(9) From these results, it may be assumed that the serological reaction may be used as an index for detecting phylogenetical relationships among various inbred lines.

(10) With regard to breeding methods, the precipitation reaction should make it possible to predict the degree of heterotic vigor in the F_1 combinations of given inbred lines, without making any crosses, because a higher heterosis usually appeared in F_1 hybrids between those inbred lines with the more remote relationship from a serological viewpoint.

K. Urano

NATIONAL INSTITUTE OF AGRICULTURAL SCIENCES
Section of Physiology and Genetics
Hiratsuka, Japan

1. Maize races native to the island Shikoku situated at the southeastern part of Japan.

About 250 samples with 3 ears for each were collected from about 200 farmer's fields in about 50 upland localities, totaling about 750 ears. On all these ears, 20 characters were measured. In order to examine the general characteristics of the races, 57 samples were chosen and grown at three stations, Hiratsuka, Iwate and Ehime. Measurements or observations were made on 29 characters. Results obtained were the following:

(1) All of the 250 samples were characteristic of a Caribbean type of tropical flint. In accordance with the topographic complexity of the arable land and the accompanying diversity in maize cultivation, the racial differentiation was extreme. About 60 or more local races were met with. The 250 samples were, however, identified as belonging to 28 distinct races.

(2) The 28 races were classified into 12 types; Okuuchi, Kowase, Wada, Gojô, Abeto, Sengoku, Hiyoshi, Okawa, Kuma, Irareko, Yellow-Yamakibi and Orange-Yamakibi. Most of them had a conical ear with orange seeds, typical of the Caribbean flint, and only two, Okuuchi and Yellow-Yamakibi, had a rather cylindrical ear with yellow seeds. Some races in the 6 types, Kowase, Wada, Gojô, Abeto, Okawa, Irareko and Orange-Yamakibi, were demonstrated to be favorable as breeding material. From a genocological viewpoint, the main peculiarities are as follows:

a) The Okuuchi type is planted as a mixed crop in sweet potato fields, and is distributed mainly over terraces on the hillsides in the southwestern coastal region. It is used purely as a catch crop; the soft ear is boiled or roasted. The erect, short, and broad

leaves and the smaller prolific ears with smaller yellow seeds were recognized as quite peculiar to this type. These peculiarities may trace their origin to hybridizations between a larger eared race of the Caribbean flint and a primitive race of pop corn. In fact, both races considered as the parent have from old times been native throughout the country.

b) Two Yamakibi types, Yellow and Orange, are planted only in the high land areas with a shifting system of cultivation, alternately repeating an upland cropping and a natural vegetation in an interval of several years. These fields are widely distributed on the sharp slopes of the high mountain tops, far apart from the residence of inhabitants, as compared with the ordinary fields where races of all other types are grown. These fields are not fertilized or cared for during the growing season of maize. Both stocks may be considered representatives of the most primitive and pure types of the Caribbean races native to Japan. This maize was characterized by having the smallest ears with large seeds. The orange type is grown for human food and is best ground as a fine powder, while the yellow type is best eaten fresh.

c) The Kowase type is native to hilly upland areas of the middle interior part. Its grains were transparent orange in color, very good in quality, rather small in size, and of considerable importance for human consumption.

d) The Wada, late in maturity, is widely grown in upland areas on the southern side of the mountain range, which forms a backbone with many mountain branches and transverses the country from east to west. The ear with many kernel-rows was the thickest in diameter, but relatively short in length, presenting an ovate or oblong shape. Grains were medium in size, not so superior in quality, but heavy in yield. It is very important as a main crop and is used as human or cattle food in such areas.

e) The Gojô contains only one race named "Gojo-Kei", and is distributed over upland areas in lower altitudes at the western part of the mountain range. This race was characterized by being the largest in ear-size as well as in kernel-or row-number, the latest in maturity, and by having some peculiarities of grain which was pale in color, coarser in texture, rather inferior in quality and heaviest in yield. It is an important crop grown for the same use as the previous type.

f) The Abeto is similar to the Gojô type in its characteristics, use and distribution. But it differs from the latter in smaller size of ear, mediate maturity, good quality and lower yeild of grain, and in the somewhat higher altitudes of its growing areas.

g) Two types, Sengoku and Hiyoshi, have a distribution area in the highlands of the western mountainous part. Both had rather small conical ears with large orange seeds. They were medium in maturity and

quality, and also rather light in grain yield. From their characteristics they may be considered as an intermediate form between a large eared late type such as Gojô or Wada and an early highland type, Kuma, Okawa or Irareko. In the western coastal hilly area, they are an important catch-crop; for the most part they are eaten when soft before the rice or sweet potato harvest, and a proportion is stored for the winter-cake. But in the western highland area in the mountain range, they are usually used to some extent as human food and a little is fed to cattle and poultry.

h) Two types, Okawa and Kuma, both comprising many leading mountain races, are suitable for highland cultivation in the mountain areas. The distribution range is the widest of all types; the Okawa type is widely spread over highland areas in the eastern and southern parts of the mountain range, and the other, Kuma, occurs in the northern part of the same range. Most of the races are good not only in grain yield and quality but also for human consumption as a staple food; they represent a main crop in the higher altitudes. The maturity was mediate.

i) The Irareko, early in maturity, is distributed over ordinary fields in the highest altitudes at the central part of the mountain range. The ear was slender and cylindrical, having the fewest number of kernel-rows, about 8 or 10. Grains were brilliantly orange in color, compact in texture, and good in quality and yield. Most of the races are planted as a staple crop for the mountain inhabitants.

(3) The results obtained from the pachytene analysis of chromosomes are shown in Table 1. They indicate that there is some cytological evidence to support the preceding classification into 12 types based on a genocological viewpoint.

a) Contrary to the data on the races native to the foot of Mt. Fuji (MGCNL, 32: 106-108), no B-chromosomes were observed in any of the samples examined.

b) There was a striking difference regarding the knob number, according to which the types could be arranged as follows: "Okuuchi=Kowase=Wada=Gojô=Abeto≥Sengoku>Hiyoshi>Okawa=Kuma>Irareko> Yamakibi".

c) A knob constantly appeared at the 8 knob loci of the following chromosome arms - 3L, 5L, 6L, 7L and 8L, its frequency being 90 or more percent for each locus in a total average. The knob occurrence at these loci may therefore be considered as a basic characteristic of the Caribbean flint, because such a high frequency for these loci agrees with that found in the races native to the foot of Mt. Fuji (see Table 1 in MGCNL 32: 107).

d) Another peculiarity of the knob occurrence was the presence of differences in the knob frequency among the types, appearing on arms other than the 5 arms above mentioned. An examination of this point

Table 1. Number and Position of the Chromosome Knobs in 72 Races Native to the Island Shikoku.

Chromosomes		Race										
		Okuuchi	Kowase	Wada	Gojô & Abeto	Sengoku	Hiyoshi	Okawa	Kuma	Irareko	Yamakibi	Total
		1	3	6	9	3	2	8	15	1	4	72
1	S	-	-	0.2	0.2	-	0.5	-	0.1	-	-	0.1+
	L	-	0.3	0.2	0.3	1.0	0	0.3	0.1	-	0.3	0.3
2	S	-	0.7	-	-	-	-	-	0.1	-	-	0.1-
	L	1.0	1.0	0.7	0.7	-	-	0.3	0.2	-	0.3	0.4
3	S	-	-	0.5	0.3	-	-	-	-	-	-	0.1+
	L	1.0	1.0	1.0	1.0	0.7	1.0	0.9	0.9	1.0	0.8	0.9+
4	S	-	-	-	-	-	-	-	-	-	-	0.0
	L	1.0	0.7	0.5	0.6	1.0	1.0	0.5	0.3	-	0.3	0.5-
5	S	-	-	-	-	-	-	-	-	-	-	0.0
	L	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0-
6	S	-	-	-	-	-	-	-	-	-	-	0.0
	L	1.0	2.0	2.0	2.0	2.0	2.0	1.8	1.8	2.0	1.4	1.8+
7	S	-	-	-	-	0.3	-	0.1	0.1	-	-	0.1-
	L	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	0.8	0.9+
8	S	-	-	-	-	-	-	-	-	-	-	0.0
	L	2.0	1.7	2.0	2.0	2.0	2.0	1.9	1.8	2.0	1.3	1.8-
9	S	1.0	-	0.3	0.1	-	-	-	0.2	-	0.3	0.2+
	L	-	-	-	0.2	0.3	-	0.1	0.1	-	-	0.1-
10	S	-	-	-	-	-	-	-	-	-	-	0.0
	L	-	-	-	-	-	-	-	0.1	-	-	0.0+
M	S	1	0.7	1.0	0.7	0.3	0.5	0.1	0.5	-	0.3	0.5+
	L	8	9.0	8.3	8.8	9.0	8.0	7.5	7.1	7.0	6.2	7.8-
CM		9	9.7	9.3	9.5	9.3	8.5	7.6	7.6	7.0	6.5	8.3

made it possible to present a relationship of the 12 types.

(4) In order to ascertain the agro-climatic response of the given races, measurements of the 29 characters were made on 57 samples grown under different climatic conditions at Iwate in North Japan, Hiratsuka in Middle Japan and Ehime in South Japan. With regard to the average temperature during the growing season, the 3 locations can be arranged in a sequence with approximately equal intervals of temperature difference: Hiratsuka>Ehime>Iwate. Similarly, for the average precipitation they are: Ehime>Hiratsuka>Iwate. Of the 29 characters measured, 26 were affected at the three stations. The other three characters, namely leaf width, no. of kernel-rows and kernel thickness, may be considered stable attributes of the native race with a high heritability under certain environmental conditions.

Thirteen of the 26 characters, namely tasseling time, silking time, stalk diameter, shank diameter, ear length, ear width, cob weight, no. of kernels per row, kernel width, kernel length, kernel size, kernel weight per plant and weight of 100 kernels, all relating to either the organ size or time of maturity, were closely associated with temperature. At the lower temperature, the growing period of the race was longer, probably resulting in the larger organ and heavy yield.

The variability of 6 characters, no. of tillers, plant height, stalk height, leaf length, shank length, ear height and length of tassel-branches bearing axis, all of which are connected with the length of organ, was certainly associated with precipitation. In a given place, a decrease of rain-fall is accompanied by an increase of sunshine. Under such conditions, these organs tend to elongate. But there was no tendency for an increase in the grain yield under the same conditions.

The remaining 5 characters, no. of prop-rooting nodes, no. of leaves, length of tassel and tassel-branches and no. of husks, all connected with the number of nodes, were certainly affected at the 3 stations, but apparently without regard to temperature or precipitation. At present, it cannot be said whether the variability of these characters is due to the joint effect of two factors, temperature and precipitation, or to some other unknown factors.

T. Sutô

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee

1. Further studies on breakage-fusion-bridge cycles in maize endosperm.

Previously reported investigations (Schwartz and Murray, Cytologia 1957) on anaphase configurations in young endosperm tissue indicated