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IMPERIAL AGRICULTURAL EXPERIMENT STATION
IN JAPAN.

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THE SAN JOSE SCALE

IN

JAPAN.

(251325)

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NISHIGAHARA, TOKYO,
1904.

INTRODUCTORY NOTE.

THIS paper was prepared by S. I. Kuwana, A. M. with the assistance of Messrs. S. Onuki and S. Hori, entomologists of our station at the request of the Bureau of agriculture, Department of agriculture and commerce ; it contains the results of observations concerning the origin and distribution of the San Jose Scale in Japan.

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The San Jose Scale in Japan.

I. Introductory.

This paper will deal only with the San Jose Scale, with regard to its occurrence in Japan, its introduction into the country, and the extent to which the insect has spread from the point at which it was introduced.

In relation to the occurrence of the scale, the elevation of both wild and cultivated lands has been fully described. The natural enemies and other subjects relating to the scale are now under observation.

II. General notes.

Before 1897 the San Jose Scale was not known in Japan, although it was supposed to have existed there long ago. After Mr. A. Craw, a quarantine officer of the port of San Francisco, California, U. S. A., had found this insect on trees from Japan several times during the years 1897-98, Japan has been mentioned as the original home of the scale by the authorities in America and other countries; and papers and pamphlets on the subject were handed to our station.

In 1897 there came into our hands reports saying that many plants and fruit trees from Japan had been destroyed under the strict enforcements of the quarantine regulations at the port of San Francisco, California. By virtue of the proclamation issued by the N. S. Wale's government in December 10th 1897, certain ornamental plants from Japan were refused entrance into her ports. Thus our attention was at once attracted to that pest; the exporters paid special attention to the matter and issued circulars or notices to the nurseries and fruit growers; the horticulturists began to look after the matter.

S. I. Kuwana, assistant in entomology, department of zoology, Leland Stanford Jr. University, California at that time, took a trip to collect scale insects in Japan during three Summer months, June, July and August 1900. His observation on this trip distinctly proved for the first time the wide propagation of the scale throughout the empire, many nursery men and fruit-growers learned much about the scale from him, and immediate interest and attention were secured.

A German Imperial ordinance prohibiting entirely the importation of all plants, fruit-trees and seeds, except water plants and bulbs, from Japan was promulgated on Aug. 16th 1900; This prohibition struck the exporters severely.

In the early part of April 1901, Mr. C. L. Marlatt, the first assistant entomologist, U. S. Department of agriculture, took a trip to Japan and spent here six months; the purpose of his trip was to look for the natural enemies of the San Jose Scale, and his exploration of the interior of the country was pretty thorough for a foreigner. After his return to his native country he reported many interesting facts in regard to the scale in Japan. The investigations of Kuwana and Marlatt, however, could not be as complete as they ought to have been, for they were limited as to time. The entomological division of our station took up the subject and made a more complete investigation of the matter; the following pages are the result of our work up to date. It is by no means perfect as yet, nevertheless, we believe that it will be, no doubt, very useful to the authorities outside of the empire, and will decide the question which lies before the scientific and practical world.

III. Horticultural conditions in Japan.

Any one who makes a study of the San Jose Scale in Japan, in order to observe the spreading of the scale through the country, will have to consider the past and present conditions of horticulture in Japan; without the knowledge of this industry no one can help forming a misconception in regard to the subject.

The principal fruits cultivated in early days were the native pear, per-

simmon and orange ; peach, plum, grapes and apple were but seldom found cultivated. These fruit trees are not grown in large orchards as in America, but chiefly in dooryards, little garden patches, yards near farmers' houses, and around the sides of stone walls ; pear and orange however are sometimes cultivated in somewhat extensive orchards.

Since foreign fruits were introduced, the method of their cultivation has been changed in some respects ; in almost every province or Ken there was established an experimental farm, cultivating foreign fruit trees, cereals and vegetables, mostly of American origin, along with our native ones. From this starting point there have come many private orchards, especially in Hokkaidō and the northern part of the empire ; the stock of these orchards was got from a few well known nurseries mentioned elsewhere in this paper.

IV. How the San Jose Scale was introduced into Japan.

The female insects are footless creatures, entirely lacking the power of locomotion, and pass their lives on their host plant ; hence if a tree or plant infested by the insects is transplanted, the insects are also transplanted. The transport of the plant does not destroy their vitality, unless some special means are taken to detory them ; moreover the insects are very likely to benefit greatly by the transportations, because if they are removed to a new locality, they will probably be free from the natural enemies in the native home.

It should be remembered, however, that the San Jose Scale as well as other insect foes are not excessively destructive generally under natural conditions, and they only become so when the balance of nature is disturbed by some interference. During the last half century, international commerce has developed wonderfully ; and one of the many benefits of this development has been the interchange, among different countries, of plants of all kinds ; on the other hand this interchange of plants has led to the dissemination throughout the world of many pestiferous insects.

The San Jose Scale as well as other injurious insects introduced from foreign countries, as a rule, first become established in the nurseries, as nursery men are chief importers of plants. The contiguous tops of the young

trees in the nursery rows offer the best possible opportunity for the young and movable larvae of the insects to spread from one tree to another, thus an immense number of trees being quickly infested by the pests. The interchange of scions and cuttings between farmers and gardeners also aids the distribution of the pests; the distribution of infested fruits is also a probable factor in the spread of the scale insect.

In 1871, 4th year of Meiji, Mr. J. Hosokawa, a secretary of the Internal administrative department of Japan, who was in America at that time, sent grains, seeds of vegetables, nursery stock of many kinds and American agricultural tools and implements to the country. This is the first time that fruit trees were introduced into the empire from the west, so far as we find in our records; it is known, however, that some apple and other fruit trees had already reached the land from the west, but the exact history of these trees is untraceable now. In 1875, 8th year of Meiji, the Japanese Consulate of San Francisco, California, sent a lot of fruit trees and vines, lemon, orange, berry and hop etc. to the Agricultural bureau of the Internal administrative department. In the following year 3,600 stalks of grapes and other fruit trees including apple trees were obtained from America and planted in the experimental field Kwaitakushi at Awoyama, Tokyo; after a while they were sent to nearly all local experiment fields in the empire. Since then fruits, cuttings, roots and grafts of all kinds have been introduced constantly, chiefly coming from California through the port of San Francisco.

It is very likely that the San Jose scale was introduced into Japan with the infested stock about that time. It is said by many American writers that the pest was recognized by fruit growers of California about 1873; and Prof. J. H. Comstock introduced it to the notice of the scientific world in 1880 for the first time. From these facts we can see that when the Japanese Consulate of San Francisco sent the stock from there to Japan, the pest was already widely propagated in the valley of Sant Clara, California.

V. How the San Jose Scale was spread in Japan.

(Refer to Plate III.)

From the following detailed account it will be seen that in almost every instance the infested localities trace the introduction of the pest to trees purchased from three or four well known nurseries. These nurseries, like those in America, through their shipment have been the means of spreading the scale widely throughout the empire.

As already mentioned the Kwaitakushi received stock from America in 1876, and planted the trees in the experimental field at Awoyama, Tokyo for propagation; in the few years following some were sent to Hokkaidō, Angio in Saitama-ken, Awomori-ken, and Iwate-ken for experimental purpose; of the above districts Hokkaidō, Awomori and Iwate were chosen for cultivation of apple and pear etc., while Angio for stock nursery. Angio is a celebrated nursery district known to the public for more than a century as a nursery for ornamental trees and Japanese fruit trees. Soon afterwards the well known nurseries of Ikeda and Itami in Settsu province near Osaka, and Nakazima in Aichi-ken introduced foreign fruit trees such as apple, peach, pear etc. from Tokyo to their gardens for propagation and sale. The original trees are still there.

It is a well known fact that the larger part of the scale, which has been propagated over the different provinces of the empire, has come either directly or indirectly from the above mentioned districts.

VI. Distribution and present status of the San Jose Scale in Japan.

(Refer to Plate IV.)

We have visited 482 localities in the four main islands of the empire, Hokkaidō, Hondō, Shikoku and Kiushiu, including private gardens, orchards and nurseries; and the number of trees examined in each locality varied from half a dozen to several hundreds; we crossed over high mountains and deep valleys, sea level land, plains and wild forests of high elevation where no explorers had been before.

Out of 482 localities we found the scale in 145, which are marked distinct-

ly colored on the map; in some localities the spots are omitted on account of want of space. In the accompanying pages we shall sketch out briefly the present condition of the scale distribution.

HOKKAIDŌ.

The scale does not seem to spread rapidly in the island on account of its climatical conditions, and only in 12 localities it was found by us. The first stock of the island came from America through the Kwaitakushi at Tokyo as already mentioned; the fruit trees thus introduced were apple, pear, peach, plum, apricot and grape etc., of which apple and cherry are the chief fruit trees at present.

About 1868 a German had an orchard near HAKODATE, where he cultivated apple, pear, cherry, plum, current, gooseberry and grape vine of western varieties along with some of our native ones.

HONDŌ.

1. *Awomori-ken.*

The scale has been found in 5 localities; in some of the places many hundreds of trees were killed or dug out on account of the scale; and in fact some growers are removing their orchards and establishing new ones in some remote localities with perfectly inspected stock from other growers. No where else were the apple trees so badly infested with the scale as in Hirosaki, especially at Mr. Kikuchi's orchard. In order to prevent further spreading of the scale, he destroyed many well started trees; many growers took his advice, removed badly infested trees from the orchards, and burned them. It is difficult to destroy the scale even by fighting it with the best means.

For the first time the local government obtained 50 foreign fruit trees from Tokyo in the Spring 1875 and distributed them among several individuals in the province for experiment. In the following year many

thousand trees were introduced from Tokyo and Angio, and some from Hokkaidō.

2. *Iwate-ken.*

More than 17 localities were examined, and the scale was found in 6 of them; the scale does not seem to do as much harm in this province as in Awomori, and the number of insects on an infested tree is very small, although it is pretty widely distributed.

The first stock of apple tree was introduced into Morioka city from Hokkaidō by Mr. Yokohama, who visited there 1872; the stock was obtained from a foreign preacher at Hakodate, Hokkaidō, whose origin is untraceable.

In 1875 Mr. K. Shima, the governor of Iwate-ken obtained several thousand apple trees from Angio in Saitama-ken, and distributed them to those who desired to cultivate them. Since that time the stock was obtained not only from Tokyo and Angio, but also from many other places; and some of the growers in this province had begun to send much stock to other districts.

3. *Akita-ken.*

12 localities were inspected, in 3 of which the scale was found. The stock came from Angio and Hirosaki, chiefly consisting of apple and pear trees. In some localities the infested trees were about 16 years old, having come from Tokyo through Akita city. Pear trees in this province sometimes suffered greatly from the scale.

4. *Yamagata-ken.*

In Yamagata-ken we know 4 infested localities; the orchards chiefly consist of apple and pear trees, the stock of which was mostly obtained from Angio and Tokyo; the oldest trees are not more than 16 years old.

Some infested localities are 800 ft. above sea-level and very cold in Winter. At a high elevation under such climatic conditions and also from other causes, the scale does not increase with great rapidity, and even one who has some knowledge of the scale insect might over look the San Jose Scale in the

districts, although sometimes it is very conspicuous, together with *Parlatoria*. It is said in some localities the scale once did great damage to the fruit trees, and they were treated with kerosene very vigorously ; after that the scale did not spread to so great an extent as to do actual harm to the trees.

5. *Fukushima-ken.*

The scale has been found in 2 localities, Fukushima and Wakamatsu cities. An orchard, near Wakamatsu city containing several hundred apple trees, was completely ruined by the scale and by trunk borers ; many trees were blown down by a severe wind some years ago, so the owners thought it best to remove the poor trees and plant pear trees instead of apple, and also to plant pears among the apples. When the writer visited the orchard last fall, he advised the digging up and burning of the trees, and the owners promised him this should be done. The apple trees were obtained from Niigata in 1887.

A pear orchard near the apple plantation was free from the San Jose Scale, although *Parlatoria* and other scales were not uncommon.

6. *Miyagi-ken.*

Near Miyagi city the writer found the scale on pear and apple trees ; an orchard contained about 500 trees of 10 years age, the stock having come from Yamagata ; a pear orchard at Nanai-village contained 5,000 trees of 10-15 years age. Many of the trees of these orchards were attacked by the scale. The writer particularly noticed a tree about 8 years old, and cut off about 4 ft. above the ground, and grafted on the top, protecting the grafts with straw ; the trunk under the straw was so thickly covered with the scales that it was difficult to see the bark of the tree, but on the young grafted shoots there were but very few scales.

In the yard of the agricultural school near the city also there were several apple and pear trees among other fruit trees ; these pear trees about 10 years old were of an American variety infested by the scale. In Mr. Hayakawa's orchard near the city, the scale was also found together with *Parlatoria* to some extent.

7. *Gunma-ken.*

The occurrence of the San Jose Scale in this province was noticed at the following localities : Mayebashi, Takasaki, Isezaki and Tomioka. There are no orchards generally speaking, and only a dozen or less trees standing in private yards ; the stock came chiefly from Angio or Tokyo recently.

8. *Saitama-ken.*

Angio is one of our large nursery districts growing no fruit ; and so far as we know no other localities in this province have the scale. Much infested stock was no doubt sent off from Angio all over the empire, where it was brought from Tokyo, soon after the Kwaitakushi introduced American stock, as mentioned elsewhere in this paper. So we may say that Angio directly or indirectly is a great source of the scale, because almost all nursery stock which is sold by dealers at Tokyo, Yokohama and elsewhere is obtained from Angio. Of course the stock which is sent off from this nursery district is properly inspected with regard to the San Jose Scale and all other pests at present.

9. *Chiba-ken.*

The occurrence of the scale in this province has been ascertained in 3 places, Matsudo, Yawata and Sakura. The stock was obtained from Tokyo and Angio.

10. *Ibaraki-ken.*

The San Jose Scale has been found in 5 localities, and the source of the infection appears to have been nursery stock recently introduced from Angio and other places.

11. *Tokyo-fu.*

It is very apparent that the Tokyo city is the original source of the scale in Japan, importing much American stock since 1871 and spreading it over the Empire directly or indirectly, just as it is shown on the map ; but in Tokyo there are a few nursery dealers who import foreign stock directly from foreign land.

The Mita nursery, established by Mr. Takenaka some 20 years ago, deals with both foreign and inland varieties of fruit trees and other plants, the foreign seeds and stock being chiefly imported from California, New York and Philadelphia, along with a good part of stock raised in Angio. In the Imperial vegetable garden, Shinjiku the scale is sometimes met with, but particular attention is paid to destroy it. Besides the city the writer found the scale in four localities.

12. *Kanagawa-ken.*

In this province the writer found the scale in Yokohama and Kawasaki. The largest nursery of Yokohama city is the Yokohama nursery company, exporting flowering plants, ornamental trees, shrubs and bulbs of all kinds, which are mainly collected from other nurseries in the country; among a large number of plum, cherry and a flowering quince (*PINUS SPECTABILIS* AIT.) etc., some were infested by the scale, which was destroyed at once; a pear tree, in a pot from Angio about 6 years old, was also attacked by the pest. The writer took the tree as a specimen. Other numberless trees and shrubs of both home and foreign kinds were carefully examined, but the scale could not be found. In such a nursery much vigorous measures are taken to destroy the pest, and not to export the infested plants.

Kawasaki is a well known place for Japanese pears; it is situated between Tokyo and Yokohama and close to the rail road, so that we can see the pear orchard from the windows of the cars. Besides pears there are some peaches, cherries and apple trees of rather recent introduction from Angio. Near Kawasaki city there is an orchard pertaining to the Agricultural college, Tokyo university, where the writer has found the scale on pear trees and young apple trees; and here under peculiar natural conditions and under the rational care of the men employed, the scale does not spread to such an extent as to do harm to the orchard trees.

13 *Shizuoka-ken.*

The scale has been found in two localities, Shizuoka city and Okitsu, the former obtaining the stock from Awomori-ken 1898. At Okitsu the

horticultural division of our station with a fair acreage of land was established 1902, to make both field experiments and scientific researches with regard to our horticulture ; the last year a lot of stock was brought here from Maryland, America, in which the scale was found by Mr. S. Hori. The infested trees were destroyed in the both cases.

14. *Nagano-ken.*

The scale has been found in 8 localities mostly in private yards or gardens, the infested trees being recently introduced from Nakajima in Aichi-ken and Angio etc. As a general thing along the margin of the lake Suwa, there are pear and quince orchards, where *Parlatoria* and the San Jose Scale were so numerous and so injurious as to cause the trees to produce no fruit ; therefore some of the growers had removed the trees.

Some of the localities in this province have an altitude as high as over 1,000 ft. ; and the writer believes that the climate is not suitable to the growth of the pest ; it can hardly be said to exist there, because the hosts brought there from other places do not thrive in this locality.

15. *Niigata-ken.*

The scale has been found at Niigata city, Kasaki, Nuttari, Kawahigashi and Kayaba located chiefly along the bank of the rivers Shinano and Nakano-kuchi, the hosts being comparatively young apple and pear trees. Niigata and its neighbourhood are famous for Japanese pears since a long time, having many old native pear trees everywhere in private yards and on hill sides etc. ; the writer examined these trees very carefully, but he was unable to find out the scale. The new varieties now cultivated were introduced from Yokohama, Kawasaki, Nakajima and Angio ; pear trees in some orchards were badly infested by the scale. *Parlatoria* and *Diaspis* were also not uncommon.

16. *Toyama-ken.*

Two localities were found infested by the scale, both in private gardens.

17. *Ishikawa-ken.*

The scale has been found in three localities, the infested trees being of recent introduction.

18. Fukui-ken.

Two localities, Fukui city and Tsuruga, were found infested by the scale, the stock having been obtained from Tokyo and Ikeda about 10 years ago.

19. Gifu-ken.

The scale has been observed in a few places, the infested trees being recently introduced. In the village Kuise-mura the writer has found many small pear orchards badly infested by the scale and *Parlatoria*, the new varieties of domestic and foreign pears having been introduced from Nakajima in Aichi-ken 1888. The writer has said in an article* "In this region the scale has been known for more than 30 years under the name of Ki-abura"; an explanation of this statement is needed here, for otherwise there will be, he believes, some misunderstanding in regard to Ki-abura. He visited that locality i.e. Kuise-mura last Summer again for the observation of the scale and found that the Ki-abura means not only the San Jose Scale, but also other scales and insects which are parasitic to the tree; in order to prove the matter he tested it with the aid of an experienced old man, whom he requested to point out the Ki-abura; so he showed the writer *Parlatoria* in one orchard, the San Jose Scale in another and *Pulvinaria* at different places. Thus Ki-abura includes several pests besides the San Jose Scale.

21. Aichi-ken.

The scale has been located at Nagoya city and Nakajima, the latter being one of famous nurseries for more than a century; the Nakajima nursery introduced foreign varieties of apple, pear and peach from Tokyo, Angio and Ikeda etc. rather recently for propagation and sale.

22. Shiga-ken.

The scale has been recognized in two places, Maibara and Otsu; in the agricultural experiment station of this Ken near Otsu, the writer noticed the

* Kuwana: Cont. to Biol. from the Hopkins seaside Lab. of the L. Stanford Uni., Calif. XXV-1901.

scale on a quince tree about 10 years old, and also on apple trees, which were destroyed at once ; the stock came from Angio.

23. *Miye-ken.*

The scale was found in two localities, Tsu and Owashi ; the hosts of the scale at Tsu city were orange trees, coming from Itami near Osaka in 1902.

24. *Kyoto-fu.*

The scale has been found in Kyoto city.

25. *Osaka-fu.*

Osaka city and Ikeda are known to have the scale, the latter is one of famous nurseries in Japan, sending enormous stock of trees to several districts ; the principal part of the stock however which is shipped away is produced in Itami, Hyogo-ken a few miles away to the south.

26. *Nara-ken.*

The scale has been found in two localities. The celebrated Yoshino-mountain has various native cherry trees for many centuries, and indeed is almost covered with them, the so-called Yamazakura. Mr. S. Hori, one of our former entomologists, carefully investigated the scale on the trees, but he failed to find it.

27. *Hyogo-ken.*

The scale has been found in 6 localities. As already mentioned Itami is a famous nursery district, especially for citrus trees ; a lot of stock has been sent from Itami mainly to the southern parts of the empire. Mr. B. Kubo, one of well known nursery men, said that he was the first introducer of foreign apple, peach and pear from Tokyo in 1882, which trees remained in his yard until a few years ago when Mr. S. Hori visited there for research. The writer was much disappointed the last Summer, because these trees were all removed on account of the scale.

28. *Tottori-ken.*

3 localities were known to be infested by the scale, the infested trees being all recently introduced from Okayama, Shikoku and Hyogo-ken.

29. Okayama-ken.

The scale has been found in 10 localities. The scions were obtained from the Mita nursery, Tokyo by Mr. Y. Yamauchi in 1876; then in 1879 Mr. Z. Watanabe obtained stock, chiefly pear and peach, from Hyogo-ken; by these pioneers the first industry of the district was so extended as to make it one of the most important fruit districts in Japan.

30. Shimane-ken.

2 localities were known to be infested by the San Jose scale, the stock being recently introduced.

31. Hiroshima-ken.

The writer found the scale on very young apple trees of the agricultural experiment station in the Summer 1902, the stock coming from Tokyo (Angio); two other localities had also the pest.

32. Yamaguchi-ken.

The scale has been reported only from Tokuyama.

SHIKOKU.*33. Tokushima-ken.*

More than 10 localities were carefully examined, but the scale was found in but one place.

34. Kagawa-ken.

6 localities are known to be infested by the scale, the stock chiefly coming from Itami.

35. Yehime-ken.

The scale has been found in 2 localities.

KIUSHIU.

36. *Fukuoka-ken.*

When the writer was sent from Stanford University, California to Japan, three localities were known to be infested; then two other localities, Kurume and Hikosan were added, the infested plant at the latter being introduced by Mr. N. Takachiho from Tokyo. When the writer published his report* he said "An old native pear tree about 45 years old is standing by itself east of a farmer's house by a small ditch, it is about 12 inches in diameter and very old never pruned; it is very badly infested by the scale." The writer spent some time in collecting scale insects in the vicinity of Kokura city and the village Kato-mura in the latter part of August 1902, and concluded that the scale must have been brought here by natural causes as wind and birds etc. from infested regions near by.

37. *Saga-ken.*

Only one locality has been reported as infested by the scale.

38. *Nagasaki-ken.*

The scale has been found in 3 localities, Nagasaki city, Isabaya and Hayaki, on rather recently introduced trees.

39. *Kumamoto-ken.*

The scale has been discovered in 3 localities, the infested stock coming from Shikoku chiefly.

40. *Oita-ken.*

Only one locality has been found infested by the scale.

41. *Miyazaki-ken.*

Two localities have been reported as infested by the scale.

* Kuwana: The San Jose Scale in Japan; Cont. to Biol. from the Hopkins seaside Lab. Stanford Univ., Cal., XXV—1901.

42. *Kagoshima-ken.*

Only a single locality is known to be infested by the pest.

VII. Epoch of exportation of Japanese vegetation.

When Mr. A. Craw of the quarantine office at San Francisco, California had two or three times found the San Jose scale or so called subspecies of the same on plum and other trees from Japan, notably on a plum tree arrived Jan. 28th 1898, the discussion of the question of its native home once more became a burning question in America, and some people firmly believed that its native home might be proved to be Japan; many articles then appeared, and in one of them Prof. F. M. Webster, Ohio agr. experiment station said* "As I have been able to prove almost conclusively it came to us from Japan."

It is clear however that almost all articles and papers dealing with the original home of the scale were based upon fragmentary facts, and thus no firm basis for this conclusion was established. The ornamental, flowering and fruit trees of the empire had been shipped to the west steadily in enormous quantities for more than two centuries, before the time when Commodore Perry opened the door of the empire by the treaty signed by him in 1854. Since that time the exportation of Japanese vegetation has been increasing in amount; but during that whole period the scale was not found on the plants that were exported.

The stock on which Mr. Craw had found the scale in 1898 was shipped from Yokohama, and produced in a nursery where the scale was first introduced with the infested foreign stock some years before.

The following table shows the period of exportation of Japanese plants to foreign countries:—

* Report of Ent. society of Ont., 1898, pp. 3.

DATA.	NAME OF FU AND KEN.	NAME OF LOCALITY.	NAME OF PLANT.
1895	Tokyo	Tameike, Tokyo.	Grains, Seeds of vegetables and ornamental trees in general.
1898	„	Shiba, Tokyo.	Coniferous plants, camellia, maples, and other ornamental plants.
1899	„	Ushigome, Tokyo.	Lilies, camellia, coniferous plants; <i>Pirus spectabilis</i> (Kaido) etc.
1868	Osaka	Ogawa-mura, Toyono-gun.	<i>Paeonia albiflora</i> , <i>P. moutan</i> , <i>Camellia japonica</i> , <i>Larix leptolepis</i> , <i>Osmanthus fragrans</i> , maples, orchis, lilies etc.
1864	Kanagawa	Yamashita, Yokohama.	<i>Paeonia moutan</i> , <i>P. albiflora</i> , <i>Cycas revoluta</i> , <i>Rhododendron</i> , lilies, maples, camellia, bamboo etc.
1884	„	Motonaka-mura, Kuraki-gun.	<i>Paeonia moutan</i> , <i>P. albiflora</i> , <i>Cryptomeria japonica</i> , <i>Cycas revoluta</i> , <i>Trachycarpus excelsus</i> , <i>Diospyros kaki</i> , <i>Rhododendron</i> , lilies, maples, plum, peach, cherry, pine, chestnut, orange, Iris, camellia, fern, bamboo and other flowering plants.
1884	Hyogo	so called Kanui { Nakano-mura, Kawabe-gun. Nagao-mura, Kawabe-gun,	Pine, maples, camellia, lilies, Iris, bamboo, <i>Cycas revoluta</i> , <i>Rhododendron</i> , <i>Paeonia moutan</i> .
„	„		Orange, apple, pear, pine, camellia, <i>Trachycarpus excelsa</i> , <i>Kraunhia floribunda</i> and other ornamental plants and shrubs.
1624	Nagasaki	Nagasaki city.	Pine, camellia, rose, chrysanthemum, <i>Trachycarpus excelsa</i> , <i>Cycas revoluta</i> , <i>Chamaecyparis obtusa</i> and other ornamental trees and shrubs.
„	„	Koga-mura, Kita Korai-gun.	Pine, plum (flowering Ume), lilies, <i>Cycas revoluta</i> , <i>Paeonia moutan</i> , <i>Lagerstromia indica</i> , <i>Chamaecyparis obtusa</i> var. <i>breviramea</i> , <i>C. pisifera</i> var. <i>filifera</i> , <i>Santalum album</i> , <i>Euonymus japonica</i> , <i>Sciadopitys verticillata</i> , <i>Pirus spectabilis</i> and other ornamental trees and shrubs.
1882	Saitama	Angio.	Lilies, pine, box-wood, chestnut, cherry, plum, peach, pear, mulberry, maples, bamboo-camellia, <i>Diospyros kaki</i> , <i>Chamaecyparis pisifera</i> , <i>Quercus glandulifera</i> , <i>Q. acuta</i> , <i>Pasania cuspidata</i> , <i>Paulownia tomentosa</i> , <i>Sciadopitys verticillata</i> etc.

VIII. Absence of the scale in high and uncultivated regions.

(Refer to Plates V and VI.)

“I consider it probable that the scale is a native of the more or less elevated regions of Japan, not of the sea coast” are Prof. T. D. A. Cockerell’s words;* considering the professor’s wide knowledge and great experience in the Coccidæ, no doubt such a statement should be well weighed. The result of our careful investigation however proves an entirely opposite fact, namely that we find the scale most abundant in a low level between 1 to 100 metres, and the more so the less higher the region, as clearly shown in the map; and indeed no scale was found in high regions nor in wild forests. Last summer the writer explored Hakone, Nikko, Mt. Fuji, Asama, Tokasuki, Gante, Hiyei and other noted mountains; he also spent many weeks in the Kiso-mountainous region, the highest portion of Hondō, and crossed over Sennin acme between Iwate and Akita-ken, Innai acme between Akita and Yamagata-ken, Torii acme between Niigata and Fukushima-ken, Shijūmagari acme between Okayama and Tottori-ken. He penetrated the deep forests and examined them very carefully, paying special attention to wild roses, willows, wild nuts etc., but failed to find out the scale, although *Diaspis pentagona* was very common. In the author’s paper on the San Jose Scale in Japan† he says. “In a group of about a dozen wild pear trees (*PIRUS TORINGO*) I found one very badly infested by the scale, every part of the tree being covered by the scale even to the roots exposed above the soil. These trees were brought from a mountain about 4 miles from Morioka city for grafting; many female scales remained on the tree with a small hole in each, through which no doubt the parasites had escaped. I desired very much to go to the mountain to investigate the condition of wild pear trees, but the time would not permit.”

The writer took a special trip to that region last Summer accompanied by Mr. S. Iwafuchi, in order to make researches concerning the wild pear;

* Ent. News IX-No. 4, pp 94.

† Cont. to Biol. from the Hopkins sea-side Lab.
L. Stanford Jr. Univ. Calif., XXV-1901.

and they make an excursion toward Mt. Gante about 14 miles from Morioka city. On the fields and plains the wild pear was generally distributed, giving a good chance for the investigation; and at the same time the writer paid careful attention to the following plants:

Pirus toringo Sieb. Wild pear.

(*Zumi, Himekaido, Mitsubakaido, Yatsumomo,*)

Pirus sambucifolia Ch and Schl.

(*Miyamakamado*)

Pirus aucuparia Gaertn.

(*Nanakamado*)

Pirus sinensis Lindl.

(*Nashi*)

Rosa sp.

(*Ibara*)

Acer sp.

(*Kacde*)

The result was that the writer could not find the scale on any of the plants above mentioned; so he concluded at once that the scale on the wild pear trees in Morioka city, which he found three years ago, must have come from other hosts in the yard at that time.

IX. Climatic conditions and distribution of the San Jose Scale.

It is well known fact that certain kinds of animals and plants have a definite limited range of occurrence or distribution; naturalists call such limits life zone, within which particular animals or plants thrive, and outside of which they fail to establish themselves. But up to a certain degree this natural law has been disturbed artificially by the international trade; if a plant is transferred into a climate strange to its original home, the animals fed upon it would also survive well; and they would find their food even under a great change of climate. Under considerably great change of the conditions, however, they would often be completely destroyed.

The San Jose Scale is now so widely distributed all over the empire that no one can draw any sharp line with regard to the life zone ; this is due to the fact that the pest is of rather recent introduction to the various localities where the infested fruit trees are transferred. But from careful observation we would say that it increases in certain localities more rapidly than in others ; in some localities it will disappear within a few years, because the climate and other conditions are not favorable for its life, although it might survive as at present for a time. Even at an elevation of 1,000 metres as in some parts of Shinano and Hikosan in Kinshiu we found the scale ; but judging from what the writer has observed at such altitudes, it has no great power of modification, simply living there as it was brought on.

After the actual researches in different localities and long years experience of the writer, the most favorable condition for the scale life in Japan is on rather low land not higher than 100 metres, surrounded by high hills and protected from severe wind and with plenty of moisture.

X. The food plants of the San Jose Scale in Japan.

In America the scale has a very wide range of food plants, attacking practically all of the deciduous fruit trees and many of the small fruits ; it can also sustain itself upon many ornamental shrubs and native trees, except perhaps the Conifers, pine and cedars, and weeds of the field as well as several other plants are also the host. From Dr. E. P. Felt's list of the hosts of the scale, we learn that there are 137 species of plants attacked by the scale, among which 72 are badly infested, and the remaining 65 only rarely attacked. The plants affected by the scale in Japan are much limited in number ; pear and apple trees are very frequently attacked, and others seldom, the native pear, wild cherry and other trees are free from the pest. The food plants of the scale in Japan known up to the date are given in the following list :—

- | | |
|-----------|------------------|
| 1. Pear. | (<i>Nashi</i>) |
| 2. Apple. | (<i>Ringo</i>) |
| 3. Peach. | (<i>Momo</i>) |

- | | | |
|-----|-----------------------------------|--------------------------|
| 4. | <i>Pirus spectabilis.</i> | (<i>Kaido</i>) |
| 5. | Currant. | |
| 6. | Willow. | (<i>Yanagi</i>) |
| 7. | <i>Photinia</i> sp. | (<i>Kaname</i>) |
| 8. | <i>Pæonia moutan.</i> | (<i>Botan</i>) |
| 9. | <i>Pirus toringo</i> , wild pear. | (<i>Mitsuba-Kaido</i>) |
| 10. | <i>Prunus mume</i> S. & Z. | (<i>Ume</i>) |
| 11. | <i>Cydonia vulgaris</i> Pers. | (<i>Marumero</i>) |
| 12. | <i>C. japonica</i> | (<i>Boke</i>) |
| 13. | <i>Citrus</i> sp. | (<i>Kō-Rui</i>) |
| 14. | Plum. | (<i>Sumomo</i>) |

In the following list the writer gives the names of the more important cultivated shrubs, ornamental trees and fruit trees in Japan.

List of important fruit trees in Japan.

No.	Scientific Name.	Japanese Name.
1.	<i>Castanea vulgaris</i> Lam.	Kuri.
2.	<i>Citrus aurantium</i> L.	Kunenbō.
3.	<i>C. bigaradia</i> Duh.	Daidai.
4.	var. <i>sinense</i> Gall.	Natsu-daidai.
5.	<i>C. decumana</i> L.	Zabon.
6.	<i>C. medica</i> L.	Marubushikan.
7.	var. <i>chirocarpus</i> Lour.	Bushukan.
8.	var. <i>yuzu</i> Matsu.	Yuzu.
9.	<i>C. limonum</i> Hook.	Remon.
10.	<i>C. nobilis</i> Lour.	Kauji.
11.	var. <i>microcarpa</i> Hassk.	Kinkan.
12.	<i>Cydonia sinensis</i> Thou.	Kwarin.
13.	<i>C. vulgaris</i> Pers.	Marumero.

14.	<i>Diospyros kaki</i> L. & F.	Kaki.
15.	<i>Elæagnus macrophylla</i> Thu.	Natsugumi.
16.	<i>E. umbellata</i> Thu.	Akigumi.
17.	<i>Eriobotrya japonica</i> Lindl.	Biwa.
18.	<i>Ficus carica</i> L.	Ichijiku.
19.	<i>Pirus malus</i> var. <i>tomantosa</i> Koch.	Ringo.
20.	<i>P. sinensis</i> Lindl.	Nashi.
21.	<i>Prunus amygdalus</i> Stokes.	Amendo.
22.	<i>P. armeniaca</i> L.	Anzu.
23.	<i>P. cerasus</i> L.	Mizukura.
24.	<i>P. communis</i> Huds.	Sumomo.
25.	<i>P. domestica</i> L.	Seiyō Sumomo.
26.	<i>P. mume</i> Slet. & Z.	Ume. (Mume)
27.	<i>Punica granatum</i> L.	Zakuro.
28.	<i>Ribes rubrum</i> L.	Suguri.
29.	<i>Vitis vinifera</i> L.	Budō.
30.	<i>Zizyphus vulgaris</i> var. <i>inermis</i> Bge.	Natsume.

List of important ornamental trees and shrubs in Japan.

No.	Scientific Name.	Japanese Name.
1.	<i>Acer japonicum</i> Thunb.	Meigetsu-kaede.
2.	<i>A. micranthum</i> S. & Z.	Komine-kaede.
3.	<i>A. palmatum</i> Thunb.	Kaede.
4.	var. <i>dissectum</i> Thunb.	Tamukeyama.
5.	<i>A. pycnanthum</i> C.	Hana-kaede.
6.	<i>A. rufigerum</i> S. & Z.	Uriba-kaede.
7.	<i>Aegle sepiaria</i> D. C.	Karatachi.
8.	<i>Aesculus turbinata</i> Bl.	Tochinoki.
9.	<i>Aphananthe aspera</i> Pla.	Mukunoki. †
10.	<i>Casalpinia sappan</i> L.	Suwō.

11.	<i>Calycanthus piaccox</i> L.	Rōbai.
12.	<i>Chamaecyparis pisifera</i> .	Sahara.
13.	var. <i>filifera</i> S. & Z.	Itobiba.
14.	<i>Chloranthus brachystachys</i> Bl.	Senryō.
15.	<i>Cinnamomum camphora</i> Nees.	Kusunoki.
16.	<i>Cornus</i> sp.	Mizuki.
17.	<i>Cryptomeria japonica</i> Don.	Sugi.
18.	<i>Cycus revoluta</i> Thunb.	Sotetsu.
19.	<i>Damnacanthus indicus</i> Gae.	Aridōshi.
20.	<i>Daphniphyllum macropodum</i> Mig.	Yuzuriha.
21.	<i>Dendrobium moniliforme</i> Sw.	Setsukoku.
22.	<i>Eriobotrya japonica</i> Lindl.	Biwa.
23.	<i>Euonymus alata</i> K.	Nishikiga.
24.	<i>E. japonica</i> Thunb.	Masaki.
25.	<i>Eurya ochnacea</i> Szysz.	Sakaki.
26.	<i>Gardenia florida</i> L.	Kuchinashi.
27.	<i>Ginkgo biloba</i> L.	Ichō.
28.	<i>Hydrangea hortensia</i> De. var. <i>azisai</i> A. Gr.	Azisai.
29.	<i>Ilex integra</i> Thunb.	Mochinoki.
30.	<i>Jasminum grandiflorum</i> L.	Sōkei.
31.	<i>Juniperus chinensis</i> L.	Ibuki.
32.	<i>Kerria japonica</i> D. C.	Yamabuki.
33.	<i>Lagerstrœmia indica</i> L.	Sarusuberi.
34.	<i>Larix leptolepis</i> Gorb.	Karamatsu.
35.	<i>Lespedeza bicolor</i> Tur.	Hagi.
36.	<i>L. buergeri</i> Miq.	Ki-hagi.
37.	<i>L. cyrtobotrya</i> Miq.	Maruba-hagi.
38.	<i>L. juncea</i> Pers.	Medo-hagi.
39.	<i>L. pilasa</i> S. & Z.	Neko-hagi.
40.	<i>L. villosa</i> Pers.	Inu-hagi.
41.	<i>Michelia longifolia</i> Bl.	Genkō-boku.
42.	<i>Nandina domestica</i> Thunb.	Nanten.

43.	<i>Paeonia moutan</i> Ait.	Botan.
44.	<i>P. albiflora</i> Pall.	Shakuyaku.
45.	<i>Pandanaus odoratissimus</i> L.	Takonoki.
46.	<i>Paulownia tomentosa</i> H. Bu.	Kiri.
47.	<i>Photinia wrightiana</i> Max.	Shimakaname.
48.	<i>Phyllostachys aurea</i> Riv.	Hoteichiku.
49.	<i>P. bombusoides</i> S. & Z.	Yadake.
50.	<i>P. heterocyclus</i> (Carr.)	Kikkōchiku.
51.	<i>P. mitis</i> Riv.	Mōsōchiku.
52.	<i>P. nigra</i> Mun.	Kurochiku.
53.	<i>P. quillioi</i> Riv.	Madake.
54.	<i>Pinus densiflora</i> S. & Z.	Akamatsu.
55.	<i>P. koraiensis</i> S. & Z.	Chōsen-matsu.
56.	<i>P. thunbergii</i> Parl.	Kuromatsu.
57.	<i>P. pentaphylla</i> May.	Gōyōmatsu.
58.	<i>Platycodon grandiflorus</i> D. A.	Kikiō.
59.	<i>Podocarpus chinensis</i> Wall.	Maki.
60.	<i>Prunus buergeriana</i> Miq.	Inuzakura.
61.	<i>P. campanulata</i> Max.	Kanzakura.
62.	<i>P. incisa</i> Thunb.	Mamezakura.
63.	<i>P. japonica</i> Thunb.	Niwaume.
64.	<i>P. maximowiczii</i> Rupr.	Miyazakura.
65.	<i>P. miqueliana</i> Max.	Higanzakura.
66.	<i>P. ume</i> S. & Z.	Ume.
67.	<i>P. persica</i> var. <i>vulgaris</i> D. C.	Momo.
68.	<i>P. pseudo-cerasus</i> Lindl. var. <i>sieboldii</i> Max.	Yoshinozakura.
69.	<i>P. tomentosa</i> Thunb.	Yusura-ume.
70.	<i>Quercus dentata</i> Thunb.	Kashiwa.
71.	<i>Q. glandulifera</i> Bl.	Nara.
72.	<i>Q. serrata</i> Thunb.	Kunugi.
73.	<i>Rhodea japonica</i> Roth.	Omoto.
74.	<i>Rhododendron indicum</i> Max.	

	var. <i>kämpferi</i> Max.	Tsutsuji.
75.	var. <i>macranthum</i> Max.	Satsuki.
76.	var. <i>obtusum</i> Max.	Kirislima.
77.	var. <i>ancœnum</i> Max.	Murasaki-Kiishima.
78.	<i>R. kamschatioum</i> Pall.	Yezotsutsuji.
79.	<i>R. keiskei</i> Miq.	Hikage-tsutsuji.
80.	<i>R. ledifolium</i> Dou.	Mochi-tsutsuji.
81.	var. <i>leucanthum</i> D. C.	Riukiu-tsutsuji.
82.	var. <i>narcissiflorum</i> Max.	Yodokawa-tsutsuji.
83.	<i>R. linearifolium</i> S. & Z.	Seigai-tsutsuji.
84.	<i>R. macrosepalum</i> Max.	Isotsutsuji.
85.	<i>R. pentaphyllum</i> Max.	Akebono-tsutsuji.
86.	<i>R. quinquefolium</i> Biss.	Kikio-tsutsuji.
87.	<i>R. rhombicum</i> Max.	Kobanoshi-tsutsuji.
88.	<i>R. schlippenbachii</i> Max.	Kurafune-tsutsuji.
89.	<i>R. semibarbatum</i> Max.	Baika-tsutsuji.
90.	<i>R. serpyllifolium</i> Miq.	Kōtsutsuji.
91.	<i>R. sinense</i> Sw.	Renge-tsutsuji.
92.	<i>R. subanceolatum</i> Miq.	Tō-tsutsuji.
93.	<i>R. tschonoskii</i> Max.	Shirobanano-tsutsuji.
94.	Rose sp.	Bara.
95.	<i>Salix babylonica</i> L.	Shidare-yanagi.
96.	<i>Sciadopytis verticillata</i> S. & Z.	Kōyamaki.
97.	<i>Spiraea thunbergii</i> Sieb.	Yuki-yanagi.
98.	<i>Thuja orientalis</i> L.	Konotegashiwa.
99.	<i>Thujopsis dolabrata</i> S.	Asunara.
100.	<i>Ulmus parvifolia</i> Jacq.	Nire. (Akinire).
101.	<i>Viburnum odoratissimum</i> Ker.	Sangoju.
102.	<i>Zelkova acuminata</i> Pl.	Keyaki.

XI. Two Natural Enemies of the scale.

The two most effective natural enemies of the scale in Japan are the so called Asiatic ladybird (*CHILOCORUS SIMILIS*) and a parasitic fungus (*SPHÆROSTILBE COCCOPHILA*); a detailed account of these can not now be given here, for they are still under observation, but we shall simply mention some facts related to them.

We find the ladybird feeding on *DIASPIS PENTAGONA* more commonly than on the scale, and it seems to choose the former rather than the latter, it is, however, more or less a general feeder, and feeds upon *D. PENTAGONA* and the scale as well as other small insects. It freely feeds upon the common aphids, but does not readily attack the woolly aphid; very often we have seen the cast skins of pupae as many as a dozen or more in a group on a branch of a tree, where were plenty of *D. PENTAGONA*, while it is very seldom to find even a few of the cast skins in a group with the scale colony. When the writer visited Mr. K. Abe's pear orchard near Kokura in the Summer 1900, he found a great modification of the scale; but when he visited the same orchard last year again, he found that the insects were so generally attacked by the fungus *SPHÆROSTILBE COCCOPHILA*, that live females had seldom been seen. Mr. H. Nomura said in his article* on the fungus that 71 out of 73 of the scale were dead from the effect of the fungus.

The fungus attacks *DIASPIS PENTAGONA* as well as the scale; indeed the writer believes that the disease exists on *D. PENTAGONA* as the principal host, although it attacks other scales, as the San Jose Scale and *Parlatoria*. The fungus is widely spread among *D. PENTAGONA* in the country even in very high regions as Mt. Togakushi, Shinano province; the fungus does not reach, however, the San Jose Scale in many localities, but is spreading gradually.

* Bul. No. 18, Imperial agricultural exp. station in Japan, 1901.

XII. Variation in the Species of the scale.

There is a considerable variation in the scale. The colours of male and female scales vary according to the age of the individuals, the age of the host and the place where the host grows; the habits of the scale also differ more or less under a given condition. So without a careful comparative study of a large number of specimens one is very liable to fall into misconception with regard to the species.

Prof. J. D. A. Cockerell* has described two varieties or subspecies of the San Jose Scale, *ASPIDIOTUS PERNICIOSUS*, namely *ANDROMELAS* and *ALBOPUNCTATUS*; these specimens were obtained from A. Craw, San Francisco, whose nursery stock introduced from Japan had been infested as already mentioned.

The professor has distinguished these species with the following characters:—

- A. Male scale all black, the dot and ring not distinguished by colour, but distinctly sculptured a Japanese species; *ANDROMELAS CKLL.*
- B. Male scale grayish, hardly black with a light dot and ring: San Jose Scale, *ASPIDIOTUS PERNICIOSUS* Comst.
- C. Male scale grayish black, the light dot and ring very conspicuous; occurs on orange or citrus trees and on plum trees in Japan; *ALBOPUNCTATUS CKLL.*

From the fact that there had been found two subspecies of the San Jose Scale in Japan Prof. Cockerell says † “It is now to be shown for the first time that *A. PERNICIOSUS* is, with little or no doubt, a native of Japan; for in Japan there occur two varieties or subspecies of *A. PERNICIOSUS*: *ANDROMELAS* and *ALBOPUNCTATUS*. These agree almost exactly in structural forms with *PERNICIOSUS*, but the first differs noticeably in the colour of the scale, the second slightly in the scale and more noticeably in attacking citrus.” As shown by the professor they are plainly different from the true

* Technical ser. No. 6, U. S. Department of agriculture, Division of entomology, 1897.

† J. S. No. 6,

San Jose Scale, the former species has no white dot or ring on the male scale, while the latter attacks citrus growth. The professor might be right in distinguishing these two forms from the true San Jose Scale by the above given characters ; but according to the facts which we have collected from a comparative study of a great many individuals, both from the same and from different localities in the country, and from some foreign specimens, we have become able to conclude that the characters, forms and colours, which have been claimed for the so called new varieties, are common with the San Jose Scale ; and that no basis for a contrary statement can be found on such supposed distinctions.

In a group of male scales we have found that some specimens have a distinct dot and ring, while others are without both of them ; and so also some have only a white dot or ring leaving a black sculpture, while others have a white dot with a crescent or half a ring. The colours of the male scales vary from light yellowish gray to black with all kinds of intermediary shades ; some specimens are almost gray in colour, and such are generally on the old trees exposed to the weather in comparatively high regions ; the young specimens on young stock are always blackish in colour ; the scales on leaves are usually of a pale yellowish tint.

It is said that the scale does not attack the citrus trees in America, so when Prof. Cockerell had seen the scale from Japan attacking citrus growth, he considered it to be a new variety of the San Jose Scale ; from our observation we have learned that the San Jose Scale readily spreads to the citrus as well as to other fruit trees. This was learned by experiments made by Mr. S. Hori in our station.

A lot of citrus stock, sent to Miye-ken from Itami near Osaka in the Spring 1902, was badly attacked by the scale ; the trees were grown beside other fruit trees in a nursery ; the writer at once said there was but little doubt that the scales on the trees came from other infested stock in the nursery ; he examined the insect very carefully, and found it identical with the San Jose Scale. It is true the infested citrus trees, on which Mr. A. Craw found the scale some years ago, were sent from this region through a nursery man in Yokohama.

Microscopic study shows that there are also some variations in the last abdominal segment of females, hard to find, not even two halves of the same insect being equal. But the relative sizes of the chitinous processes between the first and second lobe remain almost the same "close together and nearly equal in size." The anal plates of the female are so variable in size, number and shape, as shown in the accompanying figures (PLATE II.), that in two halves of an insect they are very seldom found alike.

Prof. C. Sasaki has not recognized the occurrence of the San Jose Scale in Japan when he wrote the paper;* for there are some differences in structure in some stages, the scale, male, female and larva. The writer can not believe, from the facts which have come under his observation, that the specimens under examination are new or even different varieties of the San Jose Scale, he believes they are the true San Jose Scale, nothing else.

If we have any right to claim new species or varieties from a slight difference in colour, shape and marking of an animal, we are to make endless species and varieties. In the case of the San Jose Scale the colour and shape of male scale and female scale differ much in the minute structure as mentioned above; even the two halves of the same individual specimen can not be found to agree exactly. It is true that no two individuals are quite equal.

XIII. Control of the San Jose Scale in Japan.

(Refer to Plates VII and VIII.)

In spite of all efforts to check this and other foes the San Jose Scale eluded the farmer and fruit growers because of its inconspicuous appearance and their want of knowledge concerning it; it has rapidly extended its range until it now occurs in nearly every province of the empire; it is most abundant on pear and apple trees, growing on rather low land, and less abundant at a high range.

In the writer's report on "the San Jose Scale in Japan" he made the following remarks:—

* "On the Japanese species allied to the San Jose Scale in America," *Annotationes Zoologicae Japonenses* Vol. III, part IV, Tokyo, Japan, 1900.

“As yet neither good spraying machines nor the best insecticides have been used for the destruction of the scale, it has spread as much as nature has permitted; however the farmers use a few simple methods of destroying the pest such as soap suds, a solution of caustic soda, kerosene and kerosene mixture. The soap suds, kerosene and kerosene mixture are applied with a Japanese paint-brush, a primitive way of proceeding, and often kill the small branches without affecting the insect; solution of caustic soda (one pound of caustic soda to about ten gallons of water) is applied by means of clothe moistened with the solution, and afterwards the trees are washed with pure water.

After rain farmers go out into the orchards with old rope or cloth and rub off the scale, while the trees are wet. With proper methods of fighting the scale, especially by aiding its natural enemies, the scale can be checked in Japan.”

When our station once took up the subject and the fruit growers and farmers had learned something about the pest, the method of fighting the scale was wonderfully developed; the use of machines and insecticides and methods of application to prevent its spread were taught by lectures, talks and by other practical means, which have proved to be very effective. The work which the fruit growers and farmers carry on has been superintended by members of our station and of local experiment stations; badly infested trees and shrubs have been destroyed by fire; and when orchard were small, or the trees in a garden or yard comparatively few, such trees were dug up and burned at once. Nurseries have been inspected with special care by the specialists, and all doubtful trees have been destroyed; all stock shipped from any nursery is now carefully inspected; the plants exported from Yokohama or other ports in Japan are treated with insecticides, so that the pest can not possibly remain on the plants.

We are not fighting the pest with the most advanced methods as they are in America by means of gas, and horse or steam pumps, but using chiefly kerosene and kerosene mixtures or some other insecticides with the best home made pumps or American ones that can be procured; however in our small orchards with cheap labour and the aid of natural resistance, the fighting is done with wonderful success.

Spraying with kerosene emulsion in winter, after the trees have been pruned, is the best method of destroying the scale in Japan ; the emulsion is effective and cheap, obtained very easily anywhere ; a mixture of 1 part of the emulsion with 5 parts of water, applied in winter, kills more than 85% of the scale.

Many of the localities marked with spots on the map i. e. infested localities are now free from the scale ; and we hope and believe that we shall see a great change in the face of the map showing the distribution of the San Jose Scale in Japan, within a short time.

XIV. Conclusions.

Our investigations of the San Jose Scale in Japan since 1900 may be briefly summerized as follows :—

1. Since the writer actually made his report on the wide distribution of the scale in Japan in the summer 1900, a large part of his own time and that of other entomological members of the station has been spent in the investigation of the scale ; the trees in and near suspected orchards, nurseries, parks, private gardens and temple grounds throughout the empire were carefully examined. Special excursions were made through wild and high regions and also sea levels and plains, climbing to several mountains and penetrating into wood land and deep valleys ; the magnitude of the work and amount of labour involved are hardly apparent to those who have not been engaged in work of this kind ; a great many miles have been traveled, and many weeks have been spent in the examination of suspected trees.

In our investigation of the scale we have found that the distribution of the scale in Japan is very wide ; out of 482 localities in the four main islands it is recognized in 145.

2. In almost every instance the infested localities trace the introduction of the pest to trees purchased from the well known nurseries.

3. The scale was introduced into Japan with infested stock in 1871 or about that time from the west.

4. The purchased original and infested stock was planted at Awoyama,

Kwaitakushi-experiment field, Tokyo, whence the trees were sent all over the empire directly or indirectly.

5. No scale was discovered on trees and shrubs in the wild regions.

6. The scale was not found in uncultivated higher lands and mountains; the scale, found on high lands as in some parts of Shinano and Hikosan, Buzen, was discovered on cultivated plants recently introduced.

7. In almost every instance the infested trees were comparatively young.

8. Low and comparatively moist regions are favorable to the scale, hence it predominates in the regions not higher than 100 metres above the sea level.

9. The wild plant is free from the scale.

10. The wild pear (*PIRUS TORINGO*) in the wild region in the vicinity of Morioka city was free from the scale.

11. Two varieties, *ASPIDIOTUS PERNICIOSUS*, VAR. *ALBOPUNCTATUS* and *ASPIDIOTUS PERNICIOSUS*, VAR. *ANDROMELAS* described as being from Japan, are proved to be variations in colour and habit of the true San Jose Scale (*ASPIDIOTUS PERNICIOSUS*), and thus could not be separated from the original species.

12. The scale on citrus trees in Japan is the same as that on other hosts.

13. The chief favorite food of lady bug (*CHILOCARUS SIMILIS*) seems to be *DIASPIS PENTAGONA*, but it freely feeds upon the San Jose Scale and other small insects, as aphids etc.

14. The fungus disease is found very freely attacking the scale in Japan, in many localities, however this disease more commonly attacks *D. PENTAGONA*.

15. Except in a few localities the scale is not very effective in Japan; generally it has not been found to spread rapidly.

16. Since the fruit growers have been learned about the scale, they are taking proper care, using the best method to control or destroy it.

17. With proper care together with the aid of natural causes, the scale is readily kept in check.

18. Above all we must declare most decisively that there is not the slightest proof for the assertion that the scale is a native of Japan. The actual observations prove on the contrary that it is an imported pest.



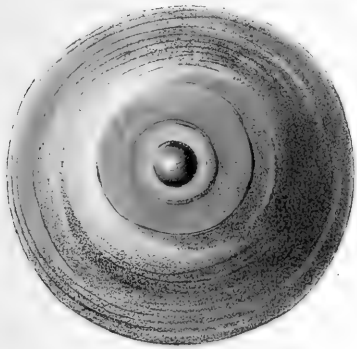
Explanation of Plate I.

The San Jose Scale, *ASPIDIOTUS PERNICIOSUS* COMST.

- I. A pear infested by the scale.
 - II. a—g. Male scales showing the variations in the color and markings.
 - III. Female scale.
 - IV. Adult female.
 - V. Newly hatched larva.
 - VI. A group of male and female scales.
-



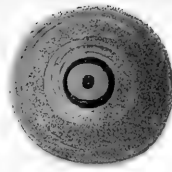
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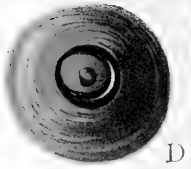
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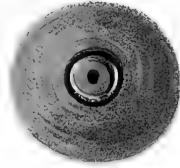
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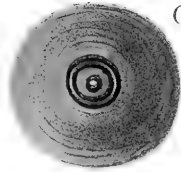
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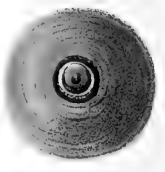
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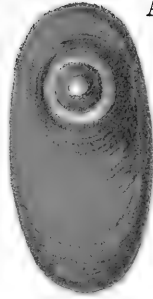
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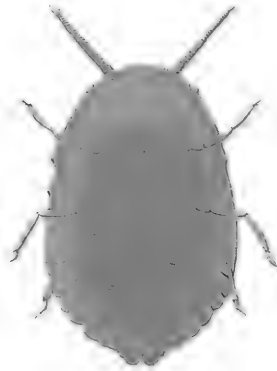
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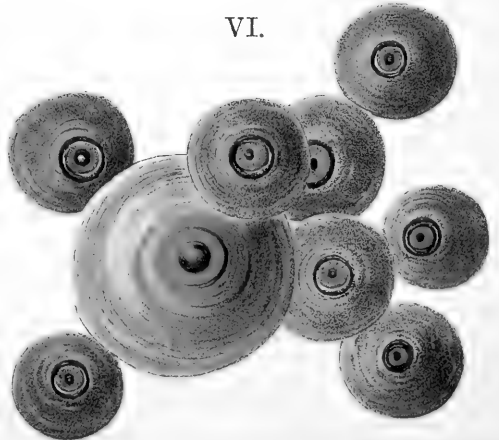
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V.



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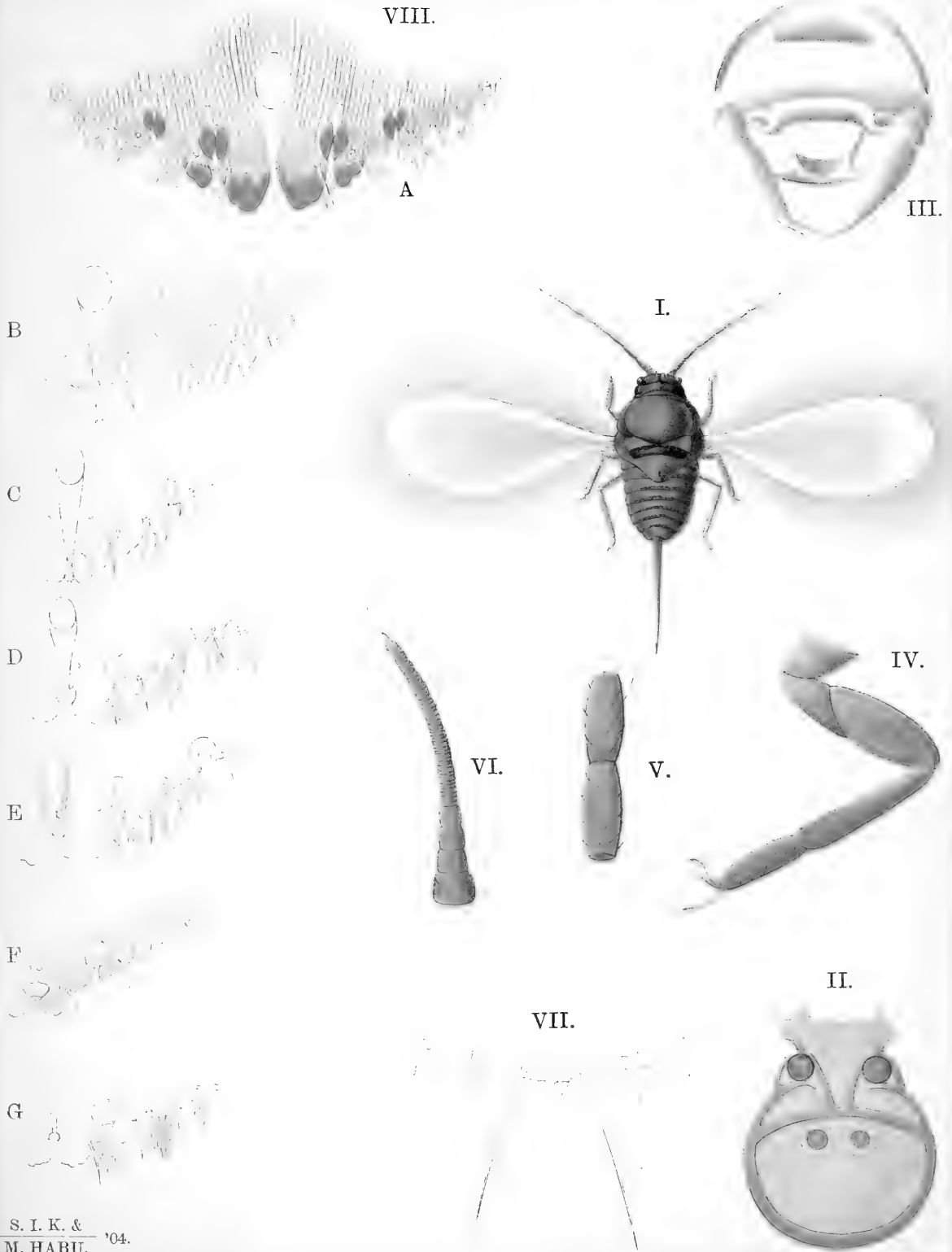
VI.



Explanation of Plate II.

The San Jose Scale, *ASPIDIOTUS PERNICIOSUS* COMST.

- I. Adult male.
 - II. Head of the same.
 - III. Thorax of the same.
 - IV. Leg of the same.
 - V. Some segments of male antenna.
 - VI. Antenna of newly hatched larva.
 - VII. Caudal end of newly hatched larva.
 - VIII. a—g. Caudal ends of last abdominal segment of female, showing the variations in the plates etc.
-



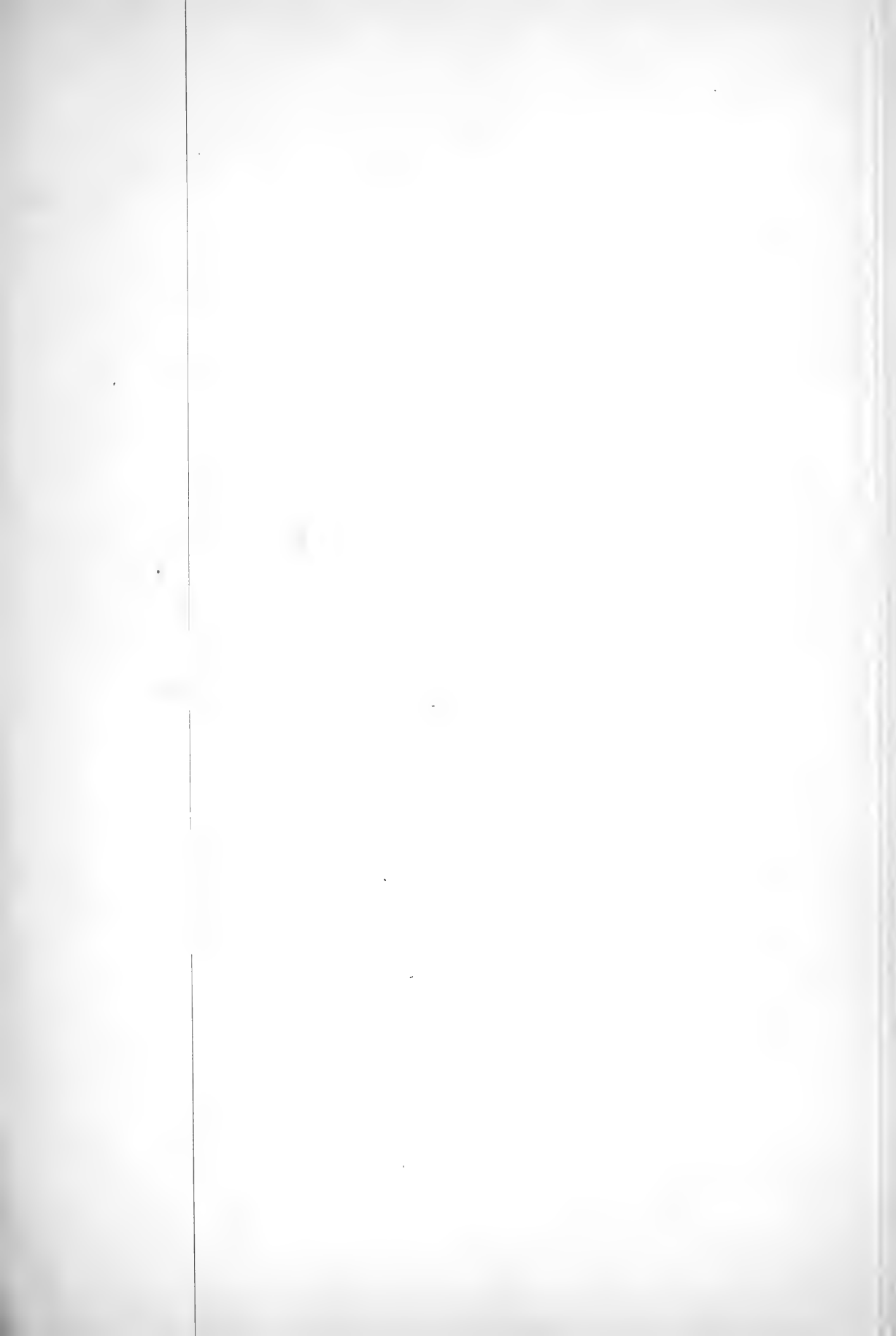
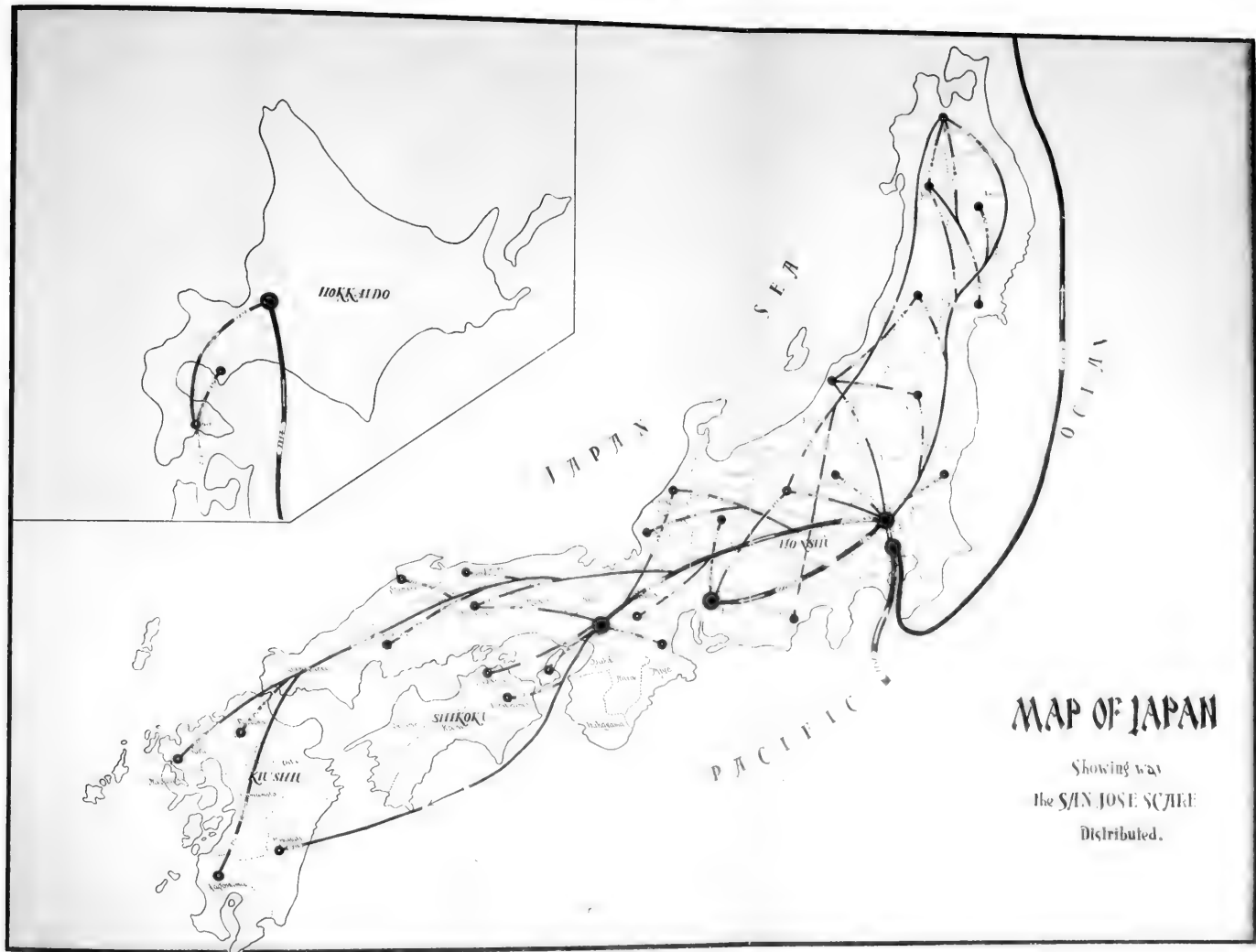


PLATE III.

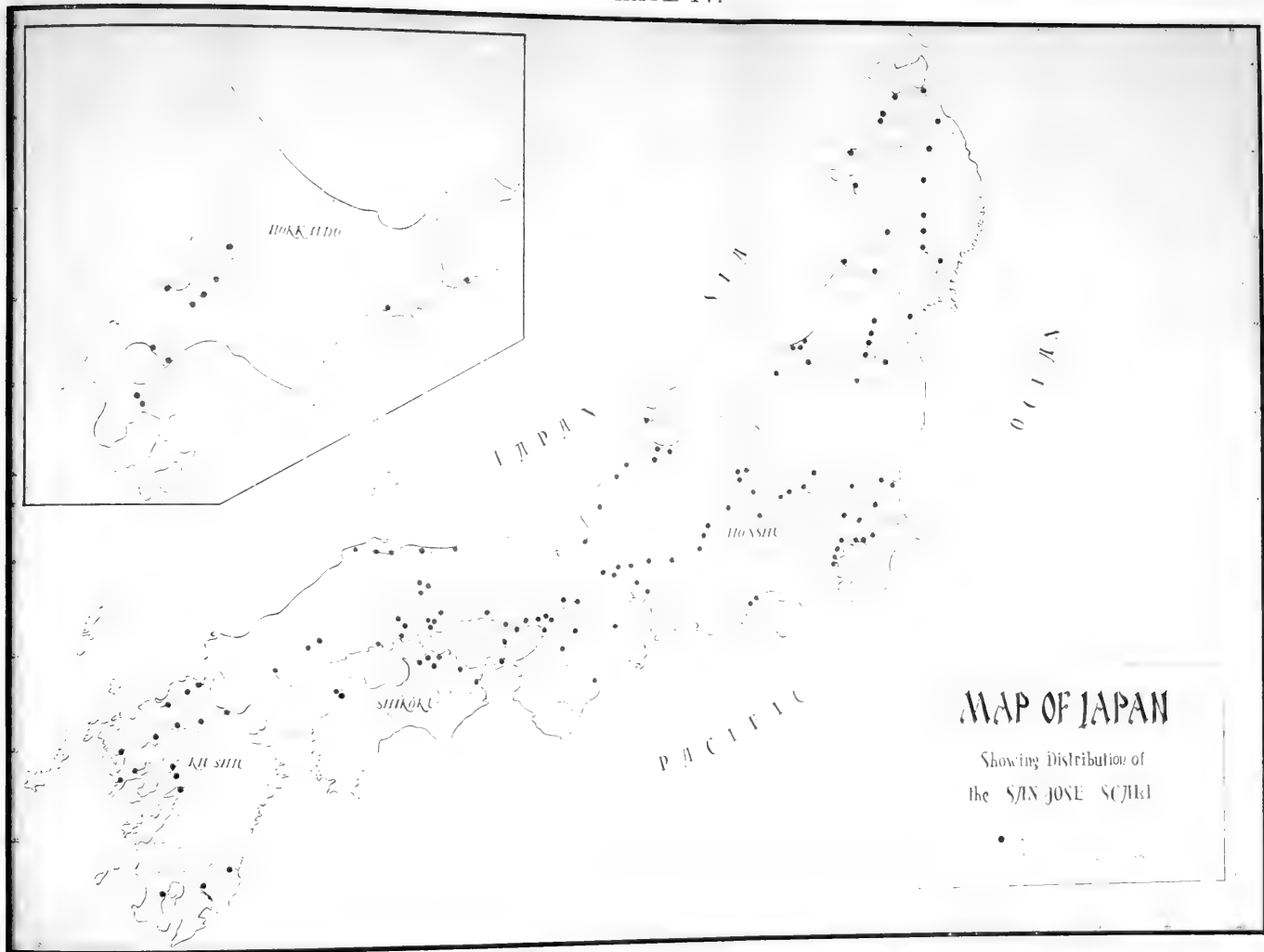


Explanation of Plate III.

Map of Japan :
showing the way the San Jose Scale distributed.
↑ Shows the direction.



PLATE IV.



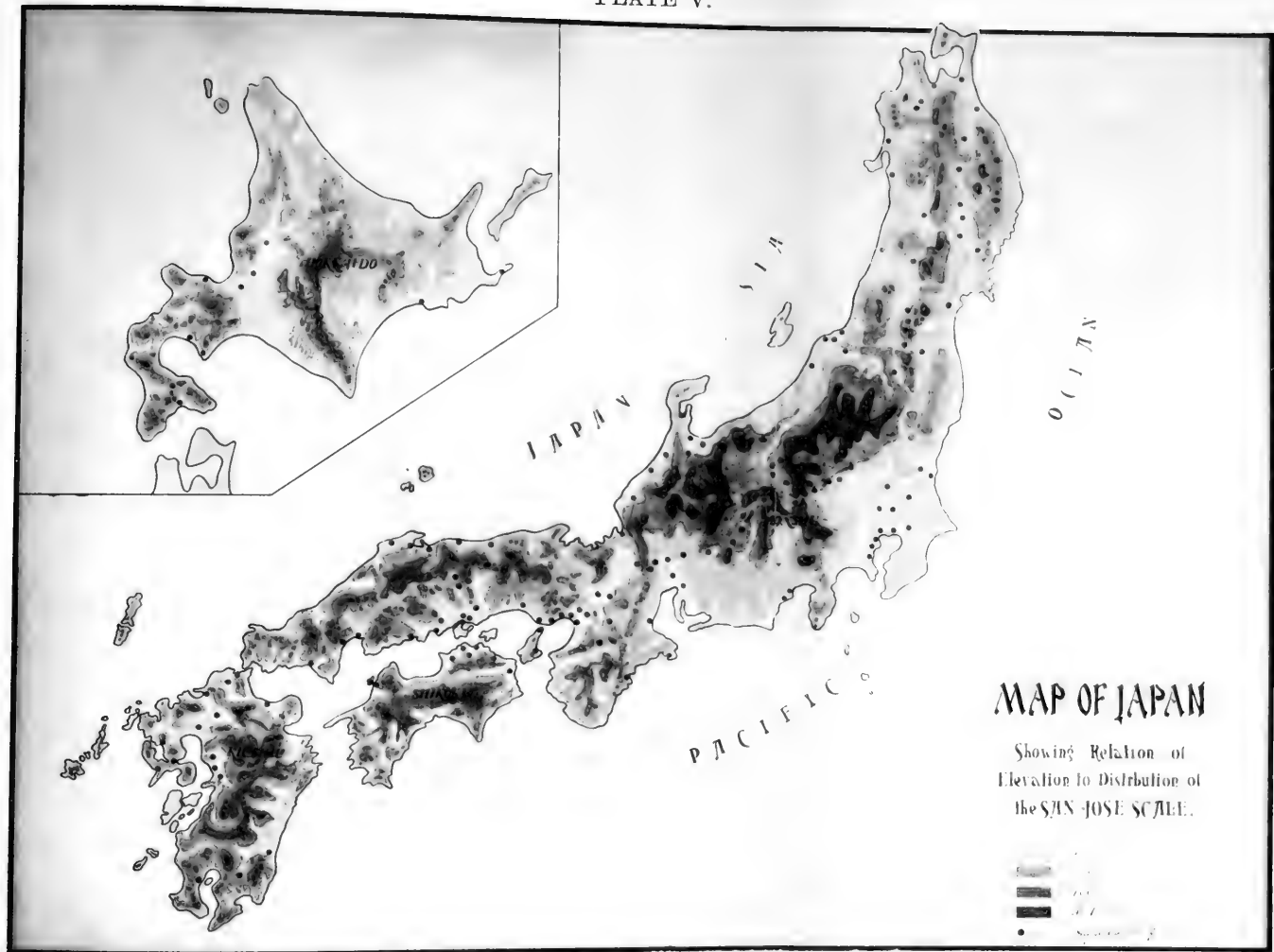
Explanation of Plate IV.

Map of Japan :
showing the distribution of the San Jose Scale in Japan

- Infested locality.
- Main line or road of Exploration.



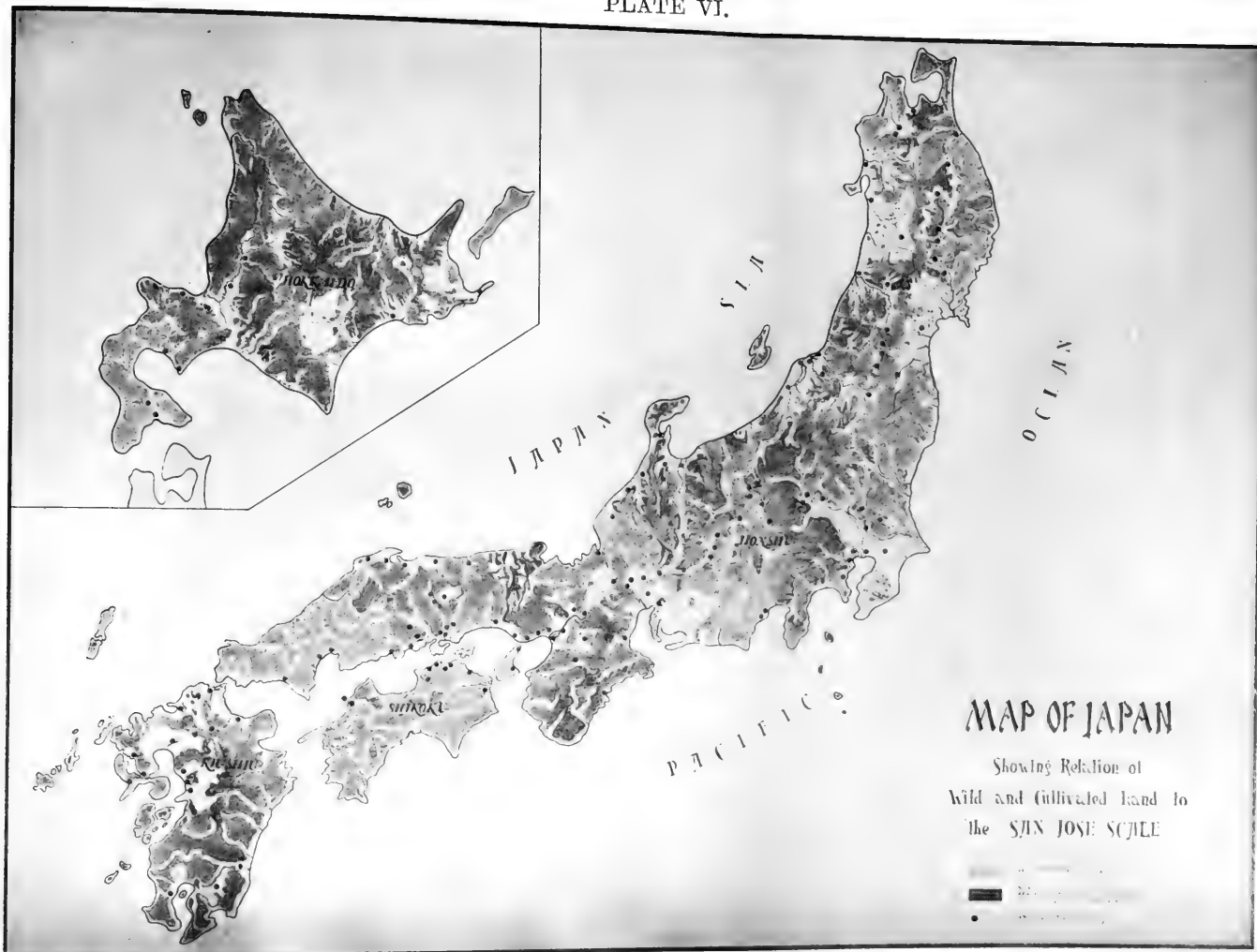
PLATE V.



Explanation of Plate V.

Map of Japan :
showing the relation of elevation to the distribution of the
San Jose Scale.

PLATE VI.



Explanation of Plate VI.

Map of Japan :
showing the relation of wild and cultivated regions to the San Jose
Scale.

- Cultivated region.
- Uncultivated region.
- State forest, crown forest, municipal forest,
patrimonial forest of temples, private forest and
experimental-forest of Colleges.
- Infested locality.

PLATE VII.



Plate VII. Peach and apple orchards, showing the winter treatment of the scale in Japan.
Photo. By. T. MURATA.

PLATE VIII.



Plate VIII. Apple and pear orchards, washing and spraying with kerosene mixture in winter.

Photo. By. T. MURATA.

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ERRAT.

Page 4	Line 15	FOR	"fruit trees and vines, lemon, orange, berry and hop etc."	
		READ	"fruit trees containing vines, lemon, orange, terry, hop etc."	
" 5	" 8	FOR	"1876"	READ "1871"
" 19	" 1	FOR	"make"	READ "made"
" "	" 2	FOR	"On"	READ "In"
" 20	" 17	FOR	"native pear wild cherry"	
	"	READ	"Wild pear, native cherry"	
" 32	" 21	FOR	"of lady bug (chilocarus similis)"	
		READ	"of the lady bug (CHILOCORUS SIMILIS)"	



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