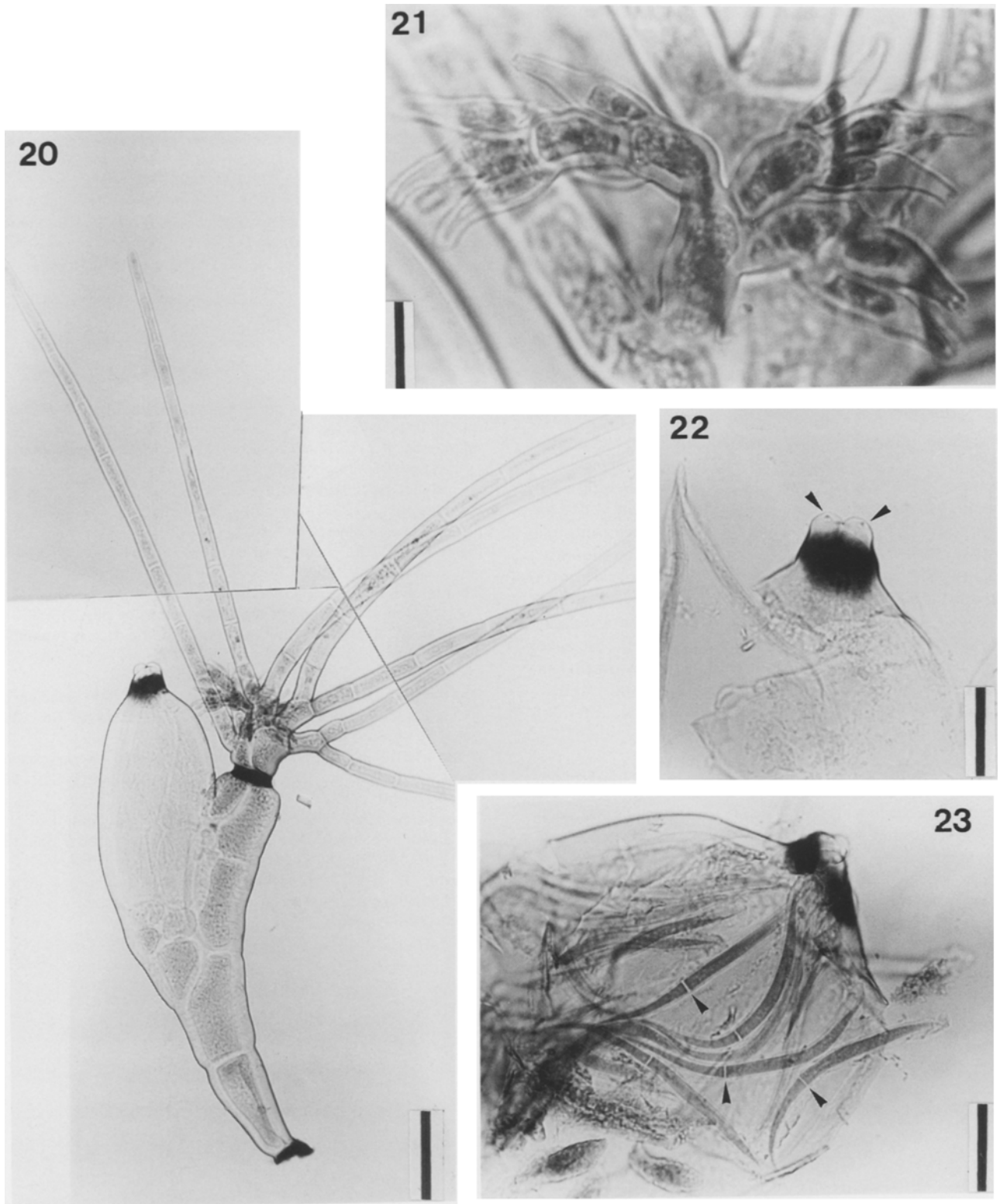
perithecial wall cells was not shown by Thaxter (1908, pl. LX, figs. 27–29). Therefore, the inner appendage and the perithecium should be checked in the type material.

The original host of *L. aristata* from the East Indies has not been identified yet, but later information provided by Terada (1976) and Sugiyama and Mochizuka (1979) indicates that the host genera of this fungus include *Colpodes* (subgen. *Loxocrepis*) and *Dicranoncus*, Platynini.

6. *Laboulbenia kwanguensis* Y.-B. Lee, Kor. J. Plant Tax. 16: 115. 1986. Type: On *Harpalus (Pseudoophonus) roninus* Bates or *H. (P.) sinicus* (Hope), Korea. Figs. 20–23

Specimens examined: On *Harpalus (Pseudoophonus) vicarius* Harold, Harpalini. KT-343, 4-IX-1974, No. 858, 17-VIII-1976, Mikasa, Hokkaido; KT-1314 (provided by M. Ishitani), 19-VIII-1995, Hutatsui, Akita.

Measurements: Total length to tip of perithecium



Figs. 20–23. *Laboulbenia kwangjuensis*.

20. Mature thallus. Outer appendage is almost crest-like in arrangement, becoming very long. Photograph is cut so that the appendage branches appear to be half their actual length. Acetocarmine staining. KT-1314. Bar=50  $\mu$ m. 21. Basal portion of appendages showing branched antheridial branchlet with apical cluster of antheridia. Acetocarmine staining. KT-1314. Bar=10  $\mu$ m. 22. Apical to subapical portion of perithecium showing bilobed posterior apex (arrowheads). Acetocarmine staining. KT-343. Bar=25  $\mu$ m. 23. Ascospores. Each arrowhead indicates submedian spore septum. Acetocarmine staining. KT-858. Bar=25  $\mu$ m.

300–310  $\mu\text{m}$ ; appendages up to 910  $\mu\text{m}$ ; perithecia 130–150  $\times$  52–62  $\mu\text{m}$ ; ascospores 70–80  $\times$  3  $\mu\text{m}$  (excluding cell wall).

This is a very beautiful and distinctive species. Thalli of the Japanese fungus are almost colorless even when they are fully mature, though Lee (1986) described the species as “hyaline, suffused with reddish brown.” The septum between cells IV and V is very oblique and does not reach cell III. The black insertion cell is located near the middle of the perithecium and is free from the perithecium. The outer appendage is composed of several long branches with a more-or-less crest-like arrangement (Fig. 20). The inner appendage is composed of two short antheridial axes; sometimes the inner basal cell bears a sterile long branch as well. The inner basal cell is smaller than the outer basal cell. Each antheridial axis is dichotomous or trichotomous and bears an apical cluster of antheridia (Fig. 21). The perithecium is more-or-less ellipsoidal, with spirally arranged outer wall cells. The spiral arrangement of outer wall cells is, however, not clearly visible in Fig. 20. The conspicuously bilobed posterior apex is always visible in lateral view (Fig. 20). The ascospores are slender and about 3  $\mu\text{m}$  in width excluding the cell wall. The position of the spore septum is slightly closer to the middle than in many other species.

In the study of the *Laboulbenia exigua* group (Terada, 1995), the narrow ascospores were photographed. However, the described measurements included the cell wall of the ascospores. For comparison, the ascospore sizes of three species in the *L. exigua* group, excluding the cell wall, are measured here: *L. exigua*, ca. 53  $\times$  2  $\mu\text{m}$ ; *L. yamadae* Ishikawa ex Terada, ca. 68  $\times$  3.5  $\mu\text{m}$ ; *L. gebleri* Terada, ca. 44  $\times$  2  $\mu\text{m}$ .

Acknowledgements—I wish to thank Dr. I. I. Tavares, University of California, Berkeley, for reviewing the manuscript and offering helpful suggestions. I also thank I. Okamoto, M. Mori, and Dr. M. Ishitani for providing me with valuable specimens. For identification of host insects, I am deeply indebted to Dr. A. Habu.

#### Literature cited

- Balazuc, J. 1982. Laboulbéniales (Ascomycètes) de Madagascar, des Comores et des Mascareignes. Bull. Mens. Soc. Linn. Soc. Bot. Lyon 51: 6–27.
- Cépède, C. and Picard, F. 1907. Observations biologiques sur les Laboulbéniales et diagnoses sommaires de quelques espèces nouvelles. Compt. Rend. 36ème session Assoc. Fr. Avanc. Sci. Reims 1907(2): 778–784.
- Cépède, C. and Picard, F. 1908. Contribution à la biologie et à la systématique des Laboulbéniales de la flore française. Bull. Sci. Fr. Belg. 42: 247–268.
- Lee, Y.-B. 1986. Taxonomy and geographical distribution of the Laboulbeniales in Asia. Kor. J. Plant Tax. 16: 89–185.
- Maire, R. 1916. Deuxième contribution à l'étude des Laboulbéniales de l'Afrique du Nord. Bull. Soc. Hist. Nat. Afrique N. 7: 6–39. Pls. 1–2.
- Majewski, T. 1994. The Laboulbeniales of Poland. Polish Bot. Stud. 7: 3–466.
- Morita, S. 1990. Notes on *Bembidion inouyei* Habu. Coleopterists' News No. 91: 1–2. (In Japanese.)
- Sugiyama, K. and Mochizuka, H. 1979. The Laboulbeniomycetes (Ascomycotina) of peninsular Malaysia. Trans. Mycol. Soc. Japan 20: 339–355.
- Tavares, I. I. 1985. Laboulbeniales (Fungi, Ascomycetes). Mycologia Memoir 9: 1–627.
- Terada, K. 1976. Some species of the Laboulbeniales from Taiwan. Trans. Mycol. Soc. Japan 17: 23–34.
- Terada, K. 1995. *Laboulbenia exigua* and related taxa (Ascomycetes, Laboulbeniales). Mycoscience 36: 293–309.
- Thaxter, R. 1892. Further additions to the North American species of Laboulbeniaceae. Proc. Amer. Acad. Arts Sci. 27: 29–45.
- Thaxter, R. 1899. Preliminary diagnoses of new species of Laboulbeniaceae. I. Proc. Amer. Acad. Arts Sci. 35: 151–209.
- Thaxter, R. 1900. Preliminary diagnoses of new species of Laboulbeniaceae. II. Proc. Amer. Acad. Arts Sci. 35: 407–450.
- Thaxter, R. 1908. Contribution toward a monograph of the Laboulbeniaceae. Part II. Mem. Amer. Acad. Arts Sci. 13: 217–469. Pls. XXVIII–LXXI.
- Thaxter, R. 1931. Contribution towards a monograph of the Laboulbeniaceae. Part V. Mem. Amer. Acad. Arts Sci. 16: 1–435. Pls. I–LX.