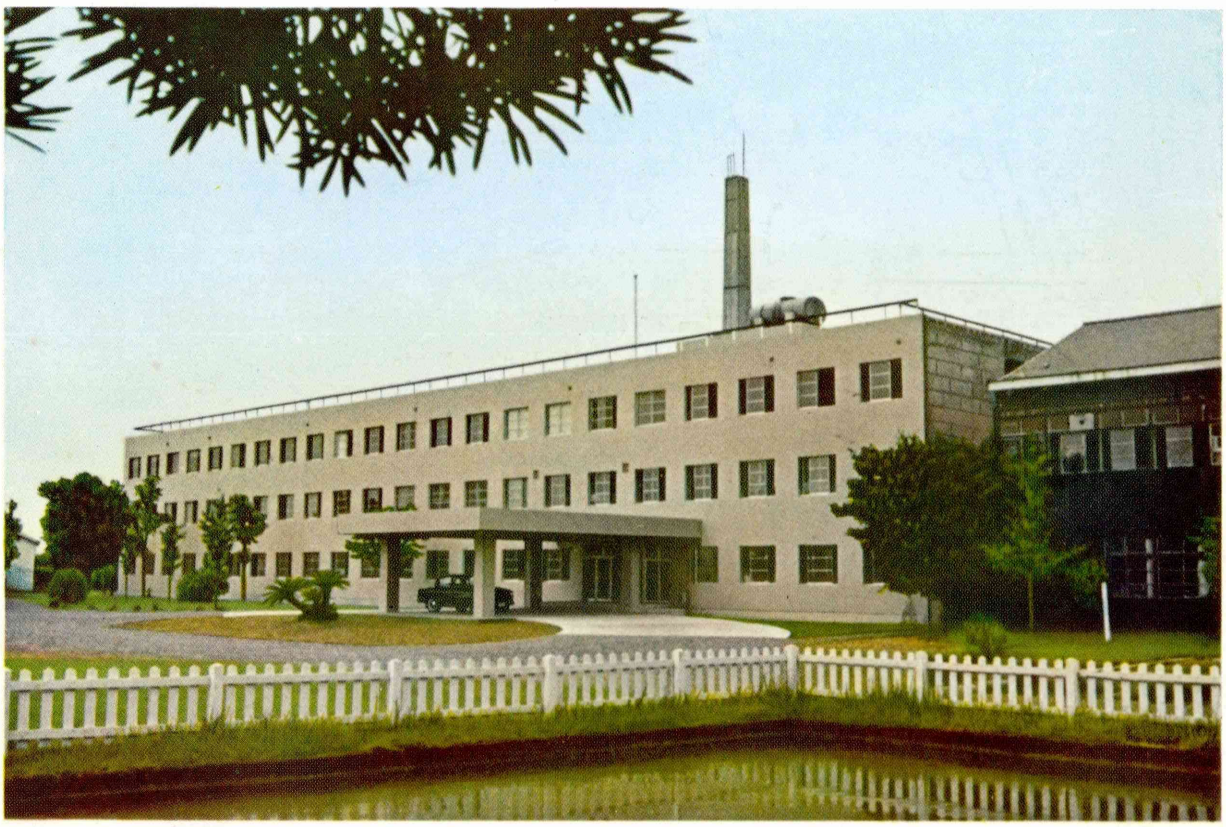
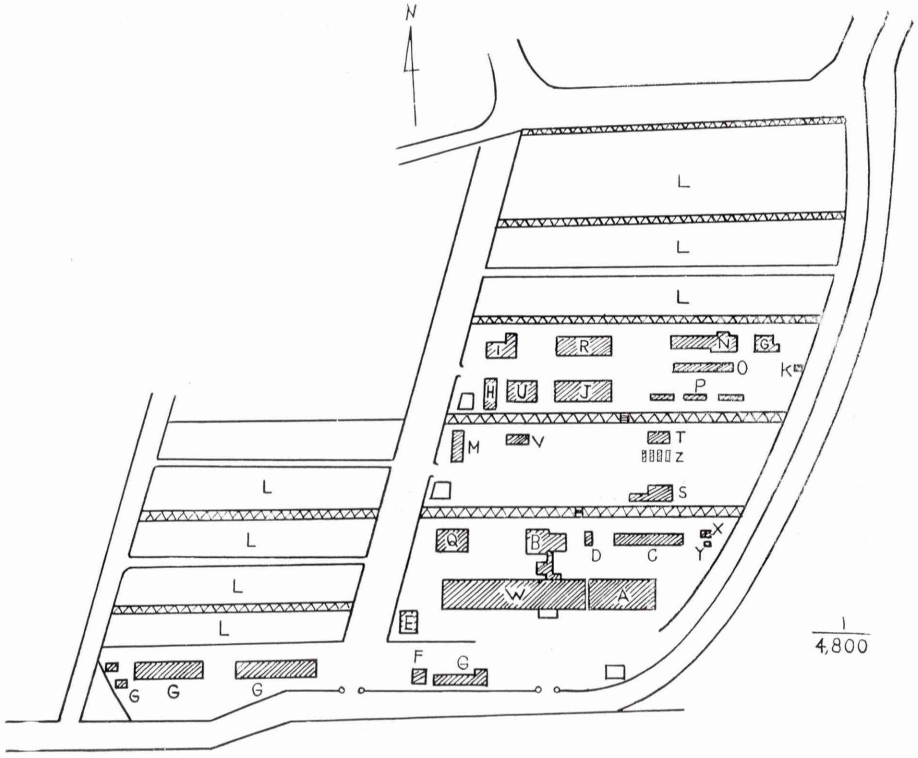
NATIONAL INSTITUTE OF GENETICS



MISIMA, JAPAN

August, 1964



Plan of the Site

A Old Building
B Adjoining Building and Library
C Glasshouse
D Transformer Substation
E Air-conditioned Greenhouse
F Garage
G Residences
H Barn
I Sericultural Laboratory
J First Mousery
K Pump House
L Experimental Fields
M Field Workroom
N Poultry House
O Testing House
P Colony Houses
Q Radio-isotope Laboratory
R Second Mousery
S Isolation Greenhouse
T Rice Laboratory
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X γ-Greenhouse
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NATIONAL INSTITUTE OF GENETICS

(JAPAN)

Location and Campus

The National Institute of Genetics is located in a suburb of the city of Misima in Sizuoka Prefecture, about a hundred kilometers west of Tokyo. It takes two hours by express train and two and half hours by local trains from Tokyo Station to Misima Station, and ten minutes by car from Misima Station to the Institute. Misima in feudal days was famous as a post town at the entrance to the Hakone passage on the Tôkaidô Highway. Nowadays it is noted for the springs and brooks which are fed by the melting snow of Mt. Fuji. Within a few kilometers from the town are several hotspring resorts: Nagaoka, Kona, Ôhito, Syuzenzi, Hatake, etc. The prosperous hotspring city of Atami can be reached in twenty minutes by train through the Tanna Tunnel, and Lake Ashi within one hour by bus. In fact, Misima is located at the center of the Fuji-Hakone-Izu District, which is one of the most beautiful spots in the country, with beautiful Mt. Fuji in the background of the city. The countryside is known for various kinds of vegetables of good quality, and for the abundance of dairy products.

The campus of the Institute is part of a small foothill on the western slope of the Hakone Range. It has an area of 811 ares; 350 ares are covered by buildings, 161 ares are occupied by roads and yards, and 300 ares by experimental fields. The Institute also has a separate piece of land of 51 ares in the neighborhood of the main campus. It is used as a nursery for rare varieties of cultivated plants, and is at the same time the site of residences. It also includes a paddy field for experimental purposes.

History

The National Institute of Genetics was officially organized on June 1st, 1949. Previous to this, the demand for a national institute devoted to the study of genetics had been expressed by Japanese geneticists on various occasions. It has been taken for granted from the beginning that such an institute should be an independent one, instead of being a part of a university or other institution. It had also been agreed upon, in view of the extensive field covered by genetics and the intricate relation between this branch of science and many others, that the institute should be designed on a fairly large scale. The first formal announcement of such demands was expressed in a resolution unanimously passed at the Thirteenth General Meeting of the Genetics Society of Japan held in August 1940 in Seoul. A little later, a special committee for the study of genetics was organized within the Japan Society for the Promotion of Science. Many senior geneticists of our country became members of this committee which paved the way for the establishment of a

national center for the study of genetics in Japan. In addition, a foundation for the promotion of theoretical and applied genetics, "The Genetics Research Institution", was organized in May, 1947. Practically, the same group of geneticists have joined also this foundation and have cooperated in its research activities. This foundation became the forerunner of the National Institute of Genetics.

In July 1948, the bill for the establishment of a national institute of genetics was presented to the Diet by the Government, and passed. The formal start of the Institute was made on June 1st, 1949, under the Government Law No. 146. On the same day, the office of the Institute was opened in the Ministry of Education with Mr. K. KENNOKI, Director of the Higher Education and Science Bureau, as the Acting Director. A council responsible for setting up the basic principles of the organization and functions of the Institute was formed on the same day. At its first meeting held on July 30th, 1949, the council nominated Dr. Kan OGUMA, Emeritus Professor of Hokkaido University, as the Director of the Institute. He was officially appointed to this office on August 10th, 1949. Within a few months the rest of the staff was chosen, and by the middle of 1950, nearly all of the members had been appointed.

The whole Institute moved into the present main campus in Misima on October 29th, 1949.

Dr. Kan OGUMA resigned from the directorship October 1st, 1955, and Dr. Hitoshi KIHARA was appointed on the same day to replace him.

At the start, the Institute had three Research Departments, for Morphological Genetics, Cytological Genetics and Physiological Genetics. To these were gradually added six departments; for Biochemical Genetics in 1953, Applied Genetics in 1954, Mutational Genetics (presently Department of Induced Mutation) in 1955, Human Genetics in 1960, Microbial Genetics in 1962 and Population Genetics in 1964. The number of regular members of the staff increased from 16 at the beginning to the present 41 (August 1964). This number does not include the Administrative Department and the part-time staff and associates in the Research Departments. The annual expenditure steadily increased from ¥14,759,000 for 1950 to ¥102,837,000 for 1964. The equipment of the Institute has been in the meantime a great deal improved and enlarged. An active development of research work was launched in all departments and soon a considerable number of reports bore the evidence of a vigorous progress. To this auspicious development the interest and assistance of the authorities of the National and Prefectural Governments have largely contributed.

In a short time the Institute has become the center of our country's genetic research. A great part of national and international symposia and meetings are organized here and geneticists from all parts of Japan are here gathering, reporting on their results and exchanging views.

At present, in the view of progressing specialization, the Institute still lacks several representative departments of the new branches of genetics, such as molecular genetics, fine genetic structure, and biophysical genetics. Also, most of the existing departments need to be enlarged and their research staff increased.

Organization and Staff

Director

Hitoshi KIHARA, D. Sc., M. J. A., Emeritus Professor of Kyoto University

Members

Department of Morphological Genetics
Yataro TAZIMA, D. Ag. (Head)
1st Lab. Yataro TAZIMA, D. Ag. (Head); Kimiharu ONIMARU
2nd Lab. Bungo SAKAGUCHI, D. Ag. (Head); Toshihiko SADO, D. Ag.

Department of Cytogenetics
Yô TAKENAKA, D. Sc. (Head)
1st Lab. Tosihide H. YOSIDA, D.Sc. (Head); Kazuo MORIWAKI, D. Sc.
2nd Lab. Yô TAKENAKA, D. Sc. (Head); Yoshiaki YONEDA, D. Sc.

Department of Physiological Genetics
Chozo OSHIMA, D. Sc. (Head)
1st Lab. Chozo OSHIMA, D. Sc. (Head); Toshifumi TAIRA, D. Sc.
2nd Lab. Hitoshi KIHARA, D. Sc. (Head); Koichiro TSUNEWAKI, Ph. D.; Sadao SAKAMOTO, M. Sc.

Department of Biochemical Genetics
Mitsuo TSUJITA, D. Ag. (Head)
1st Lab. Saburo NAWA, D. Sc. (Head)
2nd Lab. Yoshito OGAWA, M. D. (Head); Tôru ENDÔ, D. Ag.
3rd Lab. Mitsuo TSUJITA, D. Ag. (Head); Susumu SAKURAI

Department of Applied Genetics
Kan-Ichi SAKAI, D. Ag. (Head)
1st Lab. Kan-Ichi SAKAI, D. Ag. (Head); Takatada KAWAHARA, D. Ag.; Tohru FUJISHIMA, M. Ag.
2nd Lab. Kan-Ichi SAKAI, D. Ag. (Head); Shin-ya IYAMA, D. Ag.; Akira MIYAZAWA
3rd Lab. Hiko-Ichi OKA, D. Ag. (Head); Hiroko MORISHIMA, D. Ag.

Department of Induced Mutation
Seiji MATSUMURA, D. Ag. (Head)
1st Lab. Kiyoshi TUTIKAWA (Acting Head); Terumi MUKAI, Ph. D., D. Sc.
2nd Lab. Seiji MATSUMURA, D. Ag. (Head); Tarô FUJII, D. Ag.
3rd Lab. Seiji MATSUMURA, D. Ag. (Head); Hiromi ISHIWA; Mitsuo IKENAGA, M. Sc.

Department of Human Genetics
Ei MATSUNAGA, M. D., D. Sc. (Head)
1st Lab. Ei MATSUNAGA, M.D., D.Sc. (Head); Hidetsune OISHI, M. Sc.; Tomotaka SHINODA
2nd Lab. Akira TONOMURA, D. Sc. (Head)

Department of Microbial Genetics
Hitoshi KIHARA, D. Sc. (Head);
1st Lab. Tetsuo IINO, Ph. D., D. Sc. (Head); Masatoshi ENOMOTO, M. Sc.
2nd Lab. Tetsuo IINO, Ph. D., D. Sc. (Head); Hideho SUZUKI, M. Sc.; Jun-ichi ISHIDSU, M. Sc.

Department of Population Genetics
Motoo KIMURA, Ph. D., D. Sc. (Head)
1st Lab. Motoo KIMURA, Ph. D., D. Sc. (Head); Yuichiro HIRAIZUMI, D. Sc.

Department of Administration
Norihiro MORINAGA (Head)
General Affairs Section
Toyotaka MINAMIGUCHI (Head); Hiroko NAKANO; Kyôji OYAMA
Finance Section
Mutsuo TANAKA (Head); Shigeru TSURUMI; Asakichi MANO

Research Associates	13
Assistants	5
Laboratory technicians	38
Field Laborers	8
Clerks and Typists	12
Librarian	1
Chauffeur	1
Janitors, etc.	3

Honorary Members and Part-time Staff

Yoshinari KUWADA, D. Sc., M. J. A., Emeritus Professor of Kyoto University
Kan OGUMA, D. Ag., Ex-Director, Emeritus Professor of Hokkaido University
Yoshimaro TANAKA, D. Ag., D. Sc., M. J. A., Emeritus Professor of Kyushu University
Taku KOMAI, D. Sc., M. J. A., Emeritus Professor of Kyoto University
Flora A. LILIENFELD, Ph. D.
Shiro SHIRATO, M. D., Izu Teishin Hospital

Buildings and Equipments

Buildings

Building	Floor area (m^2)
Main building (three-storied)	2,980
Old building (two-storied)	1,325
Adjoining building and library (two-storied)	862
Mousery (two buildings)	563
Sericultural laboratories (two buildings)	488
Radio-isotope laboratory	394
Phytotrons (three)	606
γ-Greenhouse and operation room	89
Glasshouses	249
Poultry house	337
Barn	165
Field workroom	105
Transformer substation	28
Garage and storage house	93

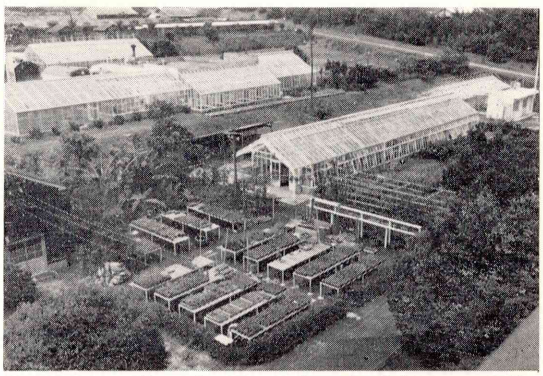


Photo 1. Greenhouses viewed from top of the main building. Front, tables with potted morning glory.

Boiler room	97
Residences	1,919

Equipments

Library

Among the valuable collections in the library, one may mention the whole GOLDSCHMIDT Library and KUWADA Library.

Since the start of the Institute in 1949 under the post-war circumstances, it was difficult to supply back-numbers even of the most important periodicals. GOLDSCHMIDT Library and KUWADA Library made up some extent for this deficiency. The library of Richard GOLDSCHMIDT was received in 1951, and he continued to send us his newly acquired reprints, periodicals and books until his death in 1958. The whole set, consisting of 36,270 reprints and about 780 books, is kept under the name of the "GOLDSCHMIDT Library". KUWADA Library was donated to this Institute by Dr. Y. KUWADA, Emeritus Professor of Kyoto University. It comprises about 482 books and 5,800 reprints. A donation of Sizuoka Prefecture made the erection of the building possible.

In the meanwhile the library received a financial support amounting to $10,000 from the Rockefeller Foundation and a donation of ¥150,000 from Dr. C. AUERBACH, Institute of Animal Genetics, Edinburgh University.

Patronaged by the good will of all those concerned, the library has been steadily expanding with purchases of new books and current as well as back numbers of periodicals and the arrival of quite a number of reprints through exchange.

The library, at present, possesses 5,185 volumes of periodicals, receiving 325 volumes every year.

Radio-isotope Laboratory

Radiation source
(1) X-rays
X-rays KXC-18 generator (Toshiba)
Specification; 200 Kvp, 25 mA
(2) γ-rays
(a) ^{137}Cs γ-rays
Source intensity ; 6,000 c (May, 1962, half life: 33 years)
Energy; 0.66 Mev.
Accessory apparatus; high speed shutter and auto-timer
Available dose rate; 230 r/hr to 55,000 r/hr (continuous)
(b) ^{60}Co γ-rays
Source intensity; 50 c (Sept., 1964, half life; 5.26 years)
Average energy; 1.25 Mev.
(3) Neutron
(a) Po-Be neutron source
Activity of Po; 10 c (Sept., 1962, half life; 138 days)
Neutron flux; 2.3×10^{7} n/sec (Sept., 1962)
(b) Ra-Be neutron source
Source intensity; 100 mg of Ra
Calculated activity of Ra; 87 mc (1960, half life; 1,622 years)

Dosimeter
Victoreen r-meter, model-570 (The Victoreen Instrument Co.)
Condenser chamber; 2.5 r, 25 r, 100 r and 250 r
Radcon (The Victoreen Instrument Co.)
Range; 0～100 r/min
Ionization chamber; multiply reading by 1/100, 1/10, 1, 10 and 100
Pocket chamber and charger reader (Toshiba)
Glass dosimeter: model-2 (Toshiba)
Fricke dosimeter: photoelectric spectrophotometer, model QR-50 (Shimadzu)
Dynacon electrometer, model-600 (Nuclear Chicago Co.). The instrument is a dynamic condenser electrometer for precise measurement of small ion currents.
Specification, imput resistance; 10^{8}, 10^{10}, 10^{12}r. imput
Capacitance; 32F, sensitivity; 10^{-16}Amp.

Survey meter
Ionization-chamber type radiation survey meter, model SBI-52101B (Toshiba)
Range; 0～20 mr/hr (×1, ×10, ×100)

Alarm monitor
Model SBI-52301
Range; 0～20 mr/hr (×1, ×10, ×100)

Radiation counter
Liquid scintillation counter, model LSC-101 (Nihon Musen Irigaku). Available for measuring ^{3}H and ^{14}C β-rays with high counting efficiencies

Spectrogammeometer
Model-1 (Radiation Counter Lab. Inc.)
Single channel recording pulse height analyzer
Analyzing energies; 0.05～10 Mev.

Electron-microscope Room

Electron Microscope:
Model JEM-6C (Japan Electron Optics Laboratory Co., Ltd.)
Resolution power 15 Å
Magnification ×600～×50,000
Accelerating voltage 60 kV
Accessory apparatus
Stereo-photography attachment (JEM-AS)
Specimen cooling attachment (JEM-AC-T)

Vacuum Evaporator: Model JEE-4B (Japan Electron Optics Laboratory Co., Ltd.)
Vacuum pressure 2×10^{-5} mmHg
Time required for evacuation 10～15min.
Accessory apparatus
Ionization vacuum gauge

Ultra Microtome: Model JUM-5 (Japan Electron Optics Laboratory Co., Ltd.)
Heat expansion type feed mechanism
Successive cutting, each section thinner than 200 Å

Ultra-centrifugal apparatus: Spinco L type

Laboratories of Microbial Genetics

Rabit-raising house: A circular house of steel-frames and concrete has the accommodation for 25 rabbits. Rabbits raised in this house are used for immunization.

Inoculating room: Two rooms in which bacterial inoculation and other works under aseptic conditions are performed. Temperature and humidity are controlled.

Deep freezer: 85×70×135 cm in size, kept at −20°C. Preservation of antisera and some chemicals.

Turbidostat: For maintaining bacterial cultures at constant concentration for a long period, now mainly being used to analyze the phase variation of *Salmonella*.

Sonicator: Vibrator with ultra-sound wave at 20 kilocycles. After the destruction of bacterial cells, cell components are fractionated and analyzed.

Spectrophotometer: Coleman universal type. Use for colorimetry as well as measurement of bacterial cell number.

In addition, incubators, shakers, autoclaves, refrigerators, centrifugators, fraction collectors and electrophoretic apparatus are equipped for the experiments of bacterial genetics and biochemical analyses.

Drosophila Laboratory

Two laboratory rooms (6×6 m) and two culture rooms (6×3 m, 3×3 m, constant temperatures 25°C and 18°C) have been occupied by several members who belong to the Departments of Physiological Genetics, Morphological Genetics, Induced Mutation, Population Genetics and Applied Genetics. A room called kitchen is used jointly for preparation of the culture media and for washing of used culture vials.

About two hundred mutant and wild type strains of *Drosophila melanogaster* are kept in the culture room for over ten years, and about seven hundred lethal strains have recently been added to our stocks. Several population cages with different natural populations of *D. melanogaster* are maintained. In addition, about forty strains of *D. pseudoobscura* and other species received from America are also raised. A large scale experiment for the study of population genetics can be carried out with five thousand vials kept simultaneously in the laboratory room.

Insectarium

For the culture of silkworms, wild silkworms and other insects, an insectary is available with a floor space of 267.8 m², to which a mulberry field of 95 ares and an oak field of 2 ares are attached. About 120 mutant strains of the silkworm are reared and maintained in this building.

Special Silkworm Laboratory

With the purpose of studying the genetic effect of radiation a special silkworm laboratory was completed in March 1960. The laboratory, with a floor space of 218.6 m², has two rooms for silkworm rearing, a γ-room, a control rearing room, two refrigerated rooms for egg preservation and growth regulation, a working

room and a machine room.

The γ-room is equipped with a rotating irradiation rack with a 3c ^{60}Co source, which permits continuous irradiation of growing silkworms while they are feeding. Both γ- and control rearing rooms are regulated automatically at a constant temperature and humidity of $25° \pm 1°C$ and $75\% \pm 5\%$, respectively.

The laboratory is designed so as to make possible the performance of silkworm experiments from artificial hatching to egg collection.

A greenhouse of 97 m^2 floor space and an underground storage for mulberry leaves are attached.

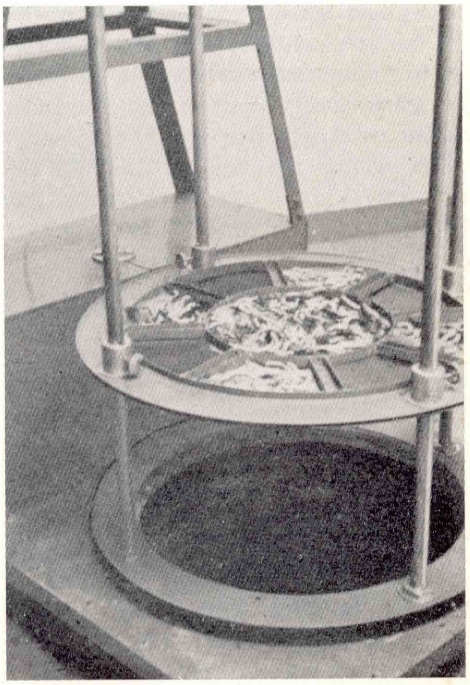


Photo 2. A rotating irradiation rack for continuous irradiation of silkworms while they are feeding. The γ-ray source is installed beneath, under the floor.

First Mousery

Completed in December 1953. This is a model mousery, 290 m^2 in floor area, containing four rooms for mice and two for rats, a working laboratory, a care-takers' room, a kitchen and storage space. It has a heating system with a circulation gas-boiler and radiators, also a special ventilation device. Metal cages are arranged on shelves on hanging and movable racks. About 7,000 animals belonging to 30 inbred mouse strains and 15 inbred rat strains are kept in the building. Most of these animals are the progeny of stocks imported from mouseries in America and England. The strains are distributed on demand to medical and biological institutes all over the country.

Second Mousery

The second mousery was built, in 1958, for studies on the genetic effects of radiation on mice. 272.7 m^2 is the total area of the building which contains eleven individual rooms; a laboratory, an office, five rooms in which the animals are kept, a kitchen, a cage-cleaning room and two rooms for heating equipments.

Each animal room is maintained at a temperature of about 24°C by an air-conditioning plant, the range being from 22° to 24°C in summer, and 24° to 26°C in winter, with a relative humidity of about 50 per cent through the year.

Rice Laboratory

The Rice Laboratory was built for studies on the origin of cultivated rice under a grant of the Rockefeller Foundation.

The greenhouse is roughly air-conditioned

and has two glassrooms, an experimental room and a machinery and working room with a fumigation chamber in a corner. Each glassroom is 45 m^2 in floor dimensions and has an about 20 m^2 paddy field in the middle, where the soil is also warmed. The warmed air is usually circulated from the heating units to the glassrooms through a duct, to keep the day temperature at 28°C and the night temperature over 18°C. The relative humidity is about 65%. But in the hot summer season the heated air is partly removed from the roof ventilators and a sunscreen can cover the glass roof in day time.

Besides the greenhouse (180 m^2 in floor dimensions), this laboratory has a short day installation comprising seven small paddy fields (each 2.6×3.5 m). Five of them are equipped each with a sliding darkroom chamber under natural condition, which slides automatically under the control of time switches, of which three are astrodials (for 35°N, 24°N and 12°N Lat.) and two are plain dials. When the cover is down, an electric fan is operated for ventilation. The remaining two fields are control ones without cover.

Gamma-greenhouse

The facility for chronic γ-ray irradiation of growing plants, "so-called" γ-greenhouse, was built in May 1964. The area of the greenhouse is 75 m^2 (5 m×15 m) and a specially designed irradiator with 40 curies of ^{137}Cs source is placed in the center of the greenhouse. ^{137}Cs source is kept in the core of a lead container of the irradiator and γ-rays irradiate one half of the greenhouse (east half), when switched on by remote control. Height of direct beam is adjusted so as to shoot one meter high from the ground level at the extremity of the irradiated area (8 meters apart from the source) making it convenient to irradiate several kinds of growing plants. Dosage or intensity is 4 r/hr at the place 1 meter apart from the source, gradually decreasing with increasing distance, and reduced to 0.2 r/hr at the farthest part. The west half or back area of the irradiator can be used as a control room; almost all γ-rays are cut off in this area by a thick lead cover of container and concrete wall closely installed on the back of the irradiator. The greenhouse is roughly air-conditioned and the temperature can be kept lower by about 5°C than that of the outside in summer. Biological and genetical reseach under low dose rate condition will be carried out with the help of this facility.

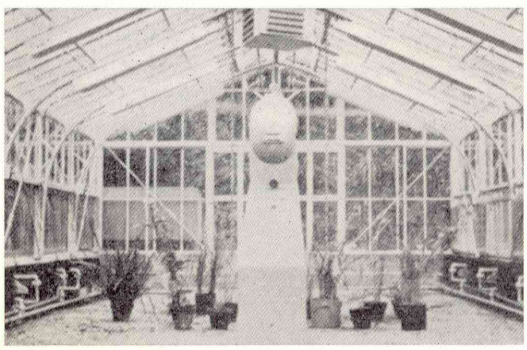


Photo 3. Inside view of the newly constructed γ-greenhouse. In its center the ^{137}Cs source is installed.

Isolation Greenhouse

The Isolation Greenhouse was built in 1957. Its surface is 341 m^2 in floor dimensions. The building is constructed with concrete or concrete blocks. In the greenhouse, six air-conditioned small isolating glasshouses are constructed for the isolation of plants which are cross- or self-pollinated. It has also a temperature-controlled glasshouse (45 m^2), an air-conditioned glasshouse (45 m^2), three

air-conditioned darkrooms (each 10 m²) with artificial light, a low-temperature darkroom (10 m²) and a screened compartment (45 m²), besides two machinery rooms and a working (preparation) room.

Air-conditioned Greenhouse

The Air-conditioned Greenhouse was constructed in 1952-53 with the support of the Research Fund of the Ministry of Education. The greenhouse (87.5 m² in floor dimensions) comprises two glasshouses (each 13.2 m²) with turn-tables and two darkrooms (each 3.3 m²) where temperature and air humidity are automatically controlled, besides the machinery room, boiler room and a conventional greenhouse (36.3 m²) heated only for plant propagation.

The glasshouses and darkrooms have a temperature range from 18° to 30°C. The temperature is lowered by 5°～10°C each night at 16:00, under the control of a time switch, and kept low until 8:00 of next morning. The relative humidity is more than 60 per cent.

Glasshouse

A glasshouse without heating, primarily designed for keeping strains of tobacco plants, but used for other purposes as well.

Seed Storage Rooms

Two storage rooms, each being 4.2×3 m in floor area, have been constructed especially for seed storage. Different systems are adopted in each room for the regulation of storage conditions. In one room, temperature is kept at 0°±1°C, while humidity is not controlled. In the other room, both temperature and humidity are regulated, at 12°±1°C and 45%±5%, respectively. The principal factor for assuring longevity of stored seeds is low temperature in the former room, and a combination of lowered humidity and relatively low temperature in the latter.

Constant Temperature Rooms

A set of six rooms, regulated at 0°, 5°, 10°, 15°, 20° and 25°C, are used for various experiments requiring such temperatures.

Research Activities

Department of Morphological Genetics

This department was started in 1949 as the First Department of this Institute. Comprising three laboratories, the department covered genetic studies of divergent organisms such as wheat, sugar beet, silkworm, poultry, mouse and man. With the expansion of the Institute, often reorganization of laboratories took place. Since 1961 the main activity of this department was directed to the genetic researches in

silkworm, a traditional experimental animal of this country.

At present the department comprises two laboratories:

First Laboratory: Silkworm genetics

Second Laboratory: Cellular differentiation

The department is well equipped for genetical studies of the silkworm, having an air-conditioned rearing house, a refrigerating room, a mulberry field, a greenhouse and ordinary laboratories. Facilities are available for investigations in cell and tissue culture.

First Laboratory

1. Silkworm genetics: Encouraged by sericultural industry silkworm genetics has achieved a great progress in Japan. More than 260 hereditary traits have been thus far analyzed and 19 linkage groups among 28 have hitherto been established. The remaining nine have already been represented each by a single marker gene. Although a number of research works on silkworm genetics have been conducted not only in this laboratory but also in many laboratories in Japan, most of the results have been published in Japanese so that the details have scarcely become known outside this country. In order to give a general account of silkworm genetics, TAZIMA published last spring an English monograph, "The Genetics of the Silkworm", Logos Press, London. In this book he emphasized that although the silkworm may lack the special suitability of *Drosophila* for formal genetics or of *Neurospora* for biochemical studies, it is an ideal organism for the study of physiological and developmental problems.

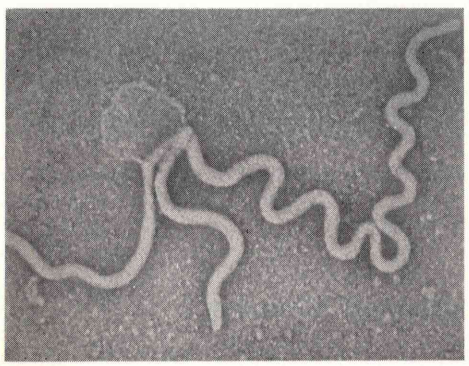


Photo 4. Treponema-like microorganisms found in the abnormal "sex-ratio" strain of *Drosophila* (4-16 μ in length and 0.08-0.15 μ in diameter). This microorganism kills only male zygotes.

2. Radiation genetics: Egg color mutants of the silkworm furnish excellent opportunities for mutation detection. TAZIMA developed a simple specific loci method, using the egg color genes as markers and studied in detail the changes in mutability of germ cells at various stages of gametogenesis for both sexes. Since then the research has been directed to the dose-rate effect on mutation induction at gonial stage. The most interesting was the finding that the dose-rate effect is reversed within a week after hatching of the larva. Several efforts have since been made in this laboratory to reveal the cause of this strange phenomenon, in connection with the mechanisms of radiation mutagenesis. Above all the most extensively carried out were experiments with dose fractionation and with neutrons. A new interpretation for radiation mutagenesis is now emerging.

In an attempt to utilize silkworm eggs for a bioassay of cosmic rays in outer space, an irradiation experiment with high energy particles is now under way in which dormant eggs of the silkworm are used.

Second Laboratory

The main project of this laboratory has been the study of the phenotypic gene expression on the cellular level on one hand, and to analyze the process of cytodifferentiation on the other.

1. Role of informational RNA on the expression of genes and cellular differentiation: Recently differentiation has been defined as the process involved in the production of a new, specific protein within a cell. This differentiated, unifunctional cell derives from the more immature, multipotent cell. The current hypothesis on the biosynthesis of proteins asserts that the

genetic informations in the DNA are transcribed into the messenger RNA which is in turn used as the template for protein synthesis. If so, it should be possible to alter the expression of genes in an individual by introducing a specific messenger RNA from another individual with different genotype. In the same manner, a cell would acquire a new function, i.e., the capacity to synthesize a new specific protein, by treatment with RNA from different tissues or from cells differentiating in different directions. In order to test those possibilities, the following experiments have been conducted.

(i) Artificial control of the genic expression in an individual by application of a specific messenger RNA derived from another individual with a different genotype.

(ii) Induction of antibody synthesizing capacity in the lymphoidal cells of non-immunized animals by introducing new informational RNA from immunized donors.

2. Heritable infections of "sex-ratio" condition in *Drosophila*: A maternally transmitted condition known as "sex-ratio" (SR) is characterized by its extreme departure from the normal sex ratio of 1:1, i.e., the progeny consists completely or almost completely of females. Absence of males is a consequence of their mortality caused by SR agent in embryonic stages. The SR agent in certain SR strains is known to be a treponema-like infectious microorganisms. Thus the SR condition in *Drosophila* has aroused a wide interest in relation to maternal inheritance and hereditary infection.

In order to extend understanding of the SR condition, experiments are now under way concerning the following problems; biochemical characteristics of the agents, comparison of biological properties and pathological effects of agents of different origin, their cultivation, host range, and mechanism of selective killing of male host infected with an agent.

Department of Cytogenetics

First Laboratory

Cytogenetic studies of animals have been carried out in this laboratory with special interest in the following three subjects.

1. Cytology of animals: Chromosomes of insects and mammals are studied in this laboratory. Among insects, chromosomes of Hemiptera, Coleoptera and Hymenoptera are studied, and several reports were published on the quantitative relationship between the total length of autosomes and that of sex chromosomes in allied species. A study on chromosomes of Muridae is carried out with special regard to the chromosomal polymorphism in natural populations and inbred strains of rats and mice.

Mechanism of breakage and reunion of animal chromosomes by treatment with radiation and some chemicals is also being studied.

2. Cytology of tumors: Chromosomes of tumors in mice and rats, which were developed spontaneously or by artificial treatment or virus infection, are studied for elucidating the relationship between chromosomal alteration and tumor development. From these studies, it was revealed that many tumors had characteristic karyotypes in their stemline cells, and that their cell types were changeable as a result of the occurrence of more adaptive mutant cells or by placing them in different conditions. Influence of tumor viruses on chromosomes and/or genes of a host cell is studied using mouse leukemias. Mechanism of synthesis of specific proteins by plasma cell tumors of mice is also studied *in vitro*.

3. Genetical study of laboratory mammals: Another important problem in this laboratory is the establishment and maintenance of inbred strains and mutant stocks of laboratory mammals, such as mouse, rat, Chinese hamster, and some

Photo 5. Blossoms of Izu-yoshino, a synthesized hybrid between *Prunus subhirtella* var. *pendula* forma *ascendens* and *P. lannesiana* var. *speciosa*. This hybrid strongly resembles the so-called Someiyoshino Cherry (*P. yedoensis*), the most popular flowering cherry tree in Japan.

others. Their strains and stocks are described in the pertinent section. New mutants of mice, i.e., falter and post-axial polydactyly, were studied genetically. Some new strains such as SMA, DM, D103, DD/M of mice, W, W-tailless, NIG-I, NIG-II, NIG-IV, Nagoya and YOS of rats, and their many sublines were established. A biochemical study on hairless mouse has been conducted in order to clarify the mechanism of gene action during development. Liver esterase in 21 strains of mice was electrophoretically examined. There was a slight difference among strains, and F_1 animals showed electrophoresis bands of both parents.

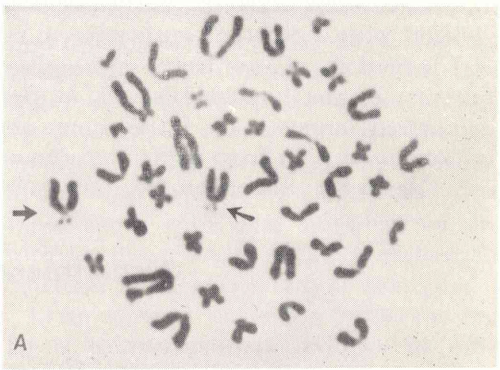
Second Laboratory

Cytological studies of higher plants are the main fields of this laboratory. Problems on sex chromosomes, sex expression, polyploidy, etc. have been investigated for many years.

In order to reveal phyletic relationships among *Nicotiana* species, TAKENAKA investigated meiotic divisions in many interspecific hybrids. Further interspecific crosses are made for obtaining hybrids not yet studied (This work is supported by Japan Monopoly Corp.).

Extracts of some higher plants such as *Aralia elata*, *Artemisia vulgaris* and *Gentiana scabra* were found by TAKENAKA to have radiomimetic effect.

TAKENAKA collected various species and varieties of cherry trees and studied the



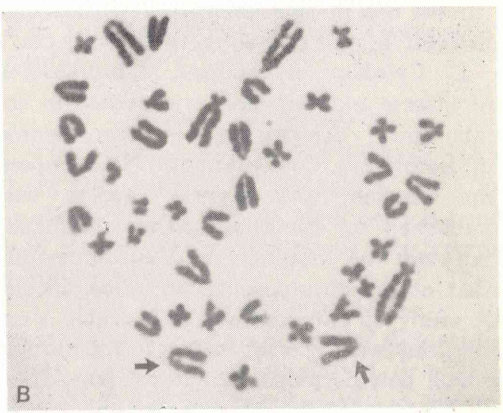


Photo 6. Metaphase chromosomes in two inbred strains of the rat, *Rattus norvegicus*. A. YOS-strain (♀), characterized by two subtelocentric No. 3 chromosomes. B. Wistar strain (♀) with two telocentric No. 3 chromosomes, indicated by arrows.

origin of Somei-yoshino (Yoshino cherry tree). This popular ornamental cherry was conclusively found to be an F_1 between Edo-higan (*Prunus subhirtella* var. *pendula* forma *ascendens*) and Oshimazakura (*Prunus lannesiana* var. *speciosa*).

In cytological studies of rice, HU observed secondary association of chromosomes in many cultivated and wild rice varieties. His conclusion is that the secondary association is not caused by chance but has some biological significance. Interchromosomal affinities in the pachytene stage of haploid rice are recently studied by CHU.

TATEOKA, presently in the National Science Museum, revised the classification of the genus *Oryza* from the cytotaxonomical point of view. YONEDA studied the cytology of yeasts, and is now working on genetic tumors of *Nicotiana* hybrids and Japanese morning glory by tissue culture.

The effort is also directed to preservation of various mutants of Japanese morning glory and investigation of their morphological characters, with the intention of pursuing morphogenetic mechanisms in higher plants.

Department of Physiological Genetics

First Laboratory

In this laboratory, physiological expressions of gene function are studied both at the cellular and the population level, using *Drosophila* as material.

1. Investigation at the cellular level is concerned with the mechanisms of eye color production. Twenty-three eye-color mutants were classified into five groups, based on the blocking mechanisms of the metabolic processes for pteridine and tryptophan; these are white, brown, yellow, orange and red eye-colors. In a single cell of compound eyes, red or yellow pigment (pteridine derivative) distributes in the distal layer and brown pigment (tryptophan metabolite) locates in the basal layer. These products appear in different regions of larval fat body cells before the adult compound eyes are formed. Through a genetic study of this phenomenon, mechanisms of gene control of cellular differentiation may be elucidated.

2. The investigations at the population level deal with the mechanisms of maintenance of deleterious genes in natural populations. The frequencies of deleterious chromosomes are considerably higher in large than in small populations. Moreover, a difference of the rates of allelism of lethal genes has been found among populations differing in size. Contrary to this, the results obtained here have shown that the allelic rates do not differ in large and small populations. Of particular interest is the phenomenon that one of the lethal genes has persisted in a population for three years. This lethal gene is close to the centromere of a chromosome with a paracentric inversion. Furthermore, most of natural lethal genes found are located in the region adjacent to the centromere of each chromosome, while spontaneous lethal genes found in laboratory stocks are distributed more nearly at random over the whole chromosome. By observation of the salivary gland chromosomes, twelve types of inversions were found in the natural populations studied, some of the inversions showing high frequencies in certain populations. These findings suggest that some of natural lethal genes are involved in an epistatic gene complexes, which are favored by natural selection, despite containing a recessive deleterious gene.

Second Laboratory

The main research problem of this laboratory is analysis of the mechanisms involved in the origin and differentiation of higher plants, such as rice, wheat and *Agropyron*. For this purpose, a considerable variety of materials collected from al-

most all over the world are maintained. Not only genetic, karyotypic and comparative gene analyses, but also physiological, morphological and anatomical methods have been applied for elucidation of the genetic basis of the origin and differentiation of species.

1. Study on rice: H. KIHARA and T. C. KATAYAMA are mainly responsible. More than 4,000 wild and cultivated *Oryza* strains belonging to 30 species have been collected during the past seven years. Many interspecific hybrids have been produced to examine their genomic relationships. In the attempt to find out new taxonomic characters in rice, a comparative anatomical study of the epidermal structures of the glume and the leaf blade was carried out by SUMP and spodogram methods. Variations of photoperiodic sensitivity between and within various *Oryza* species have been explored, and its ecological significance in regard to their phylogenetic differentiation has been clarified.

2. Study on wheat: H. KIHARA and K. TSUNEWAKI are responsible for this part. Two projects, namely, nucleus substitution and comparative gene analysis, are the main concerns.

Nucleus substitution work is carried out to examine the effects of alien cytoplasm on the expression of nucleic genes. For this purpose, various nuclei of wheat are introduced into three different alien cytoplasms of related species. It is inferred that speciation and cytoplasmic differentiation are closely interrelated. In addition this work has opened a new field for wheat breeding, namely, hybrid wheat breeding.

Distribution of homologous genes controlling spring habit, waxiness, progressive necrosis and awnedness was investigated by comparative gene analysis of common wheat and its ancestral species. Based on those results, genotypes of the putative parents, emmer wheat and *Aegilops squarrosa*, which through a spontaneous cross may have contributed to the origin of the common wheat, were determined and the place of its origin was traced.

3. Study on *Agropyron*: S. SAKAMOTO is carrying out this work. Genome analysis of Japanese and Nepalese species of *Agropyron* indicated their close phylogenetic relation. At present extensive experimental-taxonomical studies of interspecific and intergeneric hybrids in the tribe Triticeae, including *Agropyron*, *Elymus*, *Eremopyrum*, etc., are in progress.

Department of Biochemical Genetics

Into this department, established in 1953 with M. TSUJITA as its head, three laboratories, First, Second and Third, have been gradually consolidated. During this process a number of changes and shifts in their personnel have taken place. Their main research activities have been in the last ten years as follows.

First Laboratory

Investigations in biochemical genetics of insects have been carried out here since 1953 by M. TSUJITA, S. NAWA and B. SAKAGUCHI. A series of experiments have been undertaken with the lethal yellow silkworm by M. TSUJITA which revealed a close relationship between lethality and pteridine metabolism. S. NAWA studied the gene control of pteridine metabolism of eye-color mutants of *Drosophila melanogaster* in cooperation with T. TAIRA of the Department of Physiological Genetics. TSUJITA, NAWA, SAKAGUCHI and TAIRA received the 1963 prize of the Genetics Society of Japan for their contributions to "Genetical and biochemical studies of pteridine metabolism in insects".

In addition, several other researches have been carried out. Namely, studies on the pseudo-allelic *E*-series in the silkworm (TSUJITA and SAKAGUCHI); genetic determination of tyrosinase and protyrosinase in

the blood of the silkworm (SAKAGUCHI); studies on the complex *Nl-U-Di* loci in the silkworm (TSUJITA); radiation effect on genetic material (NAWA); studies of the poisoning effect of tobacco plant emanations on the silkworm (TSUJITA).

B. SAKAGUCHI was transferred to the Department of Morphological Genetics in 1961 after a two year sojourn in the United States at Yale and is continuing his interesting work started there together with Dr. POULSON on the sex agents in *Drosophila*. S. NAWA became the head of this laboratory in 1960. He specialized in pteridines in the laboratory of Dr. H. S. FORREST at the University of Texas (1961–1962) and later was studying at the University of Rochester in the laboratory of Dr. E. W. CASPARI on transformation in insects (1962–1963). At present he is continuing this work here.

Second Laboratory

This laboratory was opened in August 1953 with three research members, K. HAYASHI (Head), T. ENDO and Y. ABE.

Their research project consisted of biochemical and genetical studies on flower colors in higher plants. K. HAYASHI succeeded in isolating pure blue anthocyanin from the petals of *Commelina communis* and published about his chemical and biochemical findings. He also examined on a large scale the distribution of anthocyanins in Japanese plant populations. Besides, the synthesis and mutation of flower color were studied in Japanese morning glory, *Pharbitis Nil*, and pansies, *Viola tricolor maxima*, by Y. ABE and T. ENDO, respectively. T. ENDO summarized last year his biochemical and genetical studies on flower pigments. At present, he is studying in the U.S.A.

After HAYASHI's transfer to Tokyo University of Education in April 1956, Y. OGAWA became the head in September 1956, and ABE retired from this Institute in August 1957.

Under OGAWA's leadership, the main research project of this laboratory was directed to biochemical studies on the growth and differentiation of animal embryos and tumor tissues. In order to examine the differentiation mechanism of skeletal muscle tissues, a series of experiments were carried out, by means of immunochemical and electrophoretic techniques, on the synthesis of contractile proteins, actin and myosin, in early embryonal stages or regenerating tissue. On the other hand, the effects of promoting or inhibiting reagents on animal cell division were investigated in close connection with those researches. Finding of some antitumor agents was envisaged as a byproduct of the studies.

Third Laboratory

This laboratory started with three research members, M. TSUJITA, T. IINO and S. TSUDA. From July to May 1961 TSUJITA was the head. IINO succeeded him in June 1961, and TSUDA retired in 1962. In 1962 IINO was transferred to the newly established Department of Microbial Genetics, and since then TSUJITA is again heading this laboratory. In September 1962 SAKURAI was appointed as a new researcher.

Genetical and biochemical studies on chromogranules in the hypodermal cells of the silkworm larvae have been carried out.

Also electron-microscopical studies of the fine cell structure were started. TSUDA found mitochondrial structures in certain fungi (*Aspergillus* and *Penicillium*) using the ultra-thin sectioning method. Several other works have been carried out, namely, electron-microscopical studies of cytoplasmic polyhedral virus infecting the silkworm (TSUJITA); genetical and electron-microscopical studies of phage infecting *Pseudomonas solanacearum* (TSUJITA and MATSUI); electron-microscopical studies on the inner structure of *Paramecium caudatum* by means of ultra-thin sections (TSUJITA, TSUDA and WATANABE); and formation of tobacco mosaic virus in plastids (TSUJITA and TSUDA).

In parallel with genetical and biochemical studies of chromogranules in the hypodermal cells of the silkworm electron-microscopical studies of their fine structure are now in progress.

Department of Applied Genetics

First Laboratory

Main projects so far pursued and their results are as follows:

1. Selection experiments were conducted with chickens for egg production and with *Drosophila* for bristle number. Selection was proved to be effective. Contrary to expectation, it was noticed that the genetic variance did not change before and after the selection.

2. Hybrid vigor in chickens was investigated with a view to confirm the effect of cytoplasm on heterosis. The conclusion was that maternal effects were observed in early embryonic growth, egg production, disease resistance and tolerance against radiation damages.

3. Effects of selection under different environmental circumstances were investigated with *Tribolium*. It was found that selection for body weight was more effective under poor than under good nutrition.

A project now under way is the exploitation of developmental genetics in quantitative characters of fowl. It is hoped through this work to explain inbreeding degeneration in terms of developmental error during organ formation, to find genetic relations between organ conformation and egg production, and to define body conformations in terms of pleiotropy of polygenes.

Second Laboratory

The main lines of work conducted in this laboratory are as follows: (1) competition and migration in plants and animals, (2) developmental genetics of quantitative characters, (3) genetic studies of economic characters in tobacco plants, and (4) statistical genetics of forest trees.

Findings so far obtained from the competition studies are summarized in the following: (1) Competitive ability is a genetic character which is not associated with any visible botanic characters. (2) Mix-growing of genotypes in a population brings about increase in the frequency of some genotypes and decrease of others, which are not necessarily accompanied by an increase in fitness of the whole population. (3) Competitive effect is density-dependent, but it is necessary to distinguish density-response from competitive ability. (4) Migration in animals can be divided into random- and mass-migration, both of which are genetic but independent from each other. (5) A weakly competing genotype is unable to survive for a long time in a mixed population with a strongly competing genotype. If, however, the former is endowed with a high migratory activity, it can survive by finding a niche in a new area, which is not necessarily very suitable for its survival.

Developmental-genetic studies of quantitative characters in plants and animals are being carried on. The attention has been focused on the investigation of pleiotropy of quantitative genes by means of X-ray treatment, and on the enquiry about developmental relationships among quantitative characters by means of genetic correlations between their developmental instabilities. From the results of those investigations, the concept of "potency" in organisms has been developed, based on which differentiation of organs has been interpreted in genetic quantitative terms. Furthermore, the role of developmental instability in evolution has been elucidated.

Genetic studies on some economic characters of tobacco plants have also been conducted. Among them are inheritance of mid-rib and leaf-vein formation, inheritance of leaf color and genetic relation between nicotine content and leaf thickness.

Statistical genetic studies so far carried out with forest trees have led to establishment of a new method of estimation of genetic parameters without raising progeny. It is now intended to improve the method for those tree species in which intergenotypic competition interferes with its successful application.

Third Laboratory

H. I. OKA and H. MORISHIMA are working with problems related to the origin of cultivated rice. The present main research objects are: 1) species relationship between *Oryza sativa* and *O. glaberrima*, 2) phylogenetic relationships among rice varieties as revealed by F_2 or sporophytic sterility, 3) breeding of isogenic lines with different sterility genes, which will be used for gene analysis of F_1 and F_2 sterilities, 4) survey of variations in characters relative to breeding system, and 5) natural selection experiments with hybrid populations of wild rice species. The last one is being conducted in cooperation with the International Rice Research Institute and the Botany Institute of Academia Sinica. Studies on many other subjects were made along the same line and their results have been already published. In general, their research activity aims at evolutionary genetics in rice.

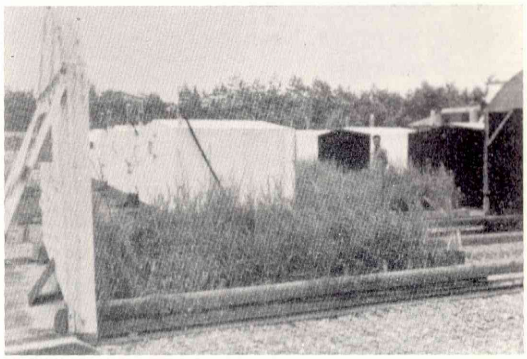


Photo 7. Short-day paddy fields for rice. Each field is specially equipped with a dark chamber, whose opening and closing are automatically controlled.

Department of Induced Mutation

First Laboratory

1. Studies on mice (K. TUTIKAWA): Radiation-induced mutation rate in mice was studied by the following two methods. By measuring the rate of induction of autosomal recessive lethals, as proposed by HALDANE, it was indicated that the genetic effect of radiation is cumulative during all developmental stages of mice even at a low dose with a low dose-rate. On the contrary, mutation rate observed by the specific loci method indicated that the dose rate effect is not linear at least within the dose rates used here. Besides those results, the sex ratio was found to decrease linearly with the total dose of chronic irradiation given to spermatogonia. Furthermore, a distinct difference was found among strains in the peripheral leucocyte number in the response to whole body X-irradiation.

2. Studies on *Drosophila* (T. MUKAI, I. YOSHIKAWA and T. YAMAZAKI): Since 1960, when MUKAI was appointed as a research member, experiments have been conducted on the genetic influence of radiation on populations and on the mechanism of maintaining genetic variation in a population, that is closely related to the former. Main results recently obtained are as follows: First, the rates of both spontaneous and radiation-induced mutations of polygenes controlling viability on the chromosome basis are extremely high in comparison with those of recessive lethal mutations. Second, those spontaneous and induced mutant-polygenes are characterized by exhibiting overdominance in homozygous genetic backgrounds.

Second Laboratory

The following three points have been the main concerns of this laboratory; (1) determination of the optimum radiation dose and method of its application to plants, (2) comparison of mutations induced by various kinds of radiation, and (3) mechanism of radiation-induced mutation in cereals.

^{60}Co γ-ray irradiator was built in 1956, with which studies on radiosensitivity of cultivated plants, their commercial varieties

and polyploids were started. At the same time, relative biological effectiveness (RBE) of thermal (JRR-1) or fast (14 MeV, 7.2 MeV, fission neutrons, etc.) neutrons and radioactive solutions (^{32}P, ^{131}I, etc.), in comparison with X- or γ-rays, were studied with wheat and *Arabidopsis*.

Furthermore, an extensive study was carried out with wheat and rice seeds for a detailed comparison of dose-rate and storage effects on growth and mutation. In this study, recovery of radiation damage under chronic irradiation and dose-rate dependency of mutation frequency were generally observed. Those phenomena were, however, often masked by storage effects, whose magnitude depended upon the kind of materials, total irradiation dose, dose rate and storage conditions (temperature, moisture, etc.). Recently, an irradiation experiment was started using the γ-field of the Institute of Radiation Breeding, for comparison with the results obtained by acute γ-rays from ^{137}Cs of this department.

Another purpose of the mutation reseasch was the induction of useful mutations such as short culm, early heading and maturity, disease resistance, and others in cereals and tobacco, color change in flowering plants (tulip, chrysanthemum, carnation, etc.), and useful bud sports in fruit trees (oranges, grapes, etc.). In addition, breeding of sugar beet by means of induced triploidy has been carried out since 1949 in cooperation with the Kihara Institute for Biological Research. Cytogenetic studies of *Triticum* and its relatives and species hybrids of *Oryza* have also been carried out.

Third Laboratory

1. Biological effects of internal radiation: One of the main projects is to clarify the mechanisms of biological effects of internal radiation caused by internally located radioisotopes, such as incorporated ^{32}P or ingested ^{90}Sr. When the radioisotopes thus located within organisms disintegrate, they usually emit ionizing radiation, and the chemical valences of the residual nuclei are also changed. The chemical valence changes of the decayed nuclei, i.e., transmutation, may have some effects on living system. Since 1961, the transmutation effects of incorporated ^{32}P on killing and induced mutation in microorganisms, plants and silkworm have been studied. In the case of bacteria, it was concluded that the killing action of decay of ^{32}P is due neither to intracellular nor extracellular β-radiation but to the transmutation effect, and the mutagenic action of ^{32}P is also due largely to the transmutated atom itself. As for higher forms, some preliminary results are obtained for induced mutation in silkworm, but the work is now in progress, and it is hoped to obtain more detailed information about this problem.

2. Biophysical studies on the mechanism of radiation-induced mutations: S. Kondo, presently Professor of Osaka University, has extensively studied relations between RBE (relative biological effectiveness) and LET (linear energy transfer), using various radiations and various biological responses. From this study, he proposed a multi-subunit target model for chromosome structure, and concluded that in most cases radiobiological effects are due to structural damages of chromosomes and that in general the shape of RBE-versus-LET curve is a reflection of the nature of primary lesions of radiation damages under consideration. Recently, he proposed a biophysical theory for radiation-induced polygenic mutations.

Along this line, molecular action of ultraviolet light upon microorganisms is now studied. Since covalently bonded dimers of thymine were isolated from ultra-violet irradiated DNA and their role in ultraviolet inactivation of microorganisms was revealed, it has become a great interest to find out whether the formation of thymine dimer is an essential, primary event for ultra-violet mutagenesis. For this purpose, quantitative relationship between thymine dimer formation and mutation frequency is now under study with *Escherichia coli*.

3. Measurement of radiation doses: It

is a routine work of this laboratory to measure and calculate radiation doses of X-rays, γ-rays and neutrons not only for our own studies but also for the workers in other laboratories or research institutes. S. KONDO developed a glass dosimeter, by which the dose of ionizing radiations absorbed by biological specimens can be easily measured. This special dosimeter is very useful for any kind of studies in radiation biology, because of its small size (1 mm in diameter and 6 mm in length), fair accuracy (better than $\pm 5\%$), linearity for wide range of dose (5 r to 10^3 r or more) and its response to any kind of ionizing radiations including both thermal and fast neutrons.

Department of Human Genetics

With the establishment of the Department of Human Genetics in April 1960, the Institute has marked the first step in a program of increased emphasis on researches in this particular field.

Genetic composition of human population is best known for Caucasians and the existing world centers of human genetics are interested mainly in this race. However, there are considerable differences in the genetic structure among ethnic groups, so that a major project of this department is concerned with a comparative study of the genetic composition of the Japanese population. Its aim is to understand how the genetic composition is related to environmental factors, past and present, of physical, biological and cultural nature, and what kind of genetic consequences may be expected from rapid changes of various factors such as those affecting in recent times social, family and marriage patterns. Along this line the following researches are going on, under a grant from the Rockefeller Foundation given in 1961.

First Laboratory

1. Selective mechanism for the maintenance of some polymorphic genes in man (E. MATSUNAGA and Y. HIRAIZUMI): Selective mechanism operating on polymorphic traits such as ABO, MN, P blood groups, secretor vs. non-secretor, and ear-wax types, are being analyzed from the standpoint of population genetics. Special attention is paid to the problem of maternal-fetal incompatibility and prezygotic selection.

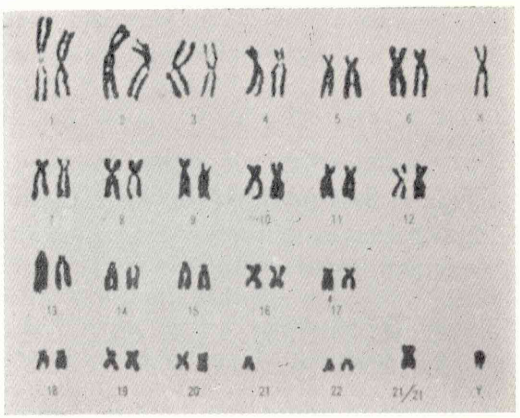


Photo 8. Chromosomes of a patient with Down's syndrome, in which 21-22/21 translocation was found.

While the effect of ABO incompatibility seemed to be significant in the previous data mostly obtained in the pre-war time, its effect has not been clearly demonstrated in the recent data. Some evidences have been obtained, which indicate prezygotic selection acting on heterozygous fathers in ABO blood groups.

2. Studies on some hereditary diseases (E. MATSUNAGA, A. TONOMURA and H. OISHI): In order to estimate the frequencies of chromosomal and gene mutations, extensive surveys on a nation-wide scale are in progress on Down's syndrome and retinoblastoma. Epidemiological approaches are adopted to elucidate factors that influence the occurrence of those diseases. Some data pertinent to eugenic aspects have been obtained.

3. Studies on biochemical genetics (T.

SHINODA): A survey was made of the frequencies of haptoglobin types and the deficiency of glucose-6-phosphate-dehydrogenase activity. Besides, studies on the relation between molecular structure and function of certain enzymes and nucleic acids are carried out by means of chemical modifications.

4. Possible genetic consequences of measures affecting population trends in Japan (E. MATSUNAGA): The recent trends of demographic patterns such as rapid decline in both mortality and birth rates, and migration from rural to urban areas are especially remarkable in this country. Possible genetic consequences of those changes are investigated from various aspects.

Second Laboratory

1. Chromosome studies in patients with congenital disorders (A. TONOMURA and H. OISHI): Practical methods for the study of human chromosomes are of very recent origin. Applying those methods, a new field has been already created in human genetics. In collaboration with several University Hospitals in Tokyo, a number of chromosome abnormalities were analyzed in various types of congenital disorders and sex anomalies. Accumulation of the data will provide evidence on the nature of the mechanisms which control those abnormalities.

2. Studies of the sex chromatin body and drumstick extrusion in interphase nuclei (A. TONOMURA and K. SOGA): Studies of the sex chromatin body in tissue cells and drumsticks in polymorphonuclear leucocytes are of fundamental importance not only for the diagnosis of sex and sexually abnormal individuals but also for genetics in general. The incidence of those structures was investigated in normal females and in patients with abnormalities in sexual development.

3. Studies of chromosome aberrations in human somatic cells *in vitro* (A. TONOMURA): With the hope of relating the findings *in vitro* to observations made on living individuals, detailed analysis of spontaneous and induced chromosome aberrations has been carried out with human embryonic cells cultured *in vitro*.

Department of Microbial Genetics

First Laboratory

The major subject of researches in this laboratory is the genetics of *Salmonella* flagella. *Salmonella* flagella are excellently suited for genetic studies on synthesis of proteinaceous antigen and cytomorphogenesis.

In acid solution below pH 3.5, a bacterial flagellum dissociates into homogeneous protein monomers called 'flagellin'. Immunological studies of both flagella and their component flagellins have indicated that a flagellin molecule is the unit of flagellar antigen. Two flagellin loci, H_1 and H_2, each of which is assumed to carry the whole genetic code for amino acid sequence of a flagellin, were disclosed by the studies of their genetic fine structures. It was demonstrated that a mutation in one of those genes produces an altered configuration of the corresponding flagellin, resulting in a change in antigen type, a modification of the flagellar shape or an alteration of the receptor site to motility phage.

For the production of flagella, several regulatory genes have been found to be involved, namely *fla*, *ah* and vh_2. A *fla*$^-$ mutation in any one of the *fla* genes causes loss or decrease of the ability to produce flagella. Fifty-three *fla*$^-$ mutants so far examined were classified into, at least, seven complementation units. One of these *fla*$^-$ mutants was found to produce flagellins but fail to construct flagella from them. The remaining *fla*$^-$ mutants can not synthesize flagellin monomers. *ah* adjoins to each *H* gene, ah_1 to H_1 and ah_2 to H_2

respectively, and switches on or off the genetic activity of the latter. The function of *ah* is effective to the adjoining *H* gene only when it is in cis-position to *H*. vh_2 regulates the stability of H_2 state. Regulatory mechanisms of those genes are under active investigation.

As regards flagellar morphogenesis, *in vitro* reconstitution of flagellar fibres from their component flagellin molecules is under study.

An efficient method to select paralyzed mutants of bacteria was invented (Enomoto and Iino 1963). By genetic complementation test, paralyzed mutants (*mot*$^-$) of *Sal. typhimurium* obtained by this method were classified into three cistrons. Biochemical studies on the function of these cistrons are in progress.

Those investigations have been partially supported by a research grant from the Institute of Allergy and Infectious Diseases, Public Health Service, U.S.A., since 1959 and by a grant from the Toyo Rayon Foundation for the Promotion of Science and Technology in 1964.

Second Laboratory

Mechanisms involved in cellular regulation of gene action are of great interest and are studied genetically and biochemically with *Salmonella*.

A new mutant, *arg-s-1*, was isolated from wild type *Sal. typhimurium* strain LT-2 by 2-aminopurine treatment. Characteristics of this mutant are as follows: (1) its growth is specifically inhibited by one of the essential amino acids, arginine, (2) the critical point of arginine concentration high enough to suppress the growth of the mutant, at least for the first ten hours, lies between 10^{-5} M and 10^{-4} M, (3) the growth inhibition by arginine is specifically and immediately removed by addition of uracil to the concentration equivalent to or higher than that of arginine, (4) the mutant shows normal activity of ornithine transcarbamylase, aspartate transcarbamylase and carbamate kinase (or carbamyl phosphate synthetase), suggesting that it has no genetic block in the structural genes controlling the structure of those enzyme proteins, and (5) ornithine transcarbamylase and aspartate transcarbamylase of the mutant do not seem to be repressed by arginine or uracil, respectively. From those observations, the mutant has most likely some genetic block in the cellular regulatory mechanism for synthesizing arginine and uracil, probably in a regulator gene. It may be a so-called 'relaxed' mutant, which has a deficiency in the controlling system of RNA synthesis.

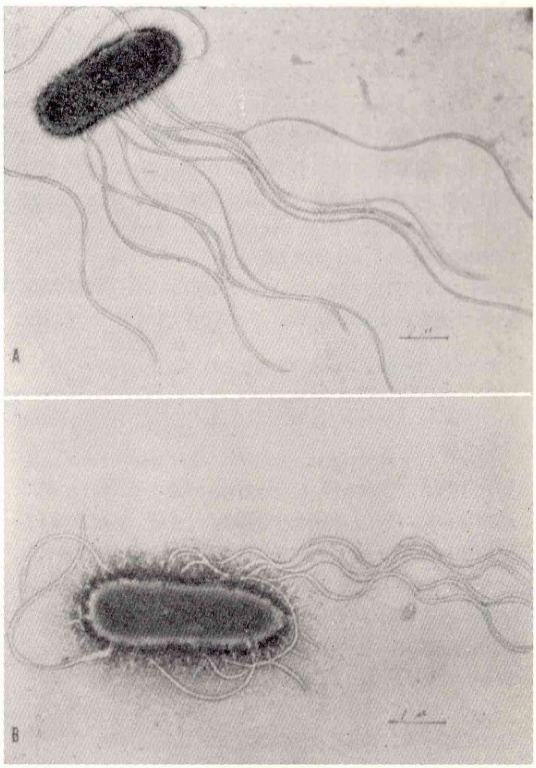


Photo 9. Electron micrographs of *Salmonella typhimurium* showing normal (A) and curly flagella (B). Negatively stained by phosphotungstate.

To clarify cellular regulation mechanisms of gene actions, it would be most helpful to bring to light the fine structure of the regulator gene itself as well as to identify repressor as a chemical substance. For this purpose, it is attempted to produce many such mutants as described above for their

genetical and biochemical analyses.

On the other hand, it is never neglected to carry out investigations *in vitro* to find out the characteristics of the repressor itself. The establishment of a system for synthesizing a specific protein *in vitro*, and finding of an efficient method for detecting the synthesized protein are essential for biochemical approach to repressor. To start with, the flagellar antigen of *Salmonella* has been chosen as a specific protein, because this protein has been genetically extensively studied in the First Laboratory of this department. Fractionation of flagellins by DEAE-cellulose or by antibody-cellulose has been carried out, through which separation of flagellins with different antigenic specificities has been successful. Now it is tried to establish a system, which will allow the synthesis of those proteins *in vitro*.

Department of Population Genetics

The department was launched in July 1964. It is the ninth and at the moment the last research department that has been added to the existing eight. Its organization is still incomplete; it contains only one division (the First Laboratory), a second division (the Second Laboratory) is expected to be added next year.

The purpose of this department is to investigate, both experimentally and theoretically, the laws which govern the genetic structure of natural populations.

When the two laboratories are completed, the research plan of the First Laboratory will be to investigate the mechanism of evolution by such means as analysis of the genetic variabilities of natural populations and selection experiments with population cages. The Second Laboratory will be devoted to mathematical and statistical studies concerning the genetics of natural populations, including those of man. For these studies, it is hoped that the laboratory will have in future the facilities of an electronic computer.

First Laboratory

Here, problems relating to the mechanism of evolution are investigated from the standpoint of population genetics. The staff members of the laboratory, their previous and present activities are as follows:

Motoo KIMURA has been working on the mathematical theory of population genetics for the past 15 years, the first ten having been devoted mainly to the solution of problems on stochastic processes of the change of gene frequencies in populations. His contributions include the finding of solutions for the processes of random genetic drift and for the probability of fixation of mutant genes in a finite population. The latter results have been used by Alan ROBERTSON in developing his theory of selection limits in animal and plant breeding.

More recently in collaboration with J. F. CROW of the University of Wisconsin, KIMURA has worked on problems relating to genetic loads, effective population number and maintenance of genetic variability in populations. He is also working on models of population structure.

Since 1952, Yuichiro HIRAIZUMI has been investigating the genetic structure of natural populations of plants and animals. The first five years, 1952-1956, were devoted to the investigation of the evolutionary dynamics in natural populations of *Trillium*. He found that random genetic drift was one of the important evolutionary factors. He has spent the next five years in America, 1956-1960, studying the selective mechanisms operating in natural populations of *Drosophila*. He discovered a new element of meiotic drive called segregation-distorter (SD). Since 1961, he has been investigating the significance of meiotic drive in the evolution of human as well as *Drosophila*

populations and he obtained some evidences of meiotic drive in human ABO blood groups. Recently he discovered an SD-like drive element in a natural population of *Drosophila melanogaster* in Japan. He is also studying the effect of radiation-induced mutations on fitness in *Drosophila*.

Stocks Maintained

Bacteria and Bacteriophages

1) Bacteria

Salmonella typhimurium
- Wild type
- Auxotrophic mutants, c. 50 strains including auxotrophy for amino acids, purines, pyrimidines, or vitamins.
- Mutants unable to utilize compounds as energy source, c. 10 strains.
- Sensitive or resistant mutants to antibiotics (Sm, Cm. Tc. etc.), c. 50 strains.
- Sensitive or resistant mutants to bacteriophages (P22, Chi, etc.), c. 50 strains.
- Non-flagellated mutants including 2 kinds of regulator mutants, c. 100 strains.
- Paralyzed mutants, c. 60 strains.

Salmonella abortus-equi
- Wild type
- Sensitive or resistant mutants to antibiotics (Sm, Cm, Tc, etc.), c. 30 strains.
- Sensitive or resistant mutants to bacteriophages (P22, Chi, etc.), c. 30 strains.
- Non-flagellated mutants, c. 30 strains.
- Paralyzed mutants, c. 10 strains.
- Serotype mutants, c. 80 strains.

Salmonella abony
- Wild type
- Hfr and F^- strains
- Auxotrophic mutants for amino acids.
- Sensitive or resistant mutants to antibiotics and bacteriophages.

Salmonella serotypes c. 30 strains including *S. para B, S. paratyphi A, S. sendai, S. heidelberg*, etc.

Escherichia coli
- Strain K, B, S, Row.
- Auxotrophic mutants for amino acids, purines, pyrimidines or vitamins.
- Sensitive or resistant mutants to antibiotics and bacteriophages.
- Hfr and F^- strains.

Serratia indica

Serratia plymuthicum

Serratia marcescens
- Color mutants
- Sensitive or resistant mutants to antibiotics or bacteriophages.

Shigella boyd

Shigella sonnei

Shigella dysenteria

Shigella flexneri
- Sensitive or resistant mutants to antibiotics (Sm, Cm, Tc, etc.).

2) Bacteriophages

Salmonella: P22, Chi

Escherichia: T_1, T_2, T_3, T_4, T_5, T_6, T_7, Lambda

Serratia: Sigma

Drosophila

1) *D. melanogaster*

Wild type	
Japanese strains	80
Foreign strains	40
Isogenic lines	9
Mutants	
1st chromosome	25
2nd 〃	19

3rd	〃	18	3rd	〃	1
4th	〃	1	4th	〃	1
Multi-chromosomal		54	5th	〃	2
Natural lethal strains		440	Multi-chromosomal		2
〃 semilethal strains		250	3) ***D. pseudoobscura***		
2) ***D. virilis***			PP strains		7
Wild type strains		4	AR	〃	10
Mutants			CH	〃	7
1st chromosome		3	ST	〃	10
2nd	〃	1			

Silkworms

About 120 mutant or synthetic strains of the silkworm are now being kept in this Institute. They represent almost all necessary genes for genetic analysis. Above all, the Institute is proud of possessing the most important chromosome aberrations, which are not available outside the Institute.

Mice, Rats and Other Laboratory Animals

1) **Inbred strains of mice (*Mus musculus*)**
A/HeMs, AKR/JaxMs, C57BL/6HeMs, C57L/HeMs, C58/LwMs, C3H/AnHeMs, C3Hf/Lw, C3HeB/De, DM/Ms, DD/Ms, D103/Ms, DBA/2, HR/De, NH/LwMs, RF/Ms, RFM, SL/Ms, SMA/Ms, SWR/JMs, SWM/Ms, STOLI.

2) **Mutant stocks of mice**
Linkage group I
chinchilla (c^{ch}), extreme dilution (c^{e}), pink-eyed dilution (p)
Linkage group II
short ear (s^{e}), dilute (d)
Linkage group III
piebald (s), hairless (hr), rhino (hr^{rh}), Viable dominant spotting (W^{v})
Linkage group V
non-agouti (a), black and tan (a^{t}), Lethal yellow (A^{y})
Linkage group VI
Caracul (Ca)
Linkage group VII
Rex (Re), tipsy (ti)
Linkage group VIII
brown (b)
Linkage group IX
tailless-wild 5 (t^{w5}), Brachyury (T), Fused (Fu)
Linkage group XI
obese (ob)
Linkage group XII
jerker (je)
Linkage group XIII
leaden (ln)
Linkage group XV
Twirler (Tw)
Mutants of unknown linkage group
furless (fs), alopetia periodica (ap), falter (fa), Post-axial polydactyly (Po), dwarf (dw)

3) **Inbred strains of rats (*Rattus norvegicus*)**
ACI/N, Albany, Buffalo, Castle's Black, CW-1, Long-Evans, Nagoya, NIG-I, NIG-II, NIG-IV, YOS, Tailless-W, Wistar, Wistar-King-A, Wayne's pink-eyed yellow hooded.

4) **Other laboratory animals**
Chinese hamster (*Cricetulus griseus*)
House rat (*Rattus rattus*)
Mastomys (*Mastomys coucha*)

Rice

Species	No. of strains	Species	No. of strains
O. abromeitiana Prod.	4	*O. malampuzhaensis* Krish. et Chand.	1
O. alta Swallen	5	*O. meyeriana* Baill.	18
O. australiensis Domin	2	*O. minuta* Presl	42
O. barthii A. Chev.	75	*O. officinalis* Wall.	76
O. brachyantha A. Chev. et Roehr.	12	*O. paraguaiensis* Wedd.	1
O. breviligulata A. Chev. et Roehr.	33	*O. perennis* Moench	90
O. coarctata Roxb.	3	*O. perrieri* A. Camus	1
O. cubensis Ekman	8	*O. punctata* Kotschy	10
O. eichingeri Peter	16	*O. ridleyi* Hook.	6
O. glaberrima Steud.	400	*O. sativa* L.	3,404
O. grandiglumis Prod.	5	*O. sativa* f. *spontanea* Roschev.	167
O. granulata Nees	11	*O. schlechteri* Pilger	1
O. latifolia Desv.	25	*O. stapfii* Roschev.	12
O. longiglumis Jansen	15	*O. subulata* Nees	1
O. malabarensis	2	*O. tisseranti* A. Chev.	1

Wheat and *Aegilops*

1) Wheat

(a) Species collection

Triticum aegilopoides Bal. var. *boeoticum* Perc. 3 strains

T. monococcum L. var. *vulgare* Körn. 2 strains

T. monococcum L. var. *flavescens* Körn.

T. timopheevi Zhuk. 2 strains

T. dicoccoides Körn. var. *fulvovillosm* Perc.

T. dicoccoides Körn. var. *kotschyanum* Schulz

T. dicoccoides Körn. var. *spontaneonigrum* Flaksb.

T. dicoccum Schübl. var. *liguliforme* Körn.

T. dicoccum Schübl. var. *arras* Hochst. 2 strains

T. dicoccum ssp. *georgicum* Dek. et Men.

T. durum Desf. var. *reichenbachii* Körn.

T. durum Desf. var. *coerulescens* (Bayle) Körn.

T. durum Desf. var. *hordeiforme* (Host) Körn.

T. durum Desf. var. *melanopus* (Al.) Körn.

T. orientale Perc.

T. persicum Vav. var. *stramineum* Zhuk.

T. persicum Vav. var. *fuliginosum* Zhuk. 2 strains

T. polonicum L. var. *vestitum* Körn.

T. pyramidale Perc. var. *recognitum* Perc.

T. turgidum L. var. *nigro-barbatum* Körn.

T. compactum Host var. *icterinum* Al.

T. compactum Host var. *humboldti* Körn. (No. 44)

T. macha Dek. et Men. var. *subletschchmicum* Dek. et Men.

T. spelta L. var. *duhamelianum* Körn. and 3 other strains

T. sphaerococcum Perc. var. *rotundatum* Perc.

T. vulgare Vill. (*T. aestivum* L.) var. *albidum* Al.

T. vulgare Vill. (*T. aestivum* L.) var. *alborubrum* Körn.

T. vulgare Vill. (*T. aestivum* L.) var. *erythroleucon* Körn.

T. vulgare Vill. (*T. aestivum* L.) var. *erythrospermum* Körn.

T. vulgare Vill. (*T. aestivum* L.) var.

ferrugineum Körn.
T. vulgare Vill. (*T. aestivum* L.) var. *graecum* Körn.
T. vulgare Vill. (*T. aestivum* L.) var. *lutescens* Al.
Synthetic hexaploid wheat 4 strains
(b) Cultivated varieties of common wheat

Japanese local varieties	200
American varieties	300
Australian varieties	84
Russian varieties	24
Scandinavian varieties	62
Tibetan varieties	19

2) ***Aegilops***

Ae. aucheri Boiss.
Ae. bicornis Jaub. et Sp. 2 strains
Ae. biuncialis Vis.
Ae. caudata L.
Ae. columnaris Zhuk. 2 strains
Ae. comosa Sibth. et Sm. 2 strains
Ae. crassa Boiss. 2 strains
Ae. cylindrica Host 3 strains
Ae. heldreichii (Holzm.) Eig
Ae. kotschyi Boiss. 4 strains
Ae. longissima Schw. et Musch.
Ae. ovata L. 6 strains
Ae. sharonensis Eig 2 strains
Ae. speltoides Tausch 2 strains
Ae. squarrosa L. 6 strains
Ae. triaristata Willd. 7 strains
Ae. triuncialis L. 7 strains
Ae. turcomanica Rosh.
Ae. umbellulata Zhuk. 3 strains
Ae. uniaristata Vis. 3 strains
Ae. variabilis Eig 3 strains
Ae. ventricosa Tausch 5 strains

Flowering Cherry Tree

Prunus apetala
P. apetala var. *pilosa*
P. incisa
P. incisa forma *Yamadai*
P. incisa var. *tomentosa*
P. incisa var. *kinkiensis*
P. nipponica kurilensis
P. subhirtella
P. subhirtella var. *pendula* forma *ascendens*
P. subhirtella var. *pendula*
P. campanulata
P. sieboldii
P. yedoensis
P. Jamasakura
P. Jamasakura var. *chikusiensis*
P. sargentii
P. verecunda
P. Lannesiana var. *speciosa*
Cultivated varieties and hybrids 110

Genes of Morning Glory (*Pharbitis Nil*)

a-1 a-1 white
a-1^f flecked-1
ac acuminate
B-1 Blown-1
b-4 blown-4
br brown
bv brimvein
Bz-1 Blizzard-1
c-1 c-1 white
ca ca white
ca^i ivory
cd contorted
cm-1 crumpled-1
cn chestnut
co cordate
co^H Hederacea
coa cocoa
cp crepe
cr cream
cs criss-crossed
ct contracted
cu couple
cy cream yellow
dc deep-crumpled
dg-1 dragonfly-1
di dingy
dk-1 duskish-1
dk-2 duskish-2

dl delicate
dl^{m} delicate mutable
dp duplicated
dw-1 dwarf-1
dy dusky
e extended
Ex Expanded
f-1 fasciated-1
f-2 fasciated-2
f-3 fasciated-3
fa fainted
fd faded
fd^{s} smeary
fe feathered
fe^{c} creased
fol folded
g glabrous
Gb Globose
h-1 hair-1
hs hard seed
hw-1 half-white-1
i-1 intense-1
Ln Lined
lp lilliputian
lt-1 light-1
m maple
m^{w} willow
mg magenta
Mr-1 Margined-1
Mr-f Margined fluctuated
p pear
p^{p} pear-petaloid
pr purple
pt petaloid
py polymorphic
r-1 r-1-white
re-1 retracted-1
Ry-1 Rayed-1
s star
Sa Striated
sc semi-contracted
si stiff
Sl Stellate
sp-1 speckled-1
sph spheloid
sr-1 side-reduced-1
st-1 striped-1
su-Cy Cream yellow suppressor
su-tw-1 tube color suppressor
sz-1 size-1
tw-1 tube-white-1
v-1 variegated-1
we weeping
wr wrinkled
y-1 yellow-1
y^{m}*-1* yellow mutable-1

Ornamental Plants

Camellia (3 species)	92 cultivated varieties
Plum	19 〃 〃
Maple	39 〃 〃

Publications

Annual Reports

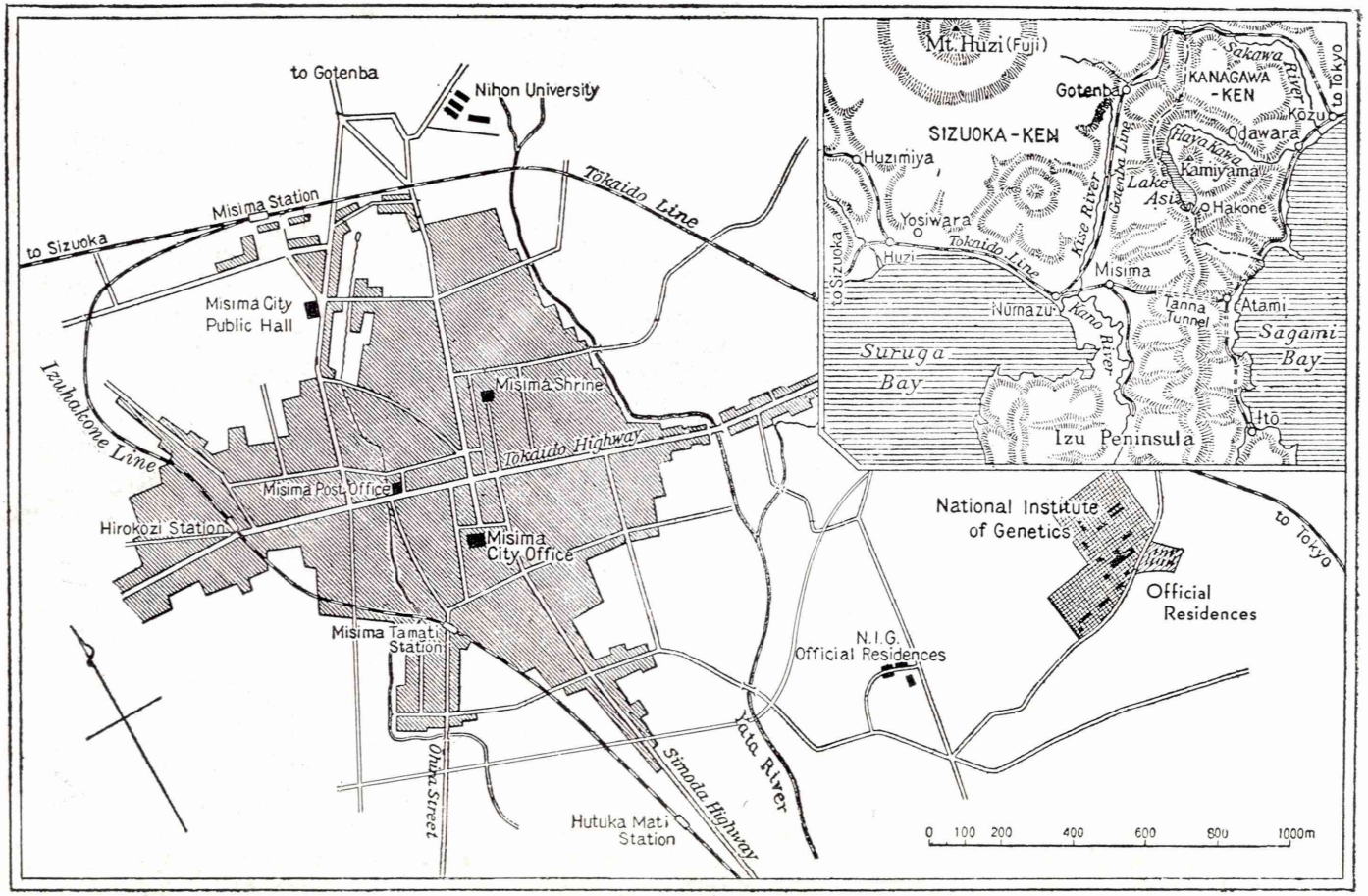
The Institute publishes the "Annual Reports" both in Japanese and English, and distributes them to institutions and individuals interested in the activities of the Institute. So far the following numbers of the English edition have been issued.

No.	Pages	Research items contained	Date of issue
1 (1949-'50)	53	46	Nov. 1951
2 (1951)	70	54	Oct. 1952
3 (1952)	69	44	Oct. 1953
4 (1953)	69	47	Aug. 1954
5 (1954)	90	57	Sept. 1955
6 (1955)	102	76	Aug. 1956

7 (1956)	105	68	Aug. 1957	11 (1960)	111	97	Oct. 1961
8 (1957)	115	76	July 1958	12 (1961)	128	101	June 1962
9 (1958)	144	84	Sept. 1959	13 (1962)	115	86	Aug. 1963
10 (1959)	162	109	Oct. 1960	14 (1963)	139	111	Sept. 1964

Contributions to Scientific Journals by the Staff

Papers written by the staff members have been contributed to various scientific journals, both domestic and foreign. Up to date (August 1964), 539 "contributions" have been printed. The reprints of these papers are distributed regularly to biological institutions and individual geneticists.



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