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# Exploration and Collection of Exobasidium Blister of Tea in Taiwan, 25th April-10th May 2005

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## Summary

We surveyed Exobasidium blister of tea at 16 locations in Taipei, Yilan, Nantou and Chiayi Counties in Taiwan and collected 56 herbarium samples from 9 areas. We obtained 8 isolates of *Exobasidium vexans*. In Taipei and Yilan Counties, all tea cultivars infected by *E. vexans* were assigned to Oolong and Tonchang (Chinese tea). In Nantou and Chiayi Counties, cultivars infected by *E. vexans* were assigned to either Oolong or the hybrid with *Camellia sinensis* var. *assamica* and *C. sinensis* var. *sinensis*. In the germination tests, additional nutrients were required for germination in Difco Czapeck medium. There is a difference in the nutrient requirements for germination of basidiospores among the origin of isolations. *Exobasidium* spp. collected from *Camellia* and *Rhododendron* spp. are examined in ITS and L-rRNA (D1/D2) regions for homology searches. These isolates show 98-100% homology with Japanese isolates. Thirteen isolates of *Exobasidium* spp. collected in Taiwan were deposited for the first time in Genebank, NIAES as a result of this exploration. These were the collections of Dr. K. Sawada in Herbarium of National Taiwan University. Twenty-four herbarium specimens of *E. vexans* and *E. reticulatum* collected in Taiwan were observed.

**Key words**: Basidiospore, *Camellia sinensis*, *Exobasidium vexans*, Germination, Taiwan

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# Introduction

Thirteen *Exobasidium* spp. have been described in Taiwan early 20th century and 7 of them were indigenous (Hsu *et al*., 2002). Culture of *Exobasidium* has been established since 1960's so there is no deposition of either the authentic isolate or one from Taiwan in ATCC, CBS and even MAFF.

Tea blister was first observed in India in 1868 and was described by Massee as *E. vexans* in 1898. History of disease communication was precisely documented elsewhere (Ezuka and Ando, 1994). *Exobasidium vexans* is the major plant pathogen for tea in the monsoon Asia (Ohishi, 2004b). There are two cultivars of *Camellia sinensis* (L.) O. Kuntze; var. *assamica* for black tea and var. *sinensis* for Chinese tea and Japanese tea (Ohishi, 2004a). On the plants of var. *sinensis*, Kawakami reported first time occurrence of tea blister in Taiwan in 1910 (Ezuka and Ando, 1994). Sawada (1919) examined morphology of the pathogen in Taiwan and identified it as *E. vexans*. He also listed 11 places of occurrence of this disease, where was famous for Oolong tea but variety of host was not noted (Sawada, 1919). First report of tea blister in Japan happened to be the same year by Horita (Ezuka and Ando, 1994). Then, this disease spread to Vietnam in 1930, Southern India and Sri Lanka in 1946, Sumatra and Java in 1949, and Malaya in 1950 (Ezuka and Ando, 1994).

However, there is a question whether Japanese isolates collected from var. *sinensis* are really the same to those from var. *assamica*. Morphology of *E. vexans* is identified as the same to pathogen of this disease. Is there any physiological differentiation on the different varieties? Comparison among several specimens is very important. But the deposited cultures in CBS and MAFF in Japan were contaminant. Data were shown from the biochemical activities and also the molecular method (Boekhout *et al*., 1995; Fell *et al.*, 1995) for CBS culture. MAFF culture was proven by the molecular method (unpublished). Japanese isolates showed very slow-growth and basidiospore production (Ezuka, 1955). However, it was replaced by contaminant now.

Recently, taxonomy of *Exobasidium* collected in Japan has morphologically and phylogenetically been revised (Nagao *et al.*, 2001, 2003a, 2003b, 2004a, 2004b). More than 80 *Exobasidium* spp. except for *E. vexans* have been isolated and cultured. Last year, Japanese isolate of *E. vexans* was successfully cultured and its molecular position was verified (AB180380). Actually, this species requires special nutrient to grow (unpublished). We wonder whether nutrient requirement is a key for culture. So we planed to compare several specimens from both vars. *assamica* and *sinensis* in the monsoon Asia.

Aim of exploration is to study tea blister pathogen, *Exobasidium vexans* and relatives in Taiwan, R. O. C. by joint teams and to share collected strains for research purposes.

# Methods and Results

## 1. Itinenary

We surveyed Exobasidium blister of tea from April 25, 2005 to May 10, 2005 in Taipei, Yilan, Nantou and Chiayi Counties (Fig.1, Table 1). We collected leaves occurring Exobasidium blister and isolated the basidiospore on the media. We occasionally collected Exobasidium diseases on *C. tunuifolia* and *Rhododendron* spp. and cultured.

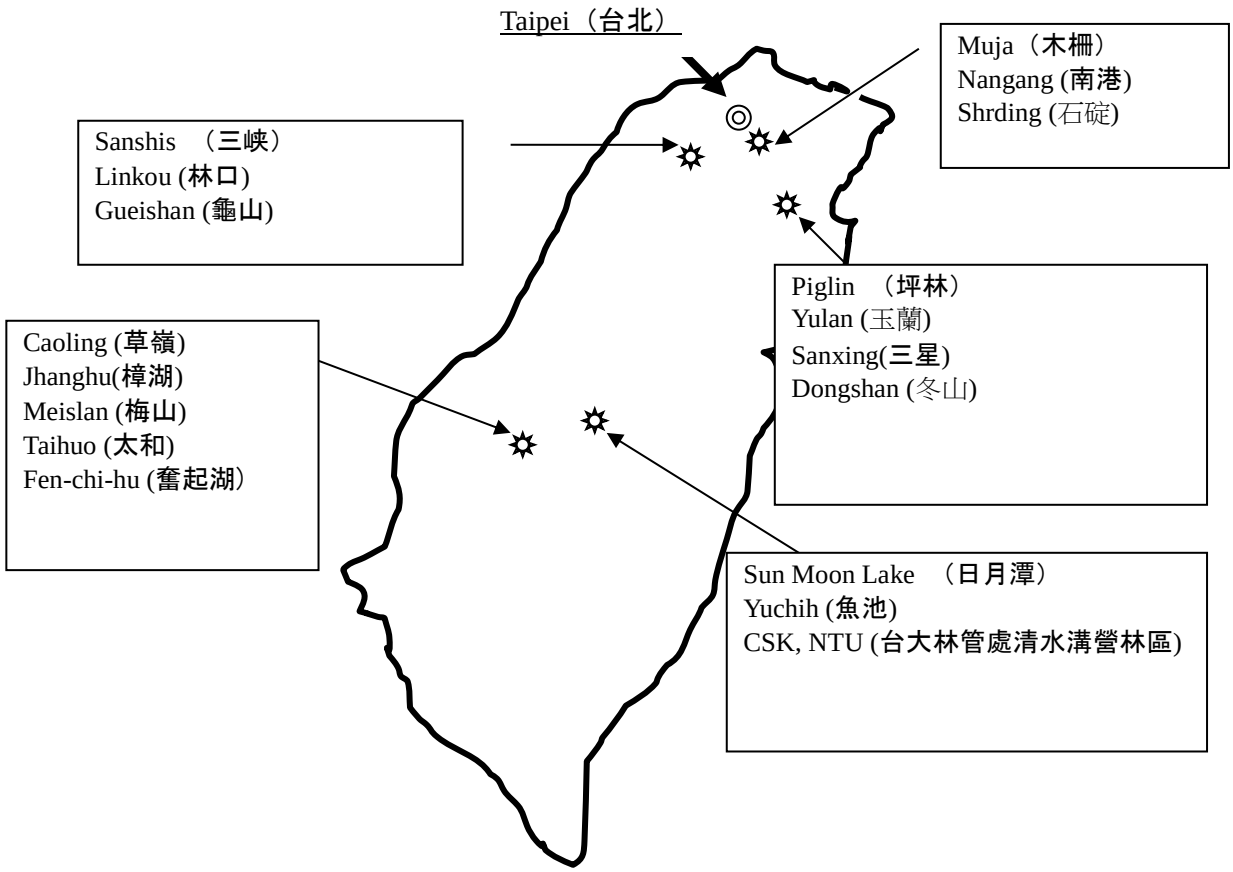


Fig. 1. Locations of exploration of *E. vexans*

Table 1. Itinerary of exploration and collection in Taiwan

| Date | Itinerary | Work |
|---|---|---|
| 27-Apr-05 | Nangang (Taipei)→Shrding (Taipei)→Muja (Taipei)→Taipei | Collection |
| 28-Apr-05 | Yulan (Yilan)→Sanxing (Yilan)→Fushan (Taipei) | Collection and moving |
| 29-Apr-05 | Fushan Botanical Garden (Taipei)→Dongshan (Yilan) | Collection |
| 1-May-05 | Yangmingshan (Taipei)→Linkou (Taipei)→Gueishan (Taoyuan) | Collection and culture |
| 2-May-05 | Formosan Aboriginal Culture Village (Nantou)→Yuchih (Nantou)→Yuchih Branch, Tea Research and Extension Station (TRES)(Nantou) | Collection and moving |
| 3-May-05 | Yuchih Branch, TRES (Nantou) →Ching-shui-kou Tract, The Experimental Forest, National Taiwan University (CSK, NTU)(Nantou) | Collection |
| 4-May-05 | CSK, NTU (Nantou) →Shitou Forest Amusement Park (Nantou)→Caoling (草嶺) | Collection |
| 5-May-05 | Caoling (草嶺)→Jhanghu (樟湖)→Meishan (Chiayi)→Taihuo (太和)→Fen-chi-hu (Chiayi) | Collection and moving |
| 6-May-05 | Fen-chi-hu →Leyecun Village, Alishan Township (阿里山鄉樂野村)→Alishan (Chiayi)→Taipei | Collection and moving |

## 2. Morphology of *E. vexans*

Fresh specimens collected in the field were used for morphological observations. Morphological observations were conducted by light microscopy (LM). The basidia, basidiospores and conidia were torn from hymenia by adhesive tape cut in 5mm square. This tape was sealed with coverslip using Canadian balsam solution. 0.01% (w/v) lacto-phenol Cotton blue solution was added to mounting fluid for LM observations.

Morphology of basidiospores was examined (Table 2). Length and width of basidiospores from collected samples were in the same range. Shape of basidiospores was ovoid to obovoid with a septum. Morphology of basidiospores from collected samples was similar to the description.

Table 2. Morphology of *Exobasidium vexans*

| Isolate | Location | Host (*Camellia sinensis*) | Length × width ($\mu$ m). | No. septum |
|---|---|---|---|---|
| 503 | Shirding, Taipei | var. *sinensis* | 9-13 × 3-4 | 1 |
| 507 | Yulan, Yilan | var. *sinensis* (Oolong) | 9-15 × 3.5-6 | 1 |
| 508 | Yulan, Yilan | var. *sinensis* (Wu-yi) | 9-14 × 3-4 | 1 |
| 509 | Yulan, Yilan | var. *sinensis* | 9-14 × 3-5 | 1 |
| 510 | Sanxing, Yilan | var. *sinensis* (Qin-xin Oolong) | 8-14 × 3-4 | (0)-1 |
| 526 | Yuchih, Nantou | Hybrid (TTES[1] No.18) | 11-15 × 3-5 | 1 |
| 529 | Yuchi Br., TRES., Nantou | Hybrid[2] | 8-13 × 3-4 | 1 |
| 531 | Yuchi Br., TRES., Nantou | Hybrid[2] | 10-13 × 3-4 | (0)-1 |
| 532 | Yuchi Br., TRES., Nantou | Hybrid[2] | 8-12 × 3-4 | 1 |
| 533 | Yuchi Br., TRES., Nantou | Hybrid[2] | 9-13 × 3-4 | 1 |

Note: 1: "TTES" was the mean of "Taiwan Tea Experiment Station's germplasm number".
2. Hybrid: *Camellia sinensis* var. *assamica* × var. *sinensis* (belong to large-leaf-type tea).

## 3. Germination of basidiospores

Germination of basidiospores was also examined according to Graafland (1960) and Sundström (1964). Three kinds of nutrient were separately added to Difco Potato Dextrose Agar (PDA) for *E. vexans*. Hereafter, the media were tentatively called medium 1, medium 2 and medium 3. Germination of basidiospores was observed everyday. Microscopic examination of germination was followed as described before (Nagao *et al.*, 2003a). A half of specimens were deposited in the herbarium of the National Institute of Agro-Environmental Sciences, Tsukuba, Ibaraki, Japan (NIAES) (Appendix I).

Mode of germination of basidiospores of *E. vexans* was by germ-tube. Three modes of germination of basidiospores were observed and described as follows. 1. Basidiospores germinated, and then conidia and chlamydospores formed (Fig 2, A & B). 2. Basidiospores slightly germinated then stopped growing the hyphae (Fig 2, C & D). 3. Basidospores partly germinated (Fig 2, E& F). Results of germination depended on the material and also the supplemental medium (Table 3). All materials of *E. vexans* grew on medium 2 as well as formed conidia and chlamydospores. According to results of germination and growth activities on another supplemental media, these isolates assigned into 3 groups. Group 1; basidiospores grew well, conidiated sometime, and formed chlamydospores on Medium 2. However, basidiospores did not germinate on Media 1 and 3. Isolates 510, 533 and 547 were assigned. These isolates were originated from both varieties. Group 2; some basidiospores grew well, conidiated sometime, and formed chlamydospores on Medium 1. However, basidiospores did not germinate on Medium 3. Only isolates 503 was assigned. This isolate was originated from var. *sinensis*. Group 3; basidiospores just formed germ tube or simple hyphae on Medium 1. Neither conidiation nor formation of chlamydospore was observed. Growth on Media 3 was dependent on the materials. Isolate 507, 508, 509, 526, 529, 531 and 532 were assigned and these isolates were originated from both cultivars. The rest of specimens of *E. vexans* which were not assigned were owing

to no basidiospores falling on the medium.

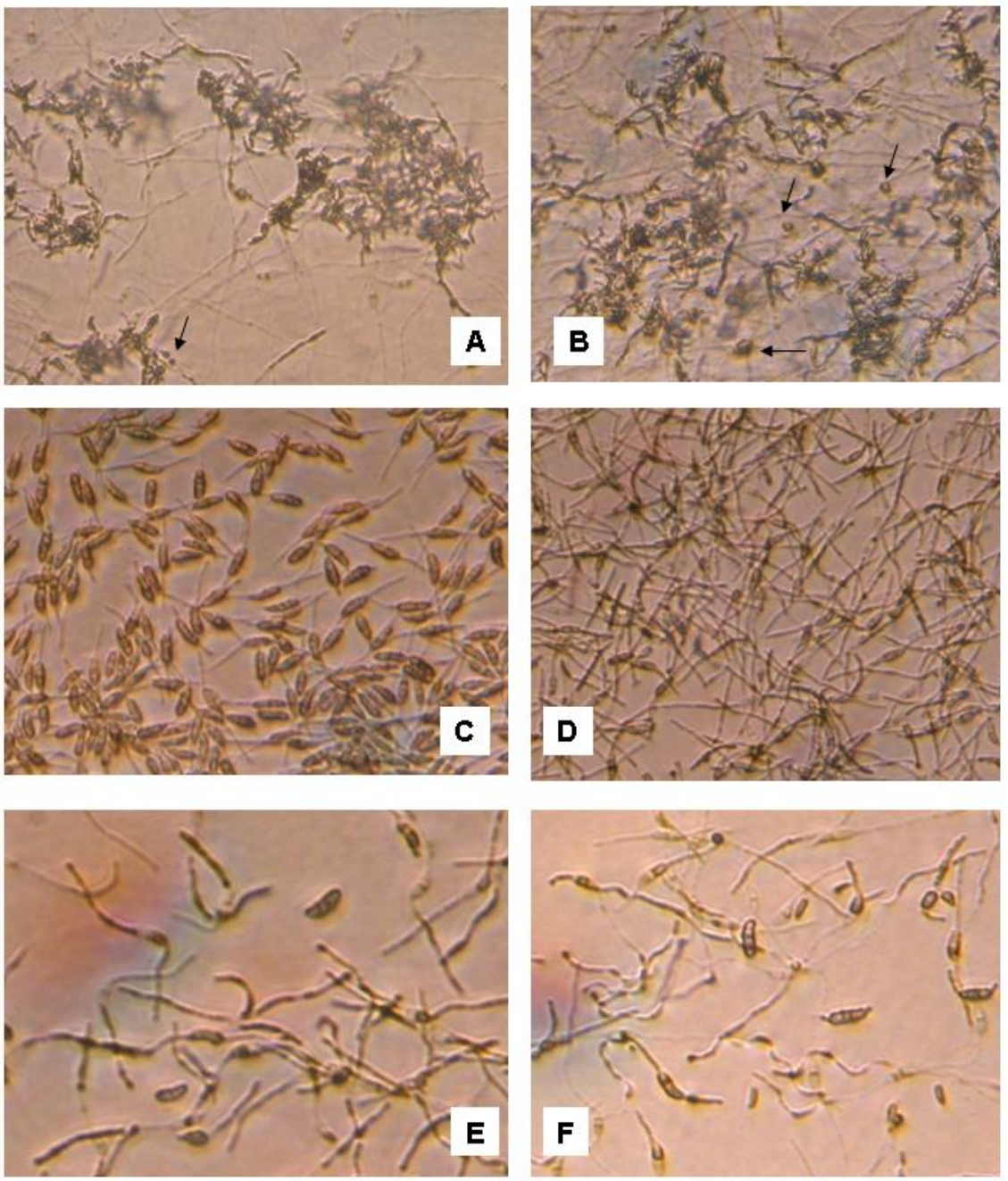


Fig. 2. Several germination patterns of *Exobasidium vexans* on three different media. A (507), B (508); Basidiopsores germinated, and condia and chlamydospores (arrowed) formed. C (507), D (529); Basidiospores slightly germinated then stopped growing the hyphae. E (531), F (532); Basidiospores partly germinated.

Table 3. Germination test of *Exobasidium vexans* on different media

| Sampling No. | Group | Spore falling | Result of germination | | |
|---|---|---|---|---|---|
| | | | Medium 1 | Medium 2 | Medium 3 |
| 503 | II | Yes | Germinated (Partly chlamydospores formed) | Germinated (Conidiation; Chlamydospores formed) | No germination |
| 507 | III | Yes | Germinated (Only germtubes; no branching) | Germinated (Conidiation; Chlamydospores formed) | Germinated (Slightly germinated but only germtubes) |
| 508 | III | Yes | Germinated (No conidiation) | Germinated (Conidiation; Chlamydospores formed) | No germination |
| 509 | III | Yes | Partly germinated | Germinated (Conidiation; Chlamydospores formed) | No germination |
| 510 | I | Yes | No germination | Germinated (Conidiation; Chlamydospores formed) | No germination |
| 526 | III | Yes | Slightly germinated (24-36μm length of germtube) | Germinated (Conidiation) | No germination |
| 529 | III | Yes | Slightly germinated (12-24μm length of germtube) | Germinated (Conidiation) | Partly germinated (7.2% of germination) |
| 531 | III | Yes | Germinated (12-24μm length of germtube) | Germinated (Conidiation) | No germination |
| 532 | III | Yes | Germinated (<24μm length of germtube) | Germinated (Conidiation) | No germination |
| 533 | I | Yes | No germination | Germinated (Conidiation) | No germination |
| 547 | I | Yes | NT[1] | Germinated | NT |

Note: 1. "NT" meant that the result didn't record owing to contamination.

## 4. Culture of basidiospore isolate

Leaves with lesion were cut into the small pieces about 5 mm square and were fixed with about 10 mm square water agar block to the inside of the lid of a sterile Petri dish, poured with each supplemental medium (medium 1, medium 2 and medium 3) acidified with 10 % (v/v) lactic acid for *E. vexans*. The dish was kept at room temperature under dark. Basidiospores then fell down from the hymenium onto the agar surface. After microscopic examination through the bottom of the Petri dish, the mass of basidiospores was transferred to new each supplemental media to grow. Cultural method for other *Exobasidium* spp. was followed as previously reported (Nagao *et al*., 2003a). Then well growing colonies were selected among these colonies and stored on home-made PDA slants as the representative strains. Cultures were kept in the Department of Plant Pathology, National Taiwan University and also deposited in Genebank, National Institute of Agrobiological Sciences, Japan (MAFF) (Appendix I).

Eight isolates finally grew well. Appearance of colonies of *E. vexans* was yellowish white to offwhite, slow-growing, fragile, and wet (Fig.3). Appearance of *E. vexans* is similar to that of *E. reticulatum* but the later shows dark reddish to brown pigment on the medium. Colonies of *E. vexans* was not yeast-like growth as seen in those of *E. camelliae* and *E. gracile* infected on *Camellia* spp. There were 4 isolates from var. *sinensis* and also 4 from hybrid of var. *assamica* and var. *sinensis*. Appearance of colonies looked like the same despite the origins of *E. vexans* that isolated from different tea cultivars (Fig.3).

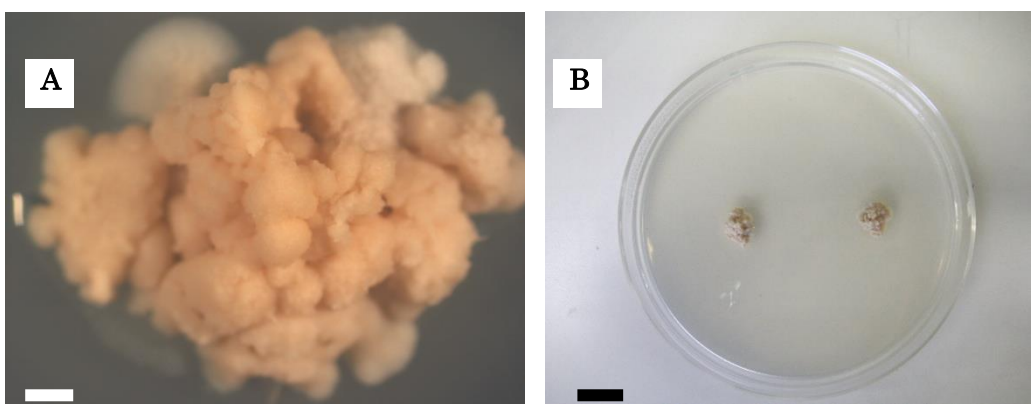


Fig. 3. A. Colony of *E. vexans* MAFF 239976. B. Growth on medium after 85 days of incubation. Bar A:1 mm, B: 10 mm.

## 5. Homology search of isolates

*Exobasidium* can be cultivated on the media. This anamorphic stage does not have particular conidia which can be useful for identification of this genus. Some of *Exobasidium* grow and form slimy colony as well as yeast but most of *Exobasidium* grow and form mycelial colony with pseudohypha and conidia. Even if one observed the piece of colony by microscope, there was no significant characteristic to identify Genus *Exobasidium*. For this reason, it is quite difficult to determine whether culture obtained is truly from *Exobasidium* or not. We tried the molecular identification to compare the cultures obtained in this exploration with the known Japanese *E. vexans*. We also examined the cultures from *Rhododendron* spp. and *C. tenuifolia*. Protocol of analysis followed to Takeuchi and Nagao (2004).

Eight *E. vexans* were examined in L-rRNA (D1/D2) regions for homology searches (Table 4). These isolates show 97-100% homology with Japanese isolate. *Exobasidium* spp. collected from *Camellia* and *Rhododendron* spp. are examined in ITS and L-rRNA (D1/D2) regions for homology searches. Five isolates show 98-100% homology with Japanese isolates. Regretfully 7 isolates were contaminated with basidiomycetous yeasts and were excluded from our collections.

Table 4. Results of morphological and molecular identification of *Exobasidium* spp

| NIAES No. | MAFF No. | Sampling No. | Host plant[1] | Morphological identification | Moleculara identification by ITS region | Homology (%) | ITS acces. No. | Moleculara identification by D1/D2 region | Homology (%) | DD accession No. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1461004 | 239976 | 503 | *C.sinensis* var. *sinensis* | *E. vexans* | | | | *E. vexans* | 99 | AB262783 |
| 1461005 | 239977 | 504 | *R.* × *pulchlum*<br>*R.* × *mucronatum* (Blume) G. Don ? | *Exobasidium* sp. | *Exobasidium* sp. MAFF238592 | 97 | AB2627 97 | *E. shiraianum* (AF487395)<br>*E. japonicum* | 99 | AB262782 |
| 1461006 | 239978 | 505 | *C. tenuifolia* (Hay.) Cohen-Stourt. | *E. camelliae-oleifera* | *E. gracile* | 99 | AB2627 98 | *E. miyabei*<br>*E. gracile* | 100<br>100 | AB262794 |
| 1461008 | 239979 | 507 | *C. sinensis* var. *sinensis* Oolong | *E. vexans* | | | | *E. vexans* | 98 | AB262784 |
| 1461009 | 239980 | 508 | *C. sinensis* var. *sinensis* Wu-yi | *E. vexans* | | | | *E. vexans* | 97 | AB262785 |
| 1461011 | 239981 | 510 | *C. sinensis* var. *sinensis* Qin-xin Oolong | *E. vexans* | | | | *E. vexans* | 100 | AB262786 |
| 1461014 | 239982 | 513 | *R. rubropilosum* Hayata var. *rubropilosum* | *Exobasidium* sp. | *E. japonicum* | 99 | AB2627 99 | *E. shiraianum* (AF487395)<br>*E. japonicum* | 99<br>99 | AB262795 |
| 1461015 | 239983 | 514 | *R. simsii* | *Exobasidium* sp. | *Exobasidium* sp. MAFF238592 | 100 | AB2628 00 | *E.woronichini i E. japonicum* | 99<br>98 | AB262796 |
| 1461024 | 239984 | 523 | *R. oldhamii* Maxim. | *E. formosanom* Sawada | *Exobasidium* sp. MAFF238592 | 98 | AB2628 01 | *E.woronichini i E. japonicum* | 99<br>99 | AB264780 |

Note: 1. The abbreviation of host names: *C.*: *Camellia*; *R.*: *Rhododendron*.

## 6. Herbarium studies of Dr. K. Sawada's collection

There are collections of Dr. K. Sawada in Herbarium of National Taiwan University. Twenty-four herbarium specimens of *E. vexans* and *E. reticulatum* collected in Taiwan were observed.

Yuchih Black Tea Experiment Substation was established in 1936.This station aimed to be the center of Assam tea experiment in Taiwan. Many hybrid cultivars were bred. Prior to establishment of this station, Dr. Sawada has collected 2 samples of Tea blister on *C. sinensis* var. *assamica* in Kaosiung (Table 5). So Tea blister has been regarded as a common disease on tea in that time.

There were many specimens of *E. reticulatum*. As he and Prof. S. Ito described this pathogen, it was reasonable to find out many specimens all over Taiwan. Although net blister blight by *E. reticulatum* were collected as well as tea blister by *E. vexans* from 1910's to 1930's, few net blister blight is found at present. In our exploration, we could not find it, either.

Table 5. List of Herbarium collection of Dr. K. Sawada in National Taiwan University

| Date of collection | Place of collection | | Pathogen | Host plant* |
|---|---|---|---|---|
| VI 1911 | Shizuoka | 静岡 | *E. reticulatum* | *Thea sinensis* |
| IV 1912 | Taipei | 台北 | *E. reticulatum* | *Thea sinensis* |
| XI 19, 1923 | Taipei | 台北・蟾蜍山 | *E. vexans* | *Thea sinensis* |
| XI 19, 1923 | Taipei | 台北・蟾蜍山 | *E. reticulatum* | *Thea sinensis* |
| XII 15, 1923 | Judung, Hsinchu | 新竹・竹東 | *E. reticulatum* | *Thea sinensis* |
| IV 12, 1924 | Shenkeng, Taipei | 台北州深坑 | *E. reticulatum* | *Thea sinensis* |
| V 31, 1924 | Beitou, Taipei | 北投 | *E. vexans* | *Thea sinensis* |
| X 13, 1924 | Shizuoka | 静岡市 | *E. vexans* | *Thea sinensis* |
| II 20, 1927 | Dashe, Kaosiung | 高雄州大社 | *E. vexans* | *Thea assamica* |
| X 10, 1927 | Caoshan | 草山 | *E. vexans* | *Thea sinensis* |
| IV 14, 1928 | Danshuei, Taipei | 淡水 | *E. vexans* | *Thea sinensis* |
| IV 14, 1929 | Keelung | 基隆 | *E. vexans* | *Thea sinensis* |
| IV 15, 1929 | Keelung | 基隆 | *E. reticulatum* | *Thea sinensis* |
| IV 17, 1929 | Pingjhen | 平鎮 | *E. reticulatum* | *Thea sinensis* （青心柱） |
| IV 17, 1929 | Pingjhen | 平鎮 | *E. reticulatum* | *Thea sinensis* （野生茶） |

(*Continued*)

| | | | | |
|---|---|---|---|---|
| XII 3, 1929 | Guanshi, Hsinchu | 新竹州関西 | *E. reticulatum* | *Thea sinensis* |
| IV 20, 1930 | Tutanshan, Wunshan | 文山郡塗潭山 | *E. vexans* | *Thea sinensis* |
| XI 30, 1930 | Danshan | 単山 | *E. vexans* | *Thea sinensis* |
| XII 13, 1930 | Guanshi, Hsinchu | 新竹州関西庄 | *E. reticulatum* | *Thea sinensis* |
| IV 23, 1931 | Dashe, Kaosiung | 高雄州大社 | *E. vexans* | *Thea assamica* (cult.) |
| V 15, 1933 | Taipei | 台北州直潭 | *E. vexans* | *Thea sinensis* |
| VII 10, 1933 | Shindian, Taipei | 台北州新店 | *E. vexans* | *Thea sinensis* |
| VII 2, 1935 | Muja, Taipei | 台北州木柵 | *E. reticulatum* | *Thea sinensis* |
| XII 2, 1939 | Muja, Taipei | 台北州木柵 | *E. vexans* | *Thea sinensis* |

*Scientific name was followed to the original description of specimen cover.

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# 台灣地區茶餅病菌 *Exobasidium vexans* 之調查紀錄 (2005 年 4 月 25 日~5 月 10 日)

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## 摘 要

於台灣地區台北縣、宜蘭縣、南投縣和嘉義縣等 16 處茶產區採集茶樹餅病之標本，其中於 9 處茶產區共採集 56 份茶樹餅病標本，並分離出 8 個茶樹餅病菌分離株。調查研究顯示，茶樹餅病菌擔孢子在 Czapeck 培養基上萌發需添加特殊的營養成分，且在不同分離株間擔孢子萌發所需的養分仍有差異性。此外，將茶樹和杜鵑花上分離到的外擔子病菌進行 ITS 和 L-rRNA (D1/D2)之序列同源性分析，結果顯示台灣地區的外擔子菌分離株和日本地區的分離株具有 98%-100%的序列相似度。台灣地區早期紀錄有 13 種外擔子菌，其中澤田兼吉先生採集的外擔子菌腊葉標本保存於台灣大學植物病理與微生物學系標本館，此趟旅程共檢視 24 份茶樹餅病菌和茶樹網餅病菌之腊葉標本。

**關鍵字：**擔孢子、茶樹、茶餅病菌、孢子萌發、台灣

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Appendix I. *Exobasidium* spp. collected from Taiwan

| NIAES No. | MAFF No. | Sampling No. | Date of sampling | Place | Host plant[1] | Morphological identification |
|---|---|---|---|---|---|---|
| 1461001 | - | 500 | 26 Apr., 2005 | Nangang, Taipei | *R.* × *pulchlum* Sweet | *Ovulinia* |
| 1461002 | - | 501 | 26 Apr., 2005 | Nangang, Taipei | *R.* × *pulchlum* | *Exobasidium* sp. |
| 1461003 | - | 502 | 26 Apr., 2005 | Shirding, Taipei | *C.sinensis* (L.) O. Kuntze var. *sinensis* | *Exobasidium* sp. |
| 1461004 | 239976 | 503 | 26 Apr., 2005 | Shirding, Taipei | *C.sinensis* var. *sinensis* | *E. vexans* |
| 1461005 | 239977 | 504 | 26 Apr., 2005 | Muja, Taipei | *R.* × *pulchlum* *R.* × *mucronatum* (Blume) G. Don ? | *Exobasidium* sp. |
| 1461006 | 239978 | 505 | 26 Apr., 2005 | Muja, Taipei 彰山寺 | *C. tenuifolia* (Hay.) Cohen-Stourt. | *E. camelliae-oleiferae* |
| 1461007 | - | 506 | 27 Apr., 2005 | Shirding, Taipei | *Salix* sp. | rust |
| 1461008 | 239979 | 507 | 28 Apr., 2005 | Yulan, Yilan | *C. sinensis* var. sinensis Oolong | *E. vexans* |
| 1461009 | 239980 | 508 | 28 Apr., 2005 | Yulan, Yilan | *C. sinensis* var. *sinensis* Wu-yi | *E. vexans* |
| 1461010 | - | 509 | 28 Apr., 2005 | Yulan, Yilan | *C. sinensis* var. *sinensis* | *E. vexans* |
| 1461011 | 239981 | 510 | 28 Apr., 2005 | Sanxing, Yilan | *C. sinensis* var. *sinensis* Qin-xin Oolong | *E. vexans* |
| 1461012 | - | 511 | 28 Apr., 2005 | Sanxing, Yilan | Polygonaceae | smut |
| 1461013 | - | 512 | 29 Apr., 2005 | Fushan Botanical Garden, Taipei | *R. simsii* Planch. | *Exobasidium* sp. |
| 1461014 | 239982 | 513 | 29 Apr., 2005 | Fushan Botanical Garden, Taipei | *R. rubropilosum* Hayata var. *rubropilosum* | *Exobasidium* sp. |
| 1461015 | 239983 | 514 | 29 Apr., 2005 | Fushan Botanical Garden, Taipei | *R. simsii* | *Exobasidium* sp. |
| 1461016 | - | 515 | 29 Apr., 2005 | Fushan Botanical Garden, Taipei | *Rhododendron* sp. | *Exobasidium* sp. |
| 1461017 | - | 516 | 29 Apr., 2005 | Fushan Botanical Garden, Taipei | *R. rubropilosum* var. *rubropilosum* | *Exobasidium* sp. |
| 1461018 | - | 517 | 29 Apr., 2005 | Dungshan, Yilan | *C. sinensis* var. *sinensis* | *E. vexans* |
| 1461019 | - | 518 | 1 May, 2005 | Yangmingshan, Taipei | *R.* × *pulchlum* | *Exobasidium* sp. |
| 1461020 | - | 519 | 1 May, 2005 | Yangmingshan, Taipei | *R. indicum* | *Exobasidium* sp. |
| 1461021 | - | 520 | 1 May, 2005 | Yangmingshan, Taipei | *R. indicum* | *Exobasidium* sp. |
| 1461022 | - | 521 | 1 May, 2005 | Yangmingshan, Taipei | *R. indicum* | *Exobasidium* sp. |
| 1461023 | - | 522 | 1 May, 2005 | Yangmingshan, Taipei | *R. indicum* | *Exobasidium* sp. |

(*Continued*)

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|---|---|---|---|---|---|---|
| 1461024 | 239984 | 523 | 1 May, 2005 | Yangmingshan, Taipei | *R. oldhamii* Maxim. | *E. formosanom* Sawada |
| 1461025 | - | ~~524~~ | 2 May, 2005 | Nantou | *R. obtusum* var. *obtusum* | *Exobasidium* sp. |
| 1461026 | - | ~~525~~ | 2 May, 2005 | Nantou | *R. scabrum* | *Exobasidium* sp. |
| 1461027 | 239985 | 526 | 2 May, 2005 | Yuchi, Nantou | *C. sinensis* Hybrid | *E. vexans* |
| 1461028 | - | ~~527~~ | 3 May, 2005 | Yuchih Br., TRES, Nantou | Bamboo | |
| 1461029 | - | 528 | 3 May, 2005 | Yuchih Br., TRES, Nantou | *C. sinensis* Hybrid | *E. vexans* |
| 1461030 | - | 529 | 3 May, 2005 | Yuchih Br., TRES, Nantou | *C. sinensis* Hybrid | *E. vexans* |
| 1461031 | - | 530 | 3 May, 2005 | Yuchih Br., TRES, Nantou | *C. sinensis* Hybrid | *E. vexans* |
| 1461032 | 239986 | 531 | 3 May, 2005 | Yuchih Br., TRES, Nantou | *C. sinensis* Hybrid | *E. vexans* |
| 1461033 | - | 532 | 3 May, 2005 | Yuchih Br., TRES, Nantou | *C. sinensis* Hybrid | *E. vexans* |
| 1461034 | - | 533 | 3 May, 2005 | Yuchih Br., TRES, Nantou | *C. sinensis* Hybrid | *E. vexans* |
| 1461035 | - | 534 | 3 May, 2005 | Yuchih Br., TRES, Nantou | *C. sinensis* Hybrid | *E. vexans* |
| 1461036 | - | 535 | 4 May, 2005 | CSK, NTU, Nantou | *C. sinensis* var. *sinensis* Oolong | *E. vexans* |
| 1461037 | - | 536 | 4 May, 2005 | CSK, NTU, Nantou | *C. sinensis* var. *sinensis* Oolong | *E. vexans* |
| 1461038 | - | 537 | 4 May, 2005 | CSK, NTU, Nantou | *R.* × *pulchlum* | *Exobasidium* sp. |
| 1461039 | 239987 | 538 | 4 May, 2005 | CSK, NTU, Nantou | *C. sinensis* var. *sinensis* Oolong 台茶 12 號(金萱) | *E. vexans* |
| 1461040 | - | 539 | 4 May, 2005 | CSK, NTU, Nantou | Polygonaceae | smut |
| 1461041 | - | ~~540~~ | 4 May, 2005 | Shitou FAP, Nantou | *R.* × *pulchlum* | *Exobasidium* sp. |
| 1461042 | - | ~~541~~ | 4 May, 2005 | Shitou FAP, Nantou | *R. scabrum* | *Exobasidium* sp. |
| 1461043 | - | 542 | 4 May, 2005 | Shitou FAP, Nantou | *R. indicum* | *Exobasidium* sp. |
| 1461044 | - | 543 | 4 May, 2005 | Shitou FAP, Nantou | *Gordonia* | (immature) |
| 1461045 | - | ~~544~~ | 4 May, 2005 | Shitou FAP, Nantou | *R.* × *mucronatum* 'Akemono' | *Exobasidium* sp. |
| 1461046 | - | 545 | 4 May, 2005 | Shitou FAP, Nantou | *R. indicum* | *Exobasidium* sp. |
| 1461047 | - | 546 | 4 May, 2005 | Shitou FAP, Nantou | *R. indicum* | *Exobasidium* sp. |
| 1461048 | 239988 | 547 | 4 May, 2005 | CSK, NTU, Nantou | *C. sinensis* Hybrid | *E. vexans* |
| 1461049 | - | ~~548~~ | 4 May, 2005 | Nantou | *R.* × *pulchlum* | *Exobasidium* sp. |

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|---|---|---|---|---|---|---|
| 1461050 | - | 549 | 4 May, 2005 | Fen-chi-hu, Zhu-ai, Chiayi | *R. kanehirae* Wilson | *Exobasidium* sp. |
| 1461051 | - | 550 | 4 May, 2005 | Fen-chi-hu, Zhu-ai, Chiayi | *R. kanehirae* | *Exobasidium* sp. |
| 1461052 | - | 551 | 4 May, 2005 | Fen-chi-hu, Zhu-ai, Chiayi | *R. kanehirae* | *Exobasidium* sp. |
| 1461053 | - | 552 | 4 May, 2005 | Fen-chi-hu, Zhu-ai, Chiayi | *P. domestica* | *Taphrina deformans* |
| 1461054 | - | 553 | 4 May, 2005 | Fen-chi-hu, Zhu-ai, Chiayi | *P. domestica* | *T. deformans* |
| 1461055 | - | 554 | 4 May, 2005 | Alishan, Chiayi | Bamboo | |

Note: 1. The abbreviation of host names: *C.*: *Camellia*; *P.*: *Prunus*; *R.*: *Rhododendron*.

2. NIAES No.: The specimen's number was deposited in the herbarium of the National Institute of Agro-Environmental Sciences, Tsukuba, Ibaraki, Japan.

3. MAFF No.: The isolate number was deposited in the Genebank, National Institute of Agrobiological Sciences, Japan.