A CONTRIBUTION TO OUR KNOWLEDGE OF VIRUS DISEASES OF PLANTS IN JAPAN

BY

TEIKICHI FUKUSHI

Introduction

During recent years it has been recognized that virus diseases constitute one of the most important groups of plant disease in Japan. Although some of these diseases must have existed for a number of years, they have attracted little attention until recent years, except the mosaic disease of tobacco and the dwarf disease of rice plant. There is some evidence to indicate that the mosaic disease of tobacco has been known in Japan since 1857. The dwarf disease of rice plant also has been known for many years although its origin is uncertain. This is the first virus disease of plant shown to be transmitted by an insect as pointed out by KUNKEL* (1926)[19] based upon the writer's information and also by HINO (1927)[5].

The dwarf disease of mulberry tree has long been recognized as one of the most serious plant diseases in Japan. It is exclusively confined to this country and has been ascribed to some cultural practices, particularly to excessive cutting back the trees in order to stimulate a new growth of branches and tender leaves for the silkworm. During recent years, however, certain investigators have claimed to have obtained evidence that this disease is infectious and belongs to the virus disease group.

With the exception of these diseases most of the virus diseases of plants are considered to have been imported from foreign countries in recent years. The list presented in this paper, while far from complete, will give some indication as to the virus diseases of plants in Japan.

On certain aspects of the virus diseases of plants

Our knowledge of the existence of the virus disease of plant dates from 1888, when E. F. SMITH[32], working with the peach yellows destructive in the

* It should be stated here that TAKATA's paper was erroneously cited by KUNKEL.

[Transact. Sapporo Nat. Hist. Soc., Vol. XII, Pt. 3, 1932]

Eastern United States of America, ascertained that this disease was communicable to healthy trees by budding, pointing to "some contagium vivum" as the causative agent, though no organisms could be found in association with the disease. A few years later, SMITH (1891[33], 93[34]) found that peach rosette was also transmitted to healthy trees by diseased buds in which no causal organisms could be demonstrated.

Almost at the same time, IWANOWSKI (1892)[13] in Russia demonstrated that the juice from the mosaic diseased tobacco leaves remained infectious after passing through the Chamberland filter. Indeed he was the first to discover the filterable virus. He himself, however, did not realize it and ascribed the infectiousness of the filtrate to the toxin which he assumed to have been produced by the causal bacteria. In 1898 BEIJERINCK[2], evidently in ignorance of IWANOWSKI's work, arrived at a similar conclusion indicating that the causative agent of the tobacco mosaic disease is filterable.

In the same year, LOEFFLER and FROSCH[24] published an epoch-making paper on the etiology of the foot and mouth disease of cattle coming to the conclusion that the causal agency of the disease is a filter-passing organism and the causative agents of small pox, cow pox, measles, scarlet fever and other infectious diseases of unknown cause are in all probability caused by organisms of this order. Thus the term filterable virus was introduced to denote these causative agents capable of passing through a Berkefeld or Chamberland filter, both of which were considered at that time as bacteria proof filters. Since that time the study of the filterable viruses has developed in increasing importance and in 1913, LIPSCHÜTZ[23] could present in his collective survey of the subject, a list of forty-one virus diseases affecting man and animals in which the filterable nature of the causative agent had been established with more or less certainty. Recently, MC KINLEY (1929)[28], in his extensive survey of the entire subject of virus diseases, described about seventy virus diseases which affect man and various animals including fowls, insects and fishes.

In spite of the earlier discovery of their representative, the virus diseases of plants have attracted less attention of pathologists than the virus diseases of animals. However, the study of the virus diseases has within recent years became a specialized field in plant pathology and at present about sixty viruses are known to induce plant diseases.

The term "virus" is originally derived from the Latin word which means poison. BEIJERINCK (1898)[2] was the first plant pathologist, as far as the writer is aware, to introduce the term virus, denoting the causative agent of the mosaic disease of tobacco. At present, however, the concept involved in the term virus is by far more complicated as compared with what BEIJERINCK

introduced and it is most difficult to formulate a definition of a virus because its essential characteristics are not definitely known.

Because the virus is exceedingly small, lying beyond the limits of microscopic visibility, and it seems to multiply in the infected plant, some pathologists incline to the view that the virus is an ultramicro-organism capable of causing an infectious disease. If the term ultramicroorganism means a cellular organism of ultramicroscopic dimension the above mentioned definition cannot be applied to all the viruses, since it is almost impossible to conceive that certain viruses represent an organism in the ordinarily accepted sense, owing to their extraordinarily small size and to their remarkable tolerance to heat, ageing and toxic substances which destroy the ordinary microorganisms. This phase of the problem will be discussed more in detail in another publication.

It appears that the virus is defined by most pathologists as a filter-passing agent capable of causing an infectious disease. Such definition holds valid for the viruses affecting man and animals, a majority of them being filterable or even ultrafilterable. However, it cannot be upheld for the viruses affecting plants which have not been definitely demonstrated to be filter passers except the filterable viruses of the tobacco mosaic, tobacco yellow mosic, cucumber mosaic etc. Furthermore, filterability through a Berkefeld or Chamberland filter is not regarded so significant as it was in the past when these filters were considered to retain all bacteria, protozoa and other microorganisms. Since it is well recognized that some bacteria, protozoa and yeasts under certain conditions will pass through various types of filters, filterability cannot always be recognized as a criterion to distinguish the virus from the filterable forms of bacteria and other microorganisms. Filterability does not depend merely upon the size of the particle to be filtered and the diameter of the pores of the filter but a variety of factors—pressure employed, time of filtration, the electric charge possessed by the particles to be filtered and the wall of filter, the H-ion concentration of the fluid, the dilution of the material to be filtered, the amount of solid matter present, etc.—exert a profound effect upon filtration.

Finally we are led to the belief that the virus may be defined as an ultramicroscopic corpuscular agent capable of inducing disease. Such definition may be open to criticism, being rather ambiguous.

At any rate it cannot be denied that the virus group in all probability is not a homogeneous one.

Under such cricumstance it may be profitless to attempt to demonstrate the cansative agent first of all in order to recognize a virus disease of plant. In this respect the virus diseases differ from the diseases caused by parasitic microorganisms. For practical purposes then by what means is a virus

disease of plant recognizable?. There are two criteria to be relied upon, viz., symptoms of the disease and the mode of transmission.

The manifestations of the virus diseases of plants are generally alike. In the first place, the most common symptom is chlorosis, which manifests itself in two types, the mosaic and yellows. The mosaic is characterized by the mottled appearance of the foliage showing a mosaic-like pattern of alternating dark green and yellowish green spots or blotches of varying sizes and shapes on the leaves as shown in the mosaic diseases and "infectious chloroses" (in BAUR's sense[1]). In the yellows, chlorosis is general throughout the affected parts as in the aster yellows, peach yellows etc. In the second place, the dwarfing of a part or the entire plant is a common symptom among virus diseases of plants. (dwarf disease of rice plant, strawberry dwarf etc.) In the third place, rosetting, an excessive tillering or branching is also one of manifestations of the disease. (peach rosette, wheat mosaic etc.) In the forth place, necrosis of certain types develops in several virus diseases of plants, particularly in the potato leaf roll, stipple streak etc. Besides these, it is not unusual that curling, rolling and other deformities of leaves, and discoloration and malformation of flowers occur in association with the virus diseases of plants. These different types of symptoms may appear either alone or in a variety of combinations.

These manifestations, however, are by no means specific for virus diseases because mottling of the foliage appears in the variegation of non-infectious nature; the yellowing of leaves is induced by an excess of lime in the soil as well as by the lack of potassium and by some other factors; and stunting of plant, overgrowth of branches and necrotic conditions are caused by certain parastic microorganisms. Consequently a virus disease of plant cannot always be recognized merely on the basis of its manifestations.

The intracellular bodies associated with certain virus diseases of plants are regarded to be of diagnostic significance to some extent but such intracellular inclusions are not present in association with all the virus diseases.

Compared with the symptoms, the mode of transmission should be regarded of much practical importance in order to recognize a virus disease of plant. Virus diseases of plants are transmitted (a) by grafting and budding, (b) by insects, (c) by inoculating the juice from the diseased plant, (d) through the seed, and (e) through the soil. The virus diseases of plants can be classified into three groups based upon the mode of transmission. The diseases of the first group can be transmitted by the organic union or grafting and budding only, peach yellows, peach rosette and little peach being the representatives. The second group includes the diseases which are transmitted principally by

the insect vectors as represented by the dwarf disease of rice plant, streak disease of sugar cane and maize, aster yellows and likewise by the rosette of peanuts and broad bean mosaic. In this group the transmission may be effected by grafting as already verified by KUNKEL (1926)[19] and STOREY and BOTTOMLEY (1928)[25] in the aster yellows and the rosette of peanuts respectively, but there is no evidence that these diseases are communicated by inoculating the juice from the affected plants into healthy plants. To the third group belong the diseases which are transmitted through the juice from the diseased plant, a majority of mosaic diseases and other virus diseases being included in this group. The transmission by grafting and by insects are usual in this group. Certain diseases of this group have been recognized as seed-borne while some others as transmitted through the soil.

If a disease of plant is demonstrated to be transmitted by any one of the above mentioned means, in conjunction with the absence of any causal organisms, in all probability it belongs to the virus disease group. Furthermore, if the disease is characterized by the manifestations mentioned before, it is no doubt a virus disease.

Virus diseases of plants in Japan

A list of the virus diseases of plants in Japan will be given below in a tabulated form, based upon a recent survey conducted by the writer.

Name of disease	Plant name	Family name	Locality
yellows	*Callistephus chinensis* NEES.	Compositae	Sapporo (FUKUSHI[2], 1929)
"	*Calendula officinalis* L.	"	" (" 1930)
"	*Erigeron annuus* PERS.	"	" (KANEGAE, 1929)
"	*Taraxacum platycarpum* DAHLST.	"	" (FUKUSHI[2], 1929)
mosaic	*Lactuca sativa* L.	"	Tottori (FUKUSHI, 1928)
"	*Zinnia elegans* JACQ.	"	" (" 1927)
mosaic	*Cucumis Melo* L.	Cucurbitaceae	*Tottori (FUKUSHI, 1928) *Sapporo (" 1929)
"	*C. Melo* var. *Conomon* MAK.	"	Hiroshima (HORI[9], 1922) Tottori (HORI[9], 1922; FUKUSHI, 1928)
"	*C. sativus* L.	"	Shizuoka (HORI[9], 1922) Okayama (KASAI[16], 1923)
"	*Cucurbita moschata* DUCH. var. *melonaeformis* MAK.	"	Tottori (FUKUSHI, 1928) Korea (NAKATA et al.,[29] 1928)

* In the green house.

Name of disease	Plant name	Family name	Locality
mosaic	*Lagenaria vulgaris* SER. var. *elavata* SER.	Cucurbitaceae	Tottori (HORI[9], 1922; FUKUSHI, 1927) Okayama (KASAI[10], 1923)
"	*Trichosanthes cucumeroides* MAXIM.	"	Kanagawa (KASAI[17], 1924)
"	*Capsicum annuum* L.	Solanaceae	throughout Japan (HORI[8], 1920, etc.)
"	*Cyphomandra betacea* SENDT.	"	*Sapporo (FUKUSHI, 1929)
"	*Lycopersicum esculentum* MILL.	"	throughout Japan (HORI[8], 1920, etc.)
"	*Nicotiana tabacum* L.	"	throughout Japan
"	*Petunia violacea* LINDL.	"	throughout Japan [Tottori (FUKUSHI, 1927) etc.]
"	*Physalis pubescens* L.	"	Tottori (FUKUSHI, 1928)
yellow mosaic	*Lycopersicum esculentum* MILL.	"	Tottori (FUKUSHI, 1928)
"	*Nicotiana tabacum* L.	"	*Sapporo (FUKUSHI, 1929)
"	*Petunia violacea* LINDL.	"	*Sapporo (KAWAI, 1932)
mosaics	*Solanum tuberosum* L.	"	throughout Japan [Hokkaido (Hokkaido Agr.. Exp. Stat.[6], 1915; TSUJI[38], 1919) etc.]
mild mosaic	"	"	Tottori (FUKUSHI, 1928) Sapporo (FUKUSHI, 1929)
crinkle mosaic	"	"	" (FUKUSHI, 1929)
leaf roll	"	"	throughout Japan [Okayama (Okayama Agr. Exp. Sta.[30], 1915; KASAI[15], 1919) etc.]
stipple streak	"	"	Sapporo (TSUJI[38], 1919; FUKUSHI, 1929)
unmottled curly dwarf	"	"	Tottori (FUKUSHI, 1928) Sapporo (" 1929)
mosaic	*Primula obconica* HANCE	Primulaceae	*Sapporo (HAYASHI, 1928) *Tokyo (FUKUSHI & KAWAI, 1932)
"	*P. denticulata* SMITH	"	" "
"infectious chlorosis"	*Euonymus japonicus* THUNB.	Celastraceae	throughout Japan
mosaic	*Crotalaria juncea* L.	Leguminosae	Tottori (FUKUSHI, 1927)
"	*Glycine Soja* BENTH.	"	Sapparo (FUKUSHI, 1929)
"	*Phaseolus angularis* WIGHT	"	throughout Japan [Morioka (MATSUMOTO[25], 1922) Korea (NAKATA et al.[29], 1928) etc.]

* In the greenhouse

Name of disease	Plant name	Family name	Locality
mosaic	*Phaseolus vulgaris* L.	Leguminosae	Sapporo (S. ITO[7], 1920; KURIBAYASHI[29], 1926) Okayama (KASAI[16], 1923) Tottori (FUKUSHI,[4] 1928)
"	*Trifolium hybridnm* L.	"	Sapporo (KAWAI, 1931)
"	*T. pratense* L.	"	Tottori (FUKUSHI[4], 1928) Sapporo (" 1929)
"	*T. repens* L.	"	Tottori (FUKUSHI[4], 1927) Sapporo (" 1929)
"	*Vicia Faba* L.	"	Tottori (FUKUSHI[4], 1928) Tokyo (" 1930) Chiba (HORI)
"	*Vigna sinensis* ENDL.	"	Morioka (MATSUMOTO[27], 1922) Okayama (KASAI[17], 1924) Tottori (FUKUSHI[4], 1928)
mosaic	*Brassica campestris* L. subsp. *Rapa* HOOK. f et ANDS.	Cruciferae	Fukuoka (TAKIMOTO[37], 1927)
"	*B. japonica* SIEB.	"	" (" ")
"	*B. Pe-tsai* BAILEY	"	" (" ")
"	*Raphanus macropoda* LEV. var.	"	" (" ")
"	*Sinapsis* sp.	"	" (" ")
"infectious chlorosis"	*Paeonia albiflora* PALL. var. *hortensis* MAK.	Ranunculaceae	Sapporo (TOGASHI, 1930)
mosaic	*Aquilegia flabellata* S. et Z.	"	Yoshida in Niigata-Ken (S. ITO, 1931) Sapporo (Y. IMAI, 1932)
"	*Diantuus Caryophyllus* L.	Caryophyllaceae	*Tokyo (FUKUSHI & KAWAI, 1932)
"	*Rumex obtusifolius* L.	Polygonaceae	Zenibako near Sapporo (FUKUSHI, 1929)
"	*Canna indica* L.	Cannaceae	Kagoshima (FUKUSHI, 1928) Sapporo (FUKUSHI, 1931)
"	*Crocus vernus* ALL.	Iridaceae	Sapporo (FUKUSHI, 1931)
"	*Iris pumila* L.	"	" (" ")
"	*I. tectorum* MAXIM.	"	" (" ")
"	*Gladiolus gandavensis* VAN. HOUTTE	"	" (" ")
"	*Hippeastrum equestre* HERB	Amaryllidaceae	* " (KAWAI, 1931)
"	*Narcissus Pseudo-Narcissus* L.	"	Morioka (TOGASHI, 1931) Sapporo (KAWAI, 1931)
"	*N. incomparabilis* MILL.	"	Morioka (TOGASHI, 1931) Sapporo (FUKUSHI, 1931)

* In the greenhouse

Name of disease	Plant name	Family name	Locality
mosaic	*N. Tazetta* L, var. *chinensis* M. ROEM.	Amaryl-lidaceae	Sapporo (FUKUSHI, 1931)
"	*Allium fistulosum* L.	Liliaceae	Miyazaki (HORI[8], 1920) Gumma (HORI[10] 1929)
"	*A. Cepa* L.	"	Shizuoka (HORI[10], 1929)
"	*Fritillaria camtschatensis* KER-GAWL.	"	Sapporo (FUKUSHI, 1929)
"	*Hyacinthus orientalis* L.	"	" (TOCHINAI, FUKUSHI, 1931)
"	*Lilium auratum* LINDL.	"	" (FUKUSHI, 1929) Kamakura (SHIMAMURA, 1931)
"	*L. dauricum* KER.	"	Sapporo (FUKUSHI, 1930)
"	*L. longiflorum* THUNB.	"	" (" 1929)
"	*L. maculatum* THUNB. var. *elegans* KOIDZ.	"	" (KAWAI, 1931)
"	*L. Makinoi* KOIDZ.	"	" (FUKUSHI, 1931)
"	*L. Maximowiczii* REGEL.	"	" (" 1929)
"	*L. philippinense* BAK. var. *formosanum* WILS.	"	*Tokyo (FUKUSHI & KAWAI 1932)
"	*L. platyphyllum* MAXIM.	"	Sapporo (FUKUSHI, 1931)
"	*L. speciosum* THUNB. var. *Tametomo* S. et Z.	"	" (" ")
"	*L. tigrinum* KER-GAWL.	"	" (" 1929)
"	*Muscari botryoides* MILL.	"	" (" 1931)
"	*Tulipa Gesneriana* L.	"	throughout Japan
"	*Saccharum officinalum* L.	Graminae	Formosa *Sapporo (FUKUSHI, 1929)
sereh	"	"	Formosa (HORI[8], 1920)
dwarf	*Oryza sativa* L.	"	Middle and Southern Japan (TAKATA[36], 1895; etc.)
stripe	"	"	Honshu and Shikoku (Imp. Agr. Exp. Sta.[11] 1917, KURIBAYASHI[21], 1931)
"	*Zoysia japonica* STEUD.	"	Nagano (KURIBAYASHI[22], 1931)
dwarf	*Avena sativa* L.	"	Hokkaido (KURIBAYASHI, 1920 See HORI[8])
"	*Hordeum sativnm* JESS, var. *hexastichon* L.	"	throughout Japan [Shizuoka (Shizuoka Agr. Exp. Sta.[31], 1916) etc.]
"	*H. sativum* var. *vulgare* HACK. f. *coeleste* MAK.	"	"
"	*Triticum sativum* LAM. var. *vulgare* HACK.	"	"
"	*Secale cereale* L.	"	Hokkaido [14]

* In the greenhouse

As shown above, 71 species of plants in 51 genera distributed through 15 families are subject to virus diseases in Japan. The total of the figures, however, will not give the number of viruses involved because some virus affects a variety of plants. It is probable that more than 25 viruses affecting plants are present. A majority of the viruses cause mosaic diseases. Among the listed plants the following 15 species appear to be new hosts:

Cyphomandra betacea SENDT. (mosaic)
Primula obconica HANCE. (")
P. denticulata SMITH (")
Crotalaria juncea L. (")
Aquilegia flabellata S. et *Z*. (")
Dianthus Caryophyllus L. (")
Iris pumila L. (")
I. tectorum MAXIM. (")
Lilium dauricum KER. (")
L. maculatum THUNB. var. *elegans* KOIDZ. (")
L. Maximowiczii REGEL (")
L. tigrinum KER-GAWL (")
L. Makinoi KOIDZ. (")
L. platyphyllum MAXIM. (")
Fritillaria camtschatensis KER-GAWL. (")

The mosaic of Primula is a hitherto-unrecorded disease, as far as the writer is aware. This mosaic was first noticed in 1928 by Mr. G. HAYASHI of this Institute on *Primula obconica* grown in the greenhouse of the Botanic Garden in Sapporo. Quite recently a similar disease was found by the writer and his collaborator on *Primula obconica* and *P. denticulata* cultivated in a greenhouse located in a suburb of Tokyo.

It may be also worthy of note that both the dwarf and stripe diseases of rice plant are exclusively confined to Japan.

The tomato mosaic was artificially transferred by the writer to *Solanum nigrum* L. and likewise the dwarf disease of rice plant to both *Panicum miliaceum* L. and *P. Crus-galli* L. var. *frumentaceum* HOOK. f. These plants, however. were not enumerated in the list because they have never been found showing the mosaic or dwarf disease in the field.

Summary

It is difficult to formulate the definition of a virus because its essential characteristics are not definitely known. In the present paper the writer critically reviewed the definitions which have been given for the virus and discussed certain aspects of the virus diseases of plants.

71 species of plants in 51 genera distributed through 15 families are subject

to virus diseases in Japan. A majority of the viruses involved cause mosaic diseases while the others are the causative agents of the yellows, leafroll, dwarf diseases and stripe diseases. Among these diseases both the dwarf and stripe disease of rice plant are confined exclusively to Japan and the Primula mosaic is a hitherto-undescribed disease. 15 species of plants were reported to be new hosts which are subject to mosaic diseases.

The writer gratefully acknowledges his indebtness to Profs. MIYABE and S. ITO for their valuable suggestions.

Botanical Institute, Faculty of Agriculture,
Hokkaido Imperial University, Sapporo.

Literature cited

1. BAUR, E.: Zur Aetiologie der infektiösen Panaschierung. Ber. Deutsch. Bot. Ges. 22: 453–460. 1904.
2. Beijerinck, M. W.: Über ein Contagium vivum fluidum als Ursache der Fleckenkrankheit der Tabaksblätter. Verhandel. Kon. Akad. Wetensch. Amsterdam II 6 (5): 1–22 illust. 1898.
3. FUKUSHI, T.: Aster yellows in Japan. (in Japanese) Agric. and Hort. 5: 577–584. illust. 1930.
4. ———: On the broad bean mosaic. (in Japanese) Jour. Pl. Protect. 17: 707–712, 779–784. illust. 1930.
5. HINO, I.: Early important records on phytopathological science in the Orient. (in Japanese) Agric. and Hort. 2: 1223–1232. illust. 1927.
6. Hokkaido Agr. Exp. Sta.: Varietal susceptibility of potatoes to the curly dwarf. (in Japanese) Ann. Rpts. for 1915: 20 (1916); for 1916: 20 (1917); for 1919; 65–66 (1921).
7. ———: A survey on the bean mosaic. (in Japanese) Ann. Rpts. for 1921: 106–109 (1923), for 1922: 113–126 (1924); for 1923: 146–162 (1926).
8. HORI, S.: Materials for the study of dwarf diseases. (in Japanese) Jour. Pl. Protect. 7: 667–671. 1920; 8: 117–120. 1921.
9. ———: Chlorosis or mosaic disease of cucurbits. (in Japanese) Agric. World 17 (16): 22–30. illust. 1922.
10. ———: Deficiency of humus in relation to plant diseases. (in Japanese) Papers presented at the Joint Meeting of Agric. Soc. in 1929. Reprint 18 pp. 1929.
11. Imperial Agric. Exp. Sta.: On the stripe disease of rice plant. (in Japanese) Ann. Rept. for 1913–1915: 41. 1917.
12. ITO, S.: Diseases of potatoes with special reference to the virus diseases. (in Japanese) Govern. Hokkaido Bur. Indust. Agric. Bull. 32. 24 pp. illust. 1930.

13. IWANOWSKI, D.: Über zwei Krankheiten der Tabakspflanze. Bull. de l'Acad. Impér. d. Sci. de St. Pétersbourg II 3: 67–70. 1892. Abst. in Beihefte z. Bot. Centralbl. 3: 266–268. 1893.

14. Japanese Dept. Agric. and Forest. Bur. Agric.: A survey on the distribution of plant diseases and insect pests. (in Japanese) II 431 pp. 1929.

15. KASAI, M.: Observations and experiments on the leafroll disease of the Irish potato in Japan. Ber. Ohara Inst. landw. Forsch. 2: 47–77. 1921.

16. ————: Mosaic disease of cucumber. (in Japanese) Agric. Lectures 5: 42–71. 1923.

17. ————: Investigatigations on the NELSON's bodies as observed in the leafroll, mosaic and healthy plants. Ber. Ohara Inst. landw. Forsch. 2: 443–461. illust. 1924.

18. ————: Studies on the potato leafroll. (in Japanese) Japanese Dept. Agric. and Forest. Bur. Agric. Mycol. and Entomol. Bull. 17. 70 pp. illust. 1926.

19. KUNKEL, L. O.: Studies on aster yellows. Amer. Jour. Bot. 13: 646–705. illust. 1926. (see p. 700)

20. KURIBAYASHI, K.: On the seed transmission of the bean mosaic. (in Japanese) Jour. Pl. Protect. 13: 199–210. 1926.

21. ————: Studies on the stripe disease of rice plant. (in Japanese) Nagano Agric. Exp. Sta. Bull. 2: 45–69. illust. 1931.

22. ————: On the relation between the stripe disease of rice plant and Delphacodes steriatellus Fall. (in Japanese) Jour. Pl. Protect. 18: 565–571, 636–640. 1931.

23. LIPSCHÜTZ, B.: Filtrierbare Infektionserreger. In KOLLE, W. und A. v. WASSERMANN's Handbuch der pathogenen Mikroorganismen. 2te Aufl. 8: 345–426. illust. 1913.

24. LOEFFLER und FROSCH.: Berichte der Kommission zur Erforschung der Maul- und Klauenseuche bei dem Institut für Infektionskrankheiten in Berlin. Centralbl. Bakt. I Abt. 23: 371–391. 1898.

25. MATSUMOTO, T.: Some experiments with Azuki-bean mosaic. Phytop. 12: 295–297. illust. 1922.

26. ————: Studies on the Azuki-bean mosaic. Prelim. Rerort I. (in Japanese) Jour. Pl. Protect. 9: 13–17. 1922.

27. ————: Further studies on the legume mosaic. (in Japanese) Jour. Pl. Protect. 9: 517–520. 1922.

28. MCKINLEY, E. B.: Filterable viruses and rickettia diseases. Philippine Jour. Sci. 39: 1–416. illust. 1929.

29. NAKATA, K. and TAKIMOTO, S.: Diseases of cultivated plants in Korea. (in Japanese) Jour. Agric. Exp. Sta. Govern. Gen. Chosen 15. 146 pp. illust. 1928.

30. Okayama, Agric. Exp. Sta.: Experiments for the control of the dwarf disease of potato. (in Japanese) Ann. Rpts. for 1915: 143–144 (1916); for 1916: 183–184 (1917).

31. Shizuoka Agric. Exp. Sta.: Dwarf disease of barley. (in Japanese) Jour. Pl. Protect. 3: 937–942. 1916.

32. SMITH, E. F.: Peach yellows: a preliminary report. U. S. Dept. Agric. Bot. Div. Bull. 9. 254 pp. illust. 1888.

33. ————: Additional evidence on the communicability of peach yellows and peach rosette. U. S. Dept. Agric. Div. Veg. Path. Bull. 1. 58 pp. illust. 1891.

34. ————: Additional notes on peach rosette. Jour. Myc. 7: 226–232. 1893.

35. STOREY, H. H. and BOTTOMLEY, A. M.: The rosette disease of peanuts. (Arachis hypogaea L.) Ann. Appl. Biol. 15: 26–45. illust. 1928.

36. TAKATA, K.: Results of experiments with the dwarf disease of rice plant. (in Japanese) Jour. Jap. Agric. Soc. No. 171: 1–4. 1895; 172: 13–32. 1896.

37. TAKIMOTO, S.: On the mosaic disease of Chinese cabbage and other crucifers. (in Japanese) Jap. Hort. Mag. 42 (7): 5–7. 1930.

38. TSUJI, R.: The curly dwarf of potato. (in Japanese) Horticulture 11: 35–39. 1919.

摘　　要

本邦產植物の傳染性萎縮病に關する知見

福　士　貞　吉

玆に植物の傳染性萎縮病と名づくるものは ウイルス病 (Viruskrankheit) 或は ヴアイラス病 (virus disease) の事である。其病原たる virus は其本体が十分闡明せられてゐない爲に之に適切な定義を與へる事が困難である。私は本文に於て virus に與へられたる定義を批判し、如何にして virus disease を判定すべきかを說いた。それに基づいて我國の植物の病害を吟味すると十五科五十一屬七十一種の植物が virus disease 即ち傳染性萎縮病に犯されることが知れる。その內最も多いのはモザイク病で約五十種の植物を犯し、外に萎黃病、萎縮病、葉捲病、縞葉枯病等がある。その中で稻の萎縮病及縞葉枯病は我國特有の病害であり、Primula のモザイク病は未だ記錄のない病害である。又新に傳染性萎縮病の罹病植物の目錄に書き加ふべき植物が十五種ある。