JAPANESE PAPERS ON GENETICS 1942-1948. ENGLISH ABSTRACTS

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I. PLANT CHROMOSOMES

HAGA, T. 1942. Geographical distribution of Trilliaceæ plants in relation to polyploidy. *Jap. Jour. Genet.*, 18, 168-171.

Trillium kamtschaticum, a diploid ($2x = 10$), is distributed to the north up to northern Saghalien and Kamtschatka through Kurile islands, the southern limit terminating in the northern districts of Honshu. Distribution of tetraploid *T. Tschonoskii* ($4x = 20$) covers the area from southern Saghalien to Formosa. Sterile triploid ($3x = 15$) and fertile hexaploid form ($6x = 30$) of *T. Hagæ*, which are the hybrids between *T. kamtschaticum* and *T. Tschonoskii*, are found in the regions where the distributional areas of the above two species overlap. *T. Smallii*, a tetraploid ($4x = 20$), is recorded in middle Kuriles and middle Saghalien to the north and up to Shikoku to the south. *T. amabile*, a fertile hexaploid hybrid ($6x = 30$), probably, between *T. kamtschaticum* and *T. Smallii*, is revealed as occurring in the overlapping region of the distributions of the supposed parental species.

In Japan two species are known in the genus *Paris*, that is, *P. tetraphylla* and *P. verticillata*, both being diploid ($2x = 10$). Distribution of these two species similarly ranges from south Saghalien to Kyushu. *Kinugasa japonica*, an octoploid species ($8x = 40$), which shows morphological characteristics intermediate between *Trillium* and *Paris* is known to occur in the northern part of Honshu, where all the species of *Paris* and *Trillium* happen to inhabit.

HAGA, T. 1944. Morphological reaction of chromosomes to low temperature. *Jap. Jour. Genet.*, 20 : 87.

Patterns of differential segments were described for the somatic chromosomes of *Trillium kamtschaticum* which were chilled at 0°C . for 5 days. Size and position of the differential segments were found to be constant and homozygous for each chromosome pair, but different pairs showing different patterns. Taking the nucleus as a whole, all 13 plants sampled from a population of Siraoi, Hokkaido, were revealed to show one and the same pattern of differential segments, suggesting a highly homozygous condition of the present population.

HAGA, T., and KURABAYASHI, M. 1947. Genome analysis in the genus *Trillium* on the basis of differential reaction of the chromosomes. *Jap. Jour. Genet.*, 22, 8.

On the basis of chromosome morphology, meiotic chromosome behaviour, external morphology and ecological findings, the genomic constitutions of five species of the genus *Trillium* known in Japan were concluded to be as shown in the following table.

It is revealed that the pattern of differential segments is characteristic for each genome. With this characteristic, constitutional genomes combined in the polyploid

species were identified with those genomes in diploid or in another polyploid, confirming the earlier conclusion reached from other lines of investigations.

	Chromosome number	Genomic constitutions
<i>T. kamtschaticum</i> . . .	2x = 10 5 _{II}	K ₁ K ₁
<i>T. Haga</i>	3x = 15 5 _{II} +5 _I	K ₁ K ₂ T
<i>T. Haga</i>	6x = 30 15 _{II}	K ₁ K ₁ K ₂ K ₂ TT
<i>T. Tschonoskii</i>	4x = 20 10 _{II}	K ₂ K ₂ TT
<i>T. Smallii</i>	4x = 20 10 _{II}	SSUU
<i>T. amabile</i>	6x = 30 15 _{II}	K ₂ K ₂ SSUU

HAGA, T., and KURABAYASHI, M. 1948. Chromosomal variation in *Trillium kamtschaticum*. *Jap. Jour. Genet.*, 23, 12-13.

Chilled somatic chromosomes of 86 plants from 4 different populations of *Trillium kamtschaticum* were classified by the patterns of differential segments. There were identified 14 types in chromosome A, 7 in B, 6 in C, 8 in D and 4 in E. Knots and ring-fragments were observed at prophase of the haploid nuclei in the process of embryosac formation. Based on these aberrations, an interpretation was set forth, that, at least, some of the chromosomal variations may have arisen through inversions involving simultaneously both the normal and differential segments and deletion of the inert differential segments. Numbers of chromosome types found in the four populations are tabulated below. Some of the chromosome types were particular to a given population, but the majority of them were found in common through all four populations. However, the frequencies of some of the chromosome types were found to be different among the populations.

Chromosome	Siraoi	Sizunai	Samani	Akkesi
A	2	8	10	7
B	2	4	2	3
C	1	6	5	2
D	2	7	8	3
E	1	4	4	4
Total	8	29	29	19
No. of plants	19	44	19	5
Index of heterozygosis . .	6.3	47.7	66.3	48.0

To estimate a general constitution of the populations, an index of heterozygosis, 100 (total of heterozygous pairs)/(total pairs involving hetero- as well as homozygous pairs), was calculated for each population. Indices are given in the table. The striking homozygosis of Siraoi population probably suggests that the present population is in process of diminution under the isolated condition. The ecological conditions seem to support this view.

KURABAYASHI, M. 1948. Differential reactivity of the chromosomes of *Paris verticillata*. *Jap. Jour. Genet.*, 23, 22.

Patterns of differential segments, revealed by cold treatment at 0° C. for three to four days, are described for *Paris verticillata* (2x = 10). Every chromosome, A to E, shows differential segments which may be terminal or intercalary. Chromosomes C and D each show three different patterns: i.e. C₁, C₂ and C₃, and D,

D⁻ and D⁺. As to these chromosomes, the following combinations were found in diploid and triploid plants : C₁C₂DD, C₁C₂DD⁻, C₁C₃DD⁺ and C₁C₂C₃DDD. The remaining types of chromosomes were always found to be identical or homozygous.

HAGA, T. 1946. Chromosome mutation under low temperature conditions. *Jap. Jour. Genet.*, 21, 90-91.

In *Trillium kamschaticum* mitosis in pollen-grains does not take place at a temperature condition of 0° C. After this finding, young uninucleate pollen-grains, in intact anthers attached to mother plants, were aged for 100 days at 0° C. Then, the aged pollen-grains were transferred from chilled to temperate condition of ca. 23° C. ; under this condition uninucleate pollen-grains completed their mitosis and were converted into binucleate state within one or two days.

Mitotic stage		Normal	Abnormal
Prophase	uninucleate . .	100	100
	micronuclei . .	0	0
Telophase	binucleate . .	96	8
	micronuclei . .	4	92

Nearly all the pollen-grains of three out of some twenty plants examined showed severe chromosomal and chromatidal breaks and fusions, which were comparable to the aberrations caused by very high X-ray irradiation. Prophase pollen-grains were found to be invariably uninucleate regardless of "normal" or "aberrant" plants. Whereas, nearly all the telophase pollen-grains of the aberrant plants showed numerous fragments, bridges and micronuclei. Despite these profound destructions, no case of breakage of the centromere was observed. Pollen-grains of normal plants at the same stage are nearly always binucleate, including no abnormal element (see table, a count of 100 pollen-grains in each case). This indicates that the aberrations have been induced during the resting stage which was forcibly prolonged by the ageing effect of low temperature.

SATÔ, D. 1941. A diploid plant with only one nucleolus and its bearing on the balance hypothesis of nucleolar chromosomes. *Bot. Mag.*, Tokyo, 55, 159-163.

In *Scilla japonica* (2n = 16, 18, 26, 34, 35, 43) the writer (1940) found only two nucleoli at telophase in polyploid series with the following combinations of basikaryotypes, i.e. 18(K = B₁B₂), 26(K = B₁B₂B₂), and 34(K = B₁B₁B₂B₂), where K is karyotype, B₁ basikaryotype with 8 chromosomes and B₂ basikaryotype with 9 chromosomes.

Paris hexaphylla (2n = 15) is triploid and has one sat-chromosome and two nucleolar chromosomes, corresponding to three nucleoli at telophase. The satellite in *Paris* consists of heterochromatin and seems to be genetically inert.

Brodiaea uniflora (2n = 12) is diploid and has only one nucleolus, corresponding to one sat-chromosome with a long stalk. This sat-chromosome alone is attached to the surface of the nucleolus at mid- and late-prophase, though many chromosomes also are attached to this nucleolus in the early prophase. Thus it may be surmised that this sat-chromosome has so great a capacity for nucleolus organisation that the other chromosomes are made inactive in function. This discovery favours the balance hypothesis of nucleolar formation.

NAGAO, S., and MASIMA, I. 1944. Studies on the chromosomes of *Chelidonium majus*. III. Variation of karyotypes found in plants coming from different localities. *Jap. Jour. Genet.*, 20, 59-63.

The somatic chromosome number of *Chelidonium majus* is 10 in Sapporo race instead of 12 as in English race. The Sapporo race is a translocation heterozygote,

entirely differing in its karyotype from that of English race, a normal diploid. The authors call the English race, in this paper, Karyotype I and the Sapporo race Karyotype II. Besides these the authors reported another three cases of variation in karyotypes in the materials collected from the suburbs of Sapporo, Otaru and Nagano, calling them Karyotypes III, IV and V.

HARADA, I. 1942. Chromosome studies on *Potamogeton*. *Jap. Jour. Genet.*, 18, 92.

The somatic chromosome numbers of 21 species of *Potamogeton* were determined as follows :

	$x = 13$	$x = 14$
$2x$	<i>oxyphyllus</i> Miquel <i>panormitanus</i> Bivona-Bernardi	<i>cristatus</i> Regel et Maack <i>Fauriei</i> Miki <i>monoginus</i> Miki <i>Vaseyi</i> Robbins
$3x$	None	<i>apertus</i> Miki <i>kamogawaensis</i> Miki
$4x$	<i>anguillanus</i> Koidzumi <i>biwaensis</i> Miki <i>crispus</i> L. <i>dentatus</i> Hagström <i>distinctus</i> Bennet <i>Fryeri</i> Bennet <i>Maackianus</i> Bennet <i>malaianus</i> Miquel <i>natanus</i> L. <i>nipponicus</i> Makino <i>perfoliatus</i> L. <i>praelongus</i> Wulfen	None
$6x$	<i>pectinatus</i> L.	None

These chromosome numbers can be classified into two groups : one is a polyploid series of $b_1 = 13$ ($2n = 26, 52, 78$) and the other $b_2 = 14$ ($2n = 28, 42$).

HARADA, I. 1943. Die Karyotyp der Gattung *Najas*. *Jap. Jour. Genet.*, 19, 120-121.

Chromosome numbers of 9 species of *Najas* (submerged weeds) are reported.

N. major Allioni and *N. tenuicaulis* Miki are dioecious, and in the female plants of both species the chromosome numbers in root tip cells are $2n = 12 = 2 l + 2 m_1 + 2 m_2 + 2 m_3 + 2 s_1 + 2 s_2$. In the male plants of both species $2n = 13$ chromosomes are observed. One small fragment-like chromosome exists beyond the normal complement. At the metaphase of PMC-I, 6 bivalents and one such special chromosome are usually observed and approximately equal frequency of pollen-grains with $n = 6$ and $n = 7$ can be recognised. The author regards this extraordinarily small chromosome as a sex chromosome.

The following 7 species are monœcious and the chromosome dimensions are much smaller. The somatic chromosome numbers are counted as follows : *N. ancistrocarpa* Braun $2n = 12, 24$, *N. feveolata* Br. $2n = 12, 24, 34$, *N. gracillima* Magnus $2n = 12$, *N. graminea* Delile $2n = 24$, *N. minor* All. $2n = 12$, *N. ogurensis* $2n = 24$, *N. sp.* $2n = 46$.

HARADA, I. 1944. A sex chromosome of *Phyllospadix*. *Jap. Jour. Genet.*, 20, 127-128.

Somatic chromosome numbers and occurrence of a peculiar sex chromosome were reported in *Phyllospadix* (submarine phanerogamous plants).

The female plants of *P. japonica* Makino have 20 short rod-shaped chromosomes (ca. $1-2\ \mu$) in root tip cells, and the male plants have $2n = 16$ chromosomes of which 15 short rod-shaped are similar to those of the female, and one large (ca. $10-15\ \mu$) V-shaped chromosome possessing one centromere. This chromosome, designated as Y, stays as a large heteropyknotic body during the resting stage. Though meiotic division in PMC was not investigated, it seems that this Y chromosome would pair with 5 short rod-shaped chromosomes.

In *P. iwatensis* Makino, the chromosome number of root tip cells is calculated as $2n = 20$.

HARADA, I. 1948. Karyotype und Entwicklungsgeschichte des fadenförmigen Pollens von Gattung *Zostera*. *Jap. Jour. Genet.*, 23, 13-14.

Numbers and shapes of somatic chromosomes in 5 species of *Zostera* (submarine phanerogamous plants) were reported by the author as follows: *Z. asiatica* Miki, *Z. caespitosa* M., *Z. caulescens* M. and *Z. marina* L. having respectively $2n = 12$ chromosomes and their shapes are short rods (ca. $1-2\ \mu$). *Z. nana* Roth has also $2n = 12$ chromosomes whose shapes are relatively long V and J (ca. $2-4\ \mu$). Six gemini chromosomes are counted in the metaphase of PMC-I of *Z. caespitosa* and *Z. marina*.

The development of "thread-like pollen" (characteristic of some submarine weeds as *Zostera*, *Phyllospadix*, etc.) could be observed in *Z. caespitosa* and *Z. marina*. Length of the pollen mother cells in the beginning of meiosis is $900\ \mu$. Cell plates of the first and second divisions of meiosis develop along the long axis of the mother cells, and the pollen tetrads thus produced therefore consist of four long parallel threads. These threads separate from each other to become young "thread-like pollen" (over $1000\ \mu$ in length). The course of pollen mitosis is normal, and the mature pollen is $1700-2000\ \mu$ in length and $8\ \mu$ in width.

INARIYAMA, S. 1948. The origin of the Japanese *Lycoris* plants. *Jap. Jour. Genet.*, 20: 87-88.

The karyotypes of 5 species of *Lycoris* known to grow in Japan and some others in China were confirmed by the author and listed in the following table:

Species	Karyotype
<i>sanguinea</i> Maxim.	2(11 I)
<i>Sprengeri</i> Comes.	2(11 I)
<i>radiata</i> var. <i>pumila</i> Hort.	2(11 I)
<i>radiata</i> Herb.	3(11 I)
<i>straminea</i> Lindl.	2(3 V+5 I)
<i>aurea</i> Herb. { 14-chro. form	2(4 V+3 I)
{ 12-chro. form	2(5 V+1 I)
{ 13-chro. form	(4 V+3 I)+(5 V+1 I)
<i>albiflora</i> Koidz.	(11 I)+(5 V+1 I)
<i>squamigera</i> Maxim.	(11 I)+2(3 V+5 I)

(V and I stand for V- and rod-chromosome respectively)

From this table, we see that in *Lycoris* there are 4 different basikaryotypes which are represented by the formulæ 11 I, 3 V+5 I, 4 V+3 I and 5 V+1 I, respectively, and also that all the karyotypes in *Lycoris* species which the author studied consist of two or three of these basikaryotypes.

Among the five species found in Japan, *L. radiata* is a triploid, and *L. albiflora* and *L. squamigera* are both regarded as hybrids in origin from the karyological and morphological points of view. *L. radiata* carries a karyotype 33 I and its external morphological characters and habits are very similar to those of *L. radiata* var. *pumila* with a karyotype 22 I. The chromosome behaviour in meiosis shows that this species, *radiata*, is an autotriploid. In this case the "variety" is in reality the original plant from which the "species" derived.

L. albiflora carries a karyotype (5 V+12 I), which consists of two different basikaryotypes, 5 V+1 I and 11 I. The facts that these correspond with the

basikaryotypes of *L. aurea* (5 V+1 I) and *L. radiata* var. *pumila* (11 I), and that the external morphological characters seem to be intermediate, indicate that *L. albiflora* may be a natural hybrid raised between these two plants.

L. squamigera carries a karyotype (6 V+21 I), which consists of three basikaryotypes, two (3 V+5 I) and one (11 I), and the external morphological characters of this plant are nearly intermediate between *L. straminea* (6 V+10 I) and *L. Sprengeri* (22 I), with some inclination to the former. It seems, thus, likely that *L. squamigera* is a natural hybrid arising from the union of a diploid gamete of *L. straminea* and normal gamete of *L. Sprengeri*.

In the above three cases the supposed original or parent species are not found in Japan; all these and their derivatives grow in China. The present distribution of these supposed parent plants forces us to conclude that *L. radiata*, *L. albiflora* and *L. squamigera* must have arisen in China. Being polyploid or hybrid, they must have been more vigorous and hardier, and have had a greater power of vegetative reproduction than their parents. They thus could have reached Japan before it became separated from the Asiatic continent.

MIDUNO, T. 1943. Karyotyp einiger *Anemone*-Pflanzen. *Jap. Jour. Genet.*, 19, 123-124.

The karyotypes of 6 species and 2 varieties of *Anemone* were observed at the mitotic divisions of root tip cells with the following results.

	$2n$	No. of nucleoli and of sat-chrom.	Types of chromosomes
<i>yunnanensis</i>	16	2	10 V, 6 I
<i>Sieboldi</i>	16	2	"
<i>Sieboldi</i> F.	16	1	"
<i>altaica</i>	16	4	"
<i>coronaria</i>	16 *	5	"
<i>slavica</i>	32	6	20 V, 12 I
<i>fiaccida</i> vf.	14	2	12 V, 2 I

* 2 I chromosomes have secondary constrictions

SATÔ, D. 1947. Origin and phylogeny of karyotypes in Agavaceæ. *Jap. Jour. Genet.*, 22, 28.

There are five different karyotypes in Agavaceæ of Hutchinson, namely, (1) *Yucca-Agave* type, (2) *Nolina* type, (3) *Phormium* type, (4) *Dracæna* type and (5) *Doryanthes* type. The phylogeny of these types was considered by the writer to be derived from the Liliaceous stock and developed to Palmæ. Accordingly the following 5 lines are postulated, based upon the karyotype analysis in these families and allies.

- (1) *Eucomis* ($2n = 60$), *Hosta* ($2n = 60$) $\rightarrow$ *Yucca-Agave* type ($2n = 60$),
- (2) *Ophiopogon* ($2n = 36$) $\rightarrow$ *Nolina* type ($2n = 36$) $\rightarrow$ *Trithrinax* ($2n = 36$),
- (3) *Dianella* ($2n = 32$) $\rightarrow$ *Phormium* type ($2n = 32$) $\rightarrow$ *Cocos* ($2n = 32$),
- (4) *Dracæna* type ($2n = 38$) $\rightarrow$ *Phœnix* ($2n = 36$), *Livistona* ($2n = 36$), *Oreodoxa* ($2n = 38$),
- (5) *Doryanthes* type ($2n = 48$).

The last type has no similar karyotypes in both Liliaceæ and Palmæ, but karyotype of *Lloydia* ($2n = 24$) seems to be the most probable one when karyotype alteration is taken into consideration and also it is similar to *Yucca-Agave* type. The detailed observation was reported in *Bot. Mag. Tokyo*, 60 (1947), 31-36.

YASUI, K. 1946. On the polyploid plants of genus *Sequoia*. *Jap. Jour. Genet.*, 21, 9-10.

Hirayosi and Nakamura determined the $2n$ chromosome number of *Sequoia sempervirens* as 66 and considered this plant as the autohexaploid plant derived from *S. gigantea* ($2n = 22$) by chromosome duplication. The author, however, holds the view that these two relic species in *Sequoia* are not closely related enough to each other for one to consider *S. gigantea* as the mother plant of *S. sempervirens*.

YAKUWA, K. 1944. On the behaviour of extra-chromosomes of *Secale cereale* L. *Jap. Jour. Genet.*, 20, 72-73.

Crossing experiments between 14- and 16-18 chromosome ryes show the facts that in the progeny, plants with even number of extra-chromosomes can be most frequently found (table 1).

In the first metaphase of 16-chromosome rye, 8 bivalents (including supernumerary one) were found in 90 per cent. of PMC. The segregation of the bivalents is normal throughout the meiotic divisions. The observations on the division of pollen grain nucleus agree with the expectation, namely 92 per cent. of the dividing nuclei showed 8-chromosomes. Lagging of supernumerary chromosomes can be observed without exception in the anaphase.

TABLE 1

Extra-chromosome numbers of the hybrids, 14×16—18 chromosome rye

Parents	Progeny									
	0	1	2	3	4	5	6	7	8	Mean
$\{0 \times 2 = 1$	4	...	10	...	...	...	...	...	...	1.4
$\{2 \times 0 = 1$	3	1	5	...	1	...	...	...	...	1.5
$0 \times 3 = 1.5$	...	1	3	...	...	...	...	...	...	1.75
$\{0 \times 4 = 2$	...	1	6	...	16	1	...	...	...	3.4
$\{4 \times 0 = 2$	...	...	3	...	2	...	...	...	...	2.8
$2 \times 2 = 2$	...	...	1	2	18	...	...	...	...	3.8
$4 \times 4 = 4$	...	...	...	...	...	...	1	...	1	7.0

2. PLANT BREEDING

ONO, T. 1948. Breeding of hop, with special reference to an induction of polyploids. *Seibutugaku Gyoseki*, 11, 1-10.

By colchicine-method the author has succeeded in producing polyploids in different strains of hop, i.e. America, Early Zug, Shinshu-wase, Sapporo No. 6, etc.

Seedlings showing symptoms of polyploidy were carefully selected and propagated vegetatively.

The gigas plants, however, were not always pure tetraploids. Of 22 such gigas female plants, 12 produced in the progeny only triploids, 3 both diploids and triploids and the remaining 7 only normal diploids. The facts indicate that in the last 2 cases all or part of the shoots might be diploid.

Sexuality of tetraploids in hop is generally male or female and that of triploids, female or intersex. Sometimes male and female intersexes are found in both polyploids.

The triploid females are economically promising.

NOGUCHI, Y. 1943. Studies on the polyploidy in spinach. *Jap. Jour. Genet.*, 10, 106-107.

The characteristics of polyploidy, such as large and thick leaves, large stomata small number of stomata in a definite leaf area, large flower and seed, appeared in the colchicine-induced tetraploid spinach. Delay of flowering time, about 16 days in male and 20 days in female plants, greater fresh- and dry-weight, rich water content and change of sex ratio (increase of female and bisexual plants) were also associated with polyploidy in spinach.

The most interesting and important fact from the standpoint of crop production, is the increase, about 15 per cent., in vitamin A and C content.

Date	Diploids		Tetraploids	
	20th March	15th April	20th March	15th April
Vitamin C (mg./100 g.)	228.3	237.5	268.5	282.0
Provitamin A (mg./100 g.)	9.8	10.8	11.3	12.3

NISHIYAMA, I. 1941. Studies on artificial polyploid plants, V. The breeding of long-fibred varieties by doubling the chromosome number in Hemp. *Bot. and Zool.*, 9, 173-179.

C₂ and C₃ progenies of colchicine-induced tetraploid *Cannabis sativa* were compared with the original diploids and the data obtained are given in the following table.

Characters	Tetraploid (in terms of Diploid 100)
Germination of seeds	92
Stem length of seedlings	134
Habit of non-branching in young plants	195
Proportion of female plants	164
Proportion of good pollen	99
Volume of seeds	135
Weight of seeds	166
Length of fibres	147
Width of fibres	134
Strength of fibres	Over 128
Elongation of fibres	92

In general, the characters of the tetraploids exceed those of the diploids in every respect, except germination of seeds, number of good pollens and elongation of single fibre. Besides causing a remarkable increase in female plants, ca. 83 per cent., chromosome doubling is an excellent technique in hemp breeding as tetraploid fibres are very long and strong.

Cytological study on C₂ progenies from the tetraploid hemp has been made and their chromosome number is found to be either $4x$, $4x \pm 1$ or $4x \pm 2$ ($x = 10$) in P.M.C. In $4x$ -plants, 20_{II} are usually counted although some univalents and chromosome complexes are sometimes formed. The chromosome configurations in $4x-1$ are $19_{II} + 1_I$ and $1_{II} + 18_{II}$ in most cases. In the latter the trivalent chromosome shows the V-shape whose two components, usually two ends, are smaller than the middle one. It is also suggested that the smaller chromosome may be X, and the larger Y, a disagreement with the works of previous authors.

NAKAMURA, M. 1942. Cytological studies in the genus *Citrus*. III. Further data on chromosome numbers. *Jour. Hort. Assoc.*, 13, 30-40.

A chromosome counting on some hundred and fifty kinds of citrus, which represent subgenera, sections and subspecies of the genus, excluding Sect. *Papeda*, has proved that they were all diploid, having 9 chromosomes at the haploid phase. In addition to those, only two examples of tetraploidy were found: the Sampson Tangero and the Shikinari-mikan, a variety of *C. madurensis*. *Poncirus trifoliata* and four subspecies of *Fortunella*, including a form of *F. Hindsii*, were also determined to have 9 chromosomes in the nuclei of the gametic cells. The Temple orange, a supposed species hybrid between *C. sinensis* and *C. Tangerina*, and the Tanikawa buntan, a hybrid between *C. grandis* and another species, were found to be the diploid forms characterised by normal meiotic division. Diploid constitution and high affinity of the chromosomes were displayed by the generic hybrids, such as the Rusk citrange (*C. sinensis* × *P. trifoliata*), the Eustis limequat (*F. japonica* × *C. aurantifolia*), the Citradia (*P. trifoliata* × *C. Aurantium*) and Thomasville citrangequat (*F. margarita* × *C. sinensis* × *P. trifoliata*).

NISHIYAMA, I., and TAKASUGI, K. 1949. Studies on artificial polyploid plants, XII. Investigations on the growth and yield of an autotetraploid radish, Minoyonbai-daikon. *Research of Food-Science*, Kyoto Univ. No. 1, pp. 1-10.

Comparative studies on the growth of two diploids (Minowase and Miyashige-daikon, $2n = 18$) and an artificially induced tetraploid radish (Minoyonbai, $2n = 36$) were made by weekly measuring of plant height, number of leaves, length and diameter of root taps, etc., of about 50 individuals in each category, for two successive seasons. The results obtained clearly showed that Minoyonbai ($4x$) and Minowase ($2x$) are superior to Miyashige ($2x$). The growth curves of the former two showed a higher vigour in Minoyonbai during the seedling stage and at the end of the season, but not in the middle of the season. Minowase is a well-known early variety in Japan.

"Pithy (porous) tissue" was found in Minowase to reach 75 per cent. in 90 days, in Miyashige 40 per cent. and in Minoyonbai only 20 per cent.

In different climatic regions in Japan during 1944-1947 the yield of Minoyonbai was consistently higher than that of the diploid varieties. Minoyonbai is probably suitable for cultivation in summer as it does not bolt in this season.

MIZUSHIMA, U. 1944. Studies on some auto- and allopolyploids made in *Brassica*, *Sinapis*, *Eruca* and *Raphanus*. *Agric. and Hort.*, 19, 743-744.

In spite of the formation of varying numbers of quadrivalents, meiosis in the autotetraploids obtained from 8(B)-, 9(C)-, 10(A)-chromosome *Brassica* species, *S. arvensis* (S), *S. alba*, *E. sativa* and *R. sativus* (R) was carried out fairly regularly resulting, in most cases, in the formation of gametes with $2x$ number of chromosomes, whereas in those obtained from the digenomic species, such as *B. carinata* (BC), *B. juncea* (AB), and *napus* (AC), the division went on quite irregularly, showing little possibility for the formation of gametes with $2x$ number. From these facts the author has concluded that, as far as the materials are concerned, in breeding desirable crops by means of allopolyploidy, only $4x \times 4x$ crosses are applicable among the so-called monogenomic species, as for the digenomic ones such crosses will result only in aneuploids.

In the 3 digenomic tetraploids made by the author, AB, AS and AR, the meiosis was quite regular, forming exclusively the corresponding number of bivalents at MI. While in the 4 digenomic hexaploids AAB, AAC, BBC and ARR, as well as in the 2 trigenomic hexaploids, ABC and BCS, there appeared frequently, besides some quadrivalents, varying numbers of univalents which made the division considerably irregular. The quadrivalent formation in the 2 trigenomic hexaploids was concluded presumably to be due to the partial homology among the 3 different genomes coexisting. All of the allopolyploids, except ABC and BBC, were plants

of the first generation just having reached their flowering stage and their fertility was unknown.

MIZUSHIMA, U. 1944. Some amphidiploids in Cruciferae. I-IV. *Breeding and Hort.*, 2, 401-404, 441-444, 481-483, 515-516.

Seven amphidiploids obtained through colchicine and acenaphthene were observed to be intermediate between their respective parents and showed clear gigas nature against untreated sister F_1 hybrids. Their origin, gametic chromosome complements and numbers are given in table 1.

TABLE 1

<i>B. carinata</i> (BC, $n = 17$)	$\times$ <i>B. campestris</i> (A, $n = 10$)	.	.	.	AABBCC, $n = 27$
<i>B. carinata</i>	$\times$ <i>B. nigra</i> (B, $n = 9$)	.	.	.	BBBCC, $n = 25^?$
<i>B. napus</i> (AC, $n = 19$)	$\times$ <i>B. pekinensis</i> (A, $n = 10$)	.	.	.	AAAACC, $n = 29$
<i>B. rapa</i> (A, $n = 10$)	$\times$ <i>R. sativus</i> (R, $n = 9$)	.	.	.	AARR, $n = 19$
<i>R. sativus</i>	$\times$ <i>B. rapa</i>	.	.	.	AARRRR, $n = 28$
<i>B. campestris</i>	$\times$ <i>S. arvensis</i> (S, $n = 9$)	.	.	.	
<i>B. rapa</i>	$\times$ <i>S. arvensis</i> (S, $n = 9$)	.	.	.	AASS, $n = 19$
<i>B. carinata</i>	$\times$ <i>S. arvensis</i> (S, $n = 9$)	.	.	.	BBCCSS, $n = 26$

(AARRRR was obtained from an occasional triploid hybrid)

In selfing, the untreated hybrids were utterly sterile, whereas the amphidiploids showed varying degrees of fertility ranging from 60-10 per cent. The MI configuration in the microsporogenesis in the untreated hybrids and the corresponding amphidiploids are given in table 2.

TABLE 2

Untreated hybrids	Amphidiploids	Self-fertility
ABC (9-1) _{II} + (9-25) _I	(7-0) _{IV} + (13-27) _{II}	ca. 50 per cent.
BBC 8 _{II} + 9 _I	(8-1) _{IV} + (9-23) _{II}	60 "
AAC 10 _{II} + 9 _I	(9-3) _{IV} + (11-23) _{II}	10 "
AR (0-5) _{II} + (19-9) _I	19 _{II}	...
ARR 9 _{II} + 10 _I	(1-9) _{IV} + (26-10) _{II}	...
AS (0-5) _{II} + (19-9) _I	19 _{II}	50 "
BCS (0-8) _{II} + (26-1) _I	(4-0) _{IV} + (18-26) _{II}	60 "

(AARR and AARRRR were just in the flowering stage)

Hosoda, T. 1946. Fertility of colchicine-induced amphidiploids between *Brassica* and *Raphanus*. *Agric. and Hort. Tokyo*, 21, 515.

F_1 seeds from the crosses *Brassica rapa* $\times$ *Raphanus sativus* were treated by colchicine and from them 4 allotetraploids and 1 allohexaploid were obtained.

The number of seeds resulted from these plants was unexpectedly small, as shown in the following table, compared with that of pods. As some other allotetraploids or allohexaploids obtained by colchicine treatment from *Brassica* species hybrids were reported to show better fertility, it may be difficult to conclude that the high degree of sterility of the author's *Brassico-Raphanus* and *Raphano-Brassica* hybrids was simply caused by the after-effect of colchicine.

Fertility of *Brassico-Raphanus* and *Raphano-Brassica* F_1 -s

Parents	Amphipolyploids (F_1)	Nos. of pods	Nos. of seeds
Turnip $\times$ Radish . . .	Tetraploid	49	5
" $\times$ " . . .	"	38	1
" $\times$ " . . .	"	42	0
Radish $\times$ Turnip . . .	"	45	23
" $\times$ " . . .	Hexaploid	16	19

HOSODA, T. 1946. On the dimension of F_1 seeds in crosses among *Brassica*, *Sinapis* and *Raphanus*. *Agric. and Hort. Tokyo*, 21, 516.

A comparison of the dimensions of parental and F_1 seeds obtained from crosses among *Brassica*, *Sinapis* and *Raphanus* was made and it was ascertained that true hybrid seeds are smaller than false hybrid seeds. The hybridity of F_1 seeds was justified by the observation of the morphological characters of the seedlings.

KONDO, N. 1942. A new *Raphanobrassica* from the cross $4x$ -*Raphanus sativus* L. $\times$ $4x$ -*Brassica oleracea* L. *Jap. Jour. Genet.*, 18, 126-130.

A new *Raphanobrassica* was obtained from the cross between autotetraploid *Raphanus sativus* L. and *Brassica oleracea* L. The parents were offsprings of autotetraploids induced by colchicine treatment.

At the first metaphase of PMC, 1-7 polyvalents and 0-1 univalent were formed in the autotetraploid *Raphanus*. In the autotetraploid *Brassica* 2-5 polyvalents and 0-2 univalents were observed.

There is indication of incompatibility in some cross-combinations as shown in the following table (plants 1 and 2) :—

Crosses	No. of flowers pollinated	No. of seeds obtained
<i>R. sativus</i> (4x)-1 $\times$ <i>B. oleracea</i> (4x)-1 .	19	20
<i>R. sativus</i> (4x)-1 $\times$ <i>B. oleracea</i> (4x)-2 .	24	22
<i>R. sativus</i> (4x)-2 $\times$ <i>B. oleracea</i> (4x)-1 .	10	0
<i>R. sativus</i> (4x)-2 $\times$ <i>B. oleracea</i> (4x)-2 .	12	0

(The reciprocal crosses were unsuccessful)

Out of the 35 seeds obtained, 29 gave rise to mature plants which were morphologically intermediate between their respective parents. Cytological investigations of the 24 individuals which bore flowers revealed that 24 plants had 36 somatic chromosomes and the chromosome configuration at meiosis was 18_{II} . One was hypertetraploid ($18_{II}+1_I$).

KIHARA, H., und YAMADA, I. 1942. Ein Fall Plasmonwirkung auf das artfremde Genom. *Seiken Zhō*, 1, 38-45.

The present studies deal with the problems of genome and plasma in inter-specific hybrids of diploid *Aegilops*, viz. *Ae. comosa* $\times$ *Ae. uniaristata*, the genome constitutions of which were established by the senior author (Kihara, 1937) as M and M^u respectively.

F_1 plants have 0.92-0.96 per cent. of good pollen and 0.82-1.1 per cent. grain set. The fertility agrees with the theoretical percentage, expected from the mode of chromosome behaviour during maturation divisions, where it is assumed that one chromosome is exchangeable between the semi-homologous M- and M^u -genome.

All the plants from the back-crosses, F_1 $\varnothing \times Ae. comosa$ ($MM^u \times MM$) were fertile and had the same morphological characters as *Ae. comosa* (MM), and those from F_1 $\varnothing \times Ae. uniaristata$ ($MM^u \times M^uM^u$) were sterile and had the same morphological characters as F_1 (MM^u).

From the data obtained, it can be said that in F_1 (MM^u) plants with comosa plasma, only one type of gamete with perfect M^u (*Ae. comosa*) genome is functional, gamete with M^u (*Ae. uniaristata*) genome is lethal.

KIHARA, H. 1944. Chromosome conjugation in a rose hybrid, *Rosa multiflora* $\times$ *R. rugosa*. *Jap. Jour. Genet.*, 20, 55-58.

Cytological studies on a species hybrid between two diploid species (*R. multiflora* $\varnothing \times rugosa$ δ) were carried out. The hybrid is found to have 1-7 (mostly 5-7)

pairs at first metaphase and the bivalents exhibit normal chromosome behaviour throughout the course of the maturation divisions. The univalents split longitudinally in the first anaphase and they are distributed to the poles at random in the second anaphase.

The hybrid produced only empty pollen grains and artificial pollination with *multiflora*-pollen gave no fruit. The sterility seems to be caused by physiological conditions affecting growth of the micro- and macrospores during the gametogenesis.

KIHARA, H., and NISHIYAMA, I. 1947. An application of the sterility of auto-tetraploids to the breeding of seedless water-melons. *Seiken Zihô*, 3, 93-103.

Among approximately 500 seedlings of water-melons treated with colchicine in the fall of 1942, many were found to have an increase in size in stomata, pollen grains and seeds. From the seeds obtained from open pollination from these individuals, tetraploids and triploids were found. The appearance of triploids was due probably to free pollination of induced C_1 tetraploids with diploid pollen.

Cytological studies showed that in the tetraploids 11_{IV} can be counted, yet sometimes their 4 elements separate into 2 bivalents. In the triploids, 11_{III} are formed in I-M, but failure of pairings such as $10_{III} + 1_{II} + 1_I$ were also noticed.

Giant nuclei, irregular in shape, due perhaps to failure or incompleteness of meiotic divisions, and pollen grains connecting with each other as in tetrad, were occasionally observed.

Pollen sterility of the triploid was high, 58-74 per cent., that of the diploid and tetraploid was 1-4 per cent. Triploid individuals appear to be most vigorous, next come the diploids; least vigorous of all are the tetraploids. Triploid and tetraploid plants set normal fruits. Though the former have practically no seed, cases in which a few seeds whose seed coats have more or less normal appearances were found in triploid fruits.

In the production of triploids, no viable seed could be obtained when $2x$ plants were used as females.

3. ANIMAL CHROMOSOMES

OGUMA, K. 1946. Karyotype and phylogeny of mantis. *La Kromosomo*, Vol. 1, 1, 1-5.

After chromosomal survey of 15 species of Mantidæ, collected by Dr J. J. Asana in East India and by the author in Japan and adjacent territories, it is proposed that the family Mantidæ should be divided into two sections, Monosomata and Trisomata, in respect to the constitution of sex-chromosomes.

MONOSOMATA.—The most subfamilies studied, viz. *Eremiaphilinae*, *Scizocephalinae*, *Hymenopodidae*, *Toxoderidae*, *Vatinæ*, and *Empusinae*, are to be classified into this section. The chromosome number in the male varies from 15 (*Didymicorypha lanceolata*) to 35 (*Humbertilia indica*) and all chromosomes are V-shaped in varied size. The sex-chromosome is V-shaped, of enormous size, and never accompanies the Y. This karyotype seems to be more primitive as compared with that of the next section.

TRISOMATA.—Species included in subfamily *Mantinae* are to be classified in this section. The chromosome number in males is 27 in every species and the shape of chromosomes is V as in the preceding section. But the sex-chromosomes are constituted of three distinct ones, X_1 , X_2 and Y. These two X's seem to have been derived from a single huge-sized X-chromosome through a certain mechanism as demonstrated by White (1940) for instance. This fact suggests to us therefore that Trisomata should be an advanced group in phylogeny.

Further, in three species of *Hierodula*, size diminution of sex-chromosomes occurs in two directions, first in X_2 (*H. ventralis*), secondly in Y (*H. tenuidentata*). From such a phenomenon it will be expected that in some unknown species the Y-chromosome may entirely disappear, only two X's being left behind. But species, if actually present, should be found in Trisomata. In this respect, therefore, the information of two X's in *Empusa* by Erazi (1940) is quite doubtful.

YAMASHINA, Y., and MAKINO, S. 1946. A study on the chromosomes of pigeons and doves. *Siebutu*, 1, 92-100.

The chromosomes of three species of the Columbidae were studied in the germ cells from embryonal gonads and adult testis. The chromosome numbers obtained are shown in the following table :—

Species	2n	n	Sex-chromo.
<i>Columba livia</i> var. <i>dom.</i>	80 spg, 79 oog.	40 ♂ (I)	XO in ♀
<i>Streptopelia decaocto</i> var. <i>risoria</i>	76 spg, 75 oog.	38 ♂ (I)	„
<i>Streptopelia orientalis</i>	75 oog.	...	„

The male 2n complex of the pigeon consists of five pairs of V-shaped elements together with the remaining rod-shaped ones, while in the female the fourth element of the medium V-shape is destitute of its mates. On this basis the fourth V-element is the sex-chromosome.

The chromosome complements of two species of doves are similar. In each of them the male complement contains 7 pairs of V-elements and the remaining pairs are telomitic rod-type of varying sizes. The fourth largest V-element is single in the female cell, and therefore this element can be accepted as the sex-chromosome.

The F₁ between *S. decaocto* ♀ and *S. orientalis* ♂ had apparently normal genital organs, in the male and in the female. The male meiotic behaviour of chromosomes seems to be regular in showing 38 bivalents.

YASUZUMI, G., KITA, T., and OKAZAKI, A. 1948. On the molecular structure of salivary gland chromosomes. II. *Jap. Jour. Genet.*, 23, 59-60.

The authors' histochemical and electron microscopic investigation on salivary gland chromosomes of *Drosophila virilis* has revealed the chemical constituents of the chromosomes as follows :

1. The euchromatin region contains amino acids, that is, tyrosine, tryptophane, arginine and others, and also enzymes, namely SH-group, Dopa's oxidase, peroxidase, and others.

2. Histidin is found as a side chain of chromonema.

3. In the matrix, glycogen is found with the help of Best's carmin method, diastase digestion, iodine, Molish's and Bauer's reaction.

4. The isoelectric point of chromosomes was determined by the dyestuff absorption methods: euchromatin, pH 3.2; heterochromatin, pH 1.35-1.90; chromonema, pH 7.65.

5. After treatment with spleen nuclease, the chromosomes are no longer stained with the Feulgen's techniques. The value of an isoelectric point of the thus treated euchromatin parts is at pH 9.8.

6. A new method devised by the authors for arginine reaction (*p*-dichloramido-benzoic acid dissolved in normal sodium hydroxide solution) has yielded very good results. Through this method euchromatin clearly gives a positive reaction while heterochromatin is negative, and tryptophane reaction produces the same result. Thus the difference in chemical composition between the euchromatin and heterochromatin has been confirmed.

7. The kind of basic protein of the salivary gland chromosomes was decided by staining with brilliantazurin B as well as isoelectric point to prove that the greater part of the basic protein was histone, a further part of it being a non-histone protein.

8. The protein of chromosomes is probably formed by Fischer's polypeptide link, and has various kinds of amino acids as its side chains.

Schematic molecular structure of the heterochromatin (β -polypeptide)

Schematic molecular structure of the interband (α -polypeptide)

Schematic molecular structure of the euchromatin (β -polypeptide)

MAKINO, S., and MOMMA, E. 1947. A new smear acetocarmine method for the demonstration of spiral structure of chromosomes in the grasshopper. *Kagaku*, 18, 36-37.

The experiment was carried out mostly with male germ cells of *Podisma* (*Acrididæ*) as material.

Pretreatment.

(1) With cold water. The testes of the grasshoppers are submerged without squashing either in tap or distilled water in a glass tube for 20-30 minutes at room temperature, or for 60 minutes at 12-13° C.

(2) With hot water. Glass tube containing distilled water and fresh testes are immersed in hot water kept at about 50° for 20 minutes.

(3) With ammonia solution. The testes are submerged *in toto* in 0.01 per cent. ammonia solution and kept at 12-13° C. for 40-45 minutes.

Staining. The pretreated testes are squashed on a slide and the cells, gently smeared, are covered with acetocarmine. To secure even penetration, leave it 2-3 minutes before placing cover-slip in position.

Amongst the three procedures attempted, the first one, especially when using cold water at 12-13° C. produces, as a whole, uniform and constant results. When the time of pretreatment has been suitable, the spiral structure of the chromosomes is observable in almost all of the dividing cells. One of the advantageous points of this technique is that in the material prepared, both the cells and the chromosomes are strikingly prevented from shrinking.

4. ANIMAL AND HUMAN BREEDING

NOZAWA, K. 1943. Genetics of *Thecamœba*. I. Heritable shell abnormalities found in *Arcella hemispherica* and *Centropyxis aculeata*. *Jap. Jour. Genet.*, 19, 189-199.

Two kinds of shell abnormalities, double-lobed and slitted, were obtained in old cultures of both these species. The phenotypes are similar to those previously described by Reynolds (1923) and Jollos (1924) in *Arcella polyzona*. They were inherited only by a few of their progeny, most of which were quite normal individuals.

It has been shown that the time (2 to 12 months) during which the progenitor of the clones had been kept in old culture favouring the appearance of abnormal individuals, had nothing to do with the degree of inheritance of the characters in question. Though old cultures are liable to yield more shell abnormalities than new ones, as found by the previous authors, it is somewhat doubtful whether the change is a dauer-modification in Jollos' sense (1924, 1939). In dauer-modifications we must make a distinction between the mechanism of appearance of the new character and of its inheritance.

There is no causal relation between the abnormality of the shell and the nuclear number in *Arcella hemispherica*. (where the nuclear number is heritable). The shell of the trinucleate line is larger than that of the binucleate line, the ratio being 1.24 to 1.00 in diameter.

INABA, F. 1944. Genetical studies on *Habrobracon pectinophoræ*. I. Sex-linked inheritance and sex-determination. *Jap. Jour. Genet.*, 20, 27-47.

The recessive mutant body-colour character, ebony (eb) seems to be sex-linked. The recombination value of ebony and the sex-gene is 19.73 ± 0.79 per cent. The back-crosses of heterozygous females with ebony males segregate into three types, namely, deficiency, excess and sub-equality, according to whether too few ebony daughters or too many ebony daughters or nearly as many ebony daughters as wild-type daughters are given.

When heterozygous daughters of a single ebony male are divided into two groups and one group is mated with their wild-type brothers and the other group

with unrelated wild-type males, the former gives either excess (75.00 ± 2.18 per cent.) or deficiency type (15.28 ± 4.72 per cent.) heterozygous daughters, while the latter invariably gives equality-type heterozygous daughters with a slight inclination towards deficiency (46.71 ± 2.46 per cent.) or excess (55.64 ± 2.54 per cent.). Thus sex-linkage of ebony disappears in the out-crosses, while it is clear in the close-crosses.

Back-crosses of F_1 heterozygous females of the out-crosses by their own ebony sons yield daughters among which ebony is either deficient (13.37 ± 1.49 per cent.) or in excess (82.43 ± 4.64 per cent.). The fact that the sex-linkage of ebony distinctly reappears with inbreeding, even directly after out-crossing, favours Whiting's multiple allele theory more than Snell's multiple factor theory of sex determination in *Habrobracon*.

A new theory of compound sex-gene is proposed by the author, namely, the male-determining gene occupies a segment of the X-chromosome and consists of subgenes like *xa*, *xb*, *xc*, . . . etc., which are characteristic to each strain and partially homologous with one another. Ebony or fused links with one of these subgenes. Female-determining genes are scattered on the autosomes, which are of different strength and are linked with different mutant genes. In haploids, the male-determining genes dominate over female-determining genes and produce males. In diploids, when the recessive male-determining subgenes become homozygous or when two different subgenes have large common homologous parts, these genes dominate over autosomal female-determining genes and produce males. Any heterozygote of male-determining subgenes, without any homologous parts in common, produces a female, since the male-determining gene is dominated over by the female-determining gene.

OMURA, S. 1948. Selective fertilisation in *Bombyx mori* (3). *Jap. Jour. Genet.*, 23, 40-41.

Two mutants for the colour of youngest larval skin, "dominant chocolate" and "black" were used. They were of different strains, the former being a pure strain continued 6 generations by sib matings, while the latter was a hybrid of economic races. The males of the latter had been known to be much stronger in fertilising ability. In double matings more than 90 per cent. of the larvæ hatched out from every batch were "black," regardless of the order of mating.

On the "black" males, the following treatments were done: (1) Removing one of the testes at the 2nd day of the 4th larval stage; sperms may be reduced to some half in quantity and may be under good nutritional condition. (2) Bleeding at full matured larval stage; sperms may be reduced in quantity, being under poor nutritional condition. (3) Cooling at 5° C. for 2 weeks at the middle stage of pupa; sperms may be affected in quality and quantity. (4) Cooling at 5° C. for 2 weeks at adult stage; sperms have been known to age, though the quantity may not be reduced.

Double matings were made by any of these treated males of "black" and untreated males of "dominant chocolate." In all cases selective fertilisation occurred clearly, every batch being occupied mainly by "black" larvæ. The results may be interpreted to show that the difference in the strength of the fertilising ability of the male moth is not due to the quantity but to the quality of the sperms.

NISHINA, Y., and MORIWAKI, D. 1941. An experiment on the grouping of gene mutations in *Drosophila melanogaster*. *Jap. Jour. Genet.*, 17, 171-174.

The object of this experiment was to see whether X-rays also give rise to simultaneous occurrence of gene mutations in one male as well as in one chromosome. The ordinary "CIB" method for sex-linked lethals was used and the F_2 maleless culture, which is regarded as the result of the presence of a lethal or lethals located in the treated X-chromosome, was carried to the next F_3 offspring. It is possible

to determine approximately whether the lethal mutation is either one in one chromosome or many in one chromosome, although by this method the determination is possible only when two or more lethals are situated far enough apart from one another. In this way, out of 17 F_2 maleless cultures induced by X-rays, there was no case with two or more lethals per chromosome, whereas in our previous work in which neutrons were used, out of 18 F_2 maleless cultures tested there were 8 samples with 2 or more gene mutations in the same chromosome.

The authors have further found that "grouping in one male" could be raised with X-rays and that an extremely high rate of "grouping in one chromosome" has been observed.

YAMASHINA, Y. 1943. Study on sterility in hybrid birds. IV. Cytological researches on hybrids in the family Phasianidae. *Jour. Fac. Sci. Hokkaido Univ.*, Ser. VI, Zool. 8, 307-386.

The chromosome number in several breeds of domestic fowl is defined, the diploid number of the males being 78 and that of the females 77. The diploid chromosomes of two subspecies of common pheasant (*Phasianus colchicus karpowi* and *P. c. versicolor*) were found to be 82 in the male and 81 in the female, while the haploid number in the primary spermatocyte is 41 (male, n) without exception. Many F_1 hybrids were produced from various combinations of these parents and were found to possess the chromosome complex of the two parents, 80 in the male hybrid and 79 in the female. The male germ cells of this hybrid do not advance beyond the pachytene stage of the primary spermatocyte and thereafter degenerate, failing to form the metaphase spindle of the first division. Degeneration of the oocyte seems to take place during the leptotene stage. Thus, complete sterility of this hybrid is proved cytologically.

The chromosome numbers in the males of the Japanese copper pheasant, *Syrnaticus soemmerringii scintillans*, the common pheasant, *Phasianus colchicus*, and the golden pheasant, *Chrysolophus pictus*, are identical, 82 in diploid and 41 in haploid. The morphological characteristics differ only in the length of the b -chromosome, which is longest in *Syrnaticus* and shortest in *Chrysolophus*.

In the testes of the hybrid between the copper pheasant and the golden pheasant the majority of the germ cells form the metaphase spindle of the first meiotic division, while some degenerate and fail to complete the second meiotic division. A few pass through the second division, most of them forming abnormally-shaped spermatozoa. Only a few develop into normal spermatozoa, thus indicating the partial fertility of the male.

In the male hybrid between the Lady Amherst pheasant, *Chrysolophus amherstiae*, and the golden pheasant, *C. pictus*, no abnormality is found. The chromosomes pass through two meiotic divisions normally and develop into functional spermatozoa, so the male hybrid is completely fertile.

Sterility in the hybrids *Gallus* $\times$ *Phasianus* and *Syrnaticus* $\times$ *Chrysolophus* is of the chromosomal type. Another factor leading to sterility is the antagonistic relationship between the nuclear element coming from the male parent and the cytoplasm of the female parent. In cases where the chromosomal dissimilarity between the parent species is very large and the nuclear elements are not harmonious, the degeneration of the hybrid germ cells occurs very early in meiosis, as in *Gallus* $\times$ *Phasianus*. If the chromosomal dissimilarity between the parents is small and the nuclear cytoplasmic relation is quite harmonious, the degeneration of the hybrid germ cells takes place in the latter stage of meiosis, as in *Syrnaticus* $\times$ *Chrysolophus*.

KOMAI, T. 1946. On the inheritance of black, yellow and tortoiseshell colour in cats, with special reference to the problem of the tortoiseshell male. *Seibutu*, 1, 1-7.

The yellow is a sex-linked gene, while black is autosomal. This may be inferred not only from breeding records but also from the census of a cat population. Yellow