Witches' Brooms of Some Conifers in Japan

By

Kazuo ITÔ* and Taketo HAMA**

Closely grouped clusters of fine slender branches are frequently produced on various woody plants. In Japan, these broom-like clusters are called "tengu's nests", which are applied to these formations by the superstitious people of Asia, who supposed them to be rest-houses of a "tengu", a long-nosed goblin. The Japanese name, "tengu's nest", may be more quaint than the English name, "witches' broom", or the German name, "Hexenbesen".

Since about the end of the nineteenth century, witches' brooms on coniferous trees have been reported by many European and American workers. Several contributions to the subject were also made by Japanese pathologists.

Witches' brooms on conifers are frequently observed in natural forests as well as in plantations of Japan. The authors, being much interested to this excrescent phenomenon, have paid particular attention to it and gathered numerous materials for study. It is the purpose of this paper to give a summary of the results of the authors' observations on the witches' brooms of Japanese conifers, and to give an outline of the reports on this subject made hitherto by earlier workers.

Some of the photographs used in this paper were taken by Mr. K. KATÔ, of Kanagawa Forest Service Station, Mr. Y. MOMOSÉ, of Nagano Branch of Kantô Forest-Tree Breeding Station, Mr. T. KOBAYASHI, of the Government Forest Experiment Station, and Mr. K. ONO, of Hokkaido Branch of the Government Forest Experiment Station. The authors take pleasure in making acknowledgment to these gentlemen for their kind cooperation.

Yellow witches' broom of *Abies* caused by *Melampsorella caryophyllacearum* SCHROET

Melampsorella caryophyllacearum SCHROET (*M. cerastii* WINT., *M. elatina* ARTHUR, *Aecidium elatinum* ALB. et SCHW.) has a wide distribution in Europe, North America and Northern Asia (FRANK 1880[5], TUBEUF 1895[35], 1930[44], ARTHUR 1929[1], BOYCE 1948[4], MIELKE 1957[26], YOSHINAGA 1904[48], HARA 1925[14], KAMEI 1959[21]). From the records of collections it appears to be widely distributed throughout Japan.

As the hosts (0, I) of the fungus, various kinds of firs are known in Japan as follows: *Abies firma* SIEB. et ZUCC. (momi), *A. homolepis* SIEB. et ZUCC. (urajiro-momi), *A. mariesii* MAST. (aomori-todo-matsu), *A. mayriana* MIYABE et KUDO (todo-matsu), *A. sachalinensis* MAST. (aka-todo-matsu) and *A. veitchii* LINDL. (shirabe). The following plant species belonging to the family Caryophyllaceae are listed as the alternate hosts (II, III) of the organism in Japan: *Cerastium ciliatum* TURCZ. (*C. alpinum* var. *beeringianum* REGEL) (takane-miminagusa), *C. schizopetalum* MAXIM. (miminagusa), *Stellaria fenzlii* REGEL (*S. yezoensis* MAXIM.) (ezo-hakobe), *S. media* CYR. (hakobe), *S. nipponica* OHWI (*S. florida* var. *angustifolia* MAXIM.)

* The Government Forest Experiment Station, Meguro, Tokyo, Japan.

** Kiso Sub-branch of the Government Forest Experiment Station, Fukushima, Nagano, Japan.

(iwa-tsumekusa), and *S. radians* L. (ezo-ôyama-hakobe) (S. Itô 1938[20]).

The fungus is perennial in the tissue of woody host. The most conspicuous symptoms of the disease caused by the fungus are branch proliferations, which produce annual crops of yellow needles. Other symptoms are branch and trunk swellings and cankers (Figs. 1～6). Aecidia of the fungus are formed on the under surface of the needle in spring (Figs. 7～9). The disease occurs not only on old trees but also on saplings.

According to Boyce (1961)[4], in North America the damage from the disease to individual trees is generally not severe, because the trunk is not often involved, and usually there are not more than one or two brooms on the branches, so that infected trees seem to grow as rapidly as sound ones. Recently, Peterson (1963)[28] has reported the same opinion that the fir broom rust appeared to have little effect on growth rates, perhaps because sampled infections were young. However, in Europe, it has been generally believed that heavy infection of the disease causes remarkable decrease in growth rate and often death of the trees.

During recent years, *Abies firma* and *A. homolepis* have been of increasing importance in the subalpine afforestation, and the witches' broom that causes severe damage to young trees has become the major disease of these firs in Japan (Hama 1964[13]).

Witches' broom of *Larix leptolepis* Gordon

Since the first record made by Itô and Chiba (1957)[19], a great number of witches' brooms on *Larix leptolepis*, Japanese larch, have been found in the following many districts of Japan: Higashi-iida, Ôita Pref., August 1957, by Y. Nagano; Mt. Fuji, Yamanashi Pref., September 1957, by O. Chiba; Tateshina, Nagano Pref., October 1957, by T. Hama; Narusawa, Yamanashi Pref., 1958, by T. Hama; Naka-shibetsu, Hokkaido, September 1960, by K. Ono; Tsumagoi, Gunma Pref., February 1962, by Y. Momosé; Takatô, Nagano Pref., May 1962, by T. Hama; Komoro, Nagano Pref., September 1962, by K. Itô; Mt. Yatsugatake, Nagano Pref., October 1962, by T. Hama.

As mentioned above, the disease appears to be widely distributed throughout Japan.

The brooms generally occur on the lower or median portion of the crown. In one case, a compact, rounded broom occupying the lower median portion of the crown, was several meters in diameter. In such examples the large, compact mass of limbs composing the broom contrasted markedly with the thin foliage of the tops of the trees. Less conspicuous brooms occur on the other Japanese larch, radially disposed round the trunk, but occasionally present on the end of a limb (Figs. 10～11).

It is typical of the materials inspected in that their internodes are shortened, leaves are spaced more closely, the whole presenting stouter appearances than normal branches (Figs. 12～14).

Since the brooming disease could not be attributed to the presence of a visible pathogen, the next logical step was to determine the transmissibility of the disease. In order to make clear whether the disease is transmissible or not, some grafting experiments were done by Momosé. Diseased scions were obtained from the apical portion of the broomed branches of about 80-year-old Japanese larch (Fig. 15). The seedling stocks used in the experiments were 3-year-old and 10-year-old, respectively. All the scions were dormant and the grafting was done in the spring of 1962. All of the grafted scions grew and showed the symptoms of

Fig. 1. A witches' broom caused by *Melampsorella caryophyllacearum* on *Abies homolepis* (6-year-old). Yabuhara, Nagano. August 1963.

Fig. 2. A witches' broom on *Abies veitchii* (about 70-year-old) caused by *Melampsorella caryophyllacearum*. Mt. Yatsugatake, Nagano. August 1963.

Figs. 3～4. Initial stage of a witches' broom on *Abies homolepis* caused by *Melampsorella caryophyllacearum*. Narusawa, Yamanashi. August 1950.
—Upper Surface (Fig. 3 ; left) and under surface (Fig. 4 ; right)—

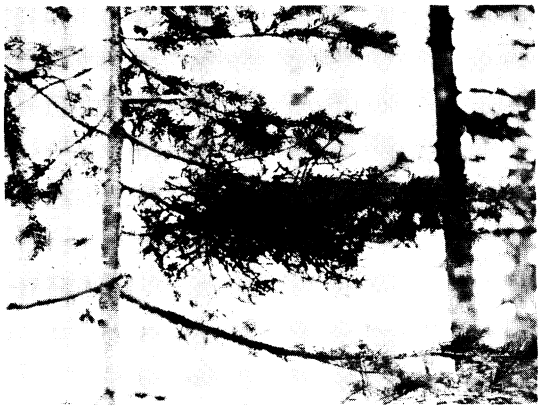

Fig. 5. A witches' broom on *Abies mayriana* caused by *Melampsorella caryophyllacearum*. Kamikawa, Hokkaido. June 1960. Photo. by Mr. K. Ono.

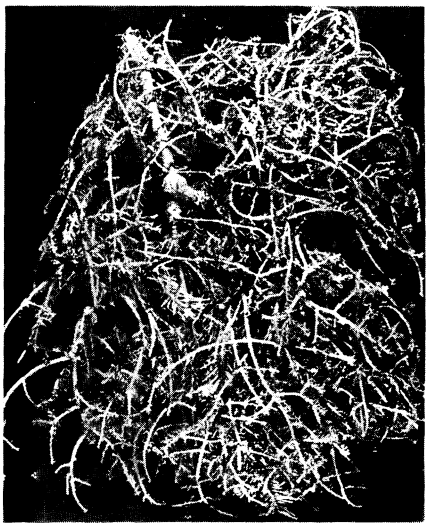

Fig. 6. Brooming branches of *Abies mayriana* caused by *Melampsorella caryophyllacearum*. Kamikawa, Hokkaido. June 1960. Photo. by Mr. K. Ono.

Fig. 7. Young shoot of *Abies firma* producing aecidia(peridermia)of *Melampsorella caryophyllacearum*, Yamazaki, Hyôgo. June 1950. × 4/5

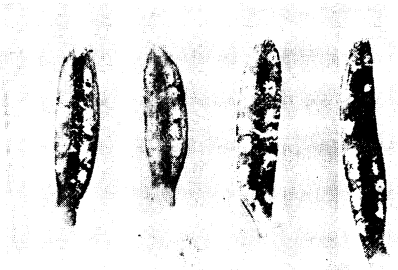

Fig. 8. Aecidia (peridermia) of *Melampsorella caryophyllacearum* on the needles of *Abies firma*. × 9/5

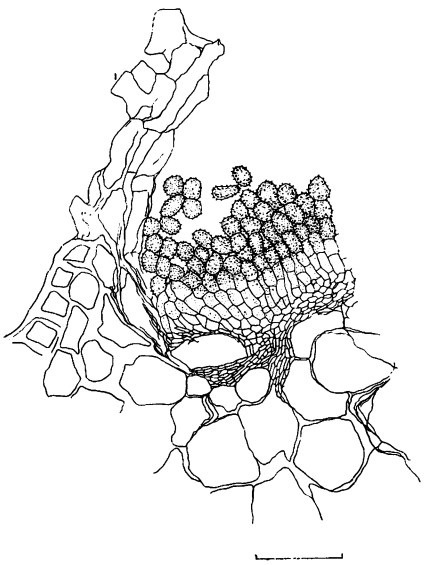

Fig. 9. A part of aecidium (peridermium) of *Melampsorella caryophyllacearum* on *Abies firma* (⌊——⌋ = 100 μ).

Fig. 11. A large witches' broom on *Larix leptolepis* (about 60-year-old). Mt. Yatsugatake, Nagano. October 1962.

← Fig. 10. A witches' broom on the trunk of *Larix leptolepis*(about 30-year-old). Takatô, Nagano. May 1962.

Figs. 12～13. Approached view of a witches' broom on *Larix leptolepis* (30-year-old), Higashiida, Ôita, August 1957. —Upper surface (Fig. 12 ; left) and under surface(Fig. 13 ; right)—

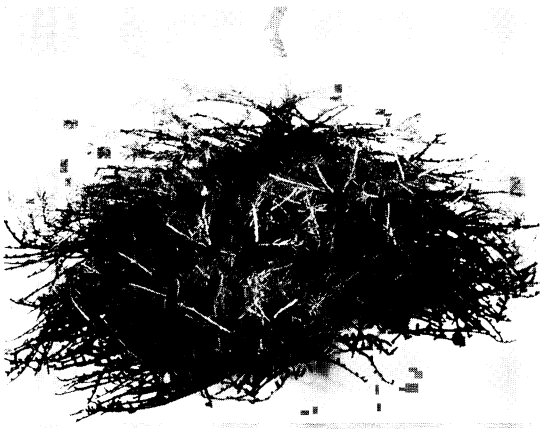

Fig. 14. A large witches' broom on *Larix leptolepis* (about 30-year-old). Narusawa, Yamanashi. September 1957.

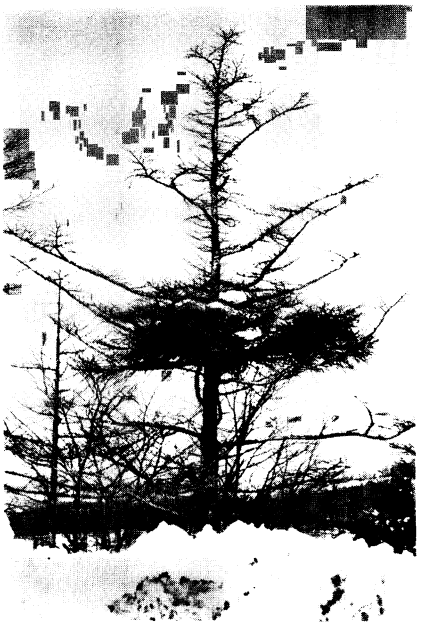

Fig. 15. A witches' broom on *Larix leptolepis* (about 80-year-old). Tsumagoi, Gunma. February 1962. Photo. by Mr. Y. Momosé.

Fig. 16. Result of grafting the brooming branchlet on a healthy seedling. s: Scion grafted. Photo. by Mr. Y. Momosé.

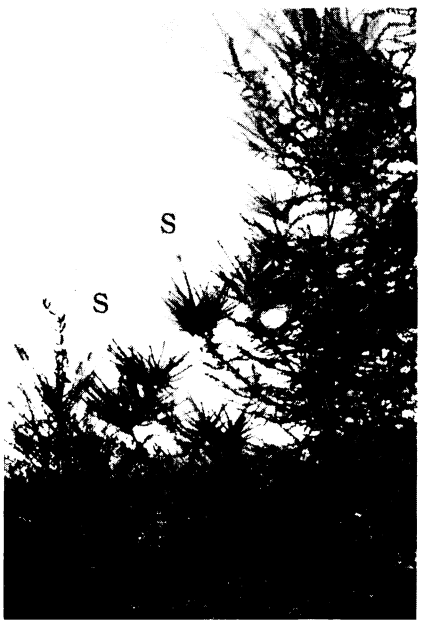

Fig. 17. Results of grafting the brooming branchlet on a healthy 10-year-old tree. s: Scions grafted. Photo. by Mr. Y. Momosé.

brooming through the summer. On the contrary, no visible brooming symptoms were observed on the stocks either in 1962 or the two subsequent years (Figs. 16～17).

According to TUBEUF (1910[39], 1933[46]) and BUCKLAND and KUIJT (1957)[3], witches' brooms on the following European and American species of *Larix* are probably non-parasitic: *Larix decidua* MILL., *L. laricina* (DU ROI) K. KOCH, *L. lyallii* PARL., and *L. occidentalis* NUTT. The experimental data in the present paper, though not extensive, indicate strongly that the brooming disease of *Larix leptolepis* in Japan is also considered to be of non-parasitic origin.

Witches' broom of *Tsuga diversifolia* MAST.

In August, 1956, a witches' broom on *Tsuga* was first discovered by T. KOBAYASHI, in Gunma Prefecture (Fig. 18). A few years later, the junior author, in 1962, found a bird's nest-type witches' broom on *Tsuga diversifolia* which was about 100 years old, had a height of 20 m and a diameter (d. b. h.) of 50 cm in the natural forest at Kaida, Nagano Prefecture (Figs. 19～20) (HAMA 1963[10]).

The cause of the disease has not yet been determined, but is probably of non-parasitic origin.

Witches' broom of *Pinus*

1. Bud-witches' broom (Knospenhexenbesen)

In old Japanese books published in the mid-nineteenth century, closely grouped clusters of buds of pine trees were described under the name of "togaeri-bana" (flowers blooming only once in a hundred years), which were much appreciated by the people at that time (SHIRAI 1925[32]). Later, KUSANO (1904)[23], who attributed their origin to a mite (*Phytoptus* sp.), made clear that the people in the feudal age had erroneously taken the bud-witches' brooms for the true flowers (Figs. 21～22). A similar malformation in *Pinus cembra* was briefly noted by TUBEUF (1910[38], 1930[45], 1933[46]) as a bud-witches' broom (Milben-Knospenhexenbesen). It is generally believed that the brooming buds caused by mites never open.

Another bud-brooming was observed on *Pinus thunbergii* PARL in Kanagawa and Kagoshima Prefectures (Figs. 23～25) (KATÔ 1955[22], ITÔ 1962[18]). In this case, the brooming buds opened later, and the root system of the broomed progeny is remarkably inferior to that of healthy comparable seedlings.

This is considered to be due to non-parasitic origin, and probably to bud-mutation (ITÔ and CHIBA 1957[19]).

2. Branch-witches' broom (Zweighexenbesen)

Though witches' brooms on pines had probably existed in Japan, the authentic report was first made by YOSHII and KANAKIYO[47] in 1953. By the shape of the witches' brooms they divided them into three forms as follows: Umbrella type, saddle type and bird's nest type. Since 1960, the junior author has frequently observed witches' brooms on *Pinus densiflora* in Nagano Prefecture, the central part of the mainland (HAMA 1962[7][9]). The large broom bearing many cones was about 1.5 m in diameter. The length of the needle was smaller in the bird's nest-type witches' broom than in the saddle-type one (Figs. 26～28).

In 1961, the junior author found witches' brooms on a 7-year-old tree of *Pinus strobus*, 110 cm in height, 22 mm in diameter at ground level at Fukushima, Nagano Prefecture. The brooms were formed on the apical parts of branches as well as on the main stem of the tree

Fig. 18. A witches broom on *Tsuga diversifolia*. Tsumagoi, Gunma. August 1956. Photo. by Mr. T. KOBAYASHI.

Fig. 19

Fig. 20

Figs. 19～20. Approached view of a witches' broom on *Tsuga diversifolia* (about 100-year-old). Kaida, Nagano. October 1962. —Upper surface (Fig. 19) and under surface (Fig. 20)—

(Fig. 29) (HAMA 1963[12]). The witches' brooms collected in Japan are very similar in appearances to those reported by TUBEUF (1905)[37].

In Europe and America parasitic witches' brooms caused by mistletoes and insects have been described on many species of *Pinus* (TUBEUF 1910[38], 1919[43], 1933[45], ZACH 1911[49], 1912[50], SOLEREDER 1905[33]), and those of non-parasitic or unknown origin have also been reported by earlier workers (BADOUX 1898[2], TUBEUF 1898[36], 1905[37], 1910[39][40], 1912[41], 1933[45], SOLEREDER 1905[33], HINTIKKA 1933[16], LIESE 1933[25], RHOADS 1945[29], BUCKLAND and KUIJT 1957[3]).

In Japan, YOSHII and KANAKIYO (1953)[47] noted that the origin of the witches' broom on *Pinus thunbergii*, the common Japanese black pine, might be virus, but their experimental proof is not sufficient. According to the authors' observations, the broom on *Pinus densiflora*, the common Japanese red pine, is probably a non-parasitic disease.

Fig. 21. A bud-witches' broom on *Pinus densiflora* (6-year-old) caused by ? a mite. Fukushima, Nagano. June 1959.

Fig. 23. Bud-witches' brooms on *Pinus thunbergii* (7-year-old). Ebina, Kanagawa. July 1955. Photo. by Mr. K. KATÔ.

Fig. 24. Approached view of the bud-witches' broom on *Pinus thunbergii* (7-year-old). Ebina, Kanagawa. July 1955. Photo. by Mr. K. KATÔ.

Fig. 22. A bud-witches' broom on *Pinus thunbergii* (25-year-old) caused by? a mite. Tarumi, Kagoshima. October 1959. × 4/5.

Fig. 25. A bud-witches' broom on *Pinus thunbergii* (3-year-old). Yokokawa, Kagoshima. July 1960. × 4/5

Fig. 26. A witches' broom on *Pinus densiflora*. Miyota, Nagano. November 1961.

Fig. 27. A brooming shoot of *Pinus densiflora*. Nagano. March 1962. × 1/3

Fig. 28. A witches' broom on *Pinus densiflora* (20-year-old). Tateshina, Nagano. January 1960.

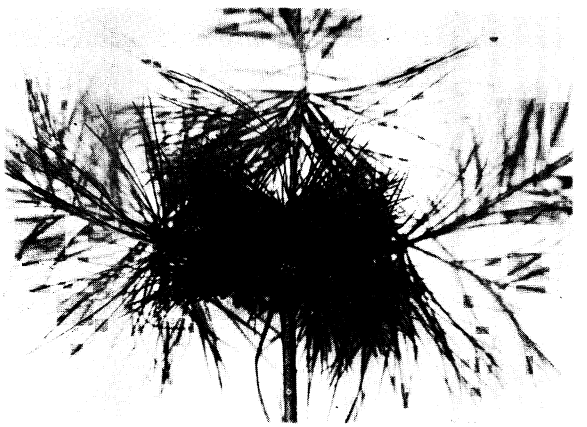

Fig. 29. A witches' broom on *Pinus strobus* (7-year-old). Fukushima, Nagano. June 1962.

Concerning the cause of the witches' broom on *Pinus strobus* found in Japan, the present authors have no reliable data at present, but they consider it to be of a non-parasitic origin as in the findings of European and American researchers (Badoux 1898[2], Tubeuf 1898[36], 1905[37], 1933[46], Buckland and Kuijt 1957[3]).

Witches' broom of *Cryptomeria japonica* D. Don

In October, 1961, the junior author first found a brooming on a 6-year-old *Cryptomeria* in a plantation at Azuma, Nagano Prefecture. In the next year, the same disease was observed by the authors on a 20-year-old tree near Suzaka City, Nagano Prefecture.

The brooms generally occur on the upper portion of the crown. A typical feature of the material inspected is that its internodes are shortened, needles are spaced very closely, and the terminal portions, so-called buds, are rounded (Fig. 30) (Hama 1962[8]).

So far as the authors can ascertain there is no account concerning the occurrence of any brooming disease on *Cryptomeria japonica*. Origin of the witches' broom is still undetermined.

Witches' broom of *Chamaecyparis pisifera* Sieb. et Zucc.

In April, 1963, the junior author collected a large witches' broom on *Chamaecyparis pisifera* in a plantation near Chino City, Nagano Prefecture. The tree bearing the witches' broom was about 30 years old, ca. 18 m in height and 20 cm in diameter at breast height.

The broom, 150 cm in length and 50 cm in width, occurred on the end of a limb developed on one side of the trunk at a point 10 m above the ground (Fig. 31). The broom consisted of a great number of branchlets with small leaves. Almost all of the leaves in the broom were twisted or turned over (Figs. 32～33) (Hama 1963[11]). Origin of the disease is unknown.

Witches' broom of *Thujopsis dolabrata* Sieb. et Zucc. caused by *Caeoma deformans* (Berk. et Br.) Tubeuf

The witches' broom is one of the most conspicuous diseases of *Thujopsis dolabrata* in plantations and natural forests. The disease is widely distributed throughout the northern and southern parts of Japan, but not in Kyûshû, and occurs very commonly in Aomori, Iwate and Ishikawa Prefectures where this tree species is economically cultivated. It attacks not only trees in the forest but also rooted cuttings in the nursery (Fig. 37) (Itô 1955[17]).

It was said that the brooming tree had been erroneously recognized as a form of this tree species under the name of "susu-asunaro" or "bariken-hiba" before about 1880(Shirai 1916[31]). The causal organism of the disease was first attributed to a species of rust fungi by Berkeley (1878), who described it as *Uromyces deformans* Berk. et Br., sp. nov. In 1889, Shirai[30], who had not seen Berkeley's paper, proposed independently for the fungus a new name, *Caeoma asunaro*. Later, in 1895, Tubeuf[34][35] who examined the specimen sent from Professor Dr. Grasmann in Tokyo, adopted *Caeoma* as the generic name of the fungus and made a new combination as *Caeoma deformans* (Berk. et Br.). According to Kusano's (1908)[24] inoculation test, the fungus is an autoecious species and needs no alternate hosts for infection.

The brooms are initially produced in the suture of leaves as the pallid, leafless, branched structures. Tops of these structures are swollen and then become saucer-shaped. Pycnidia and aecidia of the fungus are formed in the saucer-shaped portion of the mal-

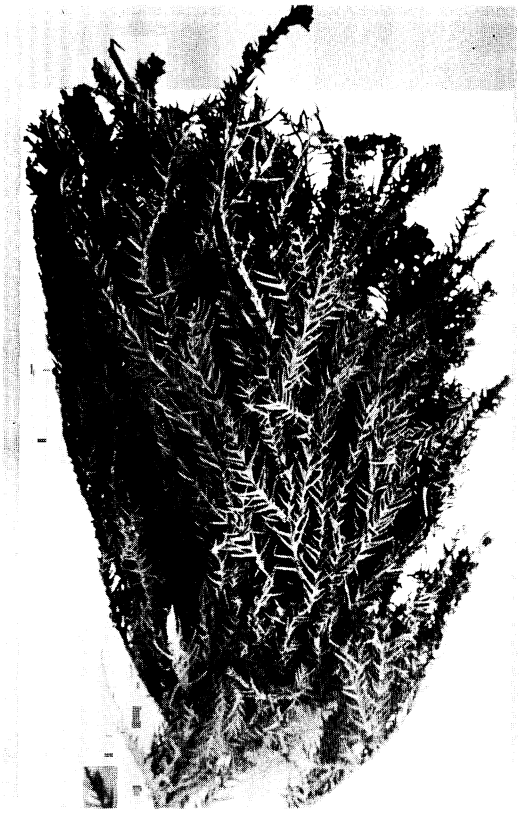

Fig. 30. A witches' broom on *Cryptomeria japonica*. Azuma, Nagano. October 1961.

Fig. 31. A witches' broom on *Chamaecyparis pisifera* (about 30-year-old). Chino City, Nagano. April 1963.

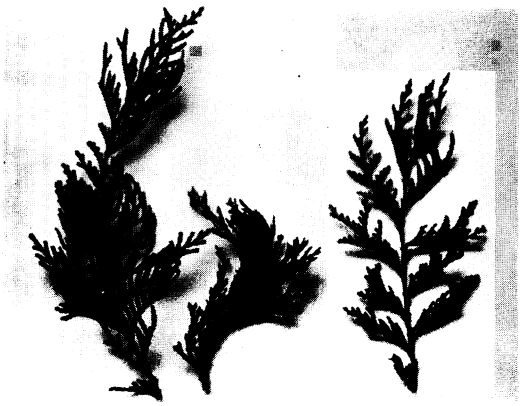

Fig. 33. Leaves forming the witches' broom on *Chamaecyparis pisifera* (left) and a healthy one (right).

Fig. 32. Shoots of *Chamaecyparis pisifera* in the witches' broom.

Fig. 34. A large witches' broom on *Thujopsis dolabrata* caused by *Caeoma deformans*. Aomori. June 1960. × 1/8

Fig. 35. A witches' broom on *Thujopsis dolabrata* caused by *Caeoma deformans*. Aomori. 1958. × 2/3

Fig. 36. Initial stage in the development of a witches' broom on *Thujopsis dolabrata*. Agematsu, Nagano. June 1960.

Fig. 37. Small witches' brooms on a rooted cutting of *Thujopsis dolabrata* caused by *Caeoma deformans*. Tateoka, Yamagata. May 1955. × 1/3

Fig. 38. Initial stage in the development of a witches' broom (b) on *Thujopsis dolabrata* caused by *Caeoma deformans*. Ishikawa. June 1952.

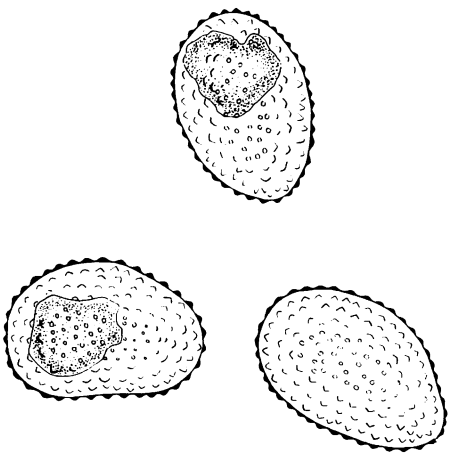

Fig. 40. Aecidiospores of *Caeoma deformans* on *Thujopsis dolabrata*.

Fig. 39. Enlargement of the initial stage in a witches' broom on *Thujopsis dolabrata* caused by *Caeoma deformans*. Gamushi, Hokkaido. May 1956. Photo. by Mr. K. Ono. × 2

Fig. 41. A witches' broom on *Thuja standishii* (about 40-year-old) caused by *Caeoma deformans*. Fukushima, Nagano. August 1958.

Fig. 42. Initial stage in the development of a witches' broom of *Thuja standishii* caused by *Caeoma deformans*.

Fig. 43. A part of a witches' broom of *Thuja standishii* caused by *Caeoma deformans*.

Fig. 44. Photomicrography of aecidiospores of *Caeoma deformans* on *Thuja standishii*. ×600

formed branchlets (Figs. 38～40). Diseased branches are usually bifurcated one to three times in a year and old brooming branches die. The brooms develop into rounded, compact, densely branched structures generally sphaerical in outline, but sometimes flattened. They range up to one meter in diameter (Figs. 34～36) (SHIRAI 1889[30], KUSANO 1904[23]). In structure, the broom is similar to *Hizikia fusiforme* (HARVEY) OKAMURA, an edible marine plant, and it is frequently given the common name of "hiziki-disease" (SHIRAI 1889[30]).

Witches' broom of *Thuja standishii* CARR. caused by *Caeoma deformans* (BERK. et BR.) TUBEUF

Among Japanese pathologists, it has been known that the witches' broom of *Thuja standishii* is caused by *Caeoma deformans* (S. Itô 1950). But, the disease has rarely been found and its definite distribution has been believed to be restricted to Shikoku, a southern island of Japan. In 1959, however, the junior author observed that severe damage of the disease had occurred on 10- to 50-year-old trees of *Thuja standishii* at Fukushima, Nagano Prefecture, the central mountain region of the mainland (HAMA 1960[6]).

Symptoms and signs of the disease are very similar to those of the broom on *Thujopsis dolabrata*. The fungus on *Thuja standishii* is almost identical with *Caeoma deformans* (Figs. 41～44).

The authors make here an incidental remark that a broom of non-parasitic origin was reported on *Thuja plicata* DONN ex. D. DON from Canada (BUCKLAND and KUIJT 1957[3]).

Literature cited

1) ARTHUR, J. C.: The plant rusts (Uredinales), New York, p. 311, (1929).
2) BADOUX, H.: Hexenbesens der Weymouthskiefer. Forst-Naturw. Zeits., **7**, p. 195, (1898).
3) BUCKLAND, D. C., and J. KUIJT: Unexplained brooming of douglas-fir and other conifers in British Columbia and Alberta. Forest Sci., **3**, pp. 236～242, (1957).
4) BOYCE, J. S.: Forest pathology, New York, pp. 188～189, (199～200), 1948, (1961).
5) FRANK, A. B.: Die Krankheiten der Pflanzen, Breslau, pp. 491～493, (1880).
6) HAMA, T.: [Witches' broom of *Thuja standishii*] (in Japanese). Forest Protection News, **9**, pp. 193～194, (1960).
7) HAMA, T.: [Witches' broom of *Pinus densiflora*] (in Japanese). *Ibid.*, **11**, p.18, (1962).
8) HAMA, T.: [A brooming disease of *Cryptomeria japonica*] (in Japanese). *Ibid.*, **11**, p. 118, (1962).
9) HAMA, T.: [Witches' brooms of *Picea hondoensis* and *Pinus densiflora*] (in Japanese). *Ibid.*, **11**, p. 180, (1962).
10) HAMA, T.: [Witches' broom of *Tsuga diversifolia*] (in Japanese). *Ibid.*, **12**, p. 71, (1963).
11) HAMA, T.: [Witches' broom of *Chamaecyparis pisifera*] (in Japanese). *Ibid.*, **12**, p. 174, (1963).
12) HAMA, T.: [Witches' broom of *Pinus strobus*] (in Japanese). *Ibid.*, **12**, . p 192, (1963).
13) HAMA, T.: [Witches' brooom of *Abies veitchii*] (in Japanese). *Ibid.*, **13**, p. 22, (1964).

14) HARA, K.: Zyubyô-gaku kakuron [Selected tree diseases] (in Japanese). Shizuoka, pp. 139～140, (1925).

15) HARA, K.: Zikken zyumoku byôgai hen [A text-book of tree diseases] (in Japanese). Tokyo, pp. 93～94, (1927).

16) HINTIKKA, T. J.: Muutamia havaintoja männyn tuulenpesitä. Acta Forestalia Pennica, **39** (2), pp. 1～15, (1933),

17) ITÔ, K.: Zusetsu zyubyô kôgi [A text-book of tree diseases] (in Japanese), Tokyo, p. 148, (1955).

18) ITÔ, K.: Zusetsu zyubyô shinkô [A new text-book of tree diseases] (in Japanese), Tokyo, p. 228, (1962).

19) ITÔ, K. and O. CHIBA: [Two brooming diseases of conifers] (in Japanese). Forest Protection News, **6**, pp. 249～251, (1957).

20) ITÔ, S.: Mycological flora of Japan II. Basidiomycetes (2). Uredinales-Melampsoraceae (in Japanese). Tokyo, pp. 74～77, p. 359, (1938).

21) KAMEI, S.: The disease and decay of todo fir (in Japanese). Hoppô Ringyô Sôsho 12, pp. 77～160, (1959).

22) KATÔ, K.: [Malformation in buds of *Pinus thunbergii*] (in Japanese). Forest Protection News, **4**, p. 193, (1955).

23) KUSANO, S.: Monstrous witches' brooms of conifers (in Japanese). Bot. Mag. (Tokyo) **18** (213), pp. 211～214, (1904).

24) KUSANO, S.: [Development of *Caeoma deformans* (BERK. et BR.) TUBEUF] (in Japanese). *Ibid.*, **22** (257), p. 237, (1908).

25) LIESE, J.: Vererbung der Hexenbesenbildung bei der Kiefer. Zeits. Forst. u. Jagdw., **65**, pp. 541～544, (1933).

26) MIELKE, J. L.: The yellow witches' broom of subalpine fir in the Intermountain region. Intermount. Forest & Range Exp. Sta., Research Note 47, pp. 5, (1957).

27) MOMOSÉ, Y.: Unpublished.

28) PETERSON, R. S.: Effects of broom rusts on spruce and fir. U. S. Dept. Agr., Forest Serv., Intermount. Forest & Range Expt. Sta., Research paper INT-7, pp. 10 (1963).

29) RHOADS, A. S.: Witches' broom of pine trees in Florida. Plant Dis. Reptr., **29**, pp. 26～28, (1945) (Cited from R. A. M. **24**, pp. 345～346, 1945).

30) SHIRAI, M.: [Witches' broom of *Thujopsis dolabrata*] (in Japanese). Bot. Mag. (Tokyo), **3** (29), pp. 239～241, (1889).

31) SHIRAI, M.: Saikin shokubutsu byôri-gaku [Plant pathology] (in Japanese). Tokyo, pp. 332～333, (1916).

32) SHIRAI, M.: Shokubutsu yôi-kô [Monstrous phenomena in the vegetable kingdom] (in Japanese), Tokyo, pp. 206～209, (1925).

33) SOLEREDER, : Über Hexenbesen auf *Quercus rubra* L., nebst einer Zusammenstellung der auf Holzpflanzen beobachteten Hexenbesen. Naturw. Zeits. f. Land- u. Forstw., **3**, pp. 17～23, (1905).

34) TUBEUF, C. von: Ueber die Anpassung Erscheinung der hexenbesenartigen Fruchticative Gall auf *Thujopsis dolabrata* in Japan. Bot. Centralb., **61**, 48, (1895).

35) TUBEUF, C. von: Pflanzenkrankheiten durch kryptogame Parasiten verursacht. Berlin, pp. 417～421; 432～433, (1895).

36) Tubeuf, C. von: Le balai de sorcier sur le pin Weymouth par J. P. J. Koltz. Forst.-naturw. Zeits., **7**, p. 196, (1898).
37) Tubeuf, C. von: Hexenbesen an *Pinus strobus*. Naturw. Zeits. f. Land- u. Forstw., **3**, pp. 512～513, (1905).
38) Tubeuf, C. von: Knospen-Hexenbesen und Zweig-Tuberkulose der Zirbelkiefer. Naturw. Zeits. Forst- u. Landw., **8**, pp. 1～12, (1910).
39) Tubeuf, C. von: Aufklärung der Erscheinung der Fichten-hexenbesen. *Ibid.*, **8**, pp. 349～351, (1910).
40) Tubeuf, C. von: Vererbung der Hexenbesen. *Ibid.*, **8**, pp. 582～583, (1910).
41) Tubeuf, C. von: Über die Natur der nicht-parasitären Hexenbesen. *Ibid.*, **10**, pp. 62～64, (1912).
42) Tubeuf, C. von: Wuchs-Abweichungen an *Pinus*. *Ibid.*, **13**, pp. 550～555, (1915).
43) Tubeuf, C. von: Überblick über die Arten der Gattung *Arceuthobium* (*Razoumowskia*) mit besonderer Berücksichtigung ihrer Biologie und praktischen Bedeutung. *Ibid.*, **17**, pp. 167～273, (1919).
44) Tubeuf, C. von: Das Problem der Knollenkiefer. Zeits., f. Pflanzenkrank., **40**, pp. 225～251, (1930).
45) Tubeuf, C. von: Die Reproduktionsknospen der Kiefer. *Ibid.*, **40**, pp. 561～573, (1930).
46) Tubeuf, C. von: Studien über symbiose und Disposition für Parasitenbefall sowie über vererbung pathologischer Eigenschaften unserer Holzpflanze. *Ibid.*, **43**, 193～242, (1933).
47) Yoshii, Hiromu and Y. Kanakiyo: On the "witches' broom" of pine (I). (in Japanese). Trans. 62nd Ann. Meet. Jap. For. Soc., pp. 161～163, (1953).
48) Yoshinaga, T.: [Parasitic fungi in Tosa Province (III)] (in Japanese). Bot. Mag. (Tokyo), **18** (204), pp. 27～37, (1904).
49) Zach, F.: Die Natur des Hexenbesens auf *Pinus silvestris* L. Naturw. Zeits. f. Forst- u. Landw., **9**, pp. 333～356, (1911).
50) Zach, F.: Notiz zu dem Aufsatz "Die Natur des Hexenbesens auf *Pinus silvestris* L.", *Ibid.*, **10**, pp. 61～62, (1912).

針葉樹のてんぐ巣病

(摘　　要)

伊　藤　一　雄(1)
浜　　武　人(2)

針葉樹のてんぐ巣病に関する多数の報告が欧米からは出されているが，わが国では特定のものを除きこの方面の記録はきわめてすくない。てんぐ巣病は各種針葉樹にみとめられ，その異常な病徴から強く人目をひくものであるが，著者らは十数年前からこれらに関心を持ち，機会あるごとに観察を行なってきた。

本報文には著者らが観察調査したわが国における針葉樹のてんぐ巣病についてその概要を記録し，なおあわせて先輩諸学者のこれらに関連する業績の紹介も行なった。

(1) 保護部樹病科長・農学博士
(2) 木曾分場保護研究室長

1. モミ類のてんぐ巣病

さび菌の1種 *Melampsorella caryophyllacearum* Schroet による本病は，欧州，北米および北アジアに広く分布し，わが国ではモミ，ウラジロモミ，アオモリトドマツ，トドマツ，アカトドマツ，シラベに発生する。本菌の中間寄主はミミナグサ類およびハコベ類とされている。モミおよびウラジロモミは最近亜高山帯造林樹種として注目されているのであるが，これらの幼齢木に発生して軽微ならざる被害を与えていることから，本病はモミ類の重要病害とみとめられるようになった（Fig. 1～9）。

2. カラマツのてんぐ巣病

本病は 1957 年に初めて本邦で記録されたが，それ以来各地で多数発見されている。本病の病因として伝染性のものとすればウイルスが一応考えられるので，てんぐ巣病枝を健全木に接木を行なってこれを調べた。接穂の部分はその後顕著なてんぐ巣の病徴を呈したが，台木の部分には2年を経過しても病徴が全く現われない。このことから，本病は伝染性のものではなく，海外から各種カラマツ類で報ぜられているように，非寄生性疾病の1種であろうと考えられる（Fig. 10～17）。

3. コメツガのてんぐ巣病

ツガ類のてんぐ巣病は 1956 年に群馬県て初めて発見されたが，その後 1962 年には長野県でコメツガでみとめられた。本病の病因は不明であるが非寄生性のものらしい（Fig. 18～20）。

4. マツ類のてんぐ巣病

（1） 芽状てんぐ巣

古くはマツの「十がえりの花」という名で好事家に珍重されたのは実はダニの1種による芽のてんぐ巣病にほかならぬことがすでにわが国の学者によって明らかにされ，のちに海外からも報告されている。著者らもクロマツおよびアカマツでこれと同一と考えられるものを見い出している。この場合，芽は普通開じょしないといわれている（Fig. 21～22）。

ところで，これとはいささか性状を異にし，芽が開じょする芽状てんぐ巣がクロマツで発見された。この病因はダニその他の寄生生物によるものではなく，芽条変異によって起こったものらしい（Fig. 23～25）。

（2） てんぐ巣病

マツのてんぐ巣病は本邦にも古くからあったらしいが，学術的な報告が出されたのは比較的近年で，1953 年のことである。著者らは長野県でアカマツおよびストローブマツにてんぐ巣を見い出した。ストローブマツのてんぐ巣は欧州の報告と形状がきわめてよく似ている。マツ類のてんぐ巣病にはヤドリギ類および小動物（昆虫およびダニ類）などによる寄生性のものと，非寄生性あるいは病因不明のものが海外では知られている。わが国でクロマツのてんぐ巣病の病因としてウイルスらしいとする説もあるが，すくなくとも著者らがみとめたアカマツおよびストローブでは非寄生性てんぐ巣とする方がよさそうてある（Fig. 26～29）。

5. スギのてんぐ巣病

著者らは長野県下で造林木クローネの上部に形成されたてんぐ巣をみとめた。スギのてんぐ巣に関する記録はこれまで知られていないようである。本病の病因は不明。

6. サワラのてんぐ巣病

長野県下で約 30 年生サワラに巨大なてんぐ巣が見い出された。てんぐ巣枝条はその鱗葉は小さく，ま

た葉は大部分ねじれたり反転したりしていた。病因未詳（Fig. 31～33)。

7. アスナロ（ヒバ）のてんぐ巣病

古くはこれを病的現象とはみとめず，アスナロの品種だろうとしてススアスナロあるいはバリケンヒバという名でよばれていたということである。本病は各地のアスナロ林で見い出されるが，また時として苗畑のさし木苗に発生してすくなからぬ被害を与えることがある。

本病の病原菌はさび菌の１種で，はじめ *Uromyces deformans* Berk. et Br. (1878) と記載されたが，これと全く独立にわが国の学者によって *Caeoma asunaro* Shirai (1889) と命名された。のちにこれは *Caeoma deformans* (Berk. et Br.) Tubeuf (1895) と訂正され，現在この名が広く採用されている。本菌は同種寄生種で中間寄主はないものとされている。

てんぐ巣のごく初期は鱗葉の部分に形成され，二叉に分岐しながらしだいに成長，古いものは枯死し，直径 1 m を越える巨大なてんぐ巣もまれではない。この病徴は海藻の１種ヒジキの形状と似ているのでヒジキ病という病名もある。てんぐ巣の先端部は皿状あるいは釘頭状を呈し，この部分に柄子殻および銹子腔が形成される（Fig. 34～40)。

8. ネズコ（クロベ）のてんぐ巣病

ネズコのてんぐ巣病はアスナロのてんぐ巣病菌 *Caeoma deformans* に因ることは知られていたが，しかし本病の発生は比較的まれで，文献で明らかにされている分布は四国だけとなっている。1959 年長野県下で本病の顕著な被害木が見い出された。その病徴はアスナロのそれと酷似し，なお病原菌は *Caeoma deformans* に違いないことも確かめられた（Fig. 41～44)。

ネズコ属の１種 *Thuja plicata* に形成されるてんぐ巣がカナダから報告されているが，これは非寄生性疾病だということである。