the last column is obtained by adding the intensities for the five kinds of plates and a single diamond. Similarly the last row represents the intensities corresponding to all the diamonds and one kind of glass. The table shows that the fluorescence depends upon the kind of glass, and also upon the particular diamond used. One would expect the former, and one might not be surprised that the black amorphous diamonds do not act as do the clear crystalline stones. But that the latter differ among themselves is strange. It was thought that the difference might be due to differences in shape and the character of the scratch. This conclusion was rejected when it was found that diamond No. 4 would always fog the plate, even when the surface of the plate was not scratched at all. When the diamond was held out of cutting position and drawn across a plate, a dark band appeared on development. Diamonds Nos. 5 and 6 could scarcely be made to fog a plate, however they were held.

That friction has much to do with fluorescence was shown by the fact that sometimes a dark band would be discontinuous in two or three places along a diamond scratch.

The band produced by No. 4 was so strong that it was thought the fluorescent light might be visible. This proved to be true. When the eye was rendered very sensitive by being in absolute darkness for an hour, the conclusions drawn from the table were verified directly. The fluorescence from No. 4 was very marked, especially when English or white crystal glass was used. No visible fluorescence could be obtained with any of the black diamonds.

To test the equation $b=2t.\tan i$ a dry plate was laid on a table, film upward. A plate of clear glass was then laid on the dry plate and a diamond was drawn across the clear plate. The mean of several measurements of b and t gave a critical angle of about 39°. For the particular plate used, this was approximately the critical angle for yellow light, showing that, whatever other wave-lengths might be present the longest waves that affected the film were those of yellow light. This conclusion was strengthened by the fact that, to the eye, the light appeared to be a greenish yellow, and that orthochromatic plates were much more sensitive to it than ordinary plates.

Measurements of b and t for plates of various thicknesses gave values of i ranging from 38.6° to 40.4°. It would seem that the fogged band should be much broader when the dry plate itself is scratched, for then the critical angle is determined by the ratio of the indices of refraction of gelatine and glass. Measurements did not confirm this point, though they showed a constant ratio between b and t.

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*How Botany is Studied and Taught in Japan.**

Modern botany was practically introduced into Japan twenty-four years ago by the late Professor Yatabe,† who studied botany at Cornell University, graduating in 1876. He became the first professor of botany at the Imperial University of Tokyo. Before him there were several botanists in Japan who studied the native plants quite thoroughly. But most of them being amateurs, did not know much about modern botany. Some of these old botanists still live. The well-known Dr. Keiské Ito, who was the Director of the Botanical Garden of the University before Professor Ya-

* A paper presented at one of the Botanical Seminaries, Cornell University, November, 1900.

† Professor Yatabe was drowned in the sea at Kamakura not far from Tokyo in August, 1899.

tabe, still lives, being in his ninety-eighth year.*

A short sketch of his life, with a portrait, by his grandson Dr. Tokutaro Ito appeared in a late number of *Annals of Botany*. †

Professor Yatabe paid especial attention to systematic botany. Soon after his return from America he began to make a large and extended collection of the native plants, making long expeditions, especially in the summer vacation. It is to his arduous labors in collecting that the larger part of the herbarium of the Imperial University is due. He found and described many plants new to science. But his contributions are rather local and quite hidden from the general notice of many botanists. It is indeed only during the last few years that Japanese botanists have begun to contribute more or less to the general progress of the science.

I will now relate how botany is taught in the Imperial University of Tokyo. Before doing so, it is necessary to say how one must prepare before entering the University. A child goes to the common school at the age of six and remains there for from six to eight years before entering the high school. In the high school, English, mathematics, history, geography, physiography, physics, chemistry, zoology, botany, physiology, mineralogy, together with some Japanese and Chinese literature, are taught. This takes five years. English is the only foreign language taught in the Japanese high schools, except in one school in Tokyo where German is studied instead of English. This is the preparatory school for the medical department of the University.

If one wishes to enter the University one must spend three years after graduating from the high school in the higher high school (Kōtō gakkō). In the higher high school three different courses are given. The first course is required for the students of law and literature; the second is required for the students of science, engineering and agriculture, and the third for the medical students. The students of medicine are separately educated, as it is necessary for them to be thoroughly acquainted with German. In these three courses further subdivisions are made, according to the specialty of the student. If he is a student of botany, he is required to take the second course and to study botany, zoology, physics, chemistry, geology, mathematics, English, German, sometimes French or a little Latin, besides some Japanese and Chinese literature. After graduating from the higher high school he is admitted to the University without examination.

There are now two imperial universities in Japan, one in Tokyo and the other in Kyoto, the old capital of Japan. The latter was founded only three years ago and contains now the Colleges of Science, Engineering, Medicine and Law. No botanical department is yet established.

The Imperial University of Tokyo is divided into six colleges or departments: the Colleges of Science, Law, Literature, Medicine, Engineering and Agriculture, the last including Forestry and Veterinary Medicine. The College of Science is further divided into seven departments. These are physics, chemistry, mathematics, astronomy, zoology, botany and geology. All the courses of the University are required except a very few elective ones. Usually it takes three years to graduate, but in the departments of Law and Medicine four years are required.

The students of botany are required to study zoology, including histology and embryology, geology, paleontology, mineralogy, physiology, physiological chemistry and bacteriology, besides botany. In the first year they have three lectures a week on general botany (morphology and physi-

*Since this paper was read Dr. K. Ito has died (Jan. 24, 1901).

†Vol. XIV., No. 55, Sept., 1900.

ology) besides three laboratory hours. The laboratory work begins in identifying the various common plants, making drawings of each. In this work Gray's 'Manual', or 'School and Field Botany,' is often used, as we have no complete manual of Japanese botany. Next comes the gross and minute anatomy from the lower to the higher plants. Especial attention is paid to the various kinds of tissues, often referring to the comparative anatomy and development, together with some microchemical reactions of more common cell-contents. In the third term especial attention is paid to fertilization, embryology and development. The fern and *equisetum* are studied from the germination of the spore to the formation of sexual organs on the prothallia. The fertilization of pine and *gingko* affords good objects for study. Cell-divisions are often studied with the root-tip of beans, pollen mother cells of *Tradescantia*, lilies, etc.

In the second year three lectures on systematic botany are given weekly and three laboratory hours are devoted to plant physiology throughout the year. Various experiments on carbon assimilation, respiration, transpiration, geotropism, heliotropism, rheotropism, hydrotropism, etc., are made. Growth is observed with various auxanometers and horizontal microscopes. Then micro-chemical studies of various important cell-contents, including the inorganic salts are made. Their distribution and the transformation within the plant bodies are then studied. Artificial pure cultures of various algæ, fungi, bacteria and yeast are made, paying special attention to the nutrient value of various organic and inorganic compounds. Water cultures of the higher plants are also made. Chemotropism of the pollen tube, fungal hyphæ and chemotaxis of bacteria are carefully studied. Regeneration of the liverwort thallus and the dandelion root, nodal growth of Gramineæ are the other objects of study. *Tradescantia* cell with its red-colored sap affords excellent material for studying the osmotic pressure in the cell. Isotonic coefficient of various organic and inorganic substances are determined according to the method of de Vries. In the third term, sometimes a special subject of study, being either original or a repetition of the previous work, is given to each student.

In the third year the only required studies are: one hour's lecture weekly on plant physiology during the first term, and one lecture and two laboratories on bacteriology during the second term. The rest of the time is spent in the work of graduate theses. Subjects of theses are mostly physiological or anatomical. Following are the subjects of theses presented to the University by the graduates in botany in the last three years:

1898.

T. Inui. 'Anatomy and physiology of the gum-resin duct of lac-tree and the other species of *Rhus*.' (English.)

1899.

K. Shibata. 'Contribution to the physiology and anatomy of bamboo.' (German.)

N. Ōno. 'On the acceleration of growth in some algæ and fungi by chemical stimuli.' (German.)

H. Hattori. 'Studies on the action of copper sulphate upon plants.' (German.)

S. Kusano. 'On the transpiration of evergreen trees during winter in middle Japan.' (English.)

K. Miyaké. 'On the carbon assimilation of evergreen leaves in Tokyo and other parts of Japan during winter.' (English.)

1900.

K. Saitō. 'Anatomical studies of Japanese fiber plants.' (German.)

Y. Yabé. 'A revision of the Umbelliferæ of Japan.' (Latin.)

The chief results of the above-mentioned

theses, except that of Mr. Yabé, are already reported in the *Botanisches Centralblatt*,* by Professor Miyoshi. Some of them have already been published, and the rest will be published soon.

In the graduate course no lectures are given. By presenting a thesis which represents five years' study after graduation the degree of 'Rigaku hakushi' (Doctor of Science) is given. Of these five years the first two must be spent at the University. There are now seven students in the graduate course of botany, one of them studying outside of the University. Their subjects of study are mostly in the lines of plant physiology and physiological anatomy.

At present there are two professors and three assistants in the Botanical Department. Professor Matsumura, who is the head of the department and the director of the Botanical Garden, has charge of systematic botany. He studied in Germany under the late Professor Sachs, in Würzburg, and Professor Pfitzer, in Heidelberg. Professor Miyoshi is the professor of plant physiology. He graduated from the Imperial University and afterward studied in Professor Pfeffer's laboratory at Leipzic for three years. He is the well-known worker on the chemotropism of fungi.

Professor Matsumura is now studying the flora of the islands of Formosa. The results of his study have been partly published. Professor Miyoshi is engaged in investigating the coloring matter of flowers, besides other physiological studies. Mr. Fanjii, the assistant, who has occupied this position for several years after graduating from the University, is making researches along morphological and ecological lines. Mr. Makino, an assistant, is now studying the difficult group of bamboo, besides his systematic researches on Japanese phanerogams and ferns.

* *Botanisches Centralblatt*, Bd. 80, No. 5, 1899, and Bd. 83, No. 11, 1900.

The Botanical Laboratory is situated in the Botanical Garden. The Botanical Garden is more than two hundred years old. The garden was used primarily for medicinal plants, but now it has many kinds of Japanese and foreign plants. There is also a large green-house. The herbarium of the Botanical Laboratory contains nearly all the Japanese plants, including tropical plants from the islands of Loochoo and Formosa, besides some exotic plants. The cryptogamic herbarium is not yet completed, as many of the lower forms are not well studied. The library of the laboratory contains the leading German, French, English and Italian journals. Zeiss microscopes are commonly used in the laboratory.

There is another botanical laboratory in the College of Agriculture. Professor Shirai has charge of plant pathology and dendrology. He is especially interested in fungi and the plant diseases. He is now studying in Berlin. Professor Ikeno, the well-known investigator of *Cycas*, is giving the lectures on plant morphology and physiology. He is engaged on investigations in histology and cytology. The leading English, German and French botanical journals are also found in this laboratory.

The botany in the higher high school in Tokyo is taught by Dr. Goto, who is a zoologist. In the Higher Normal School of Tokyo, Professor Okubo has charge of the Botanical Laboratory. Professor Miyoshi, of the Imperial University, is now giving the lectures on plant physiology during the absence of Dr. Saida, who is in Germany.

In the Agricultural Experiment Station of Tokyo there are several botanists. Mr. Hori, the chief botanist, has charge of vegetable pathology. Various kinds of plant diseases are constantly studied here. The disease of the mulberry tree, the leaves of which furnish the food for the silkworm, were the special subject of investigation during the last few years by a special com-

mittee. The cause of the disease is found to be physiological, not caused by any organism, as it was thought before. A remedy for the disease is still being investigated.

There are several botanists in Tokyo outside of the above-mentioned institutions. Dr. Okamura, who is the lecturer of the Fishery Institute of the Government, is making continued studies on the marine algæ of the Japanese seas. He has just issued the first fasciculus of his 'Algæ Japonicæ Exsiccatæ,' which contains fifty species. Dr. T. Itō, who studied botany at the University of Cambridge some fifteen years ago, is making extensive systematic studies on the flora of Loochoo islands. A part of the work was published in a late number of the Journal of the College of Science, Imperial University of Tokyo.

The works of the Japanese botanists are often published in the Journal of the College of Science, Imperial University of Tokyo, as well as in the leading foreign journals. The shorter papers appear in the *Botanical Magazine*. The magazine is published monthly, partly in Japanese and partly in the European languages. It is the organ of the Tokyo Botanical Society. The Society has about three hundred members, living in various parts of Japan. Among them we find many high and common school teachers. There are two series of small pamphlets published monthly with figures and descriptions of Japanese plants. One contains figures, with brief descriptions and remarks of the flowering plants and ferns of Japan. The other contains those of the lower cryptogams. The illustrations and descriptions in the former are made by Mr. Makino. The latter is contributed to by many Japanese botanists and edited by Professors Matsumura and Miyoshi.

A still larger work on Japanese botany has just begun to be published. This is the 'Icones Floræ Japonicæ,' a large-sized pamphlet with minute and careful drawings and descriptions of Japanese plants, compiled by the Botanical Department of the University. Volume I., Part 1, has lately been published. Mr. Makino is now engaged on the work. All the drawings and descriptions are made by his own hand.

In closing I must not neglect to make a brief statement of the Botanical Laboratory in the Agricultural College of Sapporo far north in 'Hokkaido,' the Yezo Island. The director of the Botanical Laboratory and the Botanical Garden is Professor Miyabé. He studied at Harvard University some ten years ago. The herbarium of the Laboratory has a complete set of the plants of the Yezo Island, besides other Japanese and foreign plants. Professor Miyabé is interested in fungi and plant diseases. Several works in this line have been done both by him and by his students. Professor Miyabé also studied the Laminariaceæ of the northern seas. Two new genera have been established by him in this single family.

Japan is a long country, though narrow, extending from 51° north to the tropics. The variety and richness of the flora are incomparable. Though the phanerogams and the ferns of the empire are pretty well known, many lower cryptogams have not been thoroughly investigated.

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SCIENTIFIC BOOKS.

Reservoirs for Irrigation, Water Power, and Domestic Water Supply. By James Dix Schuyler, M.Am.Soc.C.E., etc., etc. New York, John Wiley and Sons, 1901. $5. Pp. xvi + 414. 174 figs., with maps and appendix.

The subject of reclaiming by irrigation the extensive arid tracts of western North America is pressed upon the attention of the general public, and also upon that of the engineering and financial world, with increasing emphasis from year to year. Private capital is urged to