The Supernumerary Chromosome of Man

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IN A RECENT ARTICLE (Kodani, 1957b) the author reported a finding of three chromosome numbers in a group of Japanese testes and suspected that the numerical variation was due to a supernumerary chromosome. In another group of Japanese testes analyzed since then, the same three numbers have been observed again, and critical comparisons of the three caryotypes have clearly demonstrated the occurrence of a supernumerary chromosome in some of the testes.

The numerical polymorphism has thus far been reported only in Japanese. However, since the condition may occur in other ethnic groups, the chromosomes in the sex cells of White testes have been studied and compared with Japanese. This report is a detailed description of White and Japanese testes with the primary purpose of demonstrating the supernumerary chromosome of man.

MATERIALS AND METHODS

Twenty-three testes, eight from Whites and fifteen from Japanese, have been analyzed in this study. The latter were taken from epididymitis patients in a manner previously described (Kodani, 1957b). The testes from Whites were obtained from prostate cancer patients by total orchidectomy. Immediately upon removal, the testes were cut into pieces about the size of match heads and immediately fixed. Fixation was accomplished in two steps, pretreatment and postfixation. The pretreatment reagent was a mixture of equal volumes of a 1 per cent solution of chromic acid and a 3 per cent solution of potassium bichromate. (This solution is designated as K-12). After a one and one-half hour treatment in this solution, the pieces were transferred and allowed to remain in a mixture of equal volumes of 4.5 per cent chromic acid and 1.5 per cent potassium bichromate (K-24) for 17 to 20 hours. The latter mixture was always prepared immediately prior to use to insure its fixing power. During fixation the solutions were maintained at room temperature. After fixation the specimens were thoroughly washed in running water and made into Feulgen squash preparations.

Pretreatment with K-12 solution for the time specified above produces similar effects in the metaphase cells as hypotonic saline solutions and water: In the metaphase cells pretreated with K-12 and fixed with K-24, the chromosomes become well dispersed by the squashing, whereas if pretreatment with K-12 is omitted, the spreading of the chromosomes is very poor. The author's method has been found to give in

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general better fixation and dispersion of the chromosomes than pretreatment with a hypotonic saline solution or water followed by treatment with conventional fixatives.

Some of the specimens were large enough to have part of them used for sections. After fixation in either Bouin or Navashin's, serial sections were prepared. For accurate chromosome counts, sections have been entirely inadequate.

ANALYTICAL PROCEDURE AND RESULTS

From each testis enough squash preparations were made, first, to find at least several good spermatogonial metaphases in which the chromosomes could be counted accurately, and secondly, to find at least fifteen first spermatocyte metaphases in which the structures of individual chromosomes could be observed clearly. In some testes as many as thirty metaphases and in one testis sixty metaphases were analyzed. In every testis the chromosome numbers counted in the primary spermatocytes and spermatogonial metaphases were consistent and agreed exactly with each other. There was, however, one exceptional primary spermatocyte in one of the Japanese testes. In this testis fifteen first meiotic metaphases were analyzed and one of them was found to have 49 chromosomes, while other metaphases all had 48 chromosomes. This exceptional metaphase will be discussed in detail in a later section.

In a preliminary way the chromosomes in every first meiotic metaphase in each testis were designated by alphabetical letters according to their sizes except the X- and Y-chromosomes. Since size alone does not sufficiently characterize the individual chromosomes, those of the same preliminary designation in different cells were then compared with regard to shape determined by the position of the centromere. If agreement was unsatisfactory, the preliminary designations were changed until pairs of chromosomes could be defined which from cell to cell corresponded in both size and shape. By this procedure the chromosomes, at first meiotic metaphase, were seriated for each testis. No apparent discrepancies were encountered in any of the testes.

Comparisons of the Japanese testes have shown (1) that the same 23 pairs of chromosomes including the X-Y pair occur in all and (2) that while in some testes no other chromosomes besides the regular 23 pairs are present, in others a small chromosome is present either singly or in duplicate in addition to the regular members. Thus the numerical variation previously reported (Kodani, 1957b) is confirmed in the present group of Japanese testes. Furthermore, the preliminary explanation for the numerical variation as due to a supernumerary chromosome has been substantiated. In the White testes two numbers, 46 and 48, have been found. Comparisons of caryotypes representing the two numbers with each other and with those of the Japanese testes have indicated that apparently the same 23 pairs occurring regularly in Japanese are also present in both caryotypes of Whites, and the extra pair found in Japanese of the 48-chromosome type is likewise present in White individuals of the same type.

The fact that Japanese included in the present study all had epididymitis and the Whites all had prostate cancer raises the question regarding the possibility that the morbid conditions of the individuals might induce changes in the chromosome number in their testes. Dr. Masamichi Suzuki, formerly of the Atomic Bomb Casualty Commission in Hiroshima, Japan, to whom the author's sincere thanks are due, provided the author with testis specimens taken by biopsy from twenty Japanese with complaints of sterility. (These specimens are not included in the group reported here.) Some of the individuals were not exposed to the atomic bomb radiations and showed no sign of illness at any part of their bodies. Histological examinations indicated that their testes were normal. Among these apparently normal testes of the healthy individuals, the author found some with consistently 48 chromosomes and others with consistently 46 chromosomes. In view of the facts that the 46 and 48-chromosome types exist in the normal individuals and the chromosome number is consistent in each individual (46, 47, and 48) in the morbid sample observed here, it seems unlikely that the variation of the chromosome number found in the present study is due to the morbid condition of the individuals.

From a number of first meiotic metaphases observed in Japanese, two are selected from the 46-chromosome type, two from the 47 and three from the 48 for illustration. Figure 1 shows those of the 46-type in testis No. 534. Twenty-three elements are present, all unquestionably bivalents. The X-Y pair is identified by its characteristic asymmetry and the tapering distal end of one arm of the X to which the Y is attached. The sex chromosomes are conjoined in 60 per cent of first meiotic metaphases whereas they are separate from each other in the other 40 per cent. In either case the total number of chromosomes counted at metaphase I is always 46. This is substantiated by the same number found in spermatogonial metaphases in this testis, one of which is presented in figure 2.

Typical first meiotic metaphases observed in testis No. 636 are shown in figure 3. In both cells the elements, 24 in number, consist of 23 bivalents including the sex-determining pair and one univalent (designated sup. in the drawing). Since the autosomal bivalents are all structurally homozygous, the univalent chromosome cannot be a part of a chromosome broken off from an autosome. Nor can it be a fragment of the X or the Y, for these chromosomes are not any smaller than those of the 46-chromosome type. It is unquestionably an intact chromosome with its own centromere. In Fig. 3A this chromosome is located very close to a large bivalent, but this is believed to be accidental because in none of the other cells observed in this testis is the univalent chromosome paired with or located very close to any particular chromosome. The X-Y pair shows clearly the characteristic asymmetrical form in Fig. 3A. In Fig. 3B the pair is also found to be asymmetrical under the microscope, but this is not shown very clearly in the photograph, because the two ends of the pair are at different focal levels. Chromosome counts in spermatogonial metaphases (Fig. 4) all agree with first meiotic metaphases in showing the chromosome number in this testis to be 47.

From comparisons of the chromosomes of the 47-type (Fig. 3) and 46-type (Fig. 1), it can be seen that 23 bivalents in each match well. The univalent in the latter type is evidently an extra chromosome added to the regular complement of 23 pairs common to both types (see Fig. 12).

The extra chromosome is usually about the same in size as the Y-chromosome,

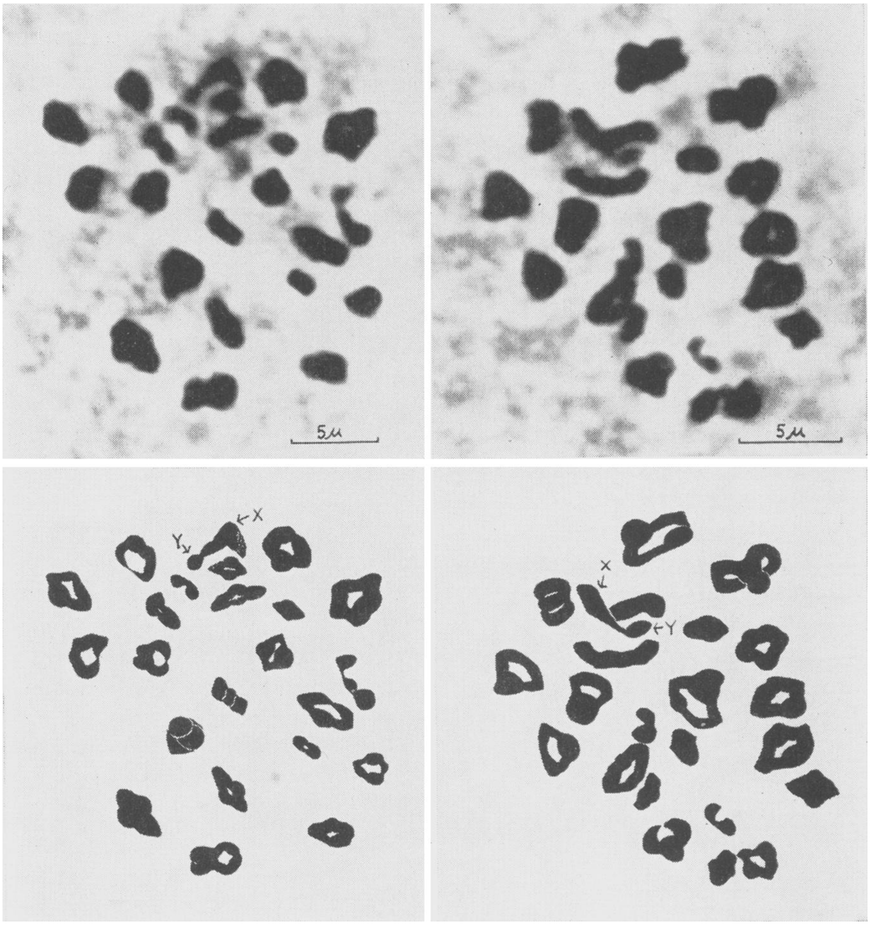

FIG. 1. Typical first spermatocyte metaphase of the Japanese testis no. 534. Note in both plates 23 bivalents including the asymmetrical X-Y pair. The chromosomes on the right figure are reproduced in Figure 12.

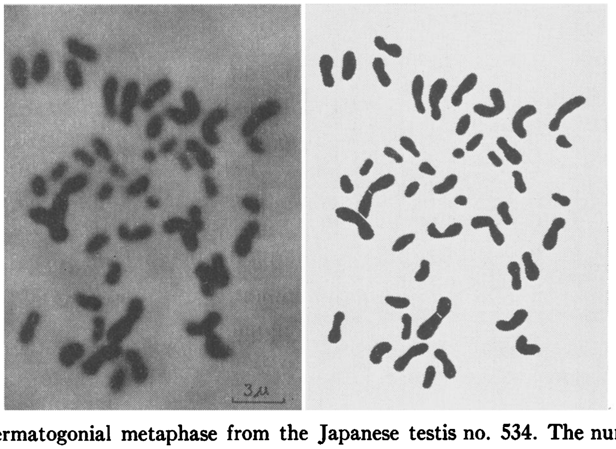

FIG. 2. A spermatogonial metaphase from the Japanese testis no. 534. The number of chromosomes is 46.

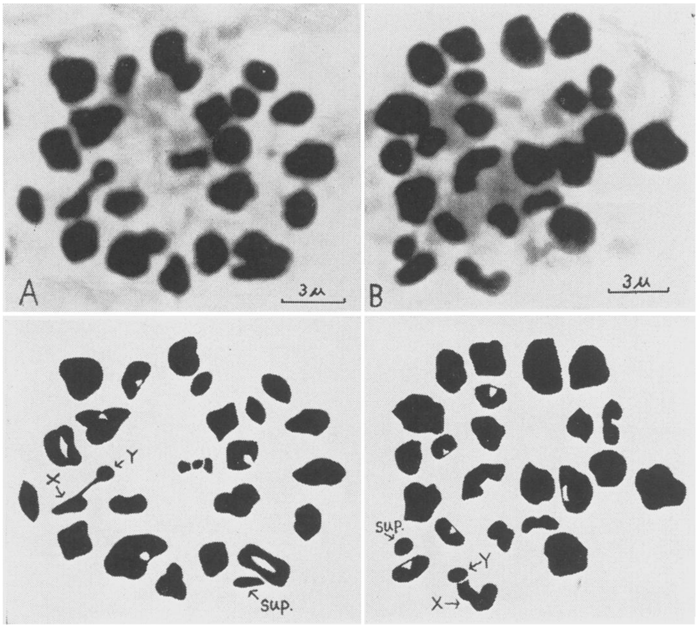

FIG. 3. Typical first meiotic metaphases of Japanese testis no. 636. Note in both plates the asymmetrical X-Y pair, 22 autosomal bivalents and a univalent supernumerary chromosome (sup.), making the total number of chromosomes 47. Plate A represents the 47-caryotype in figure 12.

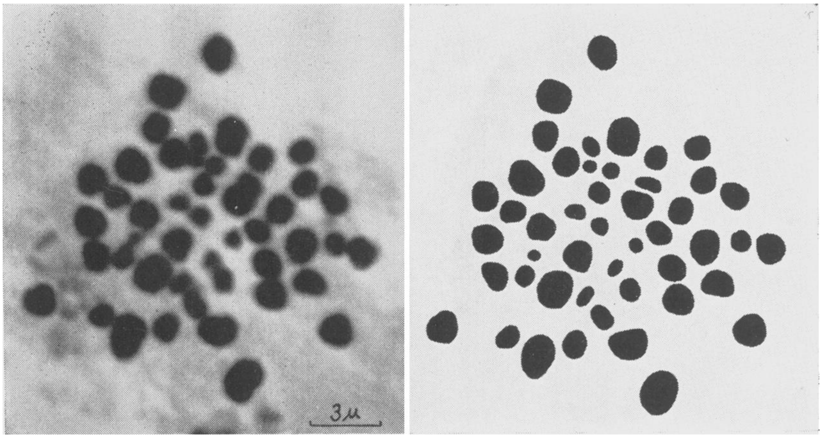

FIG. 4. A spermatogonial metaphase of the Japanese testis no. 636. Forty-seven chromosomes are shown.

although it sometimes appears slightly smaller. The exact shape has not been clearly shown in the 47-chromosome type of testes; in some cells it appeared more or less spherical while in others it was rod-shaped. However, its shape in terms of the relative lengths of its two arms has become known from the configuration observed in the testes of the 48-chromosome individuals which will be described below. The staina-

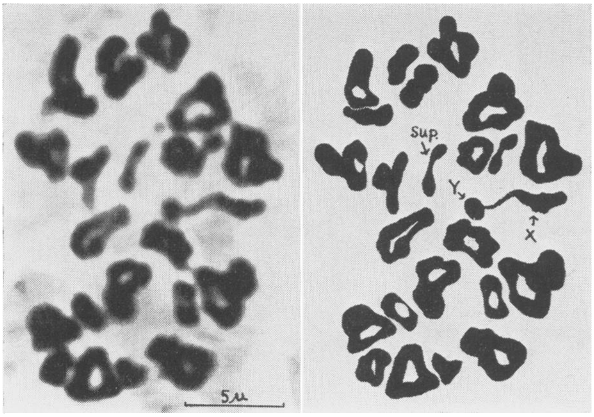

FIG. 5. A first spermatocyte metaphase of the Japanese testis no. 578, consisting of 22 autosomal bivalents and paired X-Y and supernumerary chromosomes (sup.). The total number of chromosomes is 48.

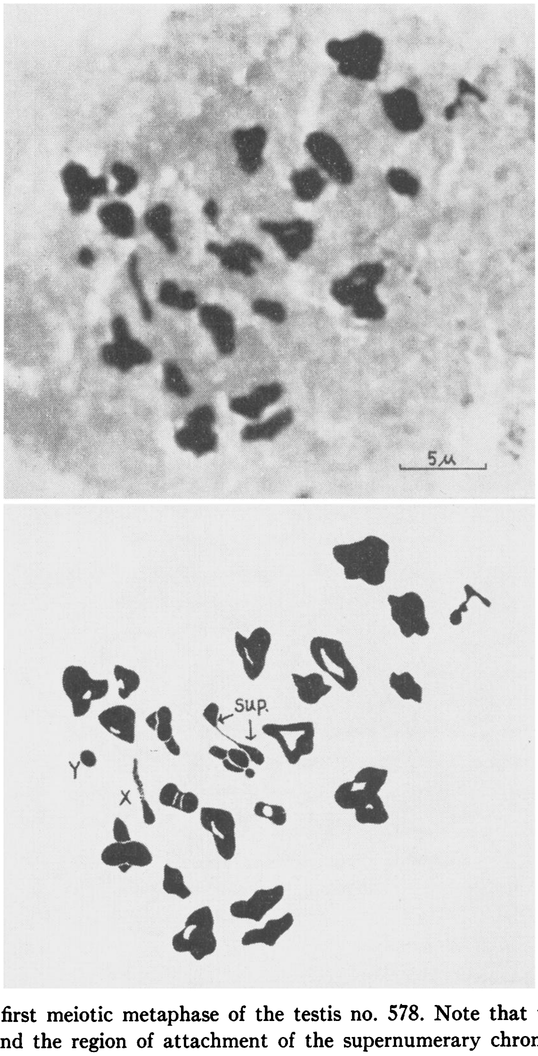

FIG. 6. Another first meiotic metaphase of the testis no. 578. Note that the sex chromosomes are not conjoined and the region of attachment of the supernumerary chromosomes (sup.) is extremely attenuated. Other autosomes are also distinctly bivalent. This figure is reproduced in figure 12 to represent the 48-caryotype in Japanese.

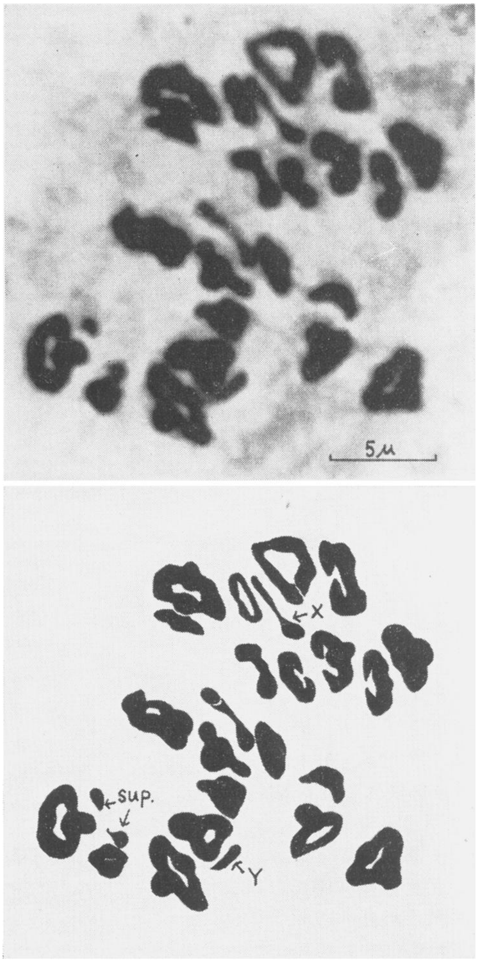

FIG. 7. This primary spermatocyte metaphase taken also from the testis no. 578 is different from those shown in the last two figures in that neither the sex-chromosomes are conjoined nor is the supernumerary pair (sup.). The total number of chromosomes is 48. For details see text.

bility and condensation of this chromosome are similar to those of the other autosomes.

Three first meiotic metaphases of the 48-chromosome individuals are presented in figures 5, 6, and 7. Twenty-four bivalents are present in figure 5. The X- and Y-chromosomes are conjoined forming an asymmetrical pair. One arm of the X to which the Y is attached is thinner and less chromatic than the other arm. This negatively heteropycnotic nature of its one arm, at first meiotic metaphase, is a unique but not consistent characteristic of the human X-chromosome (Kodani, 1957a). As in the 46- and 47-chromosome types, the X- and Y-chromosomes are thus paired in 60 per cent of first meiotic metaphases, while in 40 per cent of the cells they are separate from each other. Figure 6 illustrates one such cell with unpaired sex chromosomes.

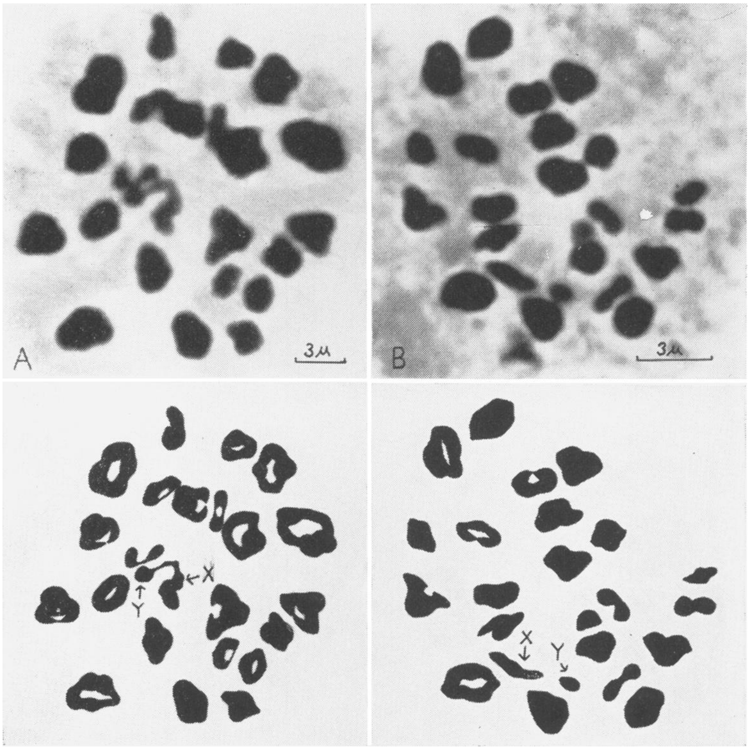

FIG. 8. First meiotic metaphases from the white testis no. 672. In A the X-Y and the autosomes are all paired, whereas in B the sex chromosomes are not conjoined while autosomal pairs are.

Here, also, except for the sex chromosomes, all autosomes are bivalent and the total number is 48. The 46 autosomes form 23 bivalents (Figs. 5 and 6), but this is not always the case: in about 10 per cent of first meiotic metaphases of individuals with 48 chromosomes a certain pair of autosomes is found as two univalents. One example is shown in figure 7. In this cell, besides the X and Y, two small autosomes of the same size (designated sup. in the drawing) are separate from each other instead of forming a bivalent. Observations of a large number of cells like this one have shown that the unpaired autosomes always belong to the same pair. Regardless of whether all chromosomes are paired or not, the total number is unquestionably 48 in the three kinds of cells in the two testes. Counts in the spermatogonia of these testes fully confirm the presence of 48 chromosomes. Comparisons of the first meiotic metaphases shown here with those of the 47-type such as the one shown in figure 3 indicate, as illustrated in figure 12, that the small pair of chromosomes labeled as sup. corresponds to the univalent chromosome in figure 3. Thus the small unpaired chromosome in the 47-chromosome-type is present in duplicate in the 48-type while entirely missing from the 46-type of testes.

Eight testes from Whites have been thoroughly analyzed to date. The first seven turned out to be of the 46-chromosome type. Two of the primary spermatocyte metaphases observed in one of these testes (No. 672) are shown in figure 8. Twenty-

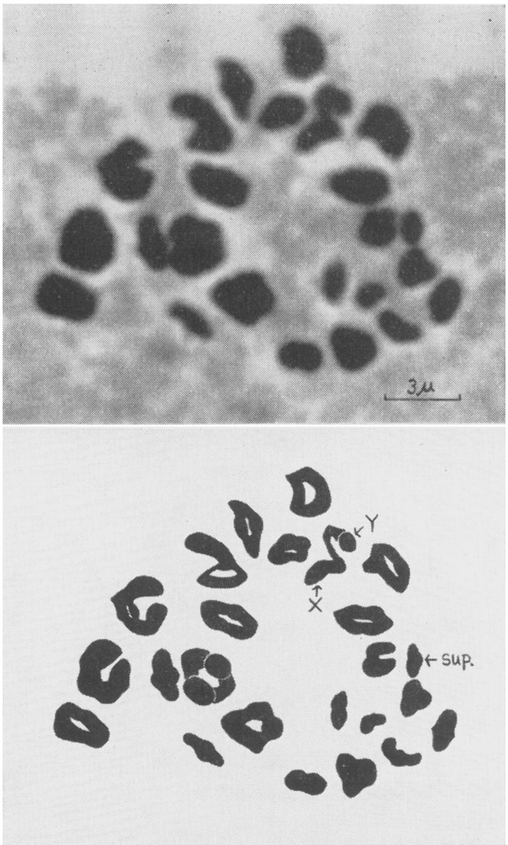

FIG. 9. A primary spermatocyte metaphase of the white testis no. 674, consisting of 22 autosoma bivalents and paired X-Y and supernumerary chromosomes (sup.). The total number of chromosomes is 48.

three bivalents are found in 8A, including the paired X-Y chromosomes. As in Japanese, the sex chromosomes are sometimes not conjoined at this stage. One example is shown in 8B. All spermatogonial counts have shown 46 chromosomes also. The chromosomes in the first meiotic metaphases shown here and in others observed in the same and six other White testes match satisfactorily those of the Japanese testes of the same type (see Fig. 12). No notable morphological differences seem to exist between the chromosomes of the two ethnic groups.

The last one of the group of eight White testes is of the 48-chromosome type. This specimen has been analyzed with special thoroughness and caution. Figures 9 and 10 represent first spermatocyte metaphases of this White testis. Twenty-four elements, all definitely bivalent, are found in these and other cells in this specimen. The matching of the chromosomes in these figures with those of the 46-chromosome type in Whites and the 48-chromosome type in Japanese indicates that an extra pair is present in the 48-type of Whites and that it corresponds to that in Japanese of the same type (see Fig. 12). As in Japanese the homologues of this pair in Whites are found some-

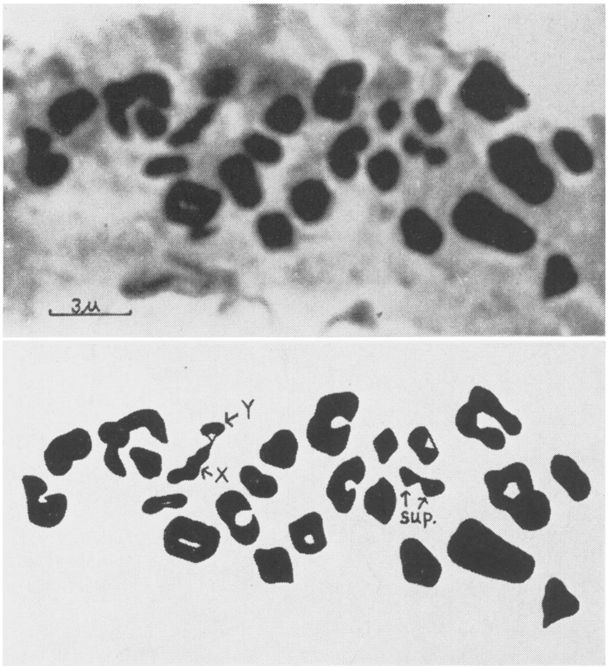

Fig. 10. Another first spermatocyte metaphase of the testis no. 674. The chromosomal constitution of this metaphase is the same as the one in the last figure. This metaphase is reproduced in figure 12 to represent the 48 caryotype in whites.

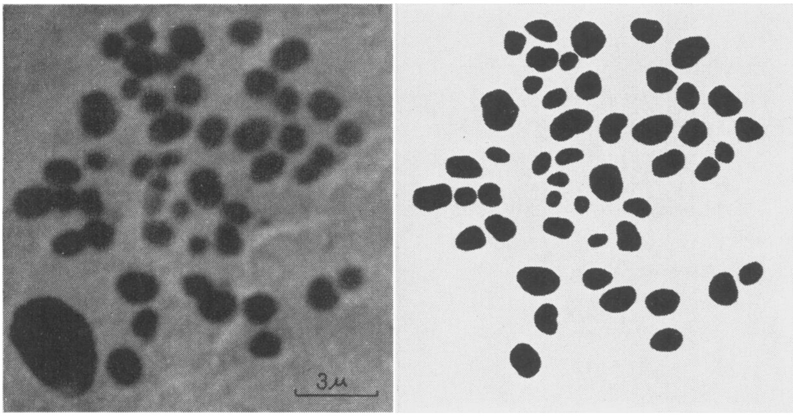

Fig. 11. A spermatogonial metaphase of the white testis no. 674. The chromosome number is 48. A large mass at the lower left corner is a sperm head.

times not conjoined at metaphase I, and when paired the attachment region is sometimes more or less extremely attenuated.

Several spermatogonial metaphases in this White testis, one of which is reproduced in figure 11, have clearly shown 48 chromosomes. The chromosomes in this particular metaphase and those shown in figure 4 represent the "balled-type" characterized by

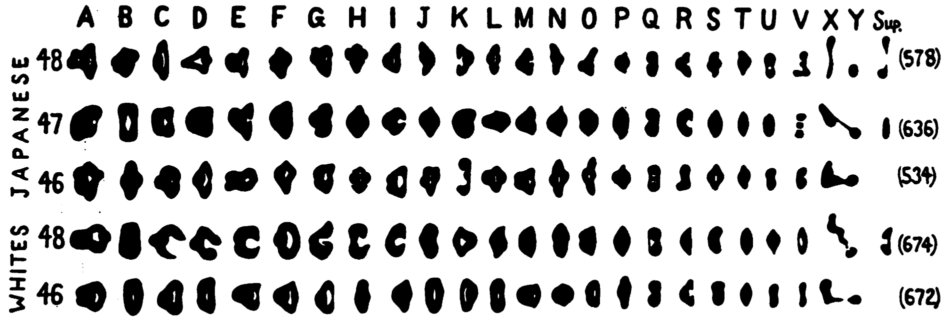

FIG. 12. First spermatocyte metaphases of three different caryotypes of man are compared to show the common set of 23 pairs (A-Y) found in all three caryotypes and the supernumerary chromosome occurring singly in the 47-type and in duplicate in the 48-type. The numbers on the left indicate the chromosome numbers and those on the right in parentheses the testis numbers. The metaphase representing testis no. 672 is not illustrated in this paper.

the overcondensation of all chromosomes into more or less regular spherical shape. This type of metaphase has been found to coexist with the "elongated-type" shown in figure 2, sometimes side by side in the same squash slide. When properly squashed the "balled" chromosomes become dispersed throughout the cell much more readily than the "elongated" chromosomes and are therefore far more favorable for accurate counting. Furthermore, the author's observations have shown that the chromosome numbers counted in the metaphase of the "balled-type" are constant within the testis. This fact indicates that a reliable conclusion could be drawn, if counts of a number of metaphases of this type all agree, as was the case with the author's materials.

DISCUSSION

Figure 12 summarizes the results of the analyses and comparisons of the three chromosome numbers found in Whites and Japanese. It represents the following three points: 1. The human species comprises individuals of three different chromosomal constitutions; 2. All individuals possess a common set of 23 pairs, but some individuals have either one or two additional chromosomes; 3. The chromosomes of Whites and Japanese are apparently alike in size and shape.

Widely varied chromosome numbers had been reported for men prior to 1923 (see Painter for references). Among these the one to be specially noted is 47 which was reported by de Winiwarter (1912) for the male. He believed that the human male has 46 autosomes and one X but no Y-chromosome. In 1923 Painter expressed the opinion that the numbers published before him were largely erroneous and he produced evidence to show that 48 was most likely the correct number. Two years later de Winiwarter and Oguma (1925) reported 47 again, but this number has never been generally accepted, because subsequent authors such as Evans and Swezy (1929), Minouchi and Ohta (1934), Shiwago and Andres (1932), Andres and Navashin (1936), Koller (1937), Hsu (1952), Mittwoch (1952), and Darlington and Haque (1955), have all published illustrations which, according to their beliefs, represented 48 chromosomes. The general impression thus created is that the original report of Painter was correct and that the chromosome number in man is consistently 48 in all male individuals.

Although it appeared that the question of the human chromosome number was settled, Tjio and Levan (1956) have recently demonstrated convincingly the presence of 46 rather than 48 chromosomes in cultured fetal tissues. Soon afterwards Ford and Hamerton (1956) reported the same number in testes from Whites in England. The latter authors expressed strong doubt concerning the occurrence in the human of any number other than 46. It is now clear, however, that the chromosome numbers 46, 47, and 48 occur in Japanese, and the first and the last, also, in Whites with little doubt that 47 will also be found in this group. It is interesting that the majority of the authors in the past had reported 48 which seems to be a much less frequent number than 46 among Whites. This was perhaps due to the fact that each author dealt with only a small number of individuals, although the possibility that some of the authors misinterpreted the number cannot be excluded.

Bender (1957) recently added another one of the 46-type, a White American female child, to the list of seven individuals of such type reported since 1956 by the authors mentioned above. The addition to this list of the seven White adults with 46 chromosomes described in this paper makes the total fifteen. In contrast to this number (15) the only 48-type individual found in Whites during the same period (1956–57) is the one reported here.

With regard to Japanese, among the 15 individuals in the present study, 9 have 46 chromosomes, 1 has 47 and 5 have 48. In the group of 21 individuals reported in the previous paper (Kodani, 1957b), the ratios of the frequency of the three numbers was 4:1:16. One individual who was then suspected to be of the 47-chromosome type was later proved to be so by the analysis of first meiotic metaphases. This is a different individual from the one reported in this paper, but the chromosomal constitution is essentially alike in both. At the time the 21 testes were picked for complete analyses from those which were preliminarily studied, the author exercised some selection in favor of those with the chromosome number larger than 46 in an attempt to find more individuals with 47 chromosomes. Therefore this group does not form a random sample. On the other hand, no such selection was made in the 15 Japanese and 8 Whites dealt with in the present study. Although these samples are too small to make a reliable estimate and comparison of the proportion of individuals with the three chromosome numbers, it seems that 48-chromosome individuals are more frequent among Japanese than among Whites. If this is actually the case, it would mean that the extra chromosome (sup.) found in the 47- and 48-caryotypes occurs more frequently in Japanese population than in White population. Studies of Whites and Japanese are being continued to find the answer to this problem and to others related to it, such as the adaptive value of this extra chromosome for the human species.

Apart from the multiple sex-chromosomes known in several species in the Mammalia, the numerical polymorphism of the autosomes in this group has been reported only in one species as far as the author is aware: Wahrman and Zahavi (1955) mention briefly, without cytologic demonstrations, a possible occurrence in the rodent *Gerbillus pyramidium* of two forms with different numbers of the autosomes inhabiting the same locality. The human is therefore the second one to be reported for such polymorphism.

In many species of the insects and flatworms (Melander, 1950), as well as in plants, supernumerary chromosomes occur frequently. They do not seem to have obvious phenotypic effects. The 47th and 48th chromosome found in some men appear to be similar to the supernumerary chromosomes of other species. It is too early, however, to be able to decide whether the supernumerary chromosomes of man have phenotypic effects.

In some insects such as the Trimerotropi (White, 1951) the number of supernumerary chromosomes is constant in the same testis, whereas in other insects such as *Neopodismopsis abdominalis* (Rothfels, 1950) different numbers may be found in different cysts. Very little is known about the numerical consistency of the supernumerary chromosome in somatic cells. In the flatworm *Polycelis tenuis* (Melander, *ibid.*), it is absent from most of the somatic cells of the adult worm. In man, although the spermatogonial and spermatocyte anaphases are not yet fully investigated, it seems from observations of a large number of first meiotic and spermatogonial metaphases that the supernumerary chromosomes are transmitted with strict regularity from cell to cell in the spermatogonia: A total of nearly 300 first meiotic metaphases were analyzed in the nine Japanese and seven Whites of the 46-chromosome type, but in none of the metaphases did the chromosome number deviate from 46. Similarly in the two Japanese having 47 chromosomes, one reported here and the other reported in the author's previous paper (1957b), the chromosome number in forty first meiotic metaphases was consistently 47. In the five Japanese and one White of the 48-chromosome type, over a hundred primary spermatocyte metaphases were analyzed, and the number of chromosomes was exactly 48 in all except one metaphase. The exceptional metaphase was found in one of the Japanese testes. Among fifteen first meiotic metaphases studied in this testis, fourteen had 48 chromosomes and one had 49 chromosomes. This exceptional metaphase consisted of the conjoined X-Y pair, 23 autosomal bivalents and one univalent. There were no indications that fragmentation occurred in the X-Y or in an autosome. The univalent was unquestionably a whole chromosome, not a fragment, and its size appeared to be much larger than that of the supernumerary chromosome, but it was difficult to tell exactly to which chromosome of the complement it corresponded. This chromosome occurred probably by non-disjunction of one of the fairly large autosomes in a spermatogonial division. At any rate, the number of the supernumerary chromosome seems to be consistent in the human spermatogonia, i.e., one in individuals with 47 chromosomes and two in those with 48 chromosomes. In the somatic tissues nothing is known about the behavior of the supernumerary chromosome, since no one has yet reported observations of the chromosomes in cultures of tissues from individuals with 47 and 48 chromosomes in their gonads.

In the flatworms, and in many insects, the supernumerary chromosome is heteropycnotic, either positively or negatively, at one meiotic stage or another, and in some species it tends to associate itself with the X-chromosome at late meiotic prophase and first-metaphase (see White, 1954, for references). On the other hand, it may tend to associate itself with the autosome in some species, as in *N. abdominalis* referred to above where Rothfels (1950) observed one of the supernumeraries attached to one of the autosomes by what he called a chiasma. These phenomena have led a number of authors to speculate upon the original derivation of the supernumerary chromosomes from either the X-chromosome or an autosome (see White, 1954, and also Ray-Chaudhuri and Guha, 1955).

In man, the supernumerary chromosome has never been found to pair or tend to associate itself with any particular autosome. Evidently no genetic homology exists between this chromosome and the autosomes. This does not necessarily mean, however, that the supernumerary chromosome was not originally derived from an autosome. With regard to the question of the possible homology between this chromosome and the X-Y pair, it is certain that trivalent association of the three chromosomes does not occur at metaphase I, in either the 47- or 48-chromosome individuals. It is also certain that the supernumerary chromosome does not pair with the Y, for in individuals having 47 chromosomes a number of first meiotic metaphases have been observed in which the X and Y are not conjoined, but the supernumerary chromosome is not paired with the Y in any of these metaphases. The possibility still remains, however, that in these individuals the X may at times be paired with the supernumerary chromosome leaving the Y unpaired, because, due to the similarity in size between the supernumerary chromosome and the Y, it is difficult to ascertain which of the two chromosomes the X is paired with at metaphase I. Studies now in progress on the structure and behavior of these chromosomes during the meiotic prophase may shed some light on the problem. Although there seem to be no indications of genetic homology between the supernumerary and the sex-determining chromosomes at present, it is still possible that the former chromosome was originally derived from the latter. The origin of the human supernumerary chromosome remains obscure.

On the basis of observations of a number of first meiotic metaphase configurations in the testes of the 48-chromosome type, the centromere in the supernumerary chromosome in man has been located near its middle. As described in the last section, the two supernumerary chromosomes in the 48-chromosome individuals are found to be separate from each other in about 10 per cent of the first meiotic metaphases, but in the majority of the other 90 per cent of the metaphases they are conjoined terminally at one arm and frequently the attachment region is more or less strikingly attenuated. These are two unique characteristics of the human supernumerary chromosomes. Occasionally these chromosomes are conjoined at both arms and the attachments are always terminal. Since their behavior during the meiotic prophase has not been investigated yet, it remains to be seen whether the terminal attachments represent true chiasmata or something else (Cooper, 1944; Schrader, 1940). The similar terminal attachment of the X-Y pair at metaphase I presents the same problem. Cytologic studies of these problems are in progress now.

Andres and Navashin (1936) compared six mitotic metaphase chromosomes in two Russian and one Japanese testis and found that while three chromosomes (the fourth, sixth, and eighth) were the same in length in both groups, the three others (the largest three of the complement) in Japanese were considerably longer than the corresponding chromosomes in Russians. As pointed out by Stern (1949), even if their observations are correct the material is too limited to draw general conclusions concerning size differences of chromosomes between Japanese and Russians. In the study reported here, in which a far greater number of White and Japanese testes have been compared, no consistent differences in shape or size have been recognized. This does not imply, however, that the chromosomes in the testes dealt with in this study are all completely homologous in structure, for some changes involving small segments and slight shifts of the centromere would not have been detected.

SUMMARY

The spermatogonial and first meiotic metaphases in 15 Japanese and 8 White testes were analyzed to determine the chromosome numbers and the sizes and shapes of individual chromosomes. Three numbers, 46, 47, and 48, were found among the Japanese, and two, 46 and 48, among the Whites. Comparisons of caryotypes representing the three numbers indicate that the numerical variation is due to a supernumerary chromosome. Some of the testes have one and others two supernumeraries besides a set of 23 pairs which is present in all of the testes. The chromosomes of Whites and Japanese are apparently alike in size and shape. Among the 15 Japanese, 9 have 46, 1 has 47 and 5 have 48 chromosomes, whereas among the 8 Whites, 7 have 46 and 1 has 48 chromosomes.

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