# STUDIES IN THE CONCEPTS OF THE SPECIES AND THE PHYSIOLOGIC FORM IN *FUSARIUM* CAUSING THE BUD BLIGHT OF MULBERRY TREES*

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with 2 plates

CONTENTS



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# I. INTRODUCTION

Most of scholars in Japan have used *Fusarium lateritium* Nees [*Gibberella moricola* (De Not.) Sacc.] as the scientific name for the causal fungus of the bud blight of mulberry trees on the basis of the classical taxonomy. But, Wollenweber [20,21] reported at first that *F. lateritium* Nees is the conidial stage of *Gibberella baccata* (Wallr.) Sacc. and that of *G. moricola* Sacc. is *F. urticearum* (Cda.) Sacc. and the latter is the causal fungus of the bud blight of mulberry trees though the former is also found in mulberry trees. Then he [22, 23] regarded the latter as a variety of the former and called it *G. baccata* (Wallr.) Sacc. v. *moricola* (D. Ntrs.) Wr. using *Fusarium lateritium* Nees v. *Mori* Desm. for the conidial stage.

The writer investigated 2 strains isolated from mulberry trees at two different places in Kyoto Prefecture under Prof. Hemmi's guidance in the Laboratory of Phytopathology and Mycology of Kyoto University and recognized [6] that one of them resembled the above Wollenweber's species, but the other strain was different from them. Though the investigation was not perfect, the writer believes even now that the above conclusion is true if he follows Wollenweber's taxonomic system. Since 1945, the writer continued this investigation at the Faculty of Textiles and Sericulture of Shinshu University, and he gained from various localities 41 strains involving the strain which was isolated from *Rubus sp.* in Holland and identified by Wollenweber with *Fusarium lateritium* Nees. From the results of the investigations of these strains for several years, the writer has come to have a fixed opinion that the causal fungi of the bud blight of mulberry trees are one species so far as the writer's investigations have been concerned. This conclusion means that he supports in many points Snyder and Hansen's opinion [16] which was proposed in 1945, instead of Wolleweber's system. In the present paper the results of these investigations together with the concepts of species and physiologic form in *Fusarium* are dealt with.

The writer must record here his heartiest thanks to Emeritus Prof. T. Hemmi, Dr. T. Abe and Dr. S. Akai for their kind suggestions and advices. He also wishes to express his thanks to Dr. Y. Nishikado who kindly contributed Wollenweber's *F. lateritium* Nees to him, and also to Mr. M. Nakamura and Mr. T. Isshi, members of his Faculty, who kindly assisted him in

the composition of this paper and in the statistical analysis of pathogenicity. The writer's thanks must also be given to the Department of Education of Government, which especially provided him with part of the expenses of this study.

## II. MATERIALS

The sources of *Fusarium* strains which were used in the present investigations are shown in the table 1. The method of single spore culture was taken of all strains at the beginning. Nos. 3, 13, 15, 17, and 27 were omitted, because their collection places were so near those of other strains on the table and the various characters of these omitted strains resemble near ones.

Table 1. Sources of strains

| No. of strain | Locality | Collector | Date of collection | Isolator | Form name of mulberry tree, etc. |
|---|---|---|---|---|---|
| 1 | Sonobe Town, Funai Dist., Kyoto Pref. | Writer | Jun. 21, 1942 | Writer | unknown |
| 2 | The grounds of the Agricultural Dep. of Kyoto Univ. | T. HEMMI | Apr. 24, 1942 | T. HEMMI | do. |
| 4 | Higashifukai, Kanō Vil., Chiisagata Dist., Nagano Pref. | Writer | Apr. 30, 1946 | Writer | Kairyōnezumigaeshi Ichinose |
| 5 | do. | do. | May 6, 1946 | do. | |
| 6 | do. | do. | May 12, 1946 | do. | Nezumigaeshi |
| 7 | Kuribayashi, Kanō Vil., Chiisagata Dist., Nagano Pref. | do. | do. | do. | unknown |
| 8 | Tazawa, Kanō Vil., Chiisagata Dist., Nagano Pref. | do. | do. | do. | do. |
| 9 | do. | do. | do. | do. | do. |
| 10 | The farm of the Textile Fac. of Shinshu Univ. | do. | May 14, 1946 | do. | Tagowase |
| 11 | do. | do. | do. | do. | Fukusimaōha |
| 12 | Higashifukai, Kanō Vil., Chiisagata Dist., Nagano Pref. | do. | May 27, 1946 | do. | unknown |
| 14 | The farm of the Textile Fac. of Shinshu Univ. | do. | Apr. 20, 1947 | do. | Jūmonji |
| 16 | Ōkawa, Kanō Vil., Chiisagata Dist., Nagano Pref. | do. | Apr. 24, 1947 | do. | unknown |
| 18 | Kaizenji, Kanō Vil., Chiisagata Dist., Nagano Pref. | do. | May 4, 1947 | do. | Kairyōnezumigaeshi |
| 19 | Nakayama, Yoda Vil., Chiisagata Dist., Nagano Pref. | K. TAMURA | May 7, 1947 | K. TAMURA | unkmown |

| No. of strain | Locality | Collector | Date of collection | Isolator | Form name of mulberry tree, etc. |
|---|---|---|---|---|---|
| 20 | Kuribayashi., Kanō Vil., Chiisagata Dist., Nagano Pref. | Writer | Apr. 24, 1947 | Writer | Kairyōnezumi-gaeshi |
| 21 | Higashifukai, Kanō Vil., Chiisagata Dist., Nagano Pref. | do. | Jun. 29, 1948 | do. | unknown |
| 22 | Yuzawa Town, Okachi Dist., Akita Pref. | S.YANAGI-SAWA | Apr. 20, 1949 | do. | Wasukejūmon-ji |
| 23 | Ōya, Kangawa Vil., Chiisagata Dist., Nagano Pref. | Writer | May 6, 1947 | do. | unknown |
| 24 | do. | do. | do. | do. | Kairyōnezumi-gaeshi |
| 25 | Higashifukai, Kanō Vil., Chiisagata Dist., Nagano Pref. | do. | May 4, 1947 | do. | Nezumigaeshi |
| 26 | Sone, Kanō Vil., Chiisagata Dist. Nagano Pref. | do. | do. | do. | unknown |
| 28 | Amori Vil., Kamiminochi Dist., Nagano Pref. | T. TAKEU-CHI | May 12, 1947 | do. | Kairyonezumi-gaeshi |
| 29 | Shinonoi Town, Sarashina Dist., Nagano Pref. | Writer | Jun. 5, 1947 | do. | do. |
| 30 | Tōfukuji Vil., Sarashina Dist., Nagano Pref. | do. | do. | do. | do. |
| 31 | Nakamura, Toyoaki Vil., Gumma Dist. Gumma Pref. | do. | Jun. 12, 1947 | do. | Nezumigaeshi |
| 32 | Tokiire, Ueda City, Nagano Pref. | do. | Oct. 8, 1947 | do. | Kairyōnezumi-gaeshi |
| 33 | Higashifukai, Kanō Vil., Chiisagata Dist., Nagano Pref. | do. | Oct. 23, 1947 | do. | do. |
| 34 | do. | do. | Jun. 14, 1948 | do. | Nezumigaeshi |
| 35 | The farm of the Agricultural Dep. of Utsunomiya Univ., Tochigi Pref. | Y. SAKU-RAI | Jun. 6, 1948 | Y. SAKU-RAI | unknown |
| 36 | Omotegi, Motohara Vil., Chiisagata Dist. Nagano Pref. | do. | Jun. 16, 1948 | do. | Ichinose |
| 37 | Banzyō, Motohara Vil. Chiisagata Dist. Nagano Pref. | do. | Jun. 15, 1948 | do. | Nezumigaeshi |
| 38 | Higashifukai, Kanō Vil. Chiisagata Dist. Nagano Pref. | Writer | Aug. 4, 1948 | Writer | do. |
| 39 | do. | do. | Oct. 10, 1948 | do. | do. |
| 40 | Holland | unknown | 1926 | WOLLEN-WEBER | *Rubus sp.* |
| 41 | Kyōwa Vil., Sarashina Dist., Nagano Pref. | S.TATEYA | Apr. 20, 1949 | Writer | *Broussonetia sp.* |

Nos. 38 and 39 are the strains which have produced usually pyriform microconidia and yielded very rarely the conidia which seemed to be the macroconidia. Microconidium has not been reported to appear in *Fusarium sp.* causing the bud blight of mulberry trees. But, the writer ascertained that pyriform microconidium showed itself in the cultures of nos. 1, 5, 6, 9, 28, 29, and 34 as if saltants appeared. Single spore cultures of these produced usually the same pyriform microconidia and yielded very rarely the conidia which seemed to be the macroconidia. These cultures are treated in this paper as nos. 6(micro), 28(micro), 29(micro), and 34(micro). Nos. 38 and 39 resemble these cultures very much, though the relation of nos. 38 and 39 to the macroconidia type is not known. The examples that the microconidia type does not return to the macroconidia type were already reported of the other types of microconidia [11, 18].

## III. PATHOGFNICITY

### (1) Methods

The mulberry trees, cultivated uniformly as far as possible in a farm since several years ago by the method of "Negari" training (a kind of short stemmed training) and spring harvest, were supplied for inoculation experiments. The form name of the supplied mulberry trees is Kairyōnezumigaeshi. In autumn, the middle part of each stem of the mulberry trees which grew up after spring harvest was sterilized with 70—80% alcohol and washed with sterilized water, and a peeling injury (2.5mm×2.0mm) was made with a knife on the bark of the stem. The injured part of each stem was inoculated with the hyphae or spores of every strain. And then, the bark was restored to its original shape as if it had not been injured and was painted with vaseline.

### (2) Results

The inoculations were carried on in the autumn of 1949, and the invaded areas by the inoculations on the stems were measured a month after the inoculations. The results are given in the table 2 in which the average values of the groups of 10 stems are shown. And in the next spring some stems killed by the inoculations were found out among them.

Table 2. Results of the inoculation

| No. of experiment / Invaded area / No. of strain | I (Inoculation Sept. 6) Length (mm) × Width (mm) | The product | II (Inoculation Oct. 8) Length (mm) × Width (mm) | The product | III (Inocula- Oct. Length (mm) × Width (mm) |
|---|---|---|---|---|---|
| 1 | 6.35×3.30 | 20.96 | 6.80×4.10 | 27.88 | 12.88×4.44 |
| 2 | 5.70×3.25 | 18.53 | 4.70×3.80 | 17.86 | 5.70×2.75 |
| 4 | 7.55×3.25 | 24.54 | 7.00×4.25 | 29.75 | 5.95×3.35 |
| 5 | 5.50×3.45 | 18.98 | 4.30×3.30 | 14.19 | 8.70×3.75 |
| 6 | 5.05×3.45 | 17.42 | 6.15×3.65 | 22.45 | 4.06×3.06 |
| 6 (micro) | 7.30×4.35 | 31.76 | 6.20×4.10 | 25.42 | 5.00×2.94 |
| 7 | 7.40×3.92 | 29.01 | 7.90×3.80 | 30.02 | 11.10×4.40 |
| 8 | 10.15×5.25 | 53.29 | 5.25×2.90 | 15.23 | 5.75×3.25 |
| 9 | 6.75×3.30 | 22.28 | 4.00×3.39 | 13.56 | 7.50×3.80 |
| 10 | 6.75×3.50 | 23.63 | 6.44×3.56 | 22.93 | 6.95×3.45 |
| 11 | 6.30×2.94 | 18.52 | 8.50×4.90 | 41.65 | 8.10×3.90 |
| 12 | 5.85×3.60 | 21.06 | 8.80×5.00 | 44.00 | 6.70×3.85 |
| 14 | 6.81×3.19 | 21.72 | 5.33×3.89 | 20.73 | 5.80×3.60 |
| 16 | 5.80×3.15 | 18.27 | 4.30×3.10 | 13.33 | 7.75×3.80 |
| 18 | 7.65×3.80 | 29.07 | 6.70×4.20 | 28.14 | 5.56×3.50 |
| 19 | 6.20×2.85 | 17.67 | 7.35×4.40 | 32.34 | 7.85×3.90 |
| 20 | 7.94×3.81 | 30.25 | 7.90×3.95 | 31.21 | 7.00×3.80 |
| 21 | 8.45×4.45 | 37.60 | 8.40×4.90 | 41.16 | 8.80×4.30 |
| 22 | 8.35×3.90 | 32.57 | 5.75×3.75 | 21.56 | 6.90×3.25 |
| 23 | 6.65×3.95 | 26.27 | 5.35×3.80 | 20.33 | 6.65×3.30 |
| 24 | 6.70×4.25 | 28.48 | 5.60×3.40 | 19.04 | 8.65×3.65 |
| 25 | 5.80×3.35 | 19.43 | 3.60×3.15 | 11.34 | 5.70×3.40 |
| 26 | 7.70×4.25 | 32.73 | 6.89×3.50 | 24.12 | 12.00×4.55 |
| 28 | 7.50×3.25 | 24.38 | 8.60×4.45 | 38.27 | 6.25×3.69 |
| 28 (micro) | 11.30×5.00 | 56.50 | 14.20×5.75 | 81.65 | 5.85×3.20 |
| 29 | 7.14×3.94 | 28.13 | 6.95×4.00 | 27.80 | 6.75×3.50 |
| 29 (micro) | 8.75×4.20 | 36.75 | 5.20×3.65 | 18.98 | 5.90×3.25 |
| 30 | 5.70×3.50 | 19.95 | 7.25×4.00 | 29.00 | 5.40×3.15 |
| 31 | 6.00×2.95 | 17.70 | 4.80×3.15 | 15.12 | 4.50×3.25 |
| 32 | 4.90×3.05 | 14.95 | 5.10×3.55 | 18.11 | 5.75×3.20 |
| 33 | 6.60×4.30 | 28.38 | 10.69×4.30 | 45.97 | 6.67×3.20 |
| 34 | 8.60×3.65 | 31.39 | 12.90×4.10 | 52.89 | 7.05×3.95 |
| 34 (micro) | 10.40×4.65 | 48.36 | 17.10×5.30 | 90.63 | 4.45×2.95 |
| 35 | 7.40×4.20 | 31.08 | 7.40×4.25 | 31.45 | 7.70×3.50 |
| 36 | 6.70×3.92 | 26.26 | 9.15×4.85 | 44.38 | 8.40×3.95 |
| 37 | 6.75×4.15 | 28.01 | 8.35×4.25 | 35.49 | 5.70×3.65 |
| 38 (micro) | 11.61×4.89 | 56.77 | 11.45×5.25 | 60.11 | 5.80×3.40 |
| 39 (micrs) | 6.55×4.05 | 26.53 | 15.67×6.06 | 94.96 | 5.15×3.30 |
| 40 | 4.20×2.55 | 10.71 | 6.00×3.40 | 20.40 | 5.65×3.35 |
| 41 | 5.85×3.30 | 19.31 | 5.00×3.45 | 17.25 | 6.63×3.88 |
| control | 2.00×1.10 | 2.20 | 2.94×1.81 | 5.32 | 2.50×2.08 |

experiments of all the strains

| tion 13) | IV (Inoculation Oct. 17) | | V (Inoculation Oct. 18) | | Average | |
|---|---|---|---|---|---|---|
| The product | Length (mm) × Width (mm) | The product | Length (mm) × Width (mm) | The product | Length (mm) × Width (mm) | The product |
| 57.19 | 7.40×4.00 | 29.60 | 5.55×3.45 | 19.15 | 7.80×3.86 | 30.11 |
| 15.68 | 6.00×3.75 | 22.50 | 5.60×3.20 | 17.92 | 5.54×3.35 | 18.56 |
| 19.93 | 7.40×3.40 | 25.16 | 12.20×4.35 | 53.07 | 8.02×3.72 | 29.83 |
| 32.63 | 6.70×3.50 | 23.45 | 7.25×3.30 | 23.93 | 6.49×3.46 | 22.46 |
| 12.42 | 6.10×3.65 | 22.27 | 6.60×3.50 | 23.10 | 5.59×3.46 | 19.34 |
| 14.70 | 5.25×3.25 | 17.06 | 6.95×3.40 | 23.63 | 6.14×3.61 | 22.17 |
| 48.84 | 6.05×3.40 | 20.57 | 7.50×3.45 | 25.88 | 7.99×3.79 | 30.28 |
| 18.69 | 5.80×3.25 | 18.85 | 7.90×3.40 | 26.86 | 6.97×3.61 | 25.16 |
| 28.50 | 6.00×3.45 | 20.70 | 7.30×3.30 | 24.09 | 6.31×3.45 | 21.77 |
| 23.98 | 6.80×3.45 | 23.46 | 6.90×3.55 | 24.50 | 6.77×3.50 | 23.70 |
| 31.59 | 6.30×3.60 | 22.68 | 7.00×3.90 | 27.30 | 7.24×3.85 | 27.87 |
| 25.80 | 6.75×3.85 | 25.99 | 6.10×3.30 | 20.13 | 6.84×3.92 | 26.81 |
| 20.88 | 7.70×3.60 | 27.72 | 6.60×3.45 | 22.77 | 6.45×3.55 | 22.90 |
| 29.45 | 7.60×3.45 | 26.22 | 6.20×3.55 | 22.01 | 6.33×3.41 | 21.59 |
| 19.46 | 7.80×3.70 | 28.86 | 5.80×3.00 | 17.40 | 6.70×3.64 | 24.39 |
| 30.62 | 7.60×4.05 | 30.78 | 7.80×3.40 | 26.52 | 7.36×3.72 | 27.38 |
| 26.60 | 5.75×3.55 | 20.41 | 5.50×3.00 | 16.50 | 6.82×3.62 | 24.69 |
| 37.84 | 10.80×4.40 | 47.52 | 5.65×3.05 | 17.23 | 8.42×4.22 | 35.53 |
| 22.43 | 7.10×3.25 | 23.08 | 6.89×3.50 | 24.12 | 7.00×3.53 | 24.71 |
| 21.95 | 6.80×3.45 | 23.46 | 5.15×3.50 | 18.03 | 6.12×3.60 | 22.03 |
| 31.57 | 4.56×3.17 | 14.46 | 6.90×3.50 | 24.15 | 6.48×3.59 | 23.26 |
| 19.88 | 5.75×3.40 | 19.55 | 6.90×3.45 | 23.81 | 5.55×3.35 | 18.59 |
| 54.60 | 7.00×3.35 | 23.45 | 5.90×3.15 | 18.59 | 7.90×3.76 | 29.70 |
| 23.06 | 8.44×4.17 | 35.19 | 7.50×4.15 | 31.13 | 7.66×3.94 | 30.18 |
| 18.72 | 7.31×3.75 | 27.41 | 4.85×3.00 | 14.55 | 8.70×4.14 | 36.02 |
| 23.63 | 6.80×3.50 | 23.80 | 6.88×3.38 | 23.25 | 6.90×3.66 | 25.25 |
| 19.18 | 4.95×3.10 | 15.35 | 7.00×3.00 | 21.00 | 6.36×3.44 | 21.88 |
| 17.01 | 6.60×3.40 | 22.44 | 5.75×3.10 | 17.83 | 6.14×3.43 | 21.06 |
| 14.63 | 6.60×3.45 | 22.77 | 6.63×3.54 | 23.47 | 5.71×3.27 | 18.67 |
| 18.40 | 5.80×3.45 | 20.01 | 5.00×3.30 | 16.50 | 5.31×3.27 | 17.36 |
| 21.34 | 7.20×3.65 | 26.28 | 5.00×3.05 | 15.25 | 7.23×3.70 | 26.75 |
| 27.85 | 9.10×4.75 | 43.23 | 8.83×3.05 | 26.93 | 9.30×3.90 | 36.27 |
| 13.13 | 9.00×4.80 | 43.20 | 4.15×2.85 | 11.83 | 9.02×4.11 | 37.07 |
| 26.95 | 4.60×3.15 | 14.49 | 6.90×3.55 | 24.50 | 6.80×3.73 | 25.36 |
| 33.18 | 6.10×3.15 | 19.22 | 6.60×3.45 | 22.77 | 7.39×3.86 | 28.53 |
| 20.81 | 6.10×3.30 | 20.13 | 4.94×2.89 | 14.28 | 6.37×3.65 | 23.25 |
| 19.72 | 8.50×3.65 | 23.73 | 7.10×3.50 | 24.85 | 8.49×4.14 | 35.15 |
| 17.00 | 8.00×3.35 | 26.80 | 6.10×3.40 | 20.74 | 8.29×4.03 | 33.41 |
| 18.93 | 3.50×3.10 | 10.85 | 4.70×2.90 | 13.63 | 4.81×3.06 | 14.72 |
| 25.72 | 5.40×3.60 | 19.44 | 7.20×3.35 | 24.12 | 6.02×3.52 | 21.19 |
| 5.20 | 2.21×2.00 | 4.42 | 2.57×2.00 | 5.14 | 2.44×1.80 | 4.39 |

(3) Discussion

When we look over the table 2, it is evident that invaded areas by every strain are much larger than the injured but not inoculated areas of control. These results seem to suggest that all the strains are, more or less, pathogenic to mulberry stems. Though the invaded areas by no. 40 strain, which is isolated from *Rubus sp.* and identified by WOLLENWEBER with *F. lateritium* NEES, are the smallest of all at the mean value, they are also far larger than the control. And the remarkable and extraordinary differences between the invaded areas by no. 40 strain and those by the other strains can not be recognized. Considering that no. 40 has been cultured for many years (since 1926) and the vitality has become weakened (as it is presumed so when the results of the writer's inoculation experiments of it to apples are compared with those of the same experiments by NISHIKADO (9) in 1937), the writer can not but assert that in the pathogenicity to the mulberry trees this strain (*F. lateritium* NEES) is not essentially different at all from the other strains.

Secondary, the writer is going to discuss on the degree of pathogenicity of all the strains. When significance for differences among the mean values of the areas is tested, it can be proved that all the strains cannot be divided into definite groups which are clearly uncontinuous. The above conclsion can be induced also by the following example : the differences ($\bar{X}$) between the mean value of no. 32 (which is the smallest of all strains isolated from mulberry trees) and the mean values of the others, their estimates of unbiased variances ($u^2$), and F ($=t^2=\frac{(\bar{X}-O)^2}{u^2}N$) are shown in the table 3.

Table 3. Results of the significance test for the differences between the mean value of no. 32 and the mean values of the others

| No. of strain | X | $U^2$ | F | No. of strain | X | $U^2$ | F |
|---|---|---|---|---|---|---|---|
| 1 | 12.75 | 226.17 | 3.59 | 24 | 5.90 | * 68.16 | 2.55 |
| 2 | 1.20 | 5.47 | 1.32 | 25 | 1.23 | 28.24 | 0.27 |
| 4 | 12.47 | 204.29 | 3.81 | 26 | 12.34 | 229.37 | 3.32 |
| 5 | 5.10 | 39.86 | 3.28 | 28 | 12.82 | 41.53 | 19.79* |
| 6 | 1.98 | 22.44 | 0.87 | 28(micro) | 18.66 | 1020.30 | 1.71 |
| 6 (micro) | 4.81 | 73.38 | 1.58 | 29 | 7.89 | 10.95 | 28.42** |
| 7 | 12.92 | 129.94 | 6.42 | 29(micro) | 4.52 | 14.03 | 7.28 |
| 8 | 7.80 | 320.70 | 0.95 | 30 | 3.70 | 21.18 | 2.23 |
| 9 | 4.41 | 34.31 | 2.83 | 31 | 1.31 | 19.57 | 0.44 |

| No. of slrain | $\bar{X}$ | $U^2$ | F | No. of strain | $\bar{X}$ | $U^2$ | F |
|---|---|---|---|---|---|---|---|
| 10 | 6.34 | 1.15 | 174.78** | 33 | 9.39 | 141.30 | 3.12 |
| 11 | 10.51 | 78.08 | 7.08 | 34 | 18.91 | 107.31 | 16.66* |
| 12 | 9.45 | 91.20 | 4.90 | 34(micro) | 19.71 | 1255.08 | 1.55 |
| 14 | 5.54 | 1.03 | 148.98** | 35 | 8.00 | 71.43 | 4.48 |
| 16 | 4.23 | 33.86 | 2.64 | 36 | 11.17 | 113.14 | 5.51 |
| 18 | 7.03 | 28.97 | 8.53* | 37 | 5.89 | 77.48 | 2.24 |
| 19 | 10.02 | 18.40 | 27.28** | 38(micro) | 17.79 | 503.96 | 3.14 |
| 20 | 7.33 | 51.47 | 5.22 | 39(micro) | 16.05 | 1204.51 | 1.07 |
| 21 | 18.17 | 334.62 | 2.51 | 40 | 2.64 | 20.19 | 1.73 |
| 22 | 7.35 | 33.99 | 7.94* | 41 | 3.83 | 14.59 | 5.03 |
| 23 | 4.67 | 12.73 | 8.57 | | | | |

Note ; *, ** showing to be significant in less than 5% and 1% danger respectively.

when we look over the table 3, it is evident that the differences between no. 32 and nos. 10, 14, 18, 19, 22, 28, 29, and 34 are significant in less than 5% danger but the differences between the former and the other strains than the latter are not significant. However, in detail the high and low values of F depend mainly not on $\bar{X}$ but on the variations of $u^2$ and so more precise plan of experiments must be carried out in future.

## IV. CLASSIFICATION BY WOLLENWEBER'S TAXONOMIC SYSTEM

WOLLENWEBER [22], and WOLLENWEBER and REINKING [23] state that ascospores, microconidia, chlamydospores, macroconidia (especially their size, shape and foot cell development), colours on cultivated stromata and growth types etc. are the signs of *Fusrium* classification. They classify all *Fusaria* into 16 sections. From these point of view the writer researched to what section do all the writer's strains belong.

1. Taxonomic Signs Which the Writer's Strains Showed

(1) Ascospore There is no doubt that the ascospore is the most important sign in classification of any system, as ascospore is the result of sexual reproduction. On mulberry stem media perithecia are easily formed by many strains, but it does not ripen so far as the writer's investigations are concerned. But, under natural conditions the writer could often find the ripened ascospores on dead mulberry stems.

Perithecial storomata are found scatterd or grouped in such manner on the surface of dead mulberry stems as perithecial stromata are rising from

under the cork layer, and they are roundish or irregular, black, and generally 1/4—1/2mm but some times 2—4mm in diameter. Perithecia form a group which has several of them on each stroma, and they are dark blue, globose or globose-ovoid, 180—230 $\mu$ in diameter and 180—260 $\mu$ in height. Asci are cylindrical or elongated-clavate, 56—90×8.0—10.0 $\mu$, and each ascus has 8-ascospores. Ascospores are elliptical or ovoid, 0-3 septate, hyaline, 11-16 ×4.0—6.0 $\mu$ (0-septate), 13—18×5.0—6.0 $\mu$ (1-septate), and 16—22×5.0—7.0 $\mu$ (3-septate). These characters resemble those of *Gibberella baccata* (WALLR.) SACC., *G. baccata* (WALLR.) v. *moricola* (D. NTRS.) WR. and *G. moricola* (DE NOT.) SACC. [22,23,24], and the writer can not recognize the essential difference among them and need not divide them into distinct species.

The strains isolated from ascospore or perithecia formed generally unripe perithecia on mulberry stem media, but some of the strains (nos. 32 and 33) have not formed perithecia at all. But there are also many strains which were isolated from conidial stage without any consideration on the formation of perithecia or ascospores. The degrees of perithecial formation on mulberry stem media of all the strains will be described in the following chapter in detail.

(2) Pyriform microconidium Pyriform microconidium is characteristic of Section *Sporotrichiella* in WOLLENWEBER'S system [23]. Pyriform microconidium has not been reported to appear in *Fusarium sp.* which causes the bud blight of mulberry trees. But it was known by the writer that pyriform microconidium showed itself in the cultures of nos. 1, 5, 6, 9, 28, 29, and 34, as if saltants appeared. Single spore cultures of these microconidia produced usually the same pyriform microconidia and yielded very rarely the conidia which seemed to be the macroconidia. The strains (nos. 38 and 39) which resemble these pyriform strains were also isolated from dead mulberry stems under the natural condition. These pyriform microconidia are 0—1 septate and hyaline. The sizes of them are given in the table 4.

Table 4. Results of measurement of pyriform microconidia on various media

| Kind of medium | No. of strain | 0-septate spore | | 1-septate spore | |
|---|---|---|---|---|---|
| | | Range ($\mu$) | Mean ($\mu$) | Range ($\mu$) | Mean ($\mu$) |
| Mulberry stem | 6(micro) | 12×7.0 | — | 12—22×6.0—10.0 | 16.4× 8.50 |
| | 28(micro) | 10×7.0 | — | 12—24×6.0—12.0 | 18.0× 9.57 |
| | 29(micro) | 12—20×6.0—12.0 | 16.0×9.0 | 14—24×8.0—12.0 | 18.1×10.28 |
| | 34(micro) | 10—12×6.0— 8.0 | 11.5×7.0 | 12—22×6.0—10.0 | 17.2× 8.35 |
| | 38(micro) | 14—18×6.0— 8.0 | 16.0×7.0 | 10—22×6.0—12.0 | 17.0× 8.61 |
| | 39(micro) | 14×7.5 | — | 12—22×6.0—12.0 | 17.0× 9.33 |

| Kind of medium | No. of strain | 0-septate spore | | 1-septate spore | |
|---|---|---|---|---|---|
| | | Range ($\mu$) | Mean ($\mu$) | Range ($\mu$) | Mean ($\mu$) |
| Potato decoction agar (1% glucose added) | 6(micro) | 16×8.0 | — | 12—22×6.0—12.0 | 17.0× 8.32 |
| | 28(micro) | — | — | 12—22×6.0—12.0 | 16.7× 8.63 |
| | 29(micro) | — | — | 14—22×7.0—12.0 | 17.3× 9.61 |
| | 34(micro) | — | — | 12—20×5.0—10.0 | 16.0× 7.82 |
| | 38(micro) | 14—20×6.0—10.0 | 16.7×7.33 | 14—22×8.0—12.5 | 18.9×10.14 |
| | 39(micro) | 16×10.0 | — | 12—22×8.0—12.0 | 17.2× 9.45 |
| Steamed rice | 6(micro) | — | — | 10—22×6.0—12.0 | 16.0× 8.44 |
| | 28(micro) | 14×7.0 | — | 12—22×6.0—12.0 | 16.0× 9.89 |
| | 29(micro) | 10—14×6.0—10.0 | 12.0×8.0 | 12—22×6.0—12.0 | 16.4× 9.41 |
| | 34(micro) | 12×10.0 | — | 12—22×6.0—12.0 | 17.4× 8.23 |
| | 38(micro) | 12—14×6.0 | 12.5×6.0 | 12—22×6.0—12.0 | 17.1× 9.70 |
| | 39(micro) | 10—14×6.0 | 12.0×6.0 | 12—22×5.0—12.0 | 16.7× 9.18 |

Note ; The measurement of microconidia was done after a month's culture at 24-26°C. The sizes of the pyriform microconidia of nos. 1, 5, and 9 resemble those of the pyriform microconidia which were shown in this table.

(3) Chlamydospore WOLLENWEBER [22], and WOLLENWEBER and REINKING[23] regarded the presence or absence of terminal and intercalary chlamydospore on hyphae as a very important taxonomic sign in *Fusarium* classification. *Fusarium lateritium* NEES v. *Mori* DESM. [*Gibberella baccata* (WOLLR.) SACC. v. *molicola* (D. NTRS.) WR.] which is the causal fungus of the bud blight of mulberry trees in WOLLENWEBER's system, does not produce chlamydospore except on conidia [22, 23]. From the results of the writer's investigations for several years, it was ascertained that nos. 1, 2, 8, 9, 10, 11, 14, 16, 19, 20, 21, 24, 25, 26, 28, 29, 30, 32, 33, 35, 36, and 37 produce both terminal chlamydospores and intercalary chlamydospores, but nos. 5, 6, 7, 18, 23, 31, 40, and 41 produce only intercalary chlamydospores and nos. 4, 6 (micro), 12, 22, 28 (micro), 29 (micro), 34, 34(micro), 38 (micro), and 39 (micro) yielded neither a terminal chlamydospore nor an intercalary chlamydospore. The partial swellings of hyphae which seem to be the juvenile type of chlamydospores were found in most strains. These strains contain some strains in which chlamydospores have not been found yet. The sizes of the chlamydospores are generally 8—20×8—20 $\mu$, and the thickness of the membranes of the chlamydospores is generally 1 $\mu$, but sometimes more than 2 $\mu$.

(4) Macroconidium Macroconidium is the most remarkable characteristic of genus *Fusarium*. Accoding to the statements of WOLLENWEBER [22], and WOLLENWEBER and REINKNG [23], the shape, size and foot cell development of macroconidium are the important signs of *Fusarium* classification. All the shapes of macroconidia are typical sickle-form and the writer cannot find any remarkably different shape among them. The foot cell development of macroconidia has been found in all strains except nos. 19, 21, and 36.

Table 5. Results of measurement of macroconidia

| No. of strain | Existence type of spore | Number of septum | 1-septate spore | |
|---|---|---|---|---|
| | | | Range ($\mu$) | Mean ($\mu$) |
| 1 | Sporodochia | 0—3 | 16—30×2.0—3.0 | 24.0×2.48 |
| 2 | do. | 3—5 | — | — |
| 4 | do. | 3—5 | — | — |
| 5 | do. | 1—4 | 16—26×2.5—3.0 | 20.3×2.83 |
| 6 | On hyphae | 1—3 | 12—24×2.0—3.0 | 17.5×2.58 |
| 7 | Sporodcchia | 3—6 | — | — |
| 8 | do. | 3—5 | — | — |
| 9 | do. | 1—4 | 18—26×2.5—3.0 | 21.3×2.58 |
| 10 | do. | 1—3 | 16—24×2.0—2.5 | 20.7×2.28 |
| 11 | do. | 1—5 | 18×3.0 | — |
| 12 | do. | 2—5 | — | — |
| 14 | do. | 0—4 | 10—20×2.5—3.0 | 13.8×2.68 |
| 16 | do. | 3—5 | — | — |
| 18 | do. | 1—5 | 14—22×2.0—3.0 | 19.3×2.50 |
| 19 | do. | 0—5 | 12—20×2.0—3.0 | 17.0×2.50 |
| 20 | do. | 3—5 | — | — |
| 21 | do. | 1—5 | 12—14×2.5 | 13.0×2.50 |
| 22 | do. | 3—5 | — | — |
| 23 | do. | 3—5 | — | — |
| 24 | do. | 1—5 | 16—18×2.0 | 17.0×2.00 |
| 25 | do. | 0—5 | 22—26×2.0—2.5 | 24.0×2.25 |
| 26 | do. | 3—5 | — | — |
| 28 | do. | 1—5 | 16—22×2.0 | 20.0×2.00 |
| 29 | do. | 3—5 | — | — |
| 30 | do. | 1—4 | 12—20×2.0—2.5 | 16.0×2.26 |
| 31 | do. | 1—5 | 14—22×2.0—2.5 | 17.3×2.17 |
| 32 | do. | 3—5 | — | — |
| 33 | do. | 2—5 | — | — |
| 34 | do. | 1—5 | 12—22×2.5—3.0 | 17.2×2.64 |
| 35 | On hyphae | 1—5 | 10—24×2.0—3.0 | 19.5×2.42 |
| 36 | do. | 0—3 | 8—18×2.5—3.5 | 13.8×2.99 |
| 37 | Sporodochia | 3—5 | — | — |
| 41 | do. | 2—5 | — | — |

Note ; nos. 38, 39 and 40 have not formed the macroconidia on the mulberry

on mulberry stem media

| 3-septate spore | | 5-septate spore | |
|---|---|---|---|
| Range ($\mu$) | Mean ($\mu$) | Range ($\mu$) | Mean ($\mu$) |
| 24—44×2.5—3.5 | 35.1×2.90 | — | — |
| 30—40×3.0—4.0 | 35.4×3.42 | 36—50×3.0—4.0 | 44.0×3.50 |
| 24—42×2.5—4.0 | 36.1×3.18 | 34—48×3.0—4.0 | 41.4×3.33 |
| 24—40×2.5—3.5 | 31.1×3.03 | — | — |
| 24—46×2.5—4.0 | 33.1×2.95 | — | — |
| 32—46×3.0—4.0 | 39.3×3.25 | 38—56×2.5—4.0 | 48.9×2.96 |
| 32—48×2.5—4.0 | 43.3×3.26 | 44—52×3.0—4.5 | 48.8×3.74 |
| 22—34×2.5—3.5 | 29.9×2.76 | — | — |
| 24—38×2.0—3.0 | 32.2×2.61 | — | — |
| 20—24×2.5—4.0 | 30.9×3.18 | 34—38×3.0—3.5 | 36.0×3.17 |
| 22—36×2.5—3.5 | 28.8×2.86 | 34—38×2.5—3.0 | 35.6×2.80 |
| 20—38×2.0—3.5 | 27.8×2.80 | — | — |
| 24—38×2.0—3.5 | 31.1×2.74 | 38—42×2.5—3.0 | 40.5×2.63 |
| 26—44×2.5—3.5 | 34.8×2.85 | 36—50×3.0—4.0 | 43.6×3.25 |
| 20—36×2.5—3.5 | 28.7×2.95 | 34—44×3.0—3.5 | 40.0×3.25 |
| 26—36×3.0—4.0 | 32.4×3.40 | 38—48×3.0—4.0 | 41.9×3.93 |
| 18—42×2.5—4.5 | 32.0×2.85 | 36—44×3.0—4.0 | 39.0×3.22 |
| 22—38×2.0—3.5 | 30.7×3.16 | 46×3.0 | — |
| 26—38×2.0—3.0 | 32.8×2.70 | 34—48×2.5—3.5 | 39.8×2.87 |
| 20—36×2.0—3.0 | 30.3×2.54 | 36—40×2.5—3.0 | 38.0×2.75 |
| 30—44×2.5—3.0 | 36.2×2.83 | 40—50×3.0—4.0 | 45.0×3.25 |
| 28—44×2.5—3.5 | 35.2×3.09 | 40—52×3.0—3.5 | 45.6×3.13 |
| 24—36×2.0—3.0 | 30.2×2.44 | 38—40×3.0 | 39.0×3.00 |
| 32—36×2.5—3.5 | 33.7×2.92 | 32—46×2.5—3.5 | 41.3×3.04 |
| 20—38×2.0—3.5 | 31.0×2.33 | — | — |
| 24—40×2.0—3.0 | 32.6×2.29 | 34—46×2.0—2.5 | 41.4×2.31 |
| 26—46×3.0—4.0 | 36.5×3.41 | 28—56×3.0—4.0 | 42.2×3.53 |
| 18—38×2.0—3.5 | 30.2×2.71 | 30—46×2.5—4.0 | 39.6×3.24 |
| 30—44×2.5—3.0 | 36.9×2.72 | 44—52×3.0 | 46.6×3.00 |
| 18—36×2.0—3.5 | 28.7×2.79 | 36—50×3.0—4.0 | 43.0×3.60 |
| 16—30×3.0—4.0 | 21.8×3.40 | — | — |
| 32—50×2.5—3.0 | 41.1×2.71 | 42—60×2.5—3.5 | 49.9×3.15 |
| 24—40×2.0—3.5 | 33.0×2.88 | 36—38×3.5—4.0 | 36.8×3.80 |

stem media.

Table 6. Results of measurement of macroconidia on potato

| No. of strain | Existence type of spore | Number of septum | 1-septate spore | |
|---|---|---|---|---|
| | | | Range ($\mu$) | Mean ($\mu$) |
| 1 | Sporodochia | 0—5 | 10—26×2.0—3.0 | 18.4×2.38 |
| 2 | do. | 3—7 | — | — |
| 4 | do. | 0—5 | 8—24×2.0—6.0 | 15.6×4.33 |
| 5 | Pionnotes | 1—6 | 16—28×2.0—3.5 | 23.8×2.69 |
| 6 | On hyphae | 0—3 | 10—24×2.0—3.0 | 15.8×2.58 |
| 7 | Pionnotes | 0—4 | 12—24×2.5—3.0 | 18.3×2.87 |
| 8 | Sporodochia | 2—5 | — | — |
| 9 | do. | 0—5 | 14—24×2.0—3.0 | 18.7×2.60 |
| 10 | Pionnotes | 1—5 | 18—28×2.5—3.0 | 23.4×2.64 |
| 11 | On hyphae | 0—3 | 8—22×2.0—3.0 | 15.5×2.80 |
| 12 | Pionnotes | 0—3 | 10—22×2.0—3.0 | 17.8×2.52 |
| 14 | do. | 1—5 | 16—28×2.0—3.0 | 20.5×2.19 |
| 16 | Sporodochia | 0—5 | 10—22×2.5—3.0 | 16.4×2.72 |
| 18 | do. | 3—5 | — | — |
| 19 | Pionnotes | 0—5 | 8—20×2.5—5.0 | 13.6×3.34 |
| 20 | Sporodochia | 1—5 | 20—22×2.0—2.5 | 21.0×2.25 |
| 21 | On hyphae | 0—5 | 10—18×2.5—5.0 | 12.0×3.14 |
| 22 | Sporodochia | 1—4 | 14—40×2.5—3.0 | 18.0×2.89 |
| 23 | do. | 1—4 | 16—22×3.0—2.5 | 19.1×2.21 |
| 24 | Pinnotes | 1—3 | 12—22×2.0—2.5 | 17.2×2.29 |
| 25 | Sporodochia | 0—3 | 12—22×2.5—3.0 | 18.5×2.64 |
| 26 | do. | 3—5 | — | — |
| 28 | do. | 1—4 | 12—26×2.0—3.5 | 18.8×2.64 |
| 29 | Pionntes | 0—4 | 10—22×2.0—3.0 | 15.7×2.49 |
| 30 | Sporodochia | 1—5 | 12—24×2.0—3.0 | 17.6×2.32 |
| 31 | Pionntes | 0—3 | 14—26×2.0—3.5 | 19.0×2.50 |
| 32 | On hyphae | 2—5 | — | — |
| 33 | Sporodochia | 4—6 | — | — |
| 34 | do. | 3—5 | — | — |
| 35 | On hyphae | 0—3 | 12—22×2.0—3.5 | 17.8×2.47 |
| 36 | do. | 1—5 | 10—14×2.5—3.0 | 12.3×2.71 |
| 37 | Sporodochia | 2—4 | — | — |
| 40 | On hyhae | 0—5 | 16—26×3.0—4.0 | 22.3×3.17 |

Note ; Nos. 38, 39, and 41 have not formed the macroconidia on the potato

decoction agar (1% glucose added) media

| 3-septate spore | | 5-septate spore | |
|---|---|---|---|
| Range ($\mu$) | Mean ($\mu$) | Range ($\mu$) | Mean ($\mu$) |
| 18—32×2.0—4.0 | 24.9×2.42 | 24—30×2.0—3.0 | 27.5×2.45 |
| 30—40×2.0—3.0 | 33.2×2.08 | 34—50×2.0—3.0 | 43.6×2.26 |
| 16—34×2.0—6.0 | 28.6×3.61 | 28—32×3.0—4.0 | 28.7×3.33 |
| 28—46×2.5—3.5 | 37.6×3.21 | 48—52×2.5—3.5 | 49.7×3.14 |
| 20—30×2.5—3.5 | 23.7×2.80 | — | — |
| 22—38×3.0—4.0 | 28.7×3.23 | — | — |
| 28—44×2.0—3.0 | 36.7×2.36 | 42—60×2.0—3.5 | 50.5×3.00 |
| 24—38×2.0—3.0 | 30.0×3.05 | 36×3.0 | — |
| 28—44×2.5—3.5 | 35.0×2.95 | 46—50×3.0—3.5 | 47.0×3.38 |
| 20—28×2.5—3.0 | 23.7×2.75 | — | — |
| 22—36×2.0—4.0 | 27.5×3.06 | — | — |
| 22—46×2.0—3.5 | 34.5×2.98 | 54×3.0 | — |
| 20—42×2.5—3.5 | 30.0×2.99 | 42—46×3.0—3.5 | 43.3×3.33 |
| 24—58×3.0—3.5 | 38.7×3.33 | 30—56×3.5—4.0 | 49.3×3.93 |
| 22—34×3.0—4.0 | 27.8×3.83 | 28—38×4.0 | 33.0×4.00 |
| 22—40×2.0—3.0 | 31.1×2.48 | 36—50×2.5—3.5 | 42.3×3.00 |
| 14—34×3.0—5.5 | 23.7×3.82 | 28—38×4.0—5.5 | 32.8×4.55 |
| 18—38×2.5—4.0 | 29.0×3.36 | — | — |
| 20—36×2.0—3.5 | 27.4×3.08 | — | — |
| 20—38×2.5—3.0 | 27.8×2.77 | — | — |
| 22—40×2.0—3.0 | 28.3×2.63 | — | — |
| 12—54×2.5—4.0 | 40.3×3.22 | 40—58×3.0—4.0 | 46.3×3.48 |
| 22—40×2.5—4.0 | 30.4×3.35 | — | — |
| 20—34×2.5—3.5 | 27.1×3.07 | — | — |
| 20—40×2.5—3.5 | 29.6×2.99 | 40×3.5 | — |
| 22—40×2.5—3.5 | 29.4×3.09 | — | — |
| 20—34×2.5—3.0 | 28.6×2.63 | 30—36×2.0—3.0 | 33.0×2.75 |
| — | — | 40—64×2.0—3.5 | 48.0×2.82 |
| 28—42×2.5—3.5 | 34.5×2.99 | 38—42×3.0—3.5 | 40.0×3.20 |
| 20—34×2.5—3.5 | 25.7×2.95 | — | — |
| 18—34×2.5—4.5 | 24.3×3.33 | 30—40×3.5—4.5 | 35.5×4.07 |
| 28—44×2.5—3.5 | 36.0×2.86 | — | — |
| 24—36×3.0—3.5 | 29.6×3.10 | 34×3.5 | — |

decoction agar (1% glucose added).

Table 7. Results of measurement of macroconidia

| No. of strain | Existence type of spore | Number of septum | 1-septate spore | |
|---|---|---|---|---|
| | | | Range ($\mu$) | Mean ($\mu$) |
| 1 | Sporodochia | 0—5 | 8—24×2.0—3.5 | 17.0×2.22 |
| 2 | do. | 0—6 | 14—22×2.0—3.0 | 18.0×2.60 |
| 4 | do. | 0—3 | 6—20×2.0 | 13.9×2.00 |
| 5 | Pionnotes | 1—4 | 18—22×2.0—3.5 | 20.0×2.75 |
| 7 | Sporodochia | 0—4 | 10—22×2.0—3.0 | 15.5×2.38 |
| 8 | do. | 3—5 | — | — |
| 9 | Pionnotes | 2—6 | — | — |
| 10 | do. | 1—5 | 12—28×2.0—3.0 | 19.0×2.28 |
| 12 | On hyphae | 1—5 | 10—24×2.0—2.5 | 18.0×2.25 |
| 14 | do. | 0—3 | 12—24×2.0—3.0 | 18.8×2.35 |
| 16 | Sporodchia | 3—5 | — | — |
| 18 | do. | 1—5 | 12—22×2.0—3.0 | 17.3×2.33 |
| 20 | Pionnotes | 0—3 | 12—24×2.0—3.5 | 18.9×2.34 |
| 21 | On hyphae | 1—5 | 8—18×3.0—3.5 | 13.4×3.14 |
| 23 | do. | 0—3 | 10—20×2.0—3.0 | 14.2×2.50 |
| 24 | Pionnotes | 0—3 | 8—24×2.0—2.5 | 18.0×2.00 |
| 26 | Sporodochia | 4—6 | — | — |
| 28 | Pionnotes | 0—3 | 10—18×1.5—2.0 | 13.7×1.99 |
| 29 | do. | 1—3 | 12—22×1.5—2.5 | 16.0×2.00 |
| 30 | do. | 0—3 | 12—26×2.0 | 18.0×2.00 |
| 31 | do. | 1—3 | 14—24×2.0—2.5 | 19.1×2.25 |
| 32 | On hyphae | 0—1 | 16—24×2.0—3.0 | 19.9×2.37 |
| 33 | Sporodochia | 1—5 | 14×2.5 | — |
| 34 | Pionnotes | 1—4 | 14—24×2.5—3.0 | 19.6×2.70 |
| 35 | On hyhae | 0—1 | 12—18×2.0—4.5 | 15.3×3.69 |
| 36 | do. | 0—3 | 10—20×2.0—3.5 | 14.2×2.59 |

Note ; Nos. 6, 11, 19, 22, 25, 37, 38, 39, 40, and 41 have not formed the macroconidia

on steamed rice media

| 3-septate spore | | 5-septate spore | |
|---|---|---|---|
| Range ($\mu$) | Mean ($\mu$) | Range ($\mu$) | Mean ($\mu$) |
| 18—38×2.0—3.0 | 25.1×2.46 | 42×3.0 | — |
| 22—40×2.0—3.5 | 32.4×2.40 | 34—48×2.0—3.5 | 41.6×2.58 |
| 12—30×2.0—3.0 | 20.4×2.03 | — | — |
| 22—42×2.0—3.0 | 30.5×2.47 | — | — |
| 26—44×2.0—3.0 | 32.1×2.32 | — | — |
| 32—46×2.5—3.5 | 41.6×3.10 | 40—54×3.0—4.0 | 47.6×3.60 |
| 24—40×2.0—3.0 | 32.4×2.56 | 34—42×3.0 | 37.6×3.00 |
| 22—36×2.5—3.5 | 28.6×2.64 | 34—42×2.5—3.5 | 38.7×2.83 |
| 18—34×2.0—3.0 | 26.3×2.58 | 32—44×2.5—3.5 | 36.2×2.90 |
| 24—30×2.5 | 26.7×2.50 | — | — |
| 24—40×2.5—3.0 | 32.8×2.64 | 36—40×2.5—3.0 | 38.0×2.89 |
| 22—40×2.0—3.0 | 32.5×2.58 | 34—36×2.5—3.0 | 35.3×2.83 |
| 20—36×2.0—3.5 | 26.6×2.56 | — | — |
| 16—32×3.0—6.0 | 22.4×3.88 | 24—40×4.0—5.5 | 32.6×4.50 |
| 18—28×2.0—3.0 | 22.6×2.50 | — | — |
| 20—30×2.0—2.5 | 25.3×2.19 | — | — |
| — | — | 26—56×2.0—4.0 | 42.9×2.83 |
| 18—26×2.0—2.5 | 22.2×2.25 | — | — |
| 16—44×2.0—3.0 | 28.1×2.19 | — | — |
| 18—40×2.0—3.0 | 25.1×2.11 | — | — |
| 26—36×2.0—2.5 | 30.3×2.34 | — | — |
| — | — | — | — |
| 30—44×2.5—3.0 | 35.7×2.75 | 38—64×2.5—3.5 | 49.5×2.91 |
| 24—38×2.5—3.0 | 30.4×2.75 | — | — |
| — | — | — | — |
| 18—24×2.0—3.5 | 21.1×2.74 | — | — |

on the steamed rice.

Further investigations are to be done on these 3 strains. The measurment of macroconidia was done after a month's culture at 24—26°C. The sizes of macroconidia are given in the table 5—7 in which the results of the measurment of 0, 2, 4, and 6 septate spores are omitted.

The length of macroconidia changes fairly much by the existence-type of spore. Attention must be paied to the existence-type when we compare the sizes of the macroconidia of the strains one another. Even though macroconidia are produced on the same existence-type as well as on the same media, statistically appreciable differences of the mean values of the length of macroconidia can be found among some strains. These differences seem to be regarded as a point of species division by WOLLWNWEBER [22], and WOLLWNWEBER and REINKING [23], but other scientists [1, 18, 19] generally disregarded that point.

(5) Colours of Cultural Stromata and Growth Types Colours of cultural stromata and growth types are also enumarated by WOLLENWEBER [22], and WOLLENWEBER and REINKING [23] among the signs which divide species and varieties in *Fusarium*. These characters which all the strains show will be described in the following chapter in detail.

2. Sections to Which All Strains Belong

From the results of the investigations concerning WOLLENWEBER'S taxonomic signs which were mentioned in the previous section, all the atrains are classified into 4 groups as follows:—

Group 1 (Section *Lateritium*) Nos. 4, 7, 12, 18, 22, 23, 31, and 40 belong to this group. These strains exhibit the characters of this Section *Lateritium*. Most of them form perithecia which resemble those of *Gibberella baccata* [22, 23]. Some of these strains yield neither a terminal chlamydospore nor an intercalary chlamydospore, and the other strains produce only intercalary chlamydospores. WOLLENWEBER [22, 23] regarded *F. lateritium* NEES v. *Mori* DESM. as the causal fungus of the bud blight of mulberry trees, but the above eight strains seem to resemble rather the basic species, *F. lateritium* NEES, in the point that they exhibit deep blue colour on cultural stromata.

Group 2 (Section *Discolor*) Nos. 2, 8, 19, 21, 32, 33, 36, 37, and 41 belong to this group. These strains exhibit the characters of this Section *Discolor*. They form terminal chlamydospores and intercalary chlamydospores. They have not yielded perithecia.

Group 3 (Section *Lateritium* or Section *Discolor*) Nos. 10, 11, 14, 16, 20, 24, 25, 26, 30, and 35 belong to this group. These strains show the characters of both Section *Lateritium* and Section *Discolor*. They form perithecia

which resemble those of *Gibberella baccata* [22, 23], but produce both terminal chlamydospores and intercalary chlamydospores.

Group 4 (Section *Lateritium* or Section *Sporotrichiella*) Nos. 1, 5, 6, 9, 28, 29, 34, (38, and 39) belong to this group. These strains resemble the strains of Group 1 very much, but they produced pyriform microconidia which are the characteristic of Section *Sporotrichiella*. And some of the above strains form both terminal chlamydospores and intercalary chlamydospores, and among the rest there are some strains which produce only intercalary chlamydospores and also there are the other strains which produce neither a terminal chlamydospore nor a intercalary chlamydospore. In the above mentioned point also, this group of strains [Nos. 1, 5, 6, 9, 28, 29, 34, (38, and 39)] takes part in both Section *Lateritium* and section *Sporotrichiella*. As the writer stated before, pyriform microconidia appeared in the oultures of macroconidia type as if saltants appeared, and single spore cultures of these pyriform microconidia did not return to macroconidia type so far as the writer's investigations were concerned, and nos. 38 and 39 were isolated from microconidia type under natural conditions.

## V. SOME CHARACTERS OF THE STRAINS ON CULTURAL MEDIA

### 1. Pigment-productions on Cultural Stroma and Growth Types

(1) Methods

Five kinds of media ; citrus skin decoction agar, potato decoction agar (1% glucose added), potato decoction agar (5% glucose added), steamed rice (rice 2 gr to 6 cc distilled water) and potato plug (no water added) were used in these investigations. On these five kinds of media every strain was cultured at 25°C±1°C mere than three times (at each time five test tubes of medium were supplied for every kind of medium) and its pigment-productions on cultural stroma and growth types were investigated.

(2) Results

(a) Pigment-productions on Cultural Stroma : Pigment-productions of all the strains on cultural stroma do not seem to be simple. But the pigments that appeared conspicuously on it can be classified into two groups. One of them is the group of pigments which show Dusky Green and Deep Slate Olive etc. on the citrus skin decoction agar and the potato decoction agar (1% and 5% glucose added) ; Vistoris Lake, Purple Drub, Slate Color,

Hay's Russet and Mars Brown etc. on the steamed rice ; and Dusky Green, Deep Slate Olive, Vandyke Brown, Lincoln Green, and Chromium Green etc. on the potato plug. The other is the group of pigments which show Orange Red, Vandyke Red, Hay's Russet, Law Sienna, Burnt Sienna, Madder Brown, Oxblood Red and Cinnamon Rufous etc. on the citrus skin decoction agar and the potato decoction agar (1% and 5% glucose added), Orange Citrine, Law Sienna, Sudan Brown, Golden Yellow and Tawny Olive etc. on the steamed rice ; and Burnt Sienna, Vandyke Red, Eugenia Red, Vernonia Purple, Brick Red, Madder Brown, Pompeian Red, Law Sienna, and Tawny Olive etc. on the potato plug.

By the addition of acids, those colours on the citrus skin decoction agar and the potato decoction agar which occurred from the pigments belonging to the former group, that is to say, Dusky Green and Deep Slate Olive etc., are changed into reddish purple ; and those colours on the same media which occourred from the pigments belonging to the latter group, that is to say, Orange Red, Vandyke Red, and Hay's Russet etc., are also changed into yellow. By the addition of alkalis, those colours on the steamed rice which occurred from the pigments belonging to the latter group, that is to say, Orange Citrine and Law Sienna etc., are changed into purple. The writer calls here the fomer group of pigments "A group", and the latter group of pigments "B group". The productivities and production-types of these pigments of all strains are given in the table 8. The number of + in the table shows the productivities, and (+) means either a half value of + or less.

Table 8. Showing Pigment-productions on cultural stromata of all strains

| No. of strain | Citrus skin agar | | Potato decoction agar (1% glucose added) | | Potato decoction agar (5% glucose added) | | Steamed rice | | Potato plug | | Type |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | A | B | A | B | A | B | A | B | |
| 1 | − | − | ++ | − | ++ | − | ++ | − | +(+) | − | A |
| 2 | − | + | − | +(+) | − | + | − | ++ | − | + | B |
| 4 | + | − | +++ | − | +++ | − | ++ | − | +(+) | − | A |
| 5 | − | − | − | − | +(+) | − | (+) | − | (+) | − | A |
| 6 | (+) | − | (+) | − | (+) | − | (+) | − | (+) | − | A |
| 6 (micro) | − | − | − | − | − | − | − | − | − | − | − |
| 7 | − | − | (+) | − | +(+) | − | + | − | (+) | − | A |
| 8 | − | +(+) | − | ++ | (+) | +++ | − | +++ | − | ++ | A B |
| 9 | − | − | − | − | − | − | − | − | − | − | − |
| 10 | +(+) | − | ++ | − | +++ | − | ++(+) | − | ++ | − | A |
| 11 | + | − | − | − | + | − | + | − | (+) | − | A |

| No. of strain | Citrus skin agar | | Potato decoction agar (1% glucose added) | | Potato decoction agar (5% glucose added) | | Steamed rice | | Potato plug | | Type |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | A | B | A | B | A | B | A | B | |
| 12 | − | − | − | − | + | − | − | − | + | − | A |
| 14 | − | − | +(+) | − | +(+) | − | + | − | − | − | A |
| 16 | − | − | (+) | − | + | − | + | − | + | − | A |
| 18 | − | ++ | (+) | +++ | − | ++(+) | − | ++ | (+) | ++ | AB |
| 19 | − | + | (+) | + | − | − | − | ++ | − | + | AB |
| 20 | − | − | (+) | − | +(+) | − | + | − | + | − | A |
| 21 | − | − | − | + | − | ++(+) | − | + | − | + | B |
| 22 | + | − | + | − | +(+) | − | ++ | − | ++ | − | A |
| 23 | − | − | (+) | − | +(+) | − | + | − | − | − | A |
| 24 | − | − | (+) | − | +(+) | − | − | − | (+) | − | A |
| 25 | − | − | + | − | +(+) | − | + | − | − | − | A |
| 26 | − | (+) | + | ++ | − | + | − | ++ | + | ++ | AB |
| 28 | − | − | +(+) | − | +(+) | − | ++ | − | + | − | A |
| 28(micro) | − | − | − | − | − | − | − | − | − | − | − |
| 29 | + | − | + | − | +(+) | − | (+) | − | + | − | A |
| 29(micro) | − | − | − | − | − | − | − | − | − | − | − |
| 30 | − | − | (+) | − | ++ | − | (+) | − | (+) | − | A |
| 31 | − | − | (+) | − | − | − | (+) | − | (+) | − | A |
| 32 | − | + | − | + | − | ++ | − | ++ | − | + | B |
| 33 | (+) | + | − | ++ | − | ++ | − | +(+) | − | ++ | AB |
| 34 | − | − | (+) | − | +(+) | − | + | − | ++ | − | A |
| 34(micro) | − | − | − | − | − | − | − | − | − | − | − |
| 35 | − | ++ | +(+) | (+) | − | +++ | − | + | − | ++ | AB |
| 36 | − | + | − | + | − | ++ | − | + | − | ++ | B |
| 37 | − | +(+) | − | +(+) | − | +++ | − | ++ | − | ++ | B |
| 38(micro) | − | − | − | − | − | − | − | − | − | − | − |
| 39(micro) | − | − | − | − | − | − | − | − | − | − | − |
| 40 | − | − | − | − | − | + | (+) | − | − | − | AB |
| 41 | − | +(+) | − | + | − | ++ | − | ++ | − | ++ | B |

(b) Growth Types : BROWN and HORN [2] distinguished growth manners of *Fusaria* on a synthetic medium into 4 growth types ; Mycelial type, Sporodochial type, Pionnotal type and Long-spore type. Through the writer's investigations to distinguish growth manners of all the strains on five kinds of media into growth types, he observed usually mycelia, sporodochia, and pionnotes, but could not find the growth manner which seemed to be characteristic of BROWN and HORN's Long-spore type. And the writer observed sclerotia and powdery conidia together with mycelia, sporodochia and pionnotes as remarkable growth manners. These growth

Table 9. Showing growth types on

| No. of strain | Citrus skin agar | | | | | Potato decoction agar (1% glucose added) | | | | | Potato decoc (5% glucose | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | Sc | S | P | Po | M | Sc | S | P | Po | M | Sc |
| 1 | (+) | − | (+) | +(+) | − | + | (+) | + | ++ | − | +(+) | + |
| 2 | + | − | (+) | − | − | + | − | − | + | − | ++ | − |
| 4 | +(+) | (+) | − | + | − | + | − | + | ++ | − | (+) | − |
| 5 | + | − | + | − | − | +(+) | − | + | +(+) | − | + | + |
| 6 | +(+) | − | ++ | − | − | ++ | (+) | − | + | − | ++ | − |
| 6 (micro) | (+) | − | − | − | +++ | − | − | − | − | ++(+) | − | − |
| 7 | +(+) | − | +(+) | (+) | − | + | − | − | +(+) | − | (+) | − |
| 8 | ++ | − | ++ | − | − | ++ | − | + | − | − | ++(+) | − |
| 9 | + | − | ++(+) | − | − | + | − | + | +(+) | − | ++ | − |
| 10 | + | (+) | +(+) | (+) | − | (+) | (+) | + | +(+) | − | +(+) | (+) |
| 11 | + | − | ++ | (+) | − | +(+) | − | − | +(+) | − | ++(+) | (+) |
| 12 | + | − | + | + | − | +(+) | − | + | (+) | − | + | + |
| 14 | + | (+) | + | − | − | +(+) | − | (+) | (+) | − | ++ | + |
| 16 | +(+) | − | − | − | − | + | (+) | + | (+) | − | ++ | +(+) |
| 18 | +(+) | − | − | (+) | (+) | ++ | − | + | − | (+) | ++(+) | − |
| 19 | + | − | +(+) | − | − | ++(+) | − | − | − | − | ++ | − |
| 20 | +(+) | (+) | + | (+) | − | + | − | +(+) | +(+) | (+) | ++(+) | +(+) |
| 21 | +(+) | (+) | (+) | − | + | ++ | (+) | (+) | − | + | ++ | − |
| 22 | + | − | + | − | − | + | + | ++ | − | − | + | + |
| 23 | + | − | ++ | − | − | + | − | ++ | (+) | − | ++ | +(+) |
| 24 | +(+) | − | (+) | − | − | + | (+) | +(+) | +(+) | − | ++ | − |
| 25 | + | − | + | − | − | +(+) | (+) | (+) | +(+) | − | ++ | + |
| 26 | ++ | − | (+) | (+) | − | ++ | − | (+) | − | (+) | ++ | − |
| 28 | + | − | + | + | − | +(+) | (+) | − | − | − | +(+) | ++ (+) |
| 28(micro) | (+) | − | − | − | ++ | ++ | − | − | − | ++(+) | − | − |
| 29 | + | + | (+) | − | − | +(+) | (+) | + | + | − | ++ | − |
| 29(micro) | − | − | − | − | +++ | − | − | + | − | +++ | − | − |
| 30 | +(+) | − | (+) | (+) | − | ++ | (+) | + | − | − | ++ | +(+) |
| 31 | + | − | − | (+) | − | + | − | +(+) | +(+) | − | +(+) | − |
| 32 | ++ | − | (+) | − | − | +(+) | − | − | (+) | − | ++ | − |
| 33 | ++ | − | − | − | − | +(+) | − | + | − | − | ++ | − |
| 34 | + | + | ++ | − | − | + | − | (+) | +(+) | − | +(+) | (+) |
| 34(micro) | − | − | − | − | +++ | − | − | − | − | +++ | − | − |
| 35 | ++ | − | (+) | − | − | ++(+) | − | − | − | − | +(+) | (+) |
| 36 | +(+) | − | − | − | + | ++ | − | − | + | − | ++ | − |
| 37 | ++ | − | + | − | − | +(+) | − | + | − | − | ++(+) | − |
| 38(micro) | (+) | − | − | − | +++ | − | − | − | − | +++ | − | − |
| 39(micro) | − | − | − | − | +++ | − | − | − | − | +++ | − | − |
| 40 | +(+) | − | (+) | − | − | + | − | − | − | − | + | (+) |
| 41 | +(+) | − | − | − | − | ++ | − | − | − | − | ++ | − |

cultural media of all strains

| tion agar added) | | | Steamed rice | | | | | Potato plug | | | | | Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S | P | Po | M | Sc | S | P | Po | M | Sc | S | P | Po | |
| − | +(+) | − | + | − | (+) | +(+) | − | +(+) | − | + | − | − | MScSP |
| − | (+) | − | +(+) | − | +(+) | (+) | − | +(+) | − | (+) | + | − | MSP |
| − | ++ | − | + | − | − | +(+) | − | (+) | − | + | +(+) | − | MScSP |
| + | +(+) | − | + | − | +(+) | + | − | +(+) | (+) | − | (+) | − | MScSP |
| − | + | − | +(+) | − | − | + | − | +(+) | − | − | (+) | − | MScSP |
| − | − | ++ | − | − | − | − | ++ | − | − | − | − | +++ | MPo |
| (+) | +++ | − | + | − | (+) | + | − | (+) | − | +(+) | (+) | − | MSP |
| − | − | − | +(+) | − | +(+) | − | − | ++ | − | + | − | − | MS |
| (+) | − | − | ++ | − | − | − | − | + | (+) | (+) | + | − | MScSP |
| (+) | (+) | − | + | − | − | + | − | +(+) | (+) | − | + | − | MScSP |
| − | − | − | +(+) | − | − | − | − | ++ | (+) | − | (+) | − | MScSP |
| (+) | (+) | − | +(+) | (+) | − | + | − | +(+) | (+) | (+) | − | − | MScSP |
| − | − | − | +(+) | + | − | − | − | +(+) | + | − | − | − | MScSP |
| − | − | − | +(+) | + | − | − | − | +(+) | (+) | − | − | − | MScSP |
| − | − | (+) | ++ | − | (+) | − | − | +(+) | − | +(+) | − | − | MSPPo |
| − | − | − | +(+) | − | (+) | − | − | +(+) | − | − | (+) | − | MSP |
| (+) | − | − | + | − | − | − | − | +(+) | (+) | − | − | − | MScSPPo |
| − | − | + | + | − | − | − | − | ++ | − | − | − | − | MScSPo |
| − | +++ | − | + | − | − | +++ | − | ++ | ++ | − | − | − | MScSP |
| + | − | − | + | − | − | − | − | +(+) | − | − | − | − | MScSP |
| (+) | − | − | + | − | − | − | − | +(+) | (+) | − | + | − | MScSP |
| − | − | − | + | +(+) | − | − | − | +(+) | − | − | − | − | MScSP |
| − | − | (+) | +(+) | − | − | − | − | +(+) | − | + | − | − | MSPPo |
| + | +(+) | − | + | − | − | − | − | +(+) | (+) | − | + | − | MScSP |
| − | − | ++ | − | − | − | − | ++ | +(+) | − | + | − | ++(+) | MSPo |
| − | + | − | +(+) | − | − | − | − | +(+) | + | − | (+) | − | MScSP |
| − | − | ++ | (+) | − | − | − | ++ | − | − | + | − | +++ | MSPo |
| + | − | − | + | − | − | − | − | +(+) | (+) | − | − | − | MScSP |
| ++ | + | − | + | − | − | − | − | +(+) | (+) | (+) | (+) | − | MScSP |
| − | − | − | +(+) | − | − | − | − | ++ | − | − | +(+) | − | MSP |
| − | (+) | − | ++ | − | − | − | − | ++ | − | − | − | − | MSP |
| (+) | − | − | +(+) | − | − | (+) | − | +(+) | − | + | − | − | MScSP |
| − | − | ++ | − | − | − | − | ++ | − | − | − | − | +++ | Po |
| − | − | − | + | − | − | + | − | +(+) | − | (+) | − | − | MScSP |
| − | − | + | +(+) | − | − | − | + | ++(+) | − | − | − | − | MPo |
| − | − | − | +(+) | − | − | − | − | ++ | − | − | − | − | MS |
| − | − | ++ | − | − | − | − | ++ | − | − | − | − | +++ | MPo |
| − | − | ++ | − | − | − | − | ++ | − | − | − | − | +++ | Po |
| − | +(+) | − | (+) | − | − | ++ | − | +(+) | − | − | − | − | MScSP |
| − | − | − | +(+) | − | − | − | − | ++ | − | − | − | − | M |

manners appear generally not individually but in combination with others on the same medium. In this paper the growth types are determined by their combination, that is to say, the presence or absence of aerial mycelia (M), sclerotia (Sc), sporodochia (S), pionnotes (P) and powdery conidia (Po) which appear on the five media. In the table 9, the degrees of development of the above mentioned growth manners on each kind of medium and these growth types of all strains which were observed after a month's cultures are given. The number of + in the table shows the degree of development of the above mentioned growth manners, and (+) means either a half value of + or less.

(3) Conclusion

(a) Pigment-productions on Cultural Stroma : Looking over the table 8, we can classify by pigment-productions on cultural stroma all the strains into 4 types as the table 10 shows.

Table 10. Classification of all strains by pigment-productions

| Pigment-production | No. of strain |
|---|---|
| A | 1, 4, 5, 6, 7, 10, 11, 12, 14, 16, 20, 22, 23, 24, 25, 28, 29, 30, 31, 34 |
| B | 2, 21, 32, 36, 37, 41 |
| AB | 8, 18, 19, 26, 33, 35, 40 |
| — | 6 (micro), 9, 28(micro), 29(micro), 34(micro), 38(micro), 39 (micro) |

(b) Growth Types : Looking over the table 9, we can classify by growth types on five kinds of media all the strains into 10 groups (or types) as in the table 11.

Table 11. Classification of all strains by growth types

| Growth type | No. of strain |
|---|---|
| MScSPPo | 20 |
| MScSP | 1, 4, 5, 6, 9, 10, 11, 12, 14, 16, 22, 23, 24, 25, 28, 29, 30, 31, 34, 35, 40 |
| MScSPo | 21 |
| MSPPo | 18, 26 |
| MSP | 2, 7, 19, 32, 33 |
| MSPo | 28(micro), 29(micro) |
| MS | 8, 37 |
| MPo | 6(micro), 36, 38(micro) |
| M | 41 |
| Po | 34(micro), 39(micro) |

## 2. Formation of Sporodochia and Perithecial Stromata on Mulberry Stem Medium

(1) Methods

Mulberry stems are cut into pieces of 10 cm length, and the each piece is put into a test tube with a little water in it. And being plugged up with a cotton, the test tube is sterilized with steam. This is called here mulberry stem medium. On the surface of this mulberry stem medium, typical sporodochia appear after about 10 days' culture, breaking out epidermis or lenticels from inside. Perithecial stromata forming typical perithecia on them also appear on these mulberry stem media after about a month's culture. The experiments of these cultures were carried on several times at 20-25°C. Five test tubes of this medium were used for every strain each time. By the way, the form names of the supplied mulberry trees are Ichinose or Kairyōnezumigaeshi.

(2) Results

The formation of sporodochia and perithecial stromata on the mulberry stem medium fluctuated fairly much even within the five test tubes which were used at each experiment. In the table 12 and 13 the average numbers of sporodochia and perithecial storomata which appeared on the media of the five test tubes are given. The numbers of sporodachia in the table 12 are the results of the investigations after a month's culture and those of perithecial stromata in the table 13 are the results of the investigations after two months' culture.

Table 12. Showing formations of sporodochia on mulberry stem media of all strains

| No. of exp. / No. of strain | I | II | III | IV | V | VI | Total | Average |
|---|---|---|---|---|---|---|---|---|
| 1 | 16.8 | 18.8 | 196.0 | 146.8 | 0.2 | 2.2 | 380.8 | 63.47 |
| 2 | 19.8 | 51.2 | 181.0 | 222.0 | 12.8 | 31.5 | 518.3 | 86.38 |
| 4 | 37.2 | 75.2 | 175.0 | 528.0 | 3.0 | 464.0 | 1282.4 | 213.73 |
| 5 | 255.0 | 10.8 | 53.2 | 298.0 | 36.4 | 23.0 | 676.4 | 112.73 |
| 6 | 17.4 | 208.0 | 21.5 | 0 | 0 | 0 | 246.9 | 41.15 |
| 6 (micro) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 36.0 | 62.0 | 41.6 | 156.0 | 87.2 | 47.0 | 429.8 | 71.63 |
| 8 | 507.0 | 800.0 | 511.0 | 811.5 | 840.0 | 653.4 | 4122.9 | 687.15 |
| 9 | 0 | 0 | 25.8 | 15.6 | 0 | 0 | 41.4 | 6.90 |
| 10 | 36.0 | 36.0 | 232.8 | 330.0 | 11.4 | 768.0 | 1414.2 | 235.70 |
| 11 | 77.4 | 16.0 | 2.0 | 99.8 | 22.4 | 1.6 | 219.2 | 36.53 |
| 12 | 159.6 | 36.4 | 76.7 | 19.0 | 11.4 | 2.0 | 305.1 | 50.85 |

| No. of exp. / No. of strain | I | II | III | IV | V | VI | Total | Average |
|---|---|---|---|---|---|---|---|---|
| 14 | 12.6 | 0 | 1.4 | 11.4 | 1.6 | 0 | 27.0 | 4.50 |
| 16 | 84.0 | 0 | 38.6 | 27.0 | 0 | 0 | 149.6 | 24.93 |
| 18 | 258.0 | 42.8 | 18.0 | 44.4 | 17.8 | 99.6 | 480.6 | 80.10 |
| 19 | 13.2 | 56.0 | 0 | 0.2 | 0 | 0 | 69.4 | 11.57 |
| 20 | 3.0 | 1.2 | 28.2 | 51.0 | 0 | 10.0 | 93.4 | 15.57 |
| 21 | 9.0 | 0 | 6.6 | 0.4 | 0.5 | 0 | 16.5 | 2.75 |
| 22 | 0 | 5.8 | 75.5 | 0 | 0 | 2.0 | 83.3 | 13.88 |
| 23 | 21.0 | 6.0 | 25.0 | 13.0 | 1.0 | 206.6 | 272.6 | 45.43 |
| 24 | 0 | 0.8 | 0.2 | 88.6 | 4.0 | 17.4 | 111.0 | 18.50 |
| 25 | 0 | 0.9 | 19.2 | 20.8 | 0 | 0.2 | 41.1 | 6.85 |
| 26 | 114.0 | 464.0 | 860.0 | 126.6 | 1.6 | 0 | 1566.2 | 261.03 |
| 28 | 20.4 | 2.8 | 210.0 | 283.0 | 10.4 | 438.8 | 965.4 | 16.09 |
| 28(micro) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | 1.2 | 135.2 | 6.4 | 86.8 | 3.6 | 160.8 | 394.0 | 65.67 |
| 29(micro) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 50.4 | 264.8 | 21.3 | 12.2 | 30.0 | 0.6 | 379.3 | 63.22 |
| 31 | 0 | 11.6 | 1.7 | 0.6 | 0 | 8.2 | 22.1 | 3.68 |
| 32 | 5.2 | 5.6 | 10.8 | 0 | 0.6 | 2.0 | 24.2 | 4.03 |
| 33 | 1.0 | 1.6 | 0 | 0 | 0 | 0 | 2.6 | 0.43 |
| 34 | 24.0 | 70.3 | 0 | 74.8 | 0 | 37.2 | 206.3 | 34.38 |
| 34(micro) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 35 | 0 | 18.0 | 2.2 | 144.6 | 2.0 | 0 | 166.8 | 27.80 |
| 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 37 | 0 | 0.6 | 0.4 | 14.8 | 2.2 | 0 | 18.0 | 3.00 |
| 38(micro) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 39(micro) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41 | 0 | 1.4 | 10.8 | 0 | 0 | 3.0 | 15.2 | 2.53 |

Table 13. Showing formations of perithecial stromata on mulberry stem media of all strains

| No. of exp. / No. of strain | I | II | III | IV | V | VI | Total | Average |
|---|---|---|---|---|---|---|---|---|
| 1 | 36.0 | 220.2 | 1000.0 | 28.6 | 1000.0 | 0 | 2284.8 | 380.80 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 13.2 | 1000.0 | 551.5 | 860.0 | 60.7 | 806.0 | 3291.4 | 548.57 |
| 5 | 518.0 | 0.5 | 36.0 | 0 | 0 | 412.4 | 966.9 | 161.15 |
| 6 | 152.0 | 6.8 | 10.1 | 0 | 0 | 0 | 168.9 | 28.15 |
| 6 (micro) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 128.0 | 0 | 23.0 | 0 | 0 | 16.8 | 167.8 | 27.97 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| No. of exp. / No. of strain | I | II | III | IV | V | VI | Total | Average |
|---|---|---|---|---|---|---|---|---|
| 10 | 44.0 | 7.5 | 242.0 | 1000.0 | 280.4 | 806.0 | 2379.9 | 396.65 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0(+) |
| 12 | 13.0 | 3.0 | 0 | 0 | 0 | 0 | 16.0 | 2.67 |
| 14 | 88.0 | 41.0 | 0 | 0 | 0 | 0 | 129.0 | 21.50 |
| 16 | 0 | 126.0 | 610.0 | 6.0 | 5.6 | 1.2 | 748.8 | 124.80 |
| 18 | 0 | 0 | 0 | 6.8 | 0 | 0.6 | 7.4 | 1.23 |
| 19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | 680.0 | 12.8 | 0 | 0 | 0 | 0 | 692.8 | 115.47 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 0 | 9.5 | 44.5 | 0 | 175.0 | 0 | 229.0 | 38.17 |
| 23 | 41.0 | 240.0 | 0 | 0 | 0.8 | 0 | 281.8 | 46.97 |
| 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0(+) |
| 25 | 0 | 211.0 | 1000.0 | 675.0 | 0 | 0 | 1886.0 | 314.33 |
| 26 | 0 | 0 | 306.0 | 14.0 | 0 | 10.0 | 330.0 | 55.00 |
| 28 | 3.0 | 23.4 | 1000.0 | 0 | 8.0 | 442.0 | 1476.4 | 246.07 |
| 28(micro) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | 0 | 1000.0 | 0 | 0 | 0 | 0 | 1000.0 | 166.67 |
| 29(micro) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 66.0 | 1.2 | 3.8 | 0 | 0 | 3.0 | 74.0 | 12.33 |
| 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | 9.0 | 310.0 | 0 | 480.0 | 2.6 | 46.0 | 847.6 | 141.27 |
| 34(micro) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 35 | 11.0 | 1.9 | 1.8 | 7.7 | 44.0 | 6.6 | 72.4 | 12.07 |
| 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 38(micro) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 39(micro) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note ; (1) When the perithecial stromata appeared innumerably on all the five mulberry stem media which were used, the writer estimated roughly the average number of them at 1000.

(2) The sign of (+) at "Average" of nos. 11 and 24 shows that the formation of perithecial stromata was ascertained by the observation after more than 2 months.

(3) Conclusion

(a) Formations of Sporodochia : When we look over the table 12, it is obvious that the formation of sporodochia of each strain fluctuates fairly much each time when the experiments were carried on. But here by comparison of the average values all the strains are classified into 4 groups

as the next table shows.

Table 14. Classification of all strains by the formation of sporodochia

| Formation degree | Criterion of classification (on average value) | No. of strain |
|---|---|---|
| I (much) | more than 100 | 4, 5, 8, 10, 26 |
| II (medium) | less than 100 and more than 10 | 1, 2, 6, 7, 11, 12, 16, 18, 19, 20, 22, 23, 24, 28, 29, 30, 34, 35 |
| III (little) | less than 10 | 9, 14, 21, 25, 31, 32, 33, 37, 41 |
| IV (none) | none | 6(micro), 28(micro), 29(micro), 34(micro), 36, 38 (micro), 39(micro), 40 |

In addition, these experiments were carried on at somewhat lower temperature than the optimum temperature for the sporodochial formation of no. 1 which was ascertained by the writer [7] to be 24—30°C.

(b) Formations of Perithecial Stromata : When we look over the table 13, it is obvious that fluctuations of the formation of perithecial stromata are more remarkable than those of the formation of sporodochia. The writer can not understand why it is. But here by comparison of the average values all the strains are classified into 4 groups as in the next table.

Table 15. Classifcation of all strains by the formation of perithecial stromata

| Formation degree | Criterion of classification (on average value) | No. of strain |
|---|---|---|
| I (much) | more than 100 | 1, 4, 5, 10, 16, 20, 25, 28, 29, 34 |
| II (medium) | less than 100 and more than 10 | 6, 7, 14, 22, 23, 26, 30, 35 |
| III (little) | less than 10 | 11, 12, 18, 24 |
| IV (none) | none | 2, 6(micro), 8, 9, 19, 21, 28(micro), 29(micro), 31, 32, 33, 34 (micro), 36, 37, 38(micro), 39 (micro), 40, 41 |

In addition, these experiments were carried on at about the optimum temperature for the formation of perithecial stromata of no. 1 which was ascertained by the writer [7] to be 16—24°C especially 22°C. NISHIKADO and others [10] investigated on the formation of ascus of *Gibberella Saubinetii* (MONT.) SACC. According to their experiments, there are also remarkable differences among supplied strains for the ascus formation of this fungus. And they say that the longer even the vigorous strains are cultured, the weaker the power of the formation becomes. But this fact that they insist on could not be observed on the writer's strains so far as his investigations

were concerned.

## VI. DISCUSSION AND CONCLUSION

### 1. On the Species Concept of *Fusarium* and the Scientific Name of the Fungus Which Causes the Bud Blight of Mulberry Trees

If the writer tries to classify all the strains into Sections, following WOLLENWEBER's taxonomic system, as he stated in chapter III, all the strains are divided into 4 groups, that is, Section *Lateritium*, Section *Discolor*, Section *Lateritium* or *Discolor*, and Section *Lateritium* or *Sporotrichiella*. And if the writer tries to classify these strains into species, following the same system, the species to which these strains belong will amount to more than 10.

A new opinion concerning *Fusarium* classification was proposed by SNYDER and HANSEN.(14, 15, 16) They stated that some morphological characters, that is, the presence or absence of chlamydospore and foot-cell development at macroconidium etc. and all the physiological characters, that is, pigment-productions on cultural stroma and growth types etc., are unstable and unreliable as the signs of *Fusarium* classification. They held also a more comprehensive opinon about the size of macroconidia as a criterion of species division. Consequently the classification of *Fusarium* was recomposed, and 8 species, no variety and 34 forms were proposed by SNYDER and HANSEN (16) instead of 16 sections, 65 species, 56 varieties and 22 forms in WOLLENWEBER's system. In addition, SNYDER and HANSEN's "form" depends only on the difference of pathogenicity and not on the differences of morphological or physiological characters on cultural media. It is in marked contrast to WOLLENWEBER's "form" which depends on the differences of morphological or physiological characters on cultural media.

If the writer seeks for WOLLENWEBER's species belonging to Section *Lateitium*, Section *Discolor* and Section *Sporotrichiella*, to which the writer's strains related, in the taxonomic system of SNYDER and HANSEN, he can find all WOLLENWEBER's species, varieties and forms belonging to Section *Lateritium*, in an emended species, that is to say, *Fusarium lateritium* (NEES) SNYDER et HANSEN [*Gibberella lateritium* (NEES) S. et H.], and he can find all WOLLENWEBER's species, varieties and forms belonging to Section *Discolor*, in an emended species and an emended form, that is to say, *Fusarium roseum* (CKE.) S. et H. and *F. roseum* S. et H. f. *cerealis* (CKE.) S. et H. [*Gibberella roseum* (CKE.) S. et H. and *G. roseum* S. et H. f. *cerealis* (CKE.) S. et H.], and also he can find all WOLLENWEBER's

species and varieties belonging to Section *Sporotrichiella*, in an emended species and an emended form, that is to say, *F. tricicntum* (CDA.) S. et H. and *F. tricinctum* (CDA.) S. et H. f. *poae* (PK.) S. et H.

The results of the writer's investigations to decide the Section to which the causal fungus of the bud blight of the mulberry trees belongs, which were mentioned in chapter III, showed that the criteria of Section separation by WOLLENWEBER were not sufficiently usable as SNYDER and HANSEN [16] and others [8, 12] pointed out. So is it with the criteria of the species separation. As a matter of fact the writer could not determine the species to which many of the writer's strains belong.

The classification by SNYDER and HANSEN may be needful for our more confirmation in future as they stated modestly, but the writer approves of it in many points, especialy in its simplicity and definiteness. According to SNYDER and HANSEN's description [16], *F. lateritium* (NEES) S. et H. Which is the emended species including all species and varieties belonging to Section *Lateritium* shows distinct relationship to *F. roseum* which is the emended species including all species and varieties belonging to Section *Discolor* and other three Sections. As the writer mentioned before, his strains show the characters of Section *Lateritium*, Section *Discolor*, Section *Lateritium* or *Discolor* and Section *Lateritium* or *Sporotrichiella*. So it is obvious that *F. lateritium* (NEES) S. et H. occupies all the characters which the writer's strains show except the character of Section *Sporotrichiella*, that is, the production of pyriform microconidia.

Though Snyder and Hansen made an emended species, *F. tricinctum* (CDA.) S. et H. instead of all WOLLENWEBER's species and varieties belonging to Section *Sporotrichiella*, the characteristic of which is the production of pyriform microconidia, they expressed, at the same time, their doubt as to how much taxonomic emphasis should be placed on the pyriform microconidia. All the writer's strains which produced the pyriform microconidia formed perithecia. And they resemble *G. lateritium* (NEES) S. et H. very much except the production of the pyriform microconidia. Considering the importance of sexual generation (perithecia) as a criterion of classification, the writer can not but doubt very much the taxonomic importance of the pyriform microconidia and consequently the significance of the species *F. tricinctum* (CDA.) S. et H.

In the above mentioned opinions, the writer regards all the strains as one species, *Fusarium lateritium* (NEES) SNYDEN et HANSEN [*Gibberella Lateritium* (NEES) SNYDER et HANSEN], and at the same time proposes to

add the character of rare production of the pyriform microconidia to the contents of the species.

## 2. On the Physiologic Form Concept

SCHROETER [13] was interested in the phenomenon of physiologic specialization in the fungus at first in 1879, and ERIKSSON [3] confirmed it definitely in 1894. Since then, a number of scholars have investigated this problem, and now it is one of the most conspicuous problems in mycology and phytopathlogy. Physiologic form means the strain which is specialized in the physiological character from the other strains in the same species. The physiological character as the criterion of physiologic form separation was at first only pathogenicity. But recently the characters on cultural media and physical and chemical reactions have been added to the criteria of separation, and even some morphological differences which are statistically appreciable are often counted among some physiologic forms. The writer is going to discuss here on the criterion of physiologic form separation and on the physiologic form in *F. lateritium* (NEES) S. et H.

Pathogenicity as the Criterion of Physiologic Form Separation——Pathogenicity means in short the relation between the causal fungus and its host. This has been adopted as the most important criterion of physiologic form separation since the beginning of the investigation. The two cases following have been reported concernig the physiological specialization in pathogenicity.

The first case is that, when one of two strains in a species is pathogenic to A plant (species or race) and not or little pathogenic to B plant (species or race) and another strain of them is pathogenic to B plant and not or little pathogenic to A plant, these two strains are called to be specialized in pathogenicity. These example have been known in the causal fungi of Rust, which are parasites. The socond case is that, when the difference of the degree of pathogenicity to a plant is recognized between two strains of a species, these two strains are called to be specialized in pahtogenicity. These examples have been known in many fungi belonging to Ascomycetes or Fungi Imperfecti, which are perthophytes.

SNYDER and HANSEN [14,15,16] applied the trinomial system of nomenclature to the scientific name of the fungus of *Fusarium*. In their trinomial system the "form" is added to the binomial when the physiological specialization in pathogenicity, as in the above mentioned first case, is recognized in the species. As the writer mentioned in chapter III, he examined the pathogenicity to mulberry trees of *Fusarium* strains which are isolated

from *Broussonetia sp.* and *Rubus sp.* as well as mulberry trees. From the results of the examinations, it was ascertained that the strains isolated from *Broussonetia sp.* and *Rubus sp.* are also pathogenic and are not essentially different at all from the other strains which were isolated from mulberry trees. This result corresponds to the fact that any "form" was not attached to *Fusarium lateritium* (NEES) S. et H. by SNYDER and HANSEN. But the writer must investigate more extensively in future the trinomial system of nomenclature which were applied to *Fusarium*.

The difference of the degree of pathogenicity to the same mulberry tree (the above mentioned second case) was examined about all the strains from the same data. But as the writer mentioned in chapter III, the reliable result could not be obtained from his data, principally because the uniform growth of mulberry trees was very difficult.

Characters on Cultural Media as the Criteria of Physiologic Form Separation ——Characters on cultural media have often been used as the criteria of physiologic form separation by many scholars. But HEMMI and his students (5,1,4) investigated the physiological specialization of *Piricularia Oryzae* BR. et CAV. and HEMMI (4) concluded that when various characters on cultural media, or physical or chemical reactions which the strains of the same species showed were used on the same rank as the criteria of physiologic form separation, he could not but be at a loss how to classify the species into the physiologic forms.

The writer invstigated some characters on the cultural media which all the strains showed, and consequently could classify the strains into various groups, that is, first into 4 groups by the pigment-productions on the cultural stromata, secondly into 10 groups by the growth types, thirdly into 4 groups by the degrees of the formation of the sporodochia, and fourthly into 4 groups by the degrees of the formation of the perithecial stromata. From these results, the writer wants to determine the physiologic form of this

Table 16. Showing the relations between the strains and their some characters on cultural media.

| No. of strain / Character | 1 | 16 | 20 | 28 | 29 | 34 | 6 (micro) | 28 (micro) | 29 (micro) |
|---|---|---|---|---|---|---|---|---|---|
| Pigement-production | A | A | A | A | A | A | — | — | — |
| Formation of sporodochia | II | II | II | II | II | II | IV | IV | IV |
| Formation of perithecial stromata | I | I | I | I | I | I | IV | IV | IV |
| New classification | I type | | | | | | II type | | |

| 34 (micro) | 38 (micro) | 39 (micro) | 6 | 7 | 22 | 23 | 30 | 21 | 32 | 37 | 41 | 4 | 5 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| — | — | — | A | A | A | A | A | B | B | B | B | A | A | A | A |
| Ⅳ | Ⅳ | Ⅳ | Ⅱ | Ⅱ | Ⅱ | Ⅱ | Ⅱ | Ⅲ | Ⅲ | Ⅲ | Ⅲ | Ⅰ | Ⅰ | Ⅰ | Ⅱ |
| Ⅳ | Ⅳ | Ⅳ | Ⅱ | Ⅱ | Ⅱ | Ⅱ | Ⅱ | Ⅳ | Ⅳ | Ⅳ | Ⅳ | Ⅰ | Ⅰ | Ⅰ | Ⅲ |
| Ⅱ type | | | Ⅲ type | | | | | Ⅳ type | | | | Ⅴ type | | | |

| 12 | 24 | 25 | 14 | 31 | 2 | 36 | 26 | 8 | 35 | 18 | 19 | 33 | 40 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | A | A | A | A | B | B | A·B | A·B | A·B | A·B | A·B | A·B | A·B | — |
| Ⅱ | Ⅱ | Ⅲ | Ⅲ | Ⅲ | Ⅰ | Ⅳ | Ⅰ | Ⅰ | Ⅱ | Ⅱ | Ⅰ | Ⅲ | Ⅳ | Ⅲ |
| Ⅲ | Ⅲ | Ⅰ | Ⅱ | Ⅳ | Ⅳ | Ⅳ | Ⅱ | Ⅳ | Ⅱ | Ⅲ | Ⅳ | Ⅳ | Ⅳ | Ⅳ |
| Ⅵ type | Ⅶ—XIX type (individual) | | | | | | | | | | | | | |

fungus. The relations between the strains and their above mentioned characters (except growth type) are given in the table 16.

The above table shows that in I type [nos. 1,16,20,28,29, and 34], II type [nos. 6(micro), 28(micro), 29(micro), 34(micro), 38(micro), and 39(micro)], III type [nos. 6,7,22,23 and 30], IV type [nos. 21,32,37, and 41], V type [nos. 4,5, and 10] and VI type [nos. 11,12, and 24], each strain resembles other of the same type in its total characters, but each of the other 13 strains forms one type respectively. Thus, all the strains are classified into 19 types by the combined characters. If the growth type is added on the same rank to the elemental characters, the number of newly classified types will increase remarkably. In this way, if the other characters are also added, the number of newly classified types will increase more and more, and will attain to 41 types in the end. This opinion corresponds to HEMMI's one (4) on the criteria of the physiologic form separation of *Piricularia Oryzae* BR. et CAV.

Conclusion—As the result of the writer's discussion concerning the criteria of the physiologic form separation in *Fusarium lateritium* (NEES) SNYDER et HANSEN, he came to the conclusion that the differences of the characters on the cultural media are not reliable to be treated on the same rank as the criteria of the physiologic form separation. Even though the difference of pathogenicity is added to the criteria, the writer can not but reach the same conclusion. In order to solve this problem, it is necessary after all for the writer to attach special importance to only one physiological character of the fungus as the criterion of the physiologic form separtiaon. From the practical point of view pathogenicity is the most important of

all physiological characters. So the writer thinks as HEMMI that it is the safest method to regard the difference of pathcgenicity as the criterion of physiologic form separation, and the differences of other physiological characters are significant as the criteria of physiologic form separation only when they correspond to the difference of pathogenicity.

Concerning the difference of pathogenicity among the strains of *Fusarium lateritium* (NEES) SNYDER et HANSEN and also concerning the physiologic form, the writer discussed in this paper already.

## VII. SUMMARY

1. The present paper deals with the investigations on the concepts of the species and physiologic form in *Fusarium* causing the bud blight of mulberry trees.

2. 34 strains of *Fusaria* isolated from mulberry trees, a strain isolated from *Broussonetia Kazinoki* SIEB. and a strain isolated from *Rubus sp.* in Holland and identified by WOLLENWEBER with *F. lateritium* NEES, were used in this investigation. Pyriform microconidia were discovered while culturing some of the above strains on artificial media and also in dead mulberry stems in natural conditions. Single spore cultures of these pyriform microconidia yielded usually the same pyriform microconidia and produced very rarely the conidia which seemed to be the macroconidia. These new pyriform strains (5 strains) were added to the members of materials for this investigations. The method of single spore culture was also taken of all macroconidium strains at the beginning of this examination.

3. Pathogenicity to mulberry stems was investigated on all the strains by inoculation experiments. And it was ascertained that all the strains including the pyriform strains and the strains isolated from *Broussonetia sp.* and *Rubus sp.* are pathogenic to mulberry trees. From the results of these inoculation experiments the differences of the degree of pathogenicity to the same mulberry trees among the strains are unknown yet.

4. According to WOLLENWEBER'S taxonomic system, all the strains are classified into 4 groups ; Section *Lateritium*, Section *Discolor*, section *Lateritium* or *Discolor*, Section *Lateritium* or *Sporotrichiella*.

5. Some characters on the cultural media of all the strains were investigated. And consequently all the strains were classified first into 4 groups by pigment-productions on the cultural stromata, secondly into 10 groups by the growth types on five cultural media, thirdly into 4 groups by the formation of sporodochia on the mulberry stem media and fourthly into 4

groups by the formation of perithecial stromata on the mulberry stem media.

6. From the results of the above investigations, the species concept of *Fusarium* and the scientific name of the causal fungus of the bud blight of mulberry trees were discussed. In conclusion the writer supports not WOLLENWEBER's taxonomic system but SNYDER and HANSEN's opinion in many points and regards all the strains as one species, *Fusarium lateritium* (NEES) SNYDER et HANSEN [*Gibberella lateritium* (NEES) SNYDER et HANSEN], and at the same time proposes to add the character of the rare production of the pyriform microconidia to the contents of the species. And the writer has some doubts about the taxonomic importance of the pyriform microconidia and therefore about the significance of *F. tricinctum* (CDA.) SNYDER et Hansen.

7. The physiologic form concept was also discussed. The writer came to the conclusion that if pathogenicity and the characters on the cultural media were treated on the same rank as the criteria of physiologic form separation, he can not but be at a loss how to classify the species into the physiologic form, and in order to solve this problem it is necessary after all for the writer to attach special importance to only one physiological character of the fungus, especially to the pathogenicity as the criterion of the separation. Concerning the difference of pathogenicity as the criterion of physiologic form separation in fungi, two different cases have been reported. But whichever case the writer wishes to apply to the writer's fungus, *Fusarium lateritium* (NEES) SNYDER et HANSEN, further investigations are necessary to determine the physiologic form in this fungus.

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## EXPLANATION OF PLATES

Plate I

Results of the inoculation experiment. The inoculation was made in November. These figures show the states of the inoculated mulberry trees in the next May. (Fig. 1—2)

Fig. 1 The inoculated stem killed.

Fig. 2 The inoculated stem not yet killed.

Causal fungus. (Fig. 3—4)

Fig. 3 Perithecial stroma and perithecia. ×62

Fig. 4 Asci. ×300

Plate II

Causal fungus. (Fig. 5—8)

Fig. 5 Ascus and ascospores. ×850

Fig. 6 Microconidia (strain no. 38). ×400

Fig. 7 Chlamydospores (terminal and intercalary). ×650

Fig. 8 Macroconidia (strain no. 1). ×500

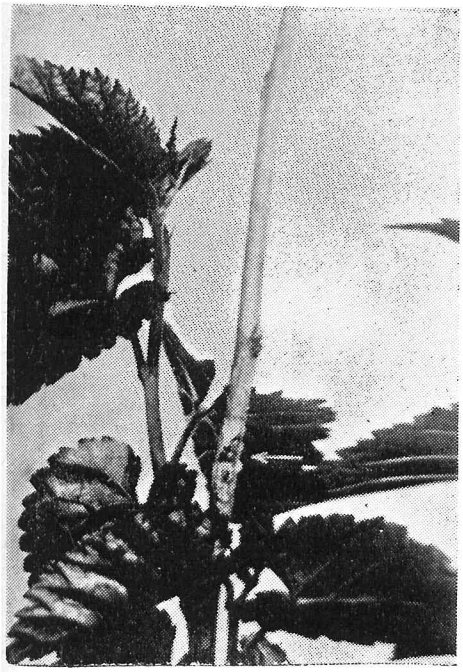

Fig 1

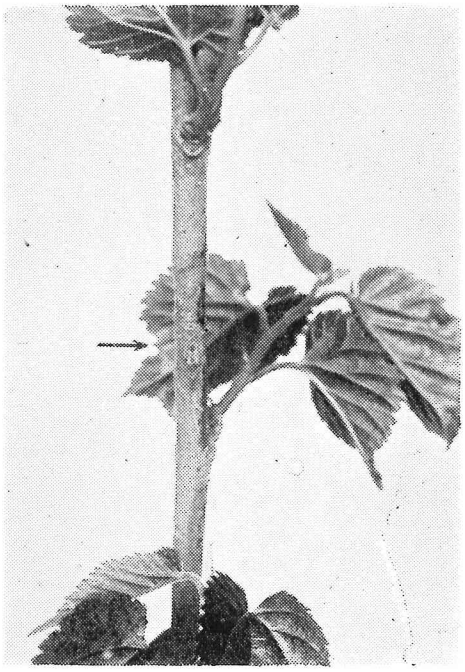

Fig. 2

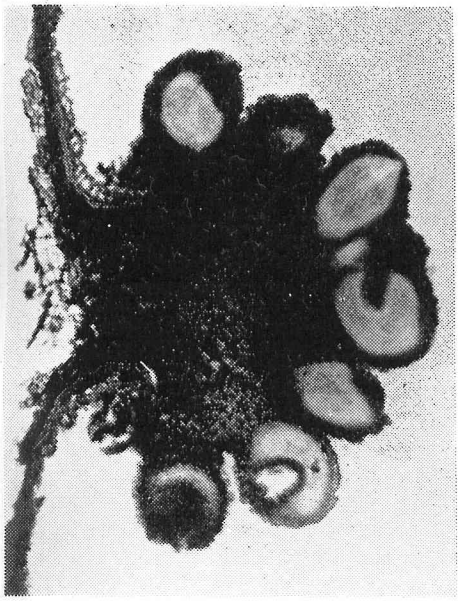

Fig. 3

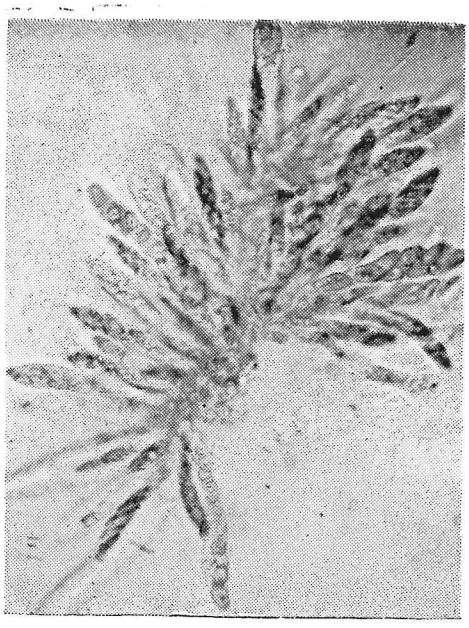

Fig. 4

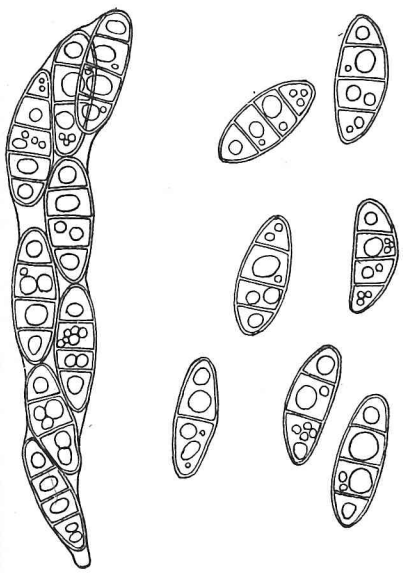

Fig. 5

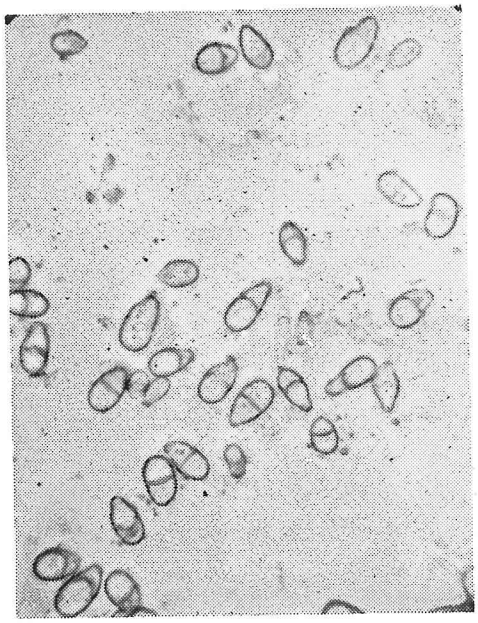

Fig. 6

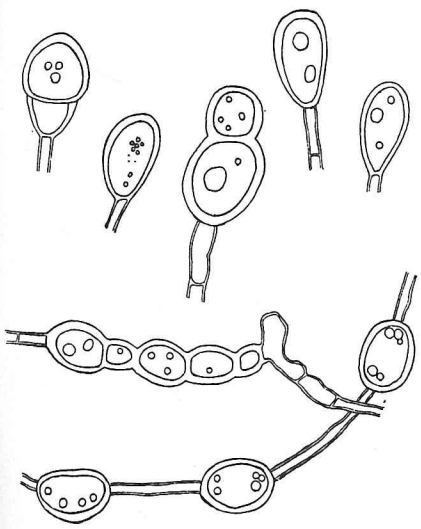

Fig. 7

Fig. 8