6) Watanabe, A., Nishigaki, S. and Konishi, C.: Effect of nitrogen-fixing blue-green algae on the growth of rice plant. Nature **168**, 748 (1951).
7) Watanabe, A.: Effect of nitrogen fixing blue green alga, ***Tolypothrix tenuis*** on the nitrogenous fertility of paddy soil and on the crop yield of rice plant. J. Gen. Appl. Microbiol. **8**, 85-91 (1962).

Breeding of Seedless Citrus Variety

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The seedlessness is considered to be quite useful for citrus fruits. Almost all of the leading varieties of citrus in the world are either seedless or nearly seedless. Thus, new varieties bred in the future could not secure its entry into the group of important commercial varieties without possessing this character. In relation to the seedlessness in citrus, various kinds of sterility have been reported. Recently, new types of the sterility were found in some of seedless varieties and hybrids, offering a particular interest for the future citrus breeding.

Reciprocal translocation in the Valencia orange

The Valencia orange is the most important variety among the late maturing citrus, and is grown more widely in the world and in larger acreage than any other variety. In Japan, however, this variety cannot grow successfully because of the unfavorable climate. Thus, the Japanese citriculture is eagerly demanding some other superior late variety well adapted to their climatic conditions.

It was made clear that the very poor seediness of Valencia orange, at least in part, is caused by the formation of a large number of inviable gametes resulted mostly from the segmental interchange of chromosomes (Iwamasa, 1963).

Cytological examinations were carried out on two trees of each of two strains of the Valencia. In pollen mother cells of each of these trees, a quadrivalent was observed frequently at metaphase I (Table 1). Out of 252 quadrivalents, 238 were non-disjunctional closed ring, 7 disjunctional ring, and remaining 7 chain-of-four (Fig. 1.). In the Lue Gim

Table 1. Chromosome configurations at metaphase I in PMCs of the Valencia and Lue Gim Gong Orange

Variety aud Strain	Frequency of PMCs								Total number of PMCs
	$8_{II}+2_{I}$	9_{II}	$1_{III}+7_{II}+1_{I}$	$1_{IV}+6_{II}+2_{I}$		$1_{IV}+7_{II}$			
				Ring[a]	Chain	Ring[a]	Ring[b]	Chain	
Valencia A-I	1	16	—	2	—	74	1	4	98
〃 A-II	2	7	1	—	—	54	1	1	66
〃 B-I	5	14	—	5	—	31	2	0	57
〃 B-II	1	3	1	2	—	70	3	2	82
(Total)	9	40	2	9	—	229	7	7	303
Lue Gim Gong	2	42	—	4	1	151	5	10	215

[a] Non-disjunctional and [b] disjunctional orientation of the quadrivalents.

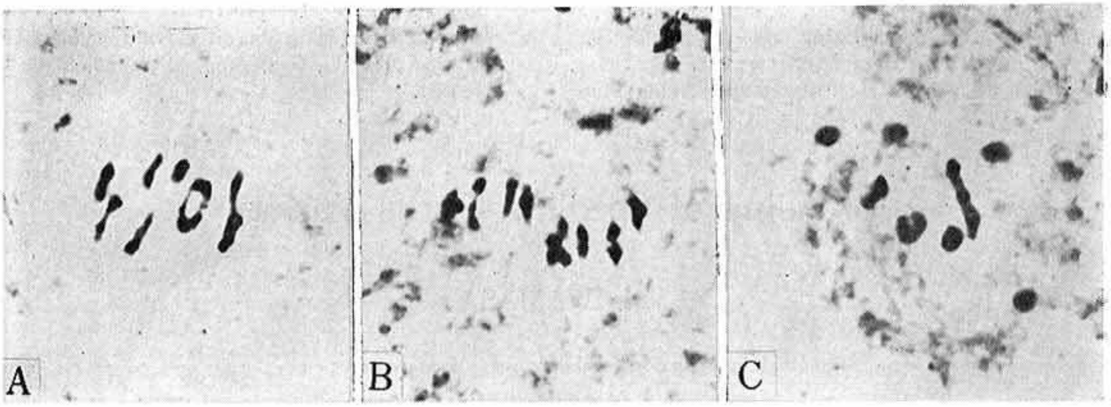

Fig. 1. Chromosome associations at metaphase I in pollen mother cells of the Valencia orange. ×2000.
A. One non-disjunctional ring and 7 bivalents.
B. One disjunctional ring and 7 bivalents.
C. One chain-of-four and 7 bivalents.

Gong orange, a nucellar seedling line of the Valencia, exactly the same chromosome behavior was also observed (Table 1). The similar phenomenon as mentioned above would also happen in the case of embryosac formation. In 14 other sweet orange varieties, consisting of 4 European, 2 Palestinian, 3 American, 4 Chinese and one Japanese, no case of structural change in chromosome constitution was observed (Iwamasa, 1966).

Nearly half of progeny of these translocation heterozygotes is almost of similar type in seedlessness, as a result of the reciprocal translocation. So the Valencia and Lue Gim Gong orange have an important significance for the breeding of new seedless varieties. From this point of view, various monoembryonic varieties, such as Hyuganatsu, Iyo and Hassaku have already been pollinated with the Valencia as our breeding project and a number of hybrid seedlings obtained are being subjected to selection.

Male sterility in Satsuma hybrids.

Tangor (tangerine × sweet orange) and tangelo (tangerine × pummelo) are noticed to be the very interesting group for the future citrus fruits. In the United States, a large number of hybrids have been produced from these crosses. Among them, some new promising hybrids were selected and taken up in commercial cultivation to some extent. Unfortunately, however, all of them were seedy and thus they could not take the place of the leading varieties.

In the Okitsu Branch, Horticultural Research Station (Ministry of Agric. and Forest.), male sterile progeny was obtained from crosses between Satsuma and sweet oranges, pummelo and their relatives. This male sterility has been recognized to be a feasible way for production of new seedless tangors and tangelos.

Because of the nucellar embryony endowed to Satsuma, only a few hybrids could be obtained when Satsuma was used as the female parent. In this station, 1,717 seedlings have been raised from various Satsuma strains polli-

Table 2. Number of plant with and without anthers among hybrids between the satsuma and several other citrus varieties

Parental combination	without anther developed	with normal anther
Satsuma × Sweet orange	5	8
Satsuma × Iyo	1	2
Satsuma × Hirado	1	0
Satsuma × Hassaku	1	2
Total	8	12

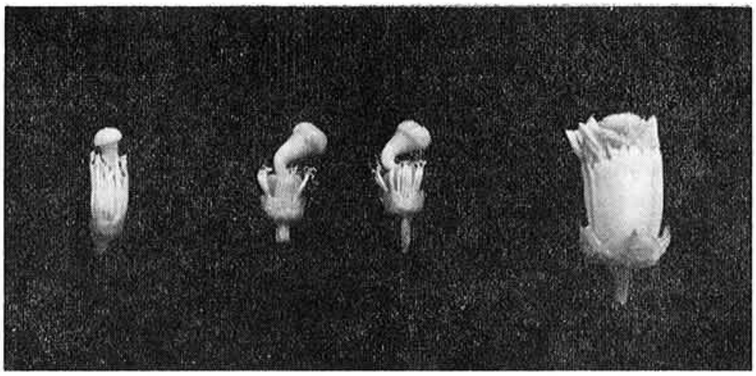

Fig. 2. Flowers of a male sterile hybrid between Satsuma and Hirado, and of its parental varieties.

Left ; satsuma, the seed-parent. Middle ; two flowers of the hybrid. Note the rudimentary anthers of the flowers. Right ; Hirado, the pollen-parent.

Table 3. Parental combination and parthenocarpic ability of hybrids without anthers

Parental combination			Parthenocarpic ability
(Satsuma strains)	×	(other varieties)	
Yakushiji	×	Joppa orange	none
Yakushiji	×	Fukuhara orange	none
Miyasako	×	Valencia orange	none
Miyasako	×	Unidentified[a]	none
Miyagawa Wase	×	Trovita orange	Parthenocarpic
Suzuki Wase	×	Iyo	Parthenocarpic
Saruwatari	×	Hirado	Parthenocarpic
Suzuki Wase	×	Hassaku	Parthenocarpic

a Pollen parent could not be identified, but it is likely recognizable as a strain of sweet orange from ecological behavior, leaf-shape and fruit characters of the hybrid.

nated with sweet oranges and several other citrus varieties. Among them, 41 were judged to be true hybrids (Nishiura and Iwasaki, 1964). As some of them had died and others have not yet come into flowering, 20 hybrid trees were examined in this study.

Parental combinations of these hybrids are described in Table 2. Satsuma strains, including five common and two early maturing types, were used as seed parents. Pollen parents used contained six varieties of sweet orange, the Hirado pummelo, the Iyo and the Hassaku. These latter three varieties originated in Japan. The Hirado is apparently a true pummelo. The Iyo is recognized as a trangor class citrus and the Hassaku is a relative of pummelo.

From the results of the investigation, it became clear that 8 of the 20 hybrid trees failed to develop their anthers in all flowers and consequently they had no matured anther, and, therefore, no pollen-grain (Fig. 2). The remaining 12 hybrids could develop normal anthers, which contained more or less viable pollen grains.

The failure in anther development usually took place so severely that the flowers of the male sterile hybrids lacked anthers completely. Sometimes very slight sign of development of anthers was noticed. Malformed pollen grains or any remnant of archesporial tissues, however, could not be observed even in the slightly developed anthers.

In contrast to the excessive male sterility, the megasporogenesis proceeded rather regularly. Generally, their styles were somewhat curved, but pollen-tubes could grow down through them, and fecundation occurred in time, resulting in the formation of ample good seeds. Out of the male sterile hybrids, 4 obtained from crosses between Satsuma and Trovita orange, Iyo, Hirado and Hassaku have produced completely seedless fruits when isolated from the surrounding pollen sources. They were taken apparently as the parthenocarpic. Remaining 4 hybrid trees failed to set any fruit under isolated conditions. This fact indicates that they lack the ability to set parthenocarpic fruits (Table 3).

A male sterile hybrid between satsuma and Trovita orange was provedto have good quality, and in addition to be monoembryonic, producing entirely zygotic progeny. This will be taken up as a very useful seed parent in the future breeding programs.

References

1) Iwamasa, M. : Reciprocal translocation in the Valencia orange. Chromosome Information Service 4, 9-10 (1963). (In English)
2) Iwamasa, M. : studies on the sterility in genus Citrus with special reference to the seedlessness. Bull. Hort. Res. Sta., Japan, Ser. B 6, 1-82(1966). (In English with Japanese summary)
3) Nishiura, M., and Iwasaki, T. : Studies on the citrus breeding II. Number of seedlings per seed and numbers of gametic and nucellar seedlings from Satsuma mandarin by cross-pollination. Ibid. 3, 1-10 (1964). (In Japanese with English summary)

Biology and Controlling Methods of Tea Red Spider Mite, *Tetranychus Kanzawai* Kishida, in Japan

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Tetranychus kanzawai Kishida is an insect pest first found among mulberry in 1927.[1] This mite is injurious to many plants including tea, mulberry, soybean, hop and grape.[2] Especially, much ocurrence has been seen among tea in recent years. Control against the mites has become of prime importance.

In India, Ceylon, Formosa and other tea producing countries in the Southeastern Asia another type of tea red spider, *Oligonychus coffeae* (Nietner), is said to do great damage to tea,[3~5] but it is not found in Japanese tea fields at all.

Life-history[6]

Tetranychus kanzawai goes through four growing stages. They are adult, egg, larva and nymph. (The last stage includes the protonymphal and deutonymphal stages.) Between larval and protonymphal stages, between protonymphal and deutonymphal stages and between deutonymphal and adult stages there are nymphochrisalis, deutochrisalis and telochrisalis stages respectively, and moulting is carried out immediately after each chrisalis stgae. Thus, the mites moult three times in total. However, some of male have no deutonymphal stage so that they moult only twice.

The mites oviposit on the undersurface of tea leaves. The females lay about 40 to 50 eggs in their life or 2.0 to 2.5 eggs per day at temperature of 20°C on the average.

The growth rate differs widely with the temperature. At 20°C egg stage lasts eight