

# Studies on various ageing phenomena in Japanese twins and siblings

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## Preface

The driving force for the occurrence of the human senescent phenomena is thought to be due to various hereditary factors. However, it has been known that the action of these hereditary factors is not autonomic, but instead is influenced by various environmental conditions. In order to make an exact analysis of the mutual relation existing between heredity and environment, the twin method is considered to be the most suitable.

Studies on a fairly number of cases of senescent twins studies have been reported from the field of clinical medicine as follows. Von Verschuer ('54) made clinical observations on 5 aged pairs as to their senescent phenomena in his studies on 150 pairs of various ages. Kallmann et al. ('56) investigated the life span and cause of death using 2536 pairs of senescent twins. Vogt ('39) made ophthalmological examinations on 42 pairs of senescent twins. As for the case study, Kürten ('34) made a clinical examination on 1 pair of 81 years old twins and Sandelius ('56) on 1 pair of 99 years old twins. Newman et al. ('37), on their studies of many twins, reported on 1 case of 59 years old twins, but made no investigation of their senescent phenomena. Concerning Japanese senescent twins, there is no noteworthy information at hand probably because of the difficulty in finding many cases and also investigating their exact life history.<sup>1</sup>

Hence, the authors have undertaken the study of various senescent phenomena and their genesis by using a fairly large number of old Japanese twins.

## Materials

We collected 27 pairs of healthy elderly twins, who are 41 to 80 years old and live in the western district of Honshū-island in Japan. As the number of DZ was found to be far smaller than that of MZ, as is mentioned later, 16 pairs of old siblings

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(SL) of the same sex were used as an approximate substitute for DZ. The ages of those siblings were between 62 and 90, and the age difference between each fraternal partner was less than six years, with an average of 3.4 years. It was assumed that this amount of disparity in age causes little effect upon the senescent phenomena.

MZ and DZ were discriminated according to the polysymptomatic similarity diagnosis, proposed by Siemens ('27) and von Verschuer ('28), with a consideration of the method by Inoue ('56). The fundamental items in this procedure are as follows.

1. Blood type: blood tests of ABO groups, MN types and Q type were made. Saliva test for S or s type was performed.

2. Fingerprint: the fingerprints of 10 fingers of both hands were investigated and they were classified into U (ulnar loops) and W (whorls), A (arches) and R (radial loops).

3. X-ray photography of bones: the head (in ventero-dorsal and latero-lateral direction), the chest (dorso-ventral), lumbar region (ventero-dorsal and latero-lateral), the right hand (dorso-palmar), and the right knee-joint (antero-posterior and latero-lateral) were photographed.

4. Teeth type: impression of all teeth by gypsum was made.

5. Hair of the head: the form of the hair of head was classified into 5 types according to Martin's method ('56).

6. Hand, finger and nail: they were morphologically observed.

7. External nose and naris: the former was classified into 9 types, and the latter into 4 types according to Martin's method ('56).

8. Brow: its shape was examined.

9. Eye: directions of the palpebral fissures were described as horizontal, outside-up or outside-down and the palpebral folds, as single and double. Also the existence of epicanthus was examined.

10. Hairs on the middle phalanx of the fingers: it was observed whether they exist or not.

11. Auricle: form of Darwin's protuberance was classified into 6 kinds and that of lobule of the auricle into 6 kinds, according to Martin's method ('56).

12. Cerumen: it was described as dry or wet.

13. Lips: their sizes and thickness were observed and they were classified into 9 kinds, and profile of the upper lip into 12 kinds, according to Martin's method ('56).

14. Head: the measurements of the head length (maximum anteroposterior diameter), head breadth (biauricular breadth), and horizontal head circumference (horizontal circumference through glabella) were made.

15. Bodily constitution: measurements of the body length, the girth of the chest, and the weight of the body were made. Moreover, types of bodily build were divided into pyknic, lean and middle.

It is to be added that in the diagnosis of zygosity, the opinions of the twins' surroundings if each partner has been really looking alike were referred.

By the above mentioned procedures we had 21 MZ (7 ♂ and 14 ♀) and 6 DZ

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(2 ♂♂, 1 ♀♀ and 3 ♂♀). Twins and siblings divided according to age are shown in Table 1.

The values of the bodily build and the other body parts of the twins are shown in Table 2.

The life history of these materials was investigated in detail. Its outline is shown in Table 3.

### Methods

The following various morphological observations or measurements were made on each pair of the twins and the siblings. In addition, photographs of various parts of the body were taken for supplementary observation.

1. The approximate number of gray hairs on the head.

Estimation of the number of gray hairs compared with that of the total hair on the head was made by inspection, and the following classification was used.

Tab. 1. Age distribution of pairs studied

Zygosity	Sex	41 ~ 49	50 ~ 59	60 ~ 69	70 ~ 79	80 ~ 90	Total Number
MZ	♂♂		2	3	1	1	7
	♀♀	1	3	6	3	1	14
DZ	♂♂	1		1			2
	♀♀		1	2	1		3
SL	♂♂ I				5	2	7
	♂♂ II			1	5	1	7
	♀♀ I			3	2	4	9
	♀♀ II			4	3	2	9

MZ: Monozygotic twins

DZ: Dizygotic twins

SL I & II: Siblings, whose age difference within 6 years

- ±(grade 1): almost absent.
- +(grade 2): less than about one-third.
- ++(grade 3): less than about two-thirds.
- +++ (grade 4): more than about two-thirds.
- ++++ (grade 5): almost all.

2. The size of alopecia senilis on the parietal region.

The degree of progress of baldness was classified as follows:

- ♂
- ±(grade 1): no distinct bald area recognized.
  - +(grade 2): one-third of the hair region or less bald.
  - ++(grade 3): one-third to two-thirds bald.
  - +++ (grade 4): more than two-thirds bald.

- ♀
- ±(grade 1): no distinct baldness.
  - +(grade 2): approximate diameter of the baldness less than 3 cm.
  - ++(grade 3): from 3 cm to 6 cm.
  - +++ (grade 4): more than 6 cm.

3. The approximate number of wrinkles on the frontal region.

The number of wrinkles on the frontal region, which cross with the median line, was counted.

4. The comparative number of sulci cutis measured on the skin replica.

The specimens of the central parts of the nape, the anterior chest and the back of the right hand were made according to "SUMP" method (SUMP Dokokwai, '36.) Then, those were photographed and the figures enlarged 12 times of the actual size were obtained. On three parts, chosen at random, of each figure a round glass with a diameter of 30 mm were put and then the average number of sulci cutis crossing its circumference was counted.

5. The formation of senile pigment spots.

The approximate number of senile pigment spots was counted on the face, the back of the right hand, the extensor surface of the right forearm, and the back region. The grade of development of those spots was classified as follows.

- ±(grade 1): formation not distinct.
- +(grade 2): less than 10 spots.
- ++(grade 3): more than 10 to 20.
- +++ (grade 4): more than 20.

6. The appearance of the senile wart.

The existence and position of senile wart on the face, the neck, the chest and the belly, and the back were recorded.

7. The development of pinguecula of the left eye.

The vertical margin of pinguecula along the cornea was measured. The degree of its development was classified as follows.

- ±(grade 1): only a trace of pinguecula.
- +(grade 2): less than 3 mm.
- ++(grade 3): from 3 mm to 6 mm.
- +++ (grade 4): more than 6 mm.

8. The development of arcus senilis (gerontoxon) of the left eye.

Classification was made as follows.

- ±(grade 1): formation not distinct.

- + (grade 2): gerontoxon extends to less than one-third of the circumference of cornea.
- ++ (grade 3): from one-third to two thirds.
- +++ (grade 4): from two-thirds to the whole circumference.

9. The development of marginal protuberances of the lumbar vertebral bodies.

X-ray photography of the lumbar region was made in both directions from a distance of 90 cm as mentioned in the previous chapter. The development of the marginal protuberances at the corners of the lumbar vertebral bodies was observed. Those were marked as one, two or three, which are explained as follows:

- 1: protuberance very thin and short.
- 2: fairly developed, but does not touch with the neighboring one.
- 3: overdeveloped and connected with the neighboring one, and is called lipping (Bohatirchuk, '55).

Then, the sum of these marks concerning each lumbar vertebral body was counted and also those of all lumbar vertebral bodies was added up.

10. The development of marginal protuberances on the upper end of the right tibia.

X-ray photography of the knee region was made in both directions from a distance of 65 cm as mentioned previously. In these X-ray photographs, examination of the existence of the marginal protuberances on the medial and lateral side of the tibia was made.

11. The fabella in the right knee.

Examining the same X-ray photograph of the right knee, as was obtained in item 10, records of the existence of the fabella were kept.

12. The calcification in the arch of aorta.

X-ray photograph of the chest was made from a distance of 150 cm as mentioned previously. On that figure, the existence of the calcified portion in the arch of aorta was examined.

Concerning the finding of the above items 6, 10, 11, 12, the rate of concordance between both partners of each pair was counted. Concerning item 9, the grade of resemblance between both partners by means of laying X-ray photographs of LII, LIII and LIV of one partner upon those of another partner was investigated. Next, concerning items 1, 2, 3, 4, 5, 7, 8, 9, the middle percentage deviation and also mean deviation of each partner according to v. Verschuer's method ('27). Calculation was made as follows:

$$\text{percentage deviation } D = \frac{a - b}{2} / \frac{a + b}{2} \times 100 = \frac{a - b}{a + b} \times 100$$

$$\text{middle percentage deviation } \varepsilon = \frac{\sum D}{n}$$

$$\text{mean deviation } f\varepsilon = \frac{\varepsilon}{\sqrt{2n}}$$

a: the value of one partner.

b: the value of another partner.

n: number of pairs.

On the other hand, we counted the coefficient of correlation  $r$  of each partner in the above mentioned items.

Then the values of  $\varepsilon$  or  $r$  for both MZ and DZ (or SL) were compared. As to the significance of the difference between both values  $\chi^2$ -test according to R. A. Fisher was made in the case of  $\varepsilon$  and  $\nu_s$  was counted in the case of  $r$  as follows.

$$\nu_s = \frac{|Z_1 - Z_2|}{\sqrt{\frac{1}{n_1 - 3} + \frac{1}{n_2 - 3}}}$$

$n_1$  or  $n_2$ : number of MZ or DZ

$$Z : \frac{1}{2} \log \frac{1+r}{1-r}$$

Then the probability  $\alpha$  for  $|v| > |\nu_s|$  was obtained by the table of normal distribution.

### Results

The findings in each item are as follows.

1. The approximate number of gray hairs on the head.

The correlation table of the approximate number of gray hairs, classified into four grades in MZ and in SL, is shown in Table 4.

From this table it is evident that the correlation is stronger in MZ than in SL. The photographs, Fig. 1 and 2 (MZ), are of cases with an inconsiderable difference

**Tab. 4. Correlation table of the approximate number of gray hairs on the head**

II	MZ					II	SL and DZ *				
	I						I				
	++++	+++	++	+	±		++++	+++	++	+	±
++++	1					++++	1 (1)				
+++	5					+++	2				
++	1 2 1					++	2 1 3				
+	1 10					+	2 1 1+(2) 1				
±						±	1 1				

$r = 0.835$  (Significant, 1% level)

$\alpha = 0.009 < 0.01$

$r = 0.255$  (Not significant)

\* written in parentheses

in the number of gray hairs between both partners, Fig. 3 (MZ), 4 (DZ), 5 (SL) are of the cases with a considerable difference.

Fig. 1. MZ N. 7 ♂ at age 81  
Approximate number of gray hairs:  
I = II

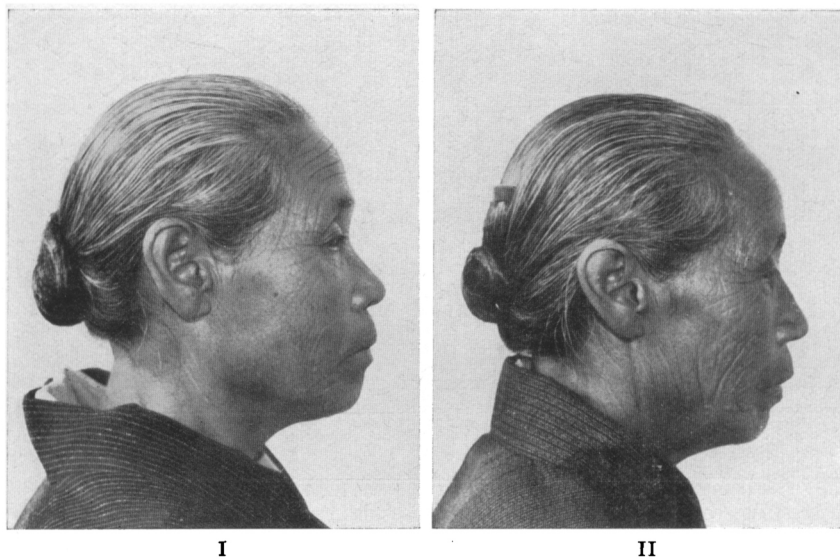
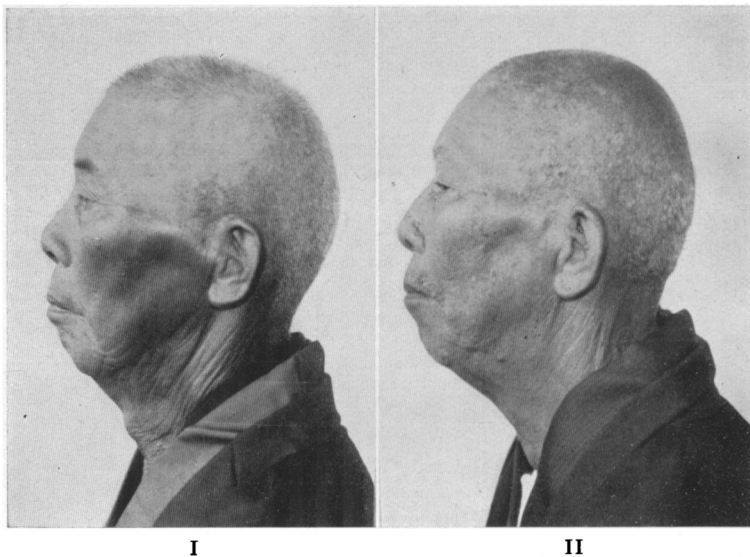


Fig. 2. MZ N. 16 ♀ at age 67  
Approximate number of  
gray hairs: I = II

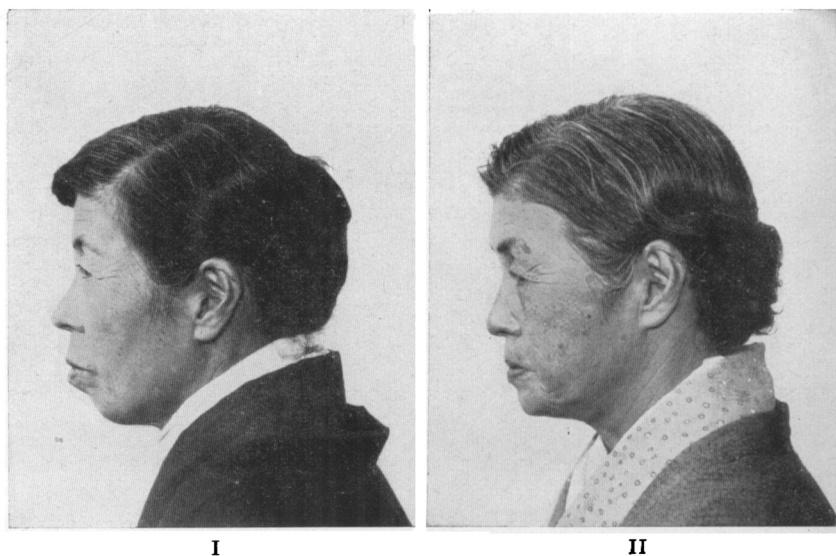


Fig. 3. MZ N. 12 ♀ at age 60  
Approximate number of  
gray hairs: I < II

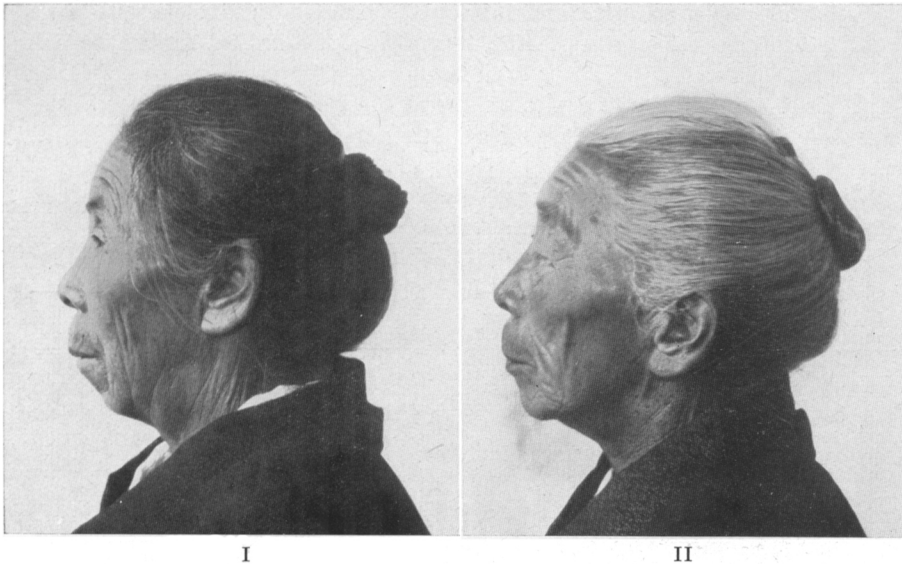
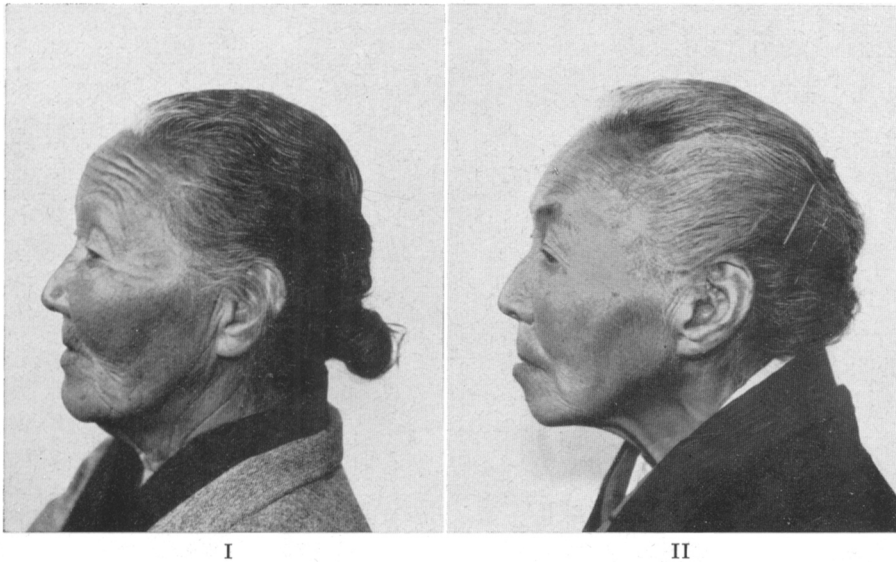


Fig. 4. DZ N. 24 ♀ at age 72  
Approximate number of gray hairs: I < II

Fig. 5. SL N. 12 ♀ at ages 72 (I) and 71 (II)  
Approximate number of gray hairs: I < II





2. The appearance and the size of alopecia senilis on the parietal region.

The correlation of the existence and of the size of alopecia senilis for each sex is shown in Table 5.

From this table we know that the existence of baldness coincides with each other in ♂ MZ, but some discordance between partners is recognized in ♂ SL. But in

Tab. 5. Correlation table of size of alopecia senilis on the parietal region

II	(1) MZ ♂♂ I					II	(2) SL ♂♂ and DZ ♂♂* I				
	++++	+++	++	+	±		++++	+++	++	+	±
++++						++++					
+++						+++					
++					I	++			I	I	
+		I				+				2 I	
±					3	±				I I+(2)	
r = 0.638 (Not significant)						r = 0.453 (Not significant)					
$\alpha = 0.46 > 0.05$											

II	(3) MZ ♀♀ I					II	(4) SL ♀♀ and DZ ♀♀* I				
	++++	+++	++	+	±		++++	+++	++	+	±
++++						++++					
+++						+++				I	
++						++			2		
+					I	+					
±					8	±			I I+(1)	2	
r = 0.366 (Not significant)						r = 0.144 (Not significant)					
$\alpha = 0.52 > 0.05$											

\* written in parentheses

the case of ♀, many discordant cases between partners as to the existence of baldness were recognized in both MZ and SL.

The value of r is not significant with regard to both partners of MZ and also of SL, and a significant difference could not be recognized between both values of r for MZ and SL.

The result with respect to the localization and of the shape of baldness is as follows: in the case of ♂, a very close resemblance was recognized between both part-

Tab. 7. Comparison of relative numbers of sulci cutis between partners by means of 'SUMP' method

Region		♂ ♂				♀ ♀				♂ ♀
		MZ	DZ	SL	Difference of $\epsilon$ bet. MZ and SL	MZ	DZ	SL	Difference of $\epsilon$ bet. MZ and SL	DZ
Nape	Pairs	6	2	7		14	0	8		3
	$\epsilon$ & $f\epsilon$ r	$6.6 \pm 1.67$ -0.269	$5.0 \pm 2.19$	$5.1 \pm 1.01$ 0.734	*	$8.0 \pm 1.71$ 0.672**	—	$6.2 \pm 1.69$ -0.220	Not significant	$6.6 \pm 2.34$
Back of right hand	Pairs	4	2	5		13	1	6		3
	$\epsilon$ & $f\epsilon$ r	$14.7 \pm 2.92$ 0.278	$5.7 \pm 2.15$	$5.4 \pm 0.60$ 0.895**	*	$16.0 \pm 3.04$ 0.496	10.0	$9.8 \pm 3.51$ 0.682	significant	$8.8 \pm 5.30$
Anterior chest	Pairs	6	2	7		14	0	8		3
	$\epsilon$ & $f\epsilon$ r	$10.4 \pm 2.69$ 0.856*	$10.6 \pm 5.66$	$15.4 \pm 3.60$ 0.672	Not significant	$9.3 \pm 1.32$ 0.783**	—	$18.0 \pm 4.73$ 0.655	Not significant	$15.9 \pm 8.45$

\* Significant, 5% level    \*\* Significant, 1% level

ners in almost all cases of MZ, and a fairly one in many cases of SL; in the case of ♀, either cases with very close resemblance or entirely no resemblance were noticed with regard to MZ, and no resemblance in all cases of SL.

The photographs of cases, where almost no difference is recognized as to the shape and the size of baldness, are shown in Fig. 6 (MZ), and cases, where a difference is recognized are shown in Fig. 7 and 8 (MZ), 9 (DZ), 10 and 11 (SL).

3. The number of wrinkles on the frontal region.

The correlation of the approximate number of the wrinkles is shown in Table 6.

This table shows that the significant difference of  $r$  is not recognized between MZ and SL.

On the photographs of all cases, the localization, the shape and the depth of wrinkles were compared between both partners. As to their localization and shape,

**Tab. 6. Correlation table of the approximate number of wrinkles in the frontal region**

II	MZ						II	SL and DZ *					
	I							I					
	7	6	5	4	3	2	7	6	5	4	3	2	
7	1		1	1			1						
6												1	
5	1		2	1	2				2	2	1		
4				8	2			1	(1)	1+(1)	1		
3				1		1				1+(1)	1	1	
2									1	1	1		

$r = 0.549$  (Significant, 5% level)

$r = 0.385$  (Not significant)

$$a = 0.76 > 0.05$$

\* written in parentheses

almost no difference in MZ was observed in many cases, as is shown in Fig. 12, 13, 14, 15, while a little difference in DZ or in SL was noticed in many cases, as is shown in Fig. 17, 18. The difference of their depth was recognized sometimes between the partners of MZ, as is shown in Fig. 16, and often in DZ or in SL, as is shown in Fig. 17.

4. The comparative number of sulci cutis.

The values of  $\epsilon$  and  $r$  were obtained from the comparative number of sulci cutis of certain parts of the skin and they are shown in Table 7.

This table shows, contrary to expectation, that the values of  $\epsilon$  in MZ are not significantly smaller than those of  $\epsilon$  in DZ or in SL at any of those three parts of the skin, both in ♂ and in ♀.

Especially it is to be noted that concerning the nape or the back of the right hand in ♂, the value of  $\epsilon$  in MZ is significantly larger than that of  $\epsilon$  in SL.

5. The development of senile pigment spots.

The correlation of the existence and the development of senile pigment spots

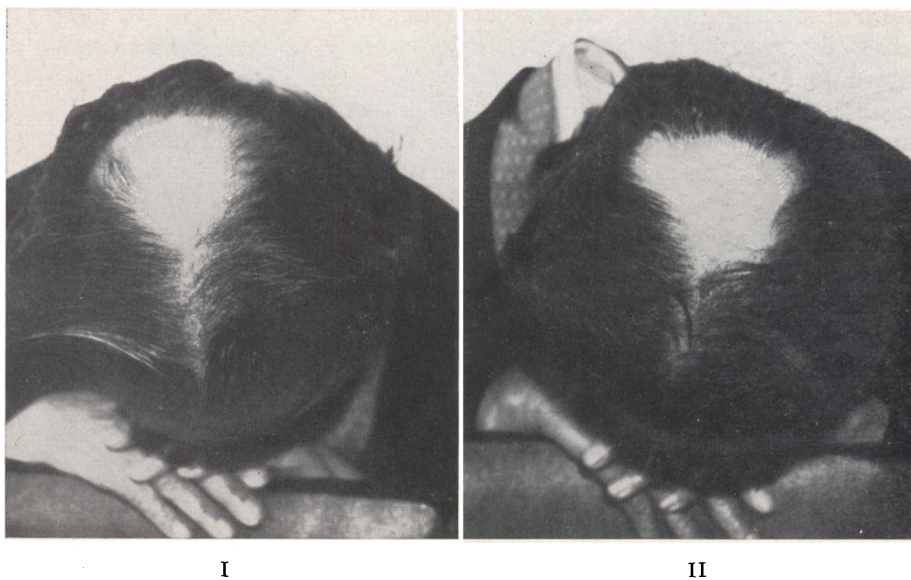
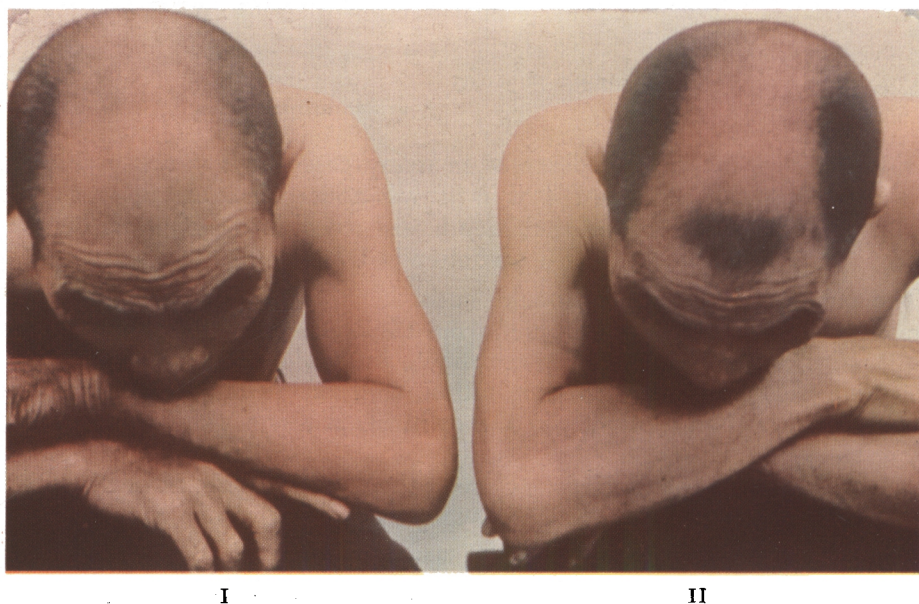


Fig. 6. MZ N. 19 ♀ at age 73  
Progression of alopecia senilis: I = II

Fig. 7. MZ N. 5 ♂ at age 68  
Progression of alopecia senilis: I > II



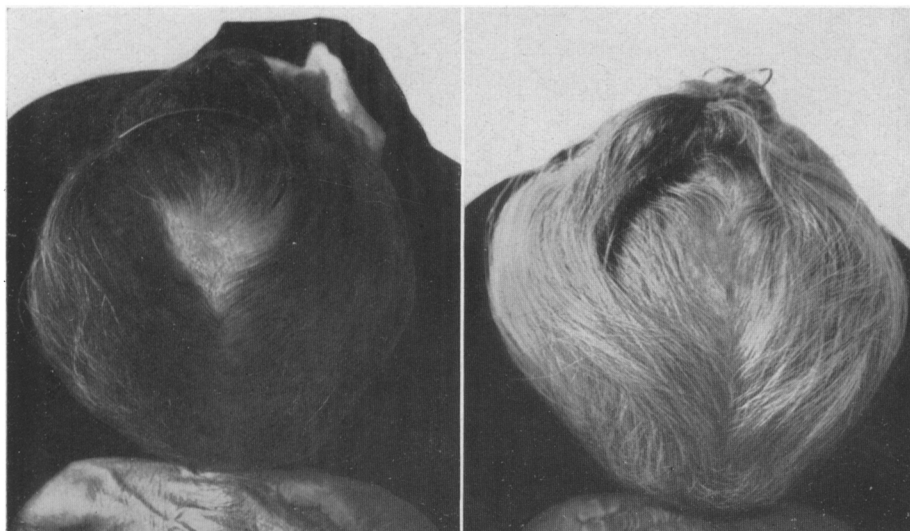


I

II

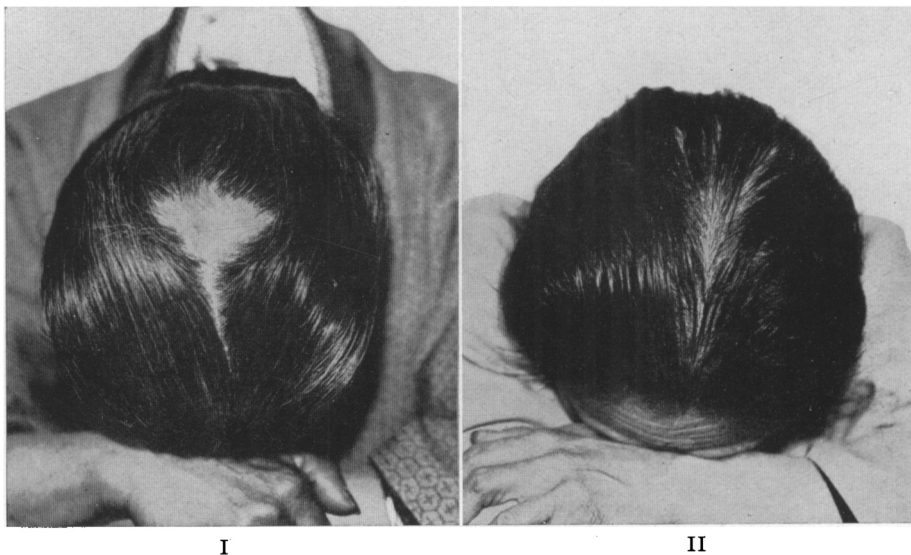
Fig. 8. MZ N. 18 ♀ at age 70  
Progression of alopecia senilis:  $I < II$

Fig. 9. DZ N. 24 ♀ at age 72  
Progression of alopecia senilis:  $I > II$



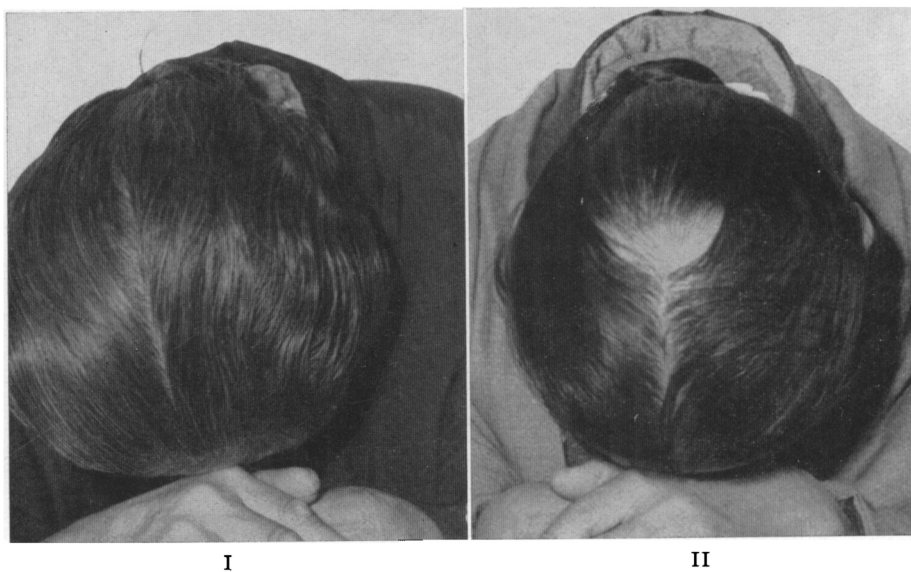
I

II

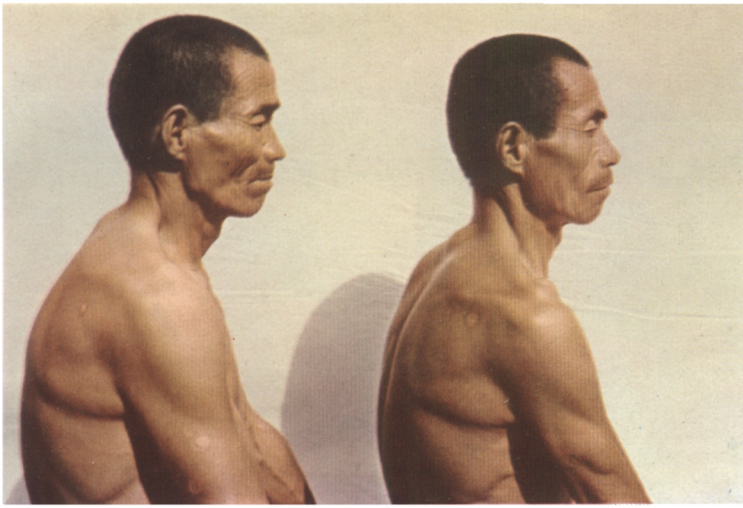


I II  
Fig. 10. SL N. 15 ♀ at ages 65 (I) and 62 (II)  
Progression of alopecia senilis: I > II

Fig. 11. SL N. 16 ♀ at ages 64 (I) and 62 (II)  
Progression of alopecia senilis: I < II



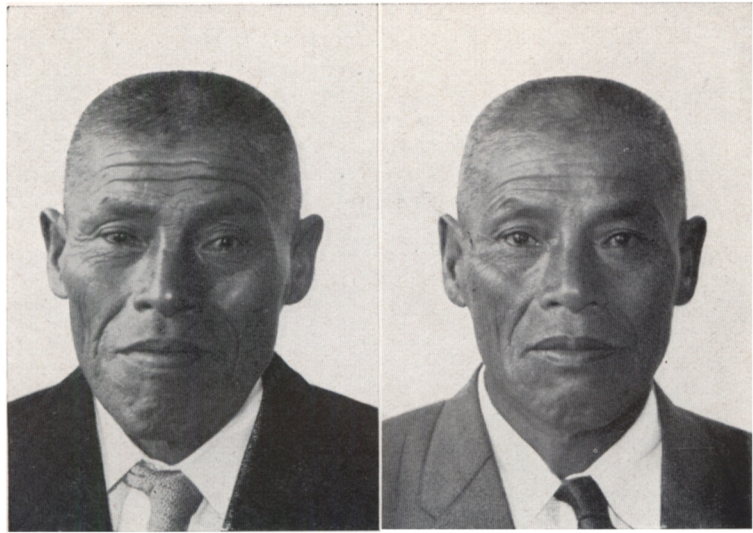
I II



I

II

Fig. 12. MZ N. 1 ♂ at age 58  
Approximate number  
and depth of wrinkles in the  
frontal region: I = II



I

II

Fig. 13. MZ N. 3 ♂ at age 64  
Approximate number of  
wrinkles in the frontal re-  
gion: I = II  
Depth of wrinkles:  
I > II



Fig. 14. MZ N. 4 ♂ at age 65  
Approximate number of  
wrinkles in the frontal re-  
gion: I < II  
Depth of wrinkles:  
I = II

Fig. 15. MZ.N. 16 ♀ at age 67  
 Approximate number of wrinkles in the frontal region:  $I < II$   
 Depth of wrinkles:  $I > II$



I

II



I

II

Fig. 16. MZ.N. 15 ♀ at age 62  
 Approximate number of wrinkles in the frontal region:  $I < II$   
 Depth of wrinkles:  $I < II$

Fig. 17. DZ N. 23 ♂ at age 63  
 Approximate number and depth of wrinkles in the frontal region:  $I > II$



I

II



**Tab. 8. Correlation table of develop**

**A. Face**

II	MZ I					II	SL and DZ *** I				
	++++	+++	++	+	±		++++	+++	++	+	±
++++						++++					
+++		5	5			+++		5	3+(1)	1	
++		1	1	2		++		4	2+(2)		
+				4		+				1	
±					3	±					

$r = 0.872^{**}$        $r = 0.217$   
 $\alpha = 0.002 < 0.01$       (Not significant)

**C. Extensor surface of right forearm**

II	MZ I					II	SL and DZ *** I				
	++++	+++	++	+	±		++++	+++	++	+	±
++++						++++					
+++			2	2	3	+++		1	4	(1)	
++				2	1	++		1	1	3	
+			1	1	7	+		1	1+(1)	3	
±						±					1+(1)

$r = 0.468^*$        $r = 0.501^*$   
 $\alpha = 0.992 > 0.05$

**B. Back of right hand**

II	MZ I					II	SL and DZ *** I				
	++++	+++	++	+	±		++++	+++	++	+	±
++++						++++					
+++				1	1	+++			4	1+(1)	
++			2	3		++		1	4		
+		1		9	1	+		1	2+(1)	3	
±					1	±					(1)

$r = 0.142$  (Not significant)       $r = 0.069$  (Not significant)  
 $\alpha = 0.984 > 0.05$

**D. Upper half of back**

II	MZ I					II	SL and DZ *** I				
	++++	+++	++	+	±		++++	+++	++	+	±
++++						++++					
+++			1	2		+++			1	(1)	
++				1		++				3	
+					6	+		1		7+(1)	(1)
±					1	±				1	3

$r = 0.773^{**}$        $r = 0.555^*$   
 $\alpha = 0.267 > 0.05$

\* Significant, level 5%  
 \*\* Significant, level 1%  
 \*\*\* written in parentheses

on the face, the back of the right hand, the right forearm and the back, is shown in Table 8.

This table shows that the correlation is stronger in MZ than in SL on the face. The higher resemblance of the localization of pigment spots on the face was noticed in many cases of MZ compared to that in DZ or in SL (Fig. 19, 21, 22). On the other hand, Fig. 20, a case of MZ, shows the discordance of the localization of spots on the back.

6. The appearance of the senile wart.

The result on the existence of senile warts is shown in Table 9.

In one concordant case of MZ (Fig. 23), the localization in both partners is almost

**Tab. 9. Appearance of the senile wart**

Zygosity	Pairs	Appearance		
		++	+-	--
MZ	21	1	2	18
DZ	3			3
SL	16	3	4	9

++: Appeared in both partners.  
 + -: Appeared only in one partner.  
 --: Not appeared.



Fig. 18. SL N. 12 ♀ at ages 72 (I) and 71 (II)  
 Approximate number of wrinkles in the frontal region: I > II  
 Depth of wrinkles: I > II

the same, but the size is different. However, the fact that there were two discordant cases of MZ, shows that the control of heredity upon the formation of senile wart is not powerful.

7. The development of pinguecula of the left eye.

The correlation of the development of pinguecula of the left eye is shown in Table 10.

From this table, control of heredity upon the development of pinguecula was recognized to be fairly strong.

8. The development of arcus senilis (gerontoxon) of the left eye.

It was found that in all cases of MZ, DZ and SL there was a concordance between partners as to the existence of arcus senilis. Now, the correlation of its development is shown in Table 11.

From this table it is recognized that the correlation is stronger in MZ than in SL.

9. The development of marginal protuberances on the lumbar vertebral bodies.

The degree of development of marginal protuberances on each lumbar vertebral body in the X-ray photographs of both partners was compared, as is shown partially in Fig. 24, 25, 26. The correlation with regard to the mark of each body and the total sum of LI-LV are shown in Table 12.

The value of  $r$  for LI-LV in MZ is somewhat larger, but with an insignificant difference, than that of  $r$  in SL. This tendency is also noticed for in the value of  $r$  for the total sum of LI-LV.

Next, the result, where the X-ray photographs of LII-LIV of both partners were placed upon each other, is shown in Table 13.

This table shows that the degree of concordance was generally larger in MZ than in SL. The copies of X-ray photographs are shown in Fig. 27, 28, 29 and 30.

10. The development of marginal protuberance on condylus lateralis et medialis of the right tibia.

Their existence is shown in Table 14 A.

Further, this result was classified according to both condylus, as is shown in Table 14 B.

From these tables, it appears that the degree of the concordance of their existence is higher in MZ than in SL. In two concordant cases of MZ, the marginal protuberance exists both on condylus lateralis et medialis of both partners, as one of those is shown in Fig. 31. On the other hand, in the two concordant cases of SL, the marginal protuberance was found on condylus lateralis et medialis of one partner, and on the condylus lateralis of the other partner. Therefore, the degree of concordance as to the development of marginal protuberances is considered to be higher in MZ than in SL.

11. The fabella in the right knee.

Their existence is shown in Table 15.

The case “ + — ” was not found in MZ, but was found in DZ and in SL. It may

Fig. 19. MZ N. 13 ♀ at age 61  
Approximate number of  
senile pigment spots on the  
face: I = II

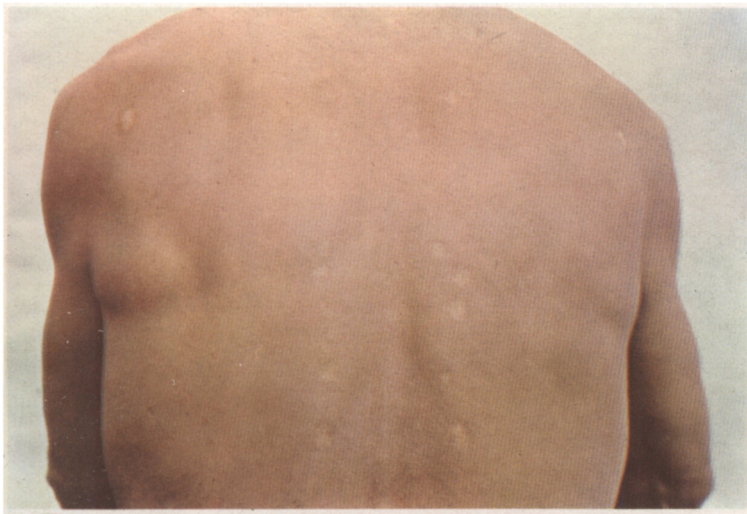
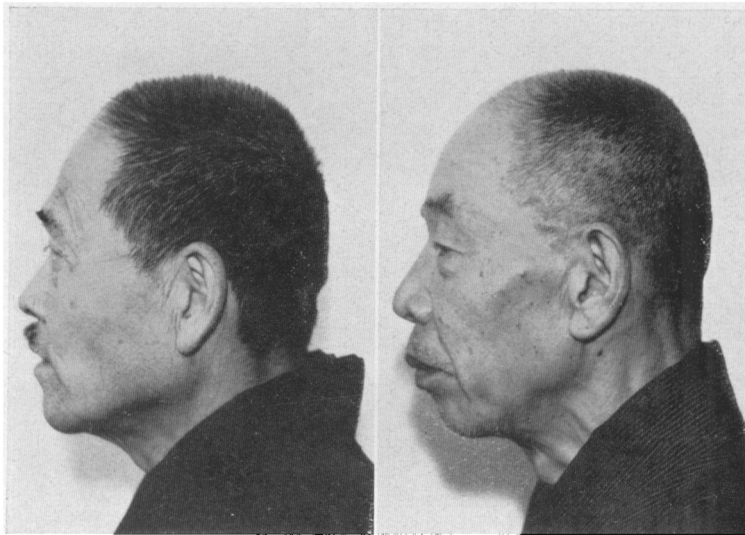


Fig. 20. MZ N. 1 ♂ at age 58  
Approximate number of  
senile pigment spots on the  
back: I < II



II



I

II

Fig. 21. SL N. 7 ♂ at ages 71 (I) and 68 (II)

Approximate number of senile pigment spots on the face: I < II



I

II

Fig. 22. SL N. 11 ♀ at ages 80 (I) and 76 (II)

Approximate number of senile pigment spots on the face: I < II



I

II

Fig. 23. MZ N. 19 ♀ at age 73

Localization of senile wart (arrow) is almost the same

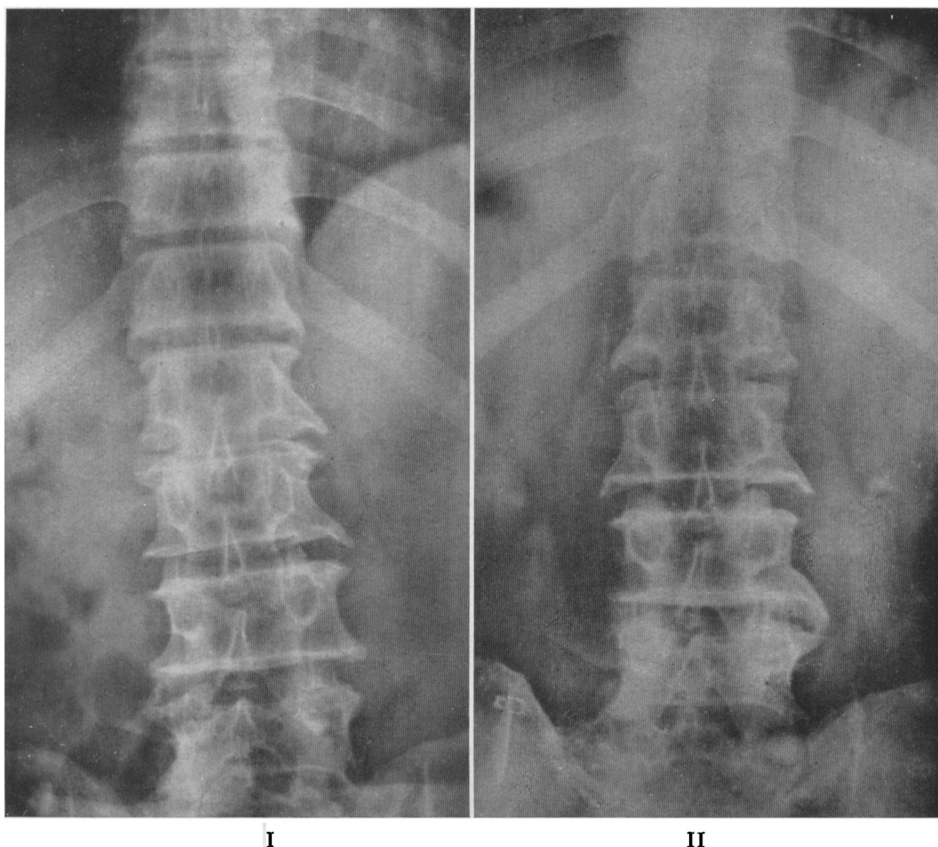


Fig. 24. MZ N. 3 ♂ at age 64

Marginal protuberances of lumbar vertebral bodies in both partners are similarly developed, but their localization is not concordant

be presumed that the degree of concordance is higher in MZ than in SL, although number of the cases are not sufficient enough to give a definite conclusion.

12. The calcification in the arch of aorta.

Their existence is shown in Table 16.

It is noticeable that the discordant cases were often found in all MZ, DZ and SL, too. One case of MZ is shown in Fig. 32.

Next, the comparison of various senescent phenomena between two partners of MZ and DZ or SL is listed in table 17 by using marks, O, V, VV, VVV.

In this table it is shown that occasionally the degree of the progression of various senescent phenomena differs fairly between both partners of MZ and in such cases, a certain phenomenon proceeds more in one partner, while on the other hand another phenomenon does in another partner. Next, there is such tendency that in DZ

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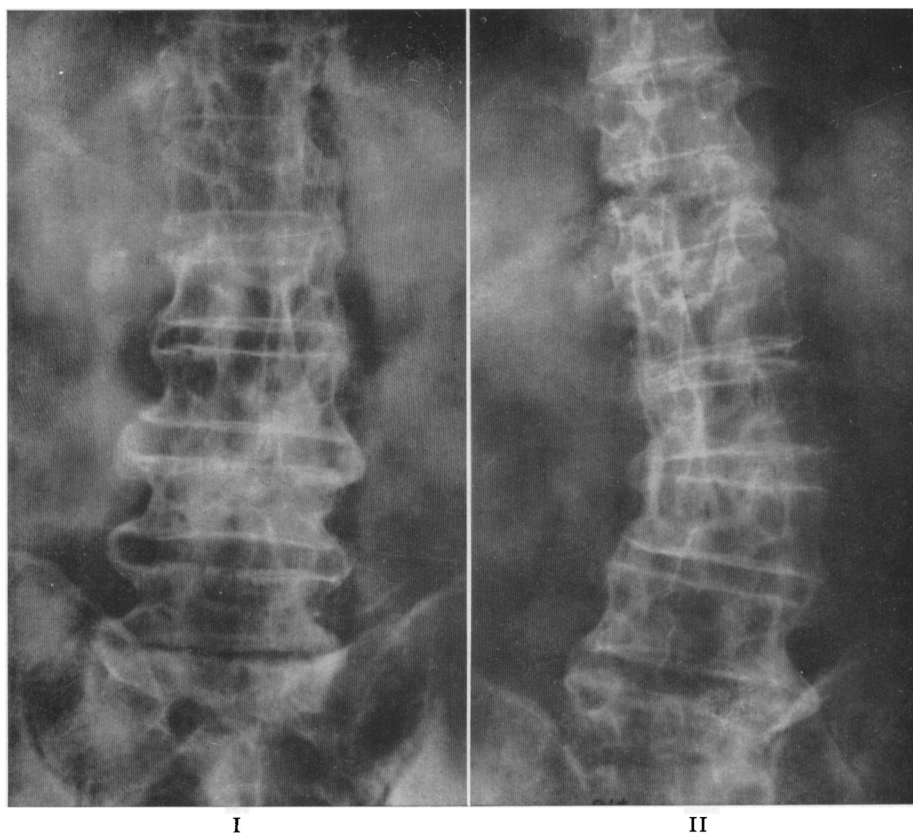


Fig. 25. MZ N. 7 ♂ at age 81  
Development of marginal protuberances of lumbar vertebral bodies: I > II

and SL difference of progression is more remarkable than in MZ, especially much more so in SL.

An attempt was made to show the resemblance or the difference between both partners by means of marks and to compare the senescent phenomena as a whole between both partners of MZ, DZ and SL by summing up these marks. That is, marks of 0, 1, 2 and 3 mean respectively O, V, VV, and VVV in Table 17, and the marks with regard to the following six important items were added up: the approximate number of gray hairs on the head, the size of alopecia senilis on the parietal region, the approximate number of wrinkles on the frontal region, the development of senile pigment spots, the development of pinguecula, and the development of arcus senilis. The average value as to MZ was 2.8, DZ 4.7 and SL 5.8. So we may consider that the degree of resemblance is larger in MZ than in DZ or SL.

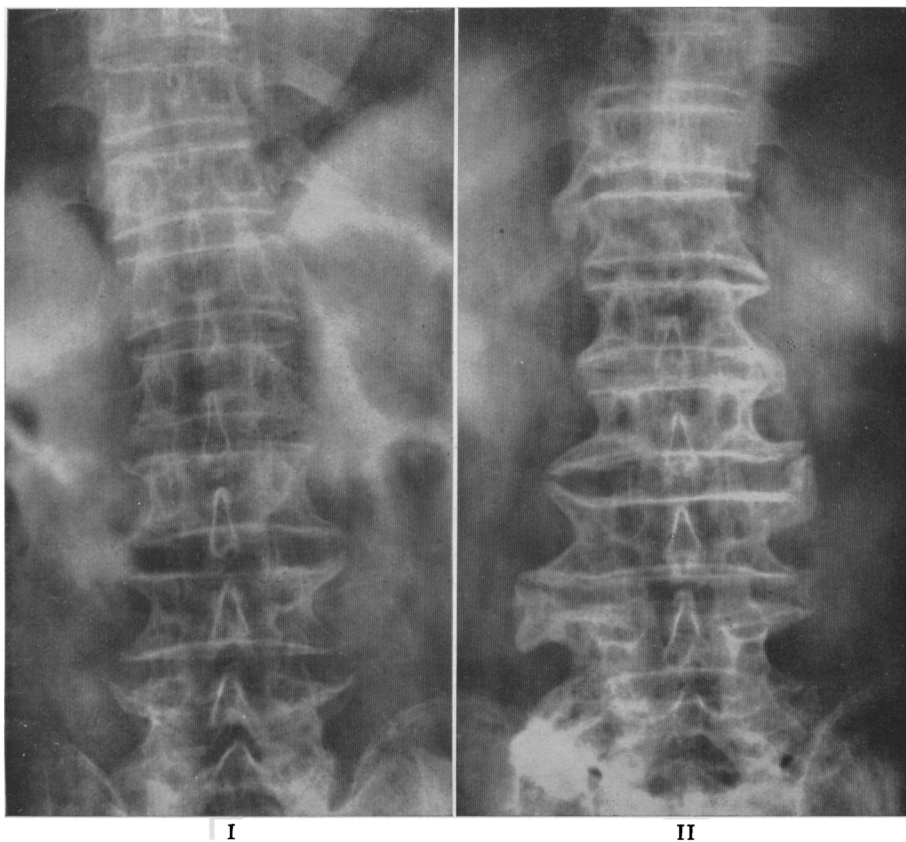


Fig. 26 SL N. 2 ♂ at ages 83 (I) and 80 (II)  
Development of marginal protuberances of lumbar vertebral bodies: I < II

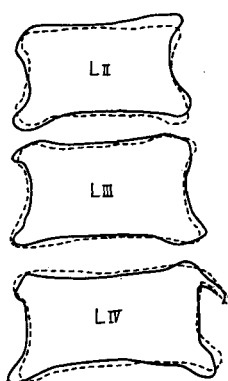


Fig. 27. MZ N. 19 ♀ I —, II .....  
Almost concordant

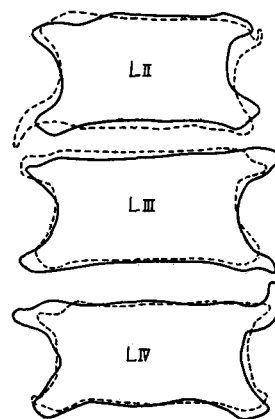


Fig. 28. MZ N. 2 ♂ I — II .....  
A little discordant



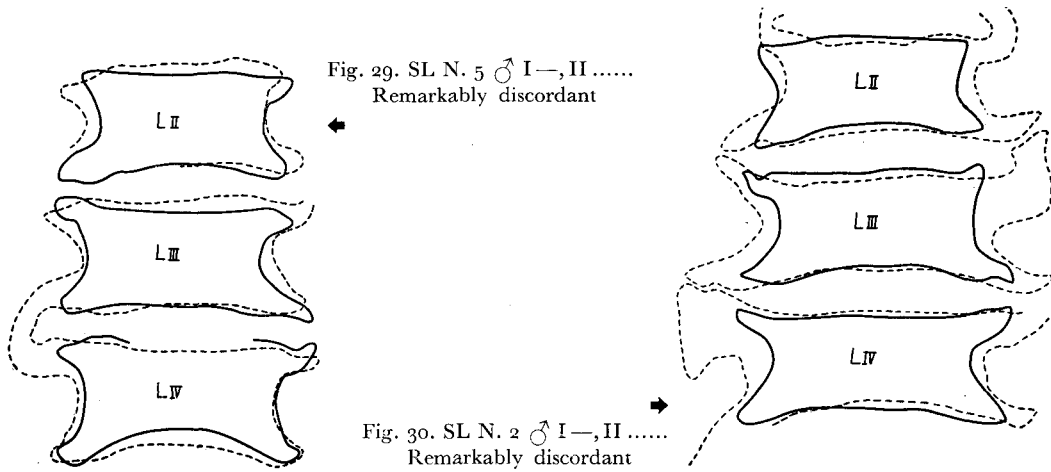
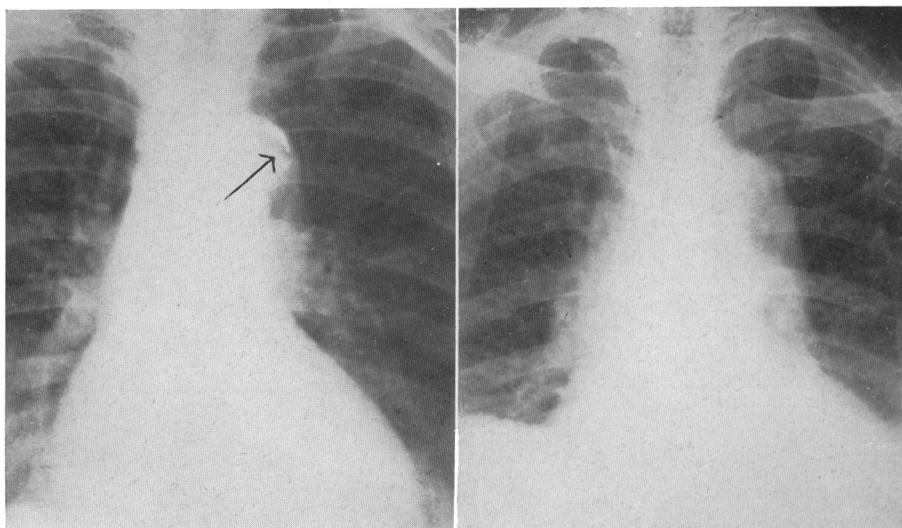


Fig. 31. MZ N. 14 ♀ at age 61  
Development of marginal protuberances of condylus medialis et lateralis in the right tibia: I = II

Fig. 32. MZ N. 18 ♀ at age 70  
Calcification in the arch of aorta: I: + (arrow)  
II: —



## Discussion

Medical or anthropological studies on senescent twins have been reported in several recent papers. The life spans and the causes of death of twins were studied by Kallmann and Sander ('49), Kallmann, Ashner and Falek ('56). The former investigators found by observation of many aged twins, similarities in many physical and psychological features of monozygotic twins partners definitely exceeded those found in dizygotic pairs and have a tendency to persist throughout life. The latter investigators collected 2536 twin cases of over 60 years of age and found that the average intra-pair difference of life spans in monozygotic pairs proved to be 36.0 months, that in homosexual dizygotic pairs 74.6 months and that in the opposite-sexed dizygotic group 106.0 months. But v. Verschuer ('58) reported by examination of 150 cases of aged twin pairs that no difference was found in the life span between MZ and DZ. Next, Vogt ('39) studied 19 pairs of MZ of from 55 to 81 years of age and found that they aged in similar manner, and in partners of MZ the patterns of the retinal blood vessels were very similar with each other. V. Verschuer ('54) made anthropological measurement on 150 pairs of twins 4 times from 1924 to 1950. According to him, in 4 pairs of MZ (♀ 3, ♂ 1), intra-pair similarities were remarkable in the appearance of gray hairs on the head, the decrease of skin tension, the development of wrinkles on the face, and the development of alopecia senilis. But in another pair of MZ ♀, he recognized a remarkable difference of these features. His conclusion is that these senescent phenomena are controlled mainly by hereditary factors.

Besides, there are case reports on senescent monozygotic twin brothers by Kallmann and Sander ('48) and by Kürten ('34). In both of those the high similarity in various clinical findings between pairs are noted. Sandelius ('56) made an anthropologic and clinical investigation on twin sisters of 99 years and states that these twins present close similarities in various features, especially resemblance in the patterns of the retinal blood vessels is striking, but they present differences only with regard to blood pressure and electrocardiograms.

The results of our study are fairly similar to those obtained by the above mentioned investigators. It is evident that many senescent phenomena are controlled considerably by hereditary factors. To those items, in which hereditary factors play a great role, belong the approximate number of gray hairs on the head, the existence, the localization and the shape of alopecia senilis on the parietal region in ♂, the localization and the form of wrinkles on the frontal region, the localization and the development of senile pigment spots on the face, the development of pinguecula and of arcus senilis of the eye, the development and the shape of marginal protuberances on the lumbar vertebral body, and the development of marginal protuberances on condylus lateralis et medialis of the tibia. On the other hand, those items which are subject to the remarkable influences of the environment are the appearance of alopecia senilis on the parietal region in ♀, the number of wrinkles on the frontal region, the comparative number of sulci cutis on the nape, the back of the right hand,

the anterior chest, the number of senile pigment spots on the back of the right hand, the extensor surface of the right forearm, and the upper half of the back of chest, the appearance of the senile wart on the body, and the calcification in the arch of the aorta.

We attempted to examine if any relationship between these senescent phenomena and the life histories could be found. As is shown in Table 17, remarkable differences between partners of some monozygotic twins are recognized as to the degree of the progression of certain senescent phenomena. We compared the life histories of partners of those twins. The details are shown in Table 18 A, B, C, D, E.

In Table 18 A, the difference is estimated between the labor of a house-wife and that of a female farmer. But, it seems to be doubtful whether the inverse relation between the development of alopecia senilis in ♀ and the quantity of labor always exists or not. As number of our cases is few, however, this problem must be examined in the future. Next, we considered the relation between the dressing of hair in the Japanese old style for many years and the progression of baldness. According to Dohi ('24), the old Japanese hair-dressing causes alopecia atrophica parietalis. Therefore, we selected those cases, in which one partner of twins had been dressing her hair in the Japanese old style for many years, while another had no such habit and investigated the existence of baldness on them. The result is shown in Table 19.

From this table, we may presume that the old Japanese hair-dressing worn for many years probably has some relation with the progression of the baldness in ♀. However, in 4 cases of MZ, in spite of such hair-dressing lasting for 10 to 35 years, the baldness was not observed on the parietal region. As for the number of delivery in Table 18 A, they were all multiparous. Therefore, the baldness seems to have no relation with delivery.

From Table 18 B, C, D, E, we can not find any environmental factor, which may have a definite relationship to the development of senile pigment spots, pinguecula of the temporal side of the left eye, the development of marginal protuberances on the upper end of the right tibia, and the calcification in the arch of the aorta. There may be a possibility that delivery has a relationship to the development of senile pigment spots or of pinguecula, but as the number of cases is very few, further investigations are necessary to ascertain it.

Consequently, as a result of examinations mentioned above, it seems to be hard task to trace any definite connection between the progression of some senescent phenomena and certain environmental factors.

### Summary

1. We collected 27 pairs of twins (MZ 21, DZ 6) ranging from 41 to 80 years, and 16 pairs of homosexual siblings (SL) ranging from 62 to 90 years, all of whom were Japanese in the western district of Honshū-Island. First, we measured the bodily constitution, certain body parts and certain bones, and investigated their life-histories. Next, we investigated various senescent phenomena. That is: — the

approximate number of gray hairs on the head, the appearance and the size of alopecia senilis in the parietal region, the approximate number of wrinkles in the frontal region, the comparative number of sulci cutis on the nape of neck, the back of the right hand, and the anterior chest, the development of senile pigment spots on the face, the back of the right hand, the extensor surface of the right forearm, and the upper half of the back, the appearance of the senile wart, the development of pinguecula, the development of arcus senilis, the development of marginal protuberances on the lumbar vertebral bodies, and the upper end of the tibia, the existence of fabella in the right knee, and the calcification in the wall of the arch of the aorta.

With regard to these items we calculated the middle percentage deviation, the coefficient of correlation, or the rate of concordance, and on the photographs or X-ray photographs the resemblance between both partners was examined.

2. We have concluded that the following items are mainly subject to the control of heredity. That is, the approximate number of gray hairs on the head, the existence, the localization and the shape of alopecia senilis on the parietal region in ♂, the localization and the shape of wrinkles on the frontal region, the localization and the development of senile pigment spots on the face, the development of pinguecula and of arcus senilis of the eye, the development and the shape of marginal protuberances on the lumbar vertebral body, and the development of marginal protuberances on condylus lateralis et medialis of the tibia. On the other hand, the following items were found to be fairly subject to influence of the environmental factors. That is, the appearance of alopecia senilis on the parietal region in ♀, the number of wrinkles on the frontal region, the comparative number of sulci cutis on the nape of neck, the back of the right hand, and the anterior chest, the number of senile pigment spots on the back of the right hand, the extensor surface of the right forearm, and the upper half of the back, the appearance of senile wart on the body, and the calcification in the arch of the aorta.

3. Concerning those senescent phenomena, which are strikingly subject to the control of heredity, a certain degree of difference between both partners of MZ was sometimes recognized. When the differences in the progression of various senescent phenomena between both partners of MZ were observed, it was often recognized that some senescent phenomena make more progress in one partner, while on the other hand the other ones do in another partner.

4. In order to decide certain environmental factors, which have influence upon the difference between both partners of MZ, we referred to the existence of heavy labor for long duration, the number of deliveries, the grade of the sunburn, the habit of alcoholic drinking, smoking, and history of various diseases. However, we could not decide that some of these factors had certain definite relationship with the progression of certain senescent phenomena. However, we might probably presume that the old-styled Japanese hair dressing worn for many years had a certain relationship with the appearance of the baldness in ♀.

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## RIASSUNTO

Sono state raccolte 27 coppie di gemelli (21 MZ, 6 DZ) dai 41 agli 80 anni, e 16 paia di fratelli omosessuali dai 62 ai 90 anni, tutti giapponesi provenienti dal distretto occidentale dell'isola di Honshu. Prima si sono misurate la costituzione del corpo, certe parti del corpo e certe ossa, e si è investigato sulla loro vita; poi sono stati presi in considerazione alcuni fenomeni della vecchiaia (capelli grigi, rughe, ecc.) e sono stati calcolati la deviazione percentuale, il coefficiente di correlazione, o il tasso di concordanza, e attraverso le fotografie e i raggi X è stata esaminata la somiglianza intracoppia. Si è concluso elencando alcuni fenomeni osservati che sono per la maggior parte soggetti al controllo dell'eredità, mentre altri risentono solo l'influenza dei fattori ambientali. Talvolta è stato ravvisato un certo grado di differenza tra i partners dei monoziotici e si è trovato che spesso i caratteri propri della vecchiaia sono più evidenti nell'uno che non nell'altro partner, ma con prevalente tendenza a differenze nell'età di insorgenza, che varia individualmente fra i cogenelli, anche per cause ambientali.

## RÉSUMÉ

On a réuni une série de 27 couples de jumeaux de 41 à 80 ans, et 16 couples de frères homosexuels japonais provenant du département occidental de l'île de Honshu. On a mesuré d'abord la constitution du corps, certaines parties du corps et certains os, et on a étudié les données anamnestiques; on a examiné ensuite un certain nombre de phénomènes de la vieillesse dont on a déterminé le pourcentage de déviation, le coefficient de corrélation, ou bien le taux de concordance, et on a examiné la ressemblance des partenaires au moyen des photographies et des radiographies. On a donc dressé une liste de phénomènes considérés qui sont surtout sujets au contrôle de l'hérédité tandis que les autres sont sujets seulement à l'influence du milieu. Quelquefois on a trouvé un certain degré de différence entre cojumeaux MZ and on a déterminé que les caractères de la vieillesse sont souvent plus évidents dans l'un que dans l'autre; toutefois la différence peut souvent s'attribuer à des facteurs de temps qui agissent d'une façon différente chez les deux individus.

## ZUSAMMENFASSUNG

Die Untersuchung befasst sich mit 27 Zwillingspaaren (21 EZ, 6 ZZ) im Alter von 41 bis 80 Jahren und 16 gleichgeschlechtlichen Geschwisterpaaren zwischen 62 und 90 Jahren: alles Japaner aus dem westlichen Distrikt der Insel Honshu. Zuerst wurde der Körperbau, gewisse Körperteile und Knochen gemessen und die Vorgeschichte der Probanden aufgenommen. Sodann wurden einige Alterserscheinungen (graues Haar, Runzeln usw.) in Betracht gezogen und davon die prozentuelle Abweichung, der Korrelationskoeffizient oder auch der Konkordanzsatz berechnet. Ausserdem wurde durch Photographien und Röntgenaufnahmen die Ähn-

lichkeit innerhalb der einzelnen Paare untersucht. Als abschluss werden einige Merkmale angegeben, die auf Grund der Beobachtung grösstenteils erbbedingt und andere, die nur umweltsbedingt sind. Manchmal war bei den Paarlingen der eineiigen Zwillinge ein gewisser Unterschiedsgrad festzustellen und oft war zu bemerken, dass die typischen Alterserscheinungen bei dem einen Paarling deutlicher als beim anderen waren mit besonderer Differenz im Alter des Auftretens, dass, auch durch Umweltseinflüsse bedingt, bei den einzelnen Paarlingen individuell verschieden ist.