

The Imperial Council of Agricultural Research

THE SILK INDUSTRY OF JAPAN

WITH

Notes on observations in the United States
of America, England, France and Italy

BY

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GLOSSARY.

Japanese terms have been explained wherever they occur in the text. The following short glossary is however useful.

Money.

- 10 rin=one sen.
- 100 sen=one yen (par value Re. 1 annas 9).

Weights.

- 10 mo=one rin.
- 10 rin=one fun=5.8 grains troy.
- 10 fun=one momme=58 grains troy.
 - =.1323 oz.
 - =3.75 grammes.
- 160 momme=one kin=1½ lbs.
- 1,000 momme=one kwanme or kamme or kan=8.27 lbs.
- 100 kin=133½ lbs. (weight of a bale of raw silk).

Land measure.

- 1 tan=1186 sq. yds. (a little less than ½ acre).
- 10 tan=one cho=2.45 acres.

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INTRODUCTORY.

This publication is the result of a study made in Japan in 1929.

The annual value of raw silk produced in Japan is computed about 1928-29 at about 700,000,000 Yen* and that of silk manufactures at about 200,000,000 Yen. About forty per cent. of the total exports of Japan is silk and silk products which thus constitutes the source of a very large portion of her wealth. The mere statement of this fact, however, does not convey an adequate idea of the benefits which the Nation as a whole derives from this industry.

I concerned myself mainly with the raw silk industry in Japan and went into the manufacturing part in a general way in order to be able to understand its requirements as regards raw silk. The following summary gives a general idea of the whole industry, and in the succeeding nine parts every important aspect of the raw silk industry is dealt with. Part X gives a general idea and development of the weaving or manufacturing industry.

An attempt has been made to elucidate the means and methods by which this vast industry has been developed with the hope that it will be of interest to all interested in sericulture in India. The United States of America utilises for her weaving industries about half of the world's exportable raw silk, and of this quantity Japan supplies about 90 per cent. On account of the high cost of labour, America depends on efficient and quick machinery for the throwing and weaving operations. Therefore the demand has been for very high class uniform raw silk which can be worked smoothly in the machines, and America has devised appliances for testing the raw silk for this purpose. Japan has made constant attempts to meet this demand and adopted up-to-date appliances and methods for production as well as for testing the quality. An attempt has been made to acquaint readers with these appliances and methods.

* Par value of Yen is one rupee nine annas.

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APPENDIX A.

WILD SILKS OF JAPAN.

1. Japanese Tasar—*Tensan*, *Yamamayu* or *Yamamai* (meaning hill silkworm)—*Antheraea yamamai*, Guér-Men.

Antheraea yamamai (locally called *Tensan*) is reared only in two places in Japan, viz., Nagano and Ibaraki Prefectures, but mostly in Nagano.

The insect is reared on cultivated oak (*Quercus serrata*) locally called *Kunugi-nara*. The area in Minami Azumi county is 500 *cho* (about 1250 acres). The seedlings are raised in nurseries and planted about 6 feet apart in fairly well prepared land in spring and then allowed to grow without further attention. The plantation becomes ready for use about three years after planting. The plants are not allowed to grow tall but kept down to a height of five or six feet by pruning carried out in the cold weather from December to February or March. They become bushy.

The eggs are gummed on long strips of paper which are tied to branches before 10th of May. The worms on hatching crawl about and feed at will. The eggs hatch in about 10 to 12 days.

The larva feeds about 50 days. It takes 7 to 10 days to spin its cocoon and pupate and the moth emerges in about 7 days more. The worms are allowed to spin on the plants and the cocoons when formed are searched out and gathered. During rearing no especial watch is kept but in the mornings the owner just takes a round through the plantation.

In a *cho* (about 2½ acres) about 75,000 eggs are tied but the average harvest is about ten thousand cocoons and in especially favourable circumstances it may be up to about 15,000. Birds, ants and other natural enemies are responsible for the loss of so many worms. Pebrine occurs in the worms but is now controlled by examination of moths. Cocoons on harvest are separated into reeling and seed cocoons.

Preparation of seed.—The seed cocoons are arranged in trays 3' × 2' with their emerging ends turned upwards and the moths on emergence crawl on to the edge of the trays and hang until their wings harden. Then a female and one or two males are confined in an open meshed conical or rather bellshaped bamboo basket with the base open. The open base has a diameter of about 8 inches and the height of the basket from base to vertex is about the same, the meshes being about one inch wide. The open end is covered with a piece of paper well secured so as not to allow the moths to escape. Pairing takes place in the evening and lasts till the next evening when eggs are laid. These baskets are hung up in a high open shed, the one we saw having a tin roof. The female moth is taken out at leisure, numbered, packed and sent for microscopic examination in the local controlling station.

Each moth lays about 200 to 250 eggs, which are glued in batches to the framework of the basket. The eggs are allowed to remain in ordinary temperature till about next spring when they are scraped off, washed in water and subjected to a temperature of about 40°F, for twenty days and hatch in about 10 days after removal from the cold storage without any kind of incubation. The price of seed cocoons is 3 sen each.

The cocoons for reeling are dried in a rough sort of drying chamber with ordinary fire to about 40 per cent. of their green weight. The price of reeling cocoons is 1½ sen each. The yield of reeled silk is about 7 *momme* (about 406 grains) from 100 cocoons with varying quantities of waste. Reeling is done without any kind of previous cooking. The reeling basins are small ordinary enamelled cooking pans placed directly over ordinary charcoal fire. Only one thread

is reeled with filaments of 4 to 5 cocoons. The filament of a cocoon is about 500 meters and its denier about 5.5. The factory we saw had 24 basins of which 12 were working, the driving power being supplied from a water wheel. The raw silk was re-reeled into ordinary hanks. The *croisure* given was about 18 inches. The machinery was of ordinary type. The wages were paid by piece work at the rate of 40 sen per 15 *momme* of reeled thread. One reeler girl or woman produced 15 to 20 *momme* a day of about 11 hours with ordinary interval.

The present price of the silk is Yen 4,200 per 10 *kan* (84 lbs.) or about Yen 52 per pound. Honda recorded Yen 65 per *kan* in 1909.

The waste is spun into thread by hand.

2. Chinese Tassar—*Sakusan*, *Antheraea pernyi*, Guér-Men.

It is reared on the same food-plant and in the same manner as *Yamamai* but at present on a small scale. In China it is reared on a large scale and is the source of the cheap Shantung silk.

The insect hibernates in winter in the cocoon and every year seed cocoons are imported for rearing. Moths emerge about May and lay eggs which are scraped off from the baskets and put on plants after about 15 days. The worms feed for about 50 days and then spin cocoons. More than 100,000 eggs distributed in about 2½ acres of plantation yield about 20,000 to 25,000 cocoons. These spring cocoons reel well. After about 25 days of spinning moths emerge and lay eggs which hatch in about 10 days and the resultant larvae feed for about 40 days before spinning cocoons which hibernate. Commercial rearing is not carried out in autumn.

About 8 *momme* (about 464 grains) of silk is obtained from 100 cocoons. The length of the filament of a cocoon is about 650 meters and its denier about 4.8.

3. *Shosan* or *Shotyū*, *Caligula japonica*, Moore.

It is not reared but wild cocoons are collected. The worms feed on camphor, chestnut, walnut, etc. Eggs hatch about April-May and the worms, after feeding for about 50 to 60 days, come down to spin on shrubs and bushes. Moths appear in August-September and the eggs which are laid hibernate and hatch next year. The cocoons are open at one end like those of Assam Eri (*Attacus ricini*, Drury) and are made into floss-silk (*mawata*).

4. *Chosan*, *Attacus rynthia*, Drury.

The worms occur wild and feed on *Ailanthus* and their cocoons are not collected.

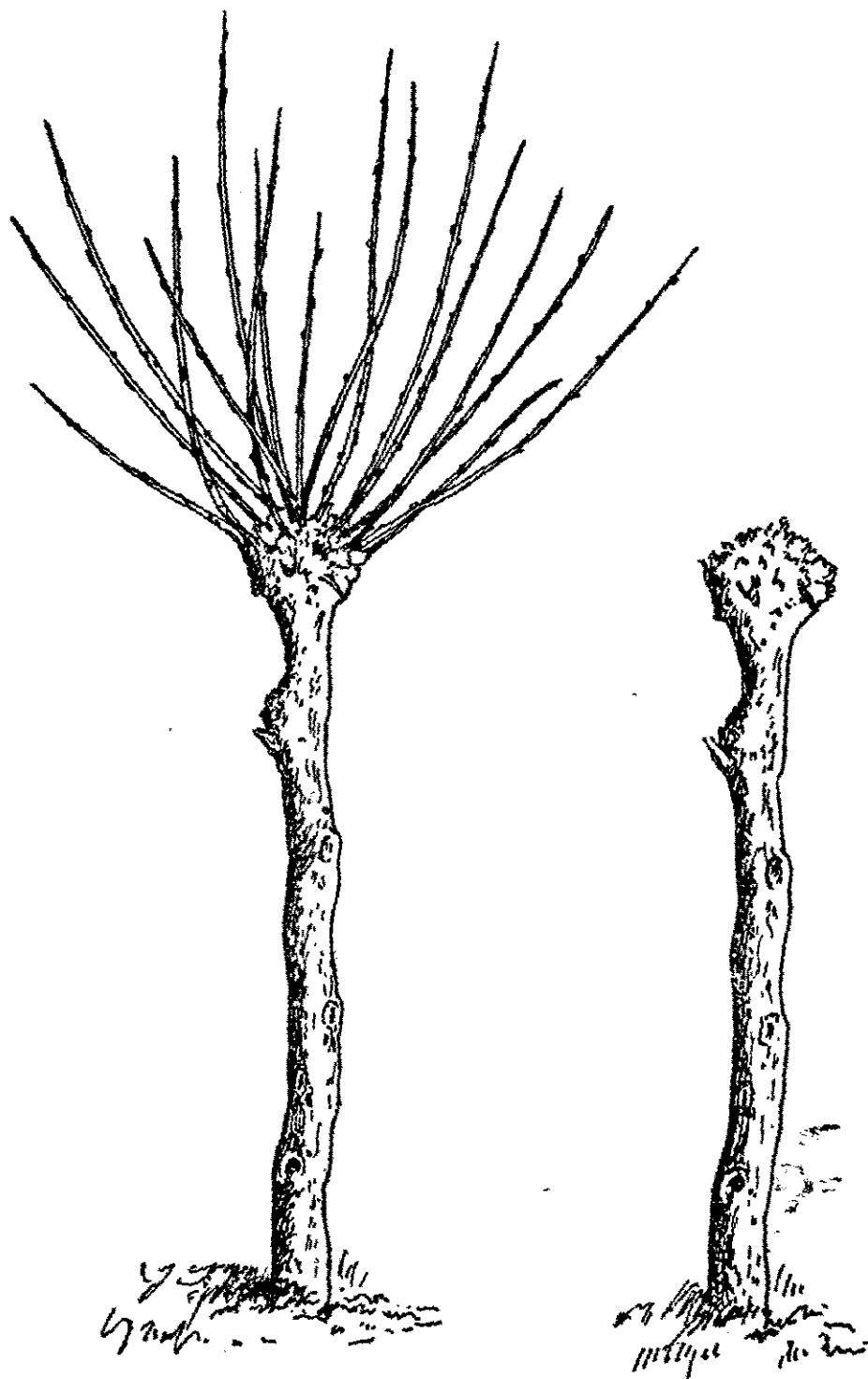


Fig. 56. Mulberry tree of France and Italy. The right hand figure shows how it is pruned and the left hand figure shows it in winter.

APPENDIX B.

A NOTE ON SERICULTURE IN FRANCE.

Mulberry.

Mulberry, varieties of *Morus alba*, is practically wholly of tree form (Fig. 56), the trees being grown on embankments or among fields. Attempts are being made to introduce a low bush form. Nursery men raise seedlings which after one year are sold (current price 25 centimes each in 1930) to grafters or cultivators who carry out grafting. Grafts are sold after about a year or a year and a half (current price Fcs. 2-50 to 3 each in 1930) and planted out, and plucking of leaves is not commenced before about ten years.

Egg production.

There are sixty-five egg-producing establishments, all on hillsides in the south of France, with their own experts and microscopists. For their control there is a Government department with one Director and 20 inspectors. The establishments have to send in reports of prospective rearing. The inspectors supervise rearing and note occurrence of diseases and also shape and silk content of cocoons. Cocoons which are passed can be used in the production of the industrial seed which is used by rearers. Egg production is not permitted unless done by one who possesses a certificate of training in the Sericultural School at Montpellier. The egg-producing operations are carried out in July and completed by about 15th August. The parent seed is produced by the cellular method. For industrial seed no definite percentage is fixed for examination, but the inspector takes any number according to his discretion and a trace of pebrine entails rejection of the lot. Filatures usually purchase eggs and give to the rearers and agree to purchase the resultant cocoons. This is said to stimulate rearing as it is found that otherwise many rearers would not do any rearing. Rearers can produce their own eggs, but in order to encourage use of examined eggs from egg-producing establishments, a bonus of 2-40 Francs is given by the Government on each kilogram of green cocoons produced. The rearers take their cocoons to the town hall where the Mayor pays this bonus on production of a certificate from the egg-producing establishment from which eggs had been purchased.

Rearing.

Rearing is done only of pure races, usually Ascoli A. S. L., Ascoli B. N., Bionne pure, Bionne striped, Bionne spherical and Gros Var. Hybrid races were tried and yielded more silk which, however, was considered irregular and the filatures preferred to stick to quality, and rearing of hybrid races was abandoned. Hibernation of eggs is commenced in cold store at 0-C to 1-C (32°F to 34°F) in October and lasts for about six months. Incubation of eggs commences about 20th April and rearing and harvesting of cocoons completed by about 15th June.

Disposal of cocoons.

The harvested cocoons are taken to the town hall and weighed. Filatures accept this weight. Cocoons are then transported to the purchasing filatures quickly by special arrangement with the railway. Stifling and drying are done by the filatures.

Price of cocoons.

When production used to be much larger than now there were cocoon markets which have almost disappeared and with their disappearance filature owners began to exploit the rearers. Therefore Government stepped in and set up a Committee. The rearers can sell cocoons in three ways. (1) In a market, where there is one, by haggling. (2) The Government Committee fixes a minimum price of cocoons calculated on the price of silk at Lyons in March, April and May and this price is published before rearing is undertaken. Rearers receive this minimum price on delivery of the cocoons. The Committee sits in November again and revises the price on the actual prices of silk prevalent from 15th May to 16th November. Within 20 days of this meeting the rearers receive the difference between the minimum price already paid and the revised price. (3) The rearers receive two-thirds of the minimum price fixed by the syndicate of filatures on delivery of cocoons and the balance within 20 days of the meeting of the Government Committee which revises the price at the end of November as above. The Committee adopts the following procedure in revising the price:—

(A) Take the average price of silk at Lyons from cocoons produced in Cevennes, from 15th May to 16th November.

(B) Subtract from (A) 9 per cent. for general expenses for sale at Lyons and Francs 50 for filature expenses.

(C) Divide the remainder of (B) by 11.5 which represents the average number of Kilos of cocoons to produce one Kilo of silk.

(D) Subtract from the result of (C) Fcs. 1.50 for cost of eggs, transport, stifling, etc., or Fc. 1 if the farmer has purchased the eggs himself. The figure thus obtained is the price of green cocoons per Kilo.

The farmers preferred the method (2).

In 1930 when the price of silk was going down it was settled before the rearing season that the above Committee would not function and the following three methods would be open—(1) sale in open market, (2) sale at price fixed according to the silk price in March, April and May with payment at delivery and (3) sale at price fixed according to silk price from March to October with payment of two-thirds of the price on delivery and of the balance in November.

Education and propaganda.

Sericultural education is provided for in the Sericultural School at Montpellier.

The National Office of Sericulture at Valence is not a Government department but all its expenses are met from funds provided by Government. It was originally started by the silk manufacturers of Lyons without any help from Government.

It still receives private subscriptions and donations. From every Fcs. 2.40 paid as bonus per kilo of green cocoons to rearers this organisation receives Fcs. 0.40 and similarly a share of the bonus paid for reeling.

The functions of this organisation are—(1) to develop mulberry and get nurseries established for the purpose, (2) to develop co-operative incubation chambers, cooperative rearing and cocoon drying chambers, (3) to spread knowledge of disinfection methods, (4) to develop cooperative organisations against risks of loss in rearing, (5) to arrange for experiment and investigation by grants, (6) to help propaganda by the publication of statistics.

It helps the farmers by buying up mulberry plants at wholesale rate and making them available at cost price and by giving grants amounting up to about half the cost when a new plantation is successfully started. It is trying to introduce bush and medium forms of mulberry.

APPENDIX C.

A NOTE ON SERICULTURE IN ITALY.

Mulberry.

Mulberry is mostly of tree form as in France, the trees being grown in the midst of cultivated fields. They are said to last 50 to 100 years. For economic reasons bush mulberry and medium tree forms as in Japan are being advocated. According to Prof. Pigorini medium trees last about 10 to 15 years and bush about 8 years. All are grown from grafts. Plucking of leaves is commenced from bush in the second year, from medium trees in the third year and from trees in the sixth year. Mulberry seedlings and grafts are raised by nursery-men and sold to the rearers. *Morus nigra* (grown in the south of Italy), *M. alba*, *M. alba* var. *cattaneo* and eight other varieties are said to be grown. In a very large nursery of Fratelli Sgaravatti Piante at Saonara near Padua, the stock used for grafts was *M. alba*.

Egg production.

There are 172 egg-producing establishments and their control is assigned to different Government Institutions. The producers are required to communicate within the month of April the places and other details of rearing.

Rearers are permitted to rear their own eggs if they like but cannot sell or give them to others.

The Law No. 1512, dated 28th June 1923 and Regulation under it No. 1204, dated 26th June 1924 for the control of production and sale of silk-worm eggs, provide that egg-production will be allowed to be carried out only according to the cellular method under permission granted by the Ministry of Agriculture on the satisfaction of a scrutiny regarding accommodation and appliances for the production of at least 500 ounces of pure seed or 1,500 ounces of hybrid seed and also regarding methods and competency of staff and on proof being provided that the applicant has joined or applied for joining the chamber of commerce and industry of the place as seed producer. The cellular method must also be followed by Italian firms carrying on work abroad. The staff is not considered competent unless possessing a certificate of training in one of the Royal Institutes of Agriculture at Milan, Perugia and Portici or the Sericultural Experiment Station of Padua and Ascoli-Piceno. The candidates for such training must be graduates of a second-grade middle school, Technical institute or middle Agricultural school or pass an entrance examination in physics, chemistry, zoology and botany of the same standard as in a second-grade middle school.

The rearing of the seed is supervised by Government inspectors who have free access to all rearing establishments and observe the condition of the parent worms. The actual examination of the moths is carried out by the producing establishments. For controlling and checking this examination a quantity of eggs amounting to 4 grams of each lot is taken, divided into two samples, sealed in presence of witnesses, and sent to two different Government institutions. If the report of the first institution, which is to be communicated before the end of February through a registered letter, be unfavourable and be appealed against within five days, the second institute carries out examination of the second sample and its report, which is to be communicated by registered letter within 15 days, is final. Presence of pebrine necessitates destruction of the whole lot within ten days of the report in the presence of the Inspector concerned. One ounce of pure seed is 30 grams and one ounce hybrid seed (indigenous yellow female crossed with Asiatic male) is 33 to 36 grams. The hybrid F_1 cross seed must be of pure races and be indicated by the races of both the male and female moths. The seed must be packed in a way so as not to be touched by hand.

Sale of eggs may be effected by the authorised producer direct or through representatives whose names should be communicated to the controlling institute before March, but not through itinerant hawkers. Eggs in possession of itinerant hawkers are summarily destroyed. Eggs produced for sale without authority are also destroyed and with the help of the police if necessary. A tax is levied by the Ministry of National Economy at the rate of ten cents on each ounce of seed sold, 10 cents on one ounce, 5 cents on $\frac{1}{2}$ ounce, 2½ cents on $\frac{1}{4}$ ounce and 1½ cents on $\frac{1}{8}$ ounce in the form of tickets or stamps which are defaced by a seal of the year of sale.

When eggs are sold in separate cells 100 layings are taken to be equivalent to one ounce. The funds thus collected are kept separate and used for meeting expenses of supervision and examination.

Import of eggs for rearing is permitted only in separate cells accompanied with the moths which laid them except in the case of eggs which are received for study and experiment and are addressed to the three Agricultural Institutes and the two Experimental Stations. The responsibility about eventual pebrine infection in the case of foreign eggs lies on the firm selling them.

Violation of the law and regulation entails a fine of Lire 50 to 1000 which may be doubled on repetition of offence.

Rearing.

Pure races are reared except in the plains of Northern Italy where first generation hybrid races are reared. In the eastern parts the temperature in the rearing season is said to be between 30°C and 32°C (about 86°F and 90°F).

Eggs are at present hibernated in refrigerators at 2°C to 3°C (about 36°F to 38°F) from about the end of December to about the end of March. The rearing season in south Italy is 1st April to 1st May and in North Italy 1st May to 1st June. Incubation is either done in an incubation room before the seed goes into the hands of the rearers or the rearers themselves take the eggs and incubate them. Incubation is done by raising the temperature by about 3 or 4 degrees every day to about 70°F in the course of about 15 days.

Sale of cocoons.

There is no organisation for fixing the price of cocoons and it is a transaction between rearers and filature owners through simple haggling. Cocoons are purchased in the raw condition by filatures through their own agent and then dried with steam heat and stored in large gunny bags which are heaped in the store. The quotations in the newly established Silk Exchange have begun to regulate the price and that of cocoons passing through the Conditioning House is now fixed by a reeling test of 4 kilograms in an established filature for which a charge of Lire 40 is paid.

Reeling.

Reeling is done on to large hanks of which denier only is tested by taking 450 meters. The hanks are examined for dirt, etc., which are picked off and no re-reeling is done.

Waste.

Great care is taken in preparing the waste. The long waste is kept separate and all dirt is picked out from it. The unreelable portions of the cocoons are boiled with pupae, the pupae separated and the stuff is then ried and beaten with sticks in order to remove the dirt.

Dry pupae are sold for use as manure or expression of oil.

Experiment, teaching, training and propaganda.

The institutions connected with Sericultural education and training in Italy are three Higher Agricultural Institutes at Milan, Perugia and Portici, one Sericultural Experimental Station at Padua started in 1871 and one Experimental Station for mulberry culture and sericulture at Ascoli-Piceno started in 1920. There is one organisation for propaganda.

APPENDIX D.

SILK VS. RAYON (ARTIFICIAL SILK).

There is still some apprehension in many quarters about rayon ousting silk. This will never happen as rayon cannot be a substitute for silk. Mr. H. Tanaka of the Imperial Japanese Sericultural Experiment Station has compared the essential properties of silk and rayon and his graph is reproduced below. It is self explanatory.

Fig. 57

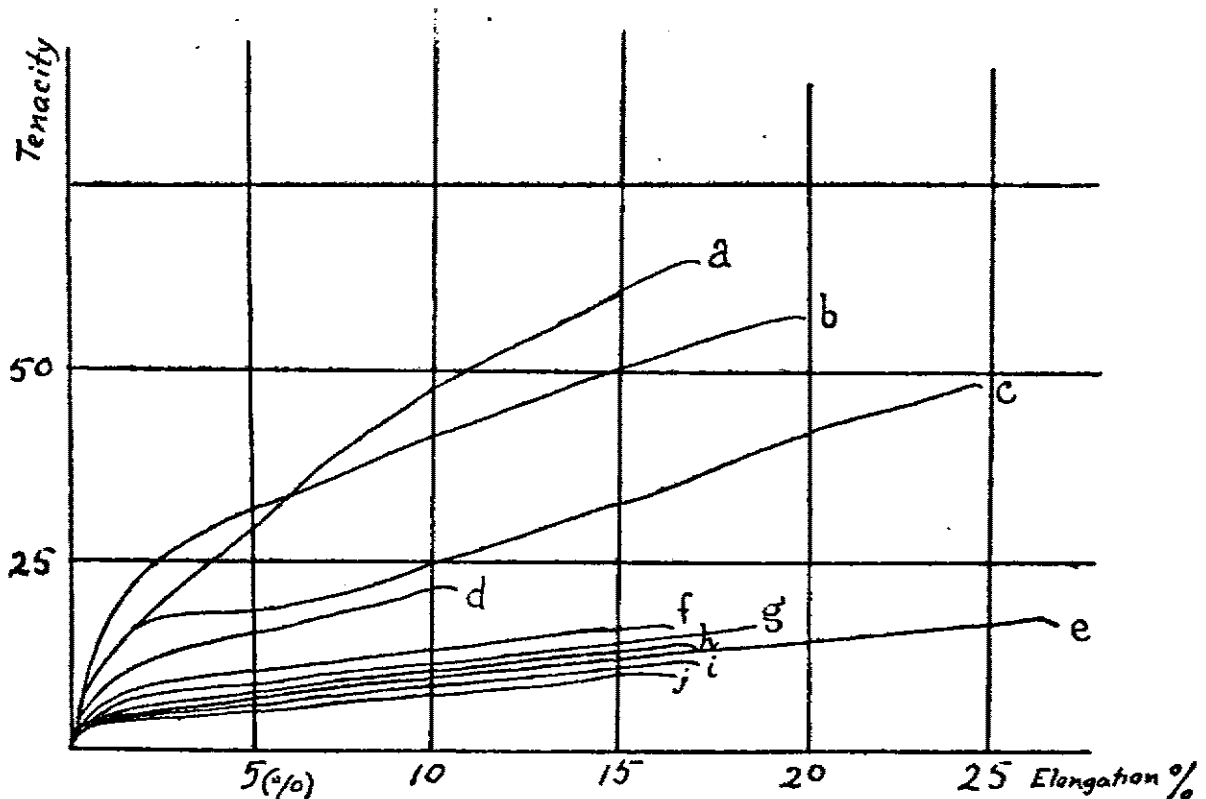


Fig. 57.—a Silk boiled off. b Raw silk. c Tasar (*A. mylitta*) raw. d Rayon—Fr. Cardonet. e Rayon—English viscose. f Rayon—Swiss viscose. g Rayon—Japanese viscose (Hiroshima Mill). h Rayon—Japanese viscose (Yonida Mill). i Rayon—Belgian viscose. j Rayon—Japanese Cupramonium. (After H. Tanaka.)

Below is quoted part of a paper read by the writer on "Sericulture in India" before the British Indian Union, London, and published in the *Indian Textile Journal* for April 1930. It explains the position of rayon as a competitor of silk. Strange as it may seem, rayon is stimulating production of certain classes of silk. Both in England and France importers were anxious to have a white silk which could be worked with rayon without being required to be bleached.

"After having given an idea of the sericultural industry, it seems necessary to discuss whether there is scope for it, especially in view of the apprehended competition of rayon or what used to be called artificial silk. Fears about this competition based no doubt on uninformed data have been the cause of much mischief and loss to India in that they prevented schemes of sericultural development being adopted. On account of its similarity in appearance to silk and its former name, rayon caused not a little anxiety to producers of silk. It is a vegetable fibre and is made by dissolving wood, especially pine wood, with chemicals and then drawing out the liquified pulp into filaments. Its nature is now being understood. It has come to be considered as a fourth fibre for clothing material in addition to cotton, silk and wool and is settling down to its own uses. As a matter of fact, much of its competition with silk is due to its deceptive appearance and ignorance of the consumers, who confuse it with silk in all countries including India. But people are learning by experience. Last year's report of the Silk Association of America notes a distinct reversion to silk from rayon in hosiery in America. A similar case has come to the knowledge of the writer in a large weaving centre in Burma. America being the largest customer, taking more than 90 per cent. of her raw silk supplies from Japan, the Silk Association of America has proposed to Japan to help in propaganda to educate the public as to the nature of silk and rayon. On the other hand, rayon is helping silk to a very great extent in mixed goods.

If we look into the production of silk and rayon the figures go to prove that rayon is hardly affecting silk. The figures of production and export of the principal silk producing countries for two recent years are quoted from the statistics published by the Silk Association of America. Rayon—

	1924-25. lbs.	1928-29. lbs.
Production in the world	85,000,000	400,000,000 (50,000 lbs. in 1920.)

Raw silk—

Production in the world (Export figures only of India and China included in this)	85,000,000	105,577,000
Production in Europe	25,066,000	28,376,000
„ Levant	1,984,000	2,381,000
„ Japan	62,642,700	87,501,800 (30,995,000 lbs. in 1915.)

Raw silk export from—

Japan	49,281,000	724,866,000
Shanghai	10,506,000	14,018,000
Canton	6,550,000	5,919,000
India	200,000	231,000

N. B.—Except that of Canton all the above silk is the product of one-brooded races of worms.

Production of rayon has gone on increasing by leaps and bounds. But experts are expecting a saturation point in the near future.

As regards silk, it has maintained its increase at about six per cent. per year. Some are of the opinion that the demand for it will actually increase at a greater rate. At present the United States of America is the largest silk consuming country. She imported about 73 per cent. of the world's production in 1928-29, and about 68 per cent. in 1924-25. During the same period Japan noted a very large demand from Canada. It is reasonable to expect that other countries which develop like Canada, will consume larger quantities of silk. It is this belief or rather certainty about increase in demand for silk which is leading various countries to make fresh efforts at increasing its production. In Japan, which is at present the largest silk producing and exporting country in the world, fresh areas are being placed under mulberry, and there has been a proposal to plant mulberry on both sides of railway lines. The Japanese Government is vigorously pushing on schemes of sericulture in Korea and Formosa. In China the Nationalist Government is trying to organize this industry on scientific lines and with this end in view has recently purchased the silk Conditioning House at Shanghai which was started and hitherto run by the Silk Association of America. The American silk manufacturers are contributing money to the foreign silk associations in China for development of sericulture in that country mainly as a protection against Japan's absolute monopoly. The largest reeling concern of Japan has recently secured lands in the Dutch East Indies with the intention of developing sericulture there. In Brazil efforts are being made to develop a sericultural industry, and Japanese settlers are being welcomed who are expected to help the scheme. One representative from Brazil was studying the industry in Japan in 1929. The Imperial Institute of England is trying to establish sericulture in Tanganayika and other places in Africa. These attempts on the part of those who are in a position to judge the trend of the industry should allay all fears about the future of silk. As a further evidence of the importance of silk it may be stated that in addition to the hitherto only one raw silk exchange at Yokohama three new raw silk exchanges have come into existence recently. One was opened at Kobe in 1923. A second one was formed at New York in 1929, and a third one in Italy in January 1930."

The correspondent of the *Rangoon Gazette*, 11th June 1930, wrote from London in May 1930 that the manufacturers of silk, badly hit by rayon about eight or nine years ago, were having record sales during the last two years owing to the public's discovery that rayon cannot equal high-grade silks. The same correspondent gave the information that one of the most important silk manufacturing companies in Lyons was engaged in negotiations for buying a large rayon factory in England and fitting it up with French machinery for producing high grade silk brocades.

Japan within the last few years has made a phenomenal development in export rayon goods and she finds that this does not interfere with her export silk goods. Some entertain fears about rayon goods competing with cotton goods.

Since writing the above further development has taken place. Russia has adopted measures to develop sericulture as a part of the Five Year Programme of industrial development and has engaged Japanese experts for the purpose. The cocoons produced have found their way to Italy to be reeled. In order to develop a reeling industry the Soviet Government has decided to erect a silk filature of Japanese type in the central part of Russia. Machinery has been ordered from Japan and two Japanese experts will work here as engineers and instructors for about three years. Russian raw silk has already appeared in the American market.

A silk Research Laboratory and Technical School has been established in south-western Germany for breeding superior stock of worms, distributing eggs and improving mulberry.

In China more sericultural stations have been established, there being now nine such stations in Kiangsu and Chekiang. Arrangements have been made for the Central Bank of China to

advance 3,000,000 dollars at 4 per cent. interest to the Silk Industry Bank which in turn will make advances to producers to improve and modernise every aspect of the industry. Since April 1930 compulsory conditioning of export raw silk has been enforced.

In Canton the industry has received large monetary help amounting to about G\$ 200,000 from America and in 1923 the Provincial Government made an annual grant of about G\$ 70,000 for the improvement of the industry to the Lingnan University, formerly known as Canton Christian College. In 1930 Government created the Kwantung Raw Silk Testing Bureau as a part of the Department of Reconstruction. Conditioning of all export silk has been enforced and facilities created for export of raw silk with certificates of tests regarding quality. The School of Silk Industry of the Lingnan University and the Kwantung Provincial Bureau of Sericulture are co-operating with the Testing Bureau in improving the industry in all its branches and Government is taking steps to establish the industry in a more suitable area in north Kwantung by free grants of land.

Attempts are being made to develop sericulture in Iraq and Mexico.

REFERENCE BOOKS ON RAW SILK.

1. Raw Silk Properties. Classification of Raw Silk and Silk throwing, by Warren P. Seem.
Silk Publishing Co., 267, Fifth Avenue, New York.
2. Raw Silk and Throwing. Warren P. Seem.
McGraw Hill Book Company Inc., 370, Seventh Avenue, New York.
3. The Second Report of the Raw Silk Classification Committee.
The Silk Association of America, 468, Fourth Avenue, New York.
(It is reproduced without illustrations in No. 7.)
4. A Raw Silk Classification with Methods of Testing (1929).
The Silk Association of America.
5. Laws and Regulations concerning the Japanese Government Silk Conditioning House,
Yokohama, Japan.
6. Serivalor, the valuation of raw silk, by A. Rosenzweig.
7. Minutes of the American-Japanese Technical Conference on Raw Silk Classification, 1929.
The Raw Silk Association of Japan, 5th Floor, Marunouchi Building, Tokyo.
8. Report of the International Conference on Raw Silk Classification, 1929.
(To be published by the Silk Association of America. Typescript notes consulted.)
9. Raw Silk, by Leo Duran.
Silk Publishing Company, 1123, Broadway, New York.
10. Silk Manufacturing and its Problems by James Chittick.
11. The *American Silk Journal*, June 1931, pp. 61-64 and August 1931, p. 33 *et. seq.*