It is my opinion that this great difference arises from *Isolation*. It is a well known theory that living beings vary when they are long kept in isolation without being intermingled to each other. The isolation, in this case, means that the Japan Sea was formed much later than the formation of the Pacific Ocean. The Pacific Ocean is the one formed from the beginning of the history of the earth; but the Japan Sea is not so old as the Pacific. In short, in my opinion, the Japan Sea was not a sea from the beginning of the earth. I can not tell whether it was a lake or land; at any rate there was no communication with the Pacific water for a long period in the history of the earth; and our country, now consisting of many islands formed a part of the continent of Asia. By depression or any other geological accidents, the basin of the Japan Sea was formed, and then communications with the Pacific water were opened. As the formation of the Japan Sea, though later than the Pacific Ocean, yet, was pretty long years ago, the monotypic genus *Coccophora*, though only one in number, has made its apparance.

In November 1926, I read a paper "On the Distribution of the Marine Algae in Japan" before the third Pan-Pacific Congress which will be published in some other day. In connection with that study I read the present paper in the August 1927 at Sendai before the Japanese Association for the Advancement of Science. The main points of the auguments is the same as that which I have already treated the present thesis with 255 species known at the time when I published "Kaisogaku Hanron" (The Elementary Treatise on Algology) 1900.

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The Right- and Left-Handedness of Phyllotaxy

By

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The direction of twining or torsion is either fixed, as is generally the case with stem-climbers, or variable. DE VRIES (1) studying the stem condition of *Dipsacus silvestris torsus* and KORIBA (2) investigating extensively the spiral inflorescence of

Spiranthes anstralis found the equality in ratio of the right and left torsion in their alternative variation. In *Plantago major* var. *asiatica*, forma *contorta*, as IKENO (3) studied in detail, the alternative conditions are also found to be of an equal proportion in the torsion of its leaves. His experiments show the fact that the variation is not inherited, but it is due to a fluctuating representation.

I

When I studied the inheritance of the Matsushima (green-variegated yellow) leaves of *Pharbitis Nil*, the Japanese morning glory, in 1925, a spiral diagram of phyllotaxy was required and I noticed an alternative variation in the direction of its winding. The calculation of the right- and left-handedness of phyllotaxy showed the fact that dimorphism occurs equally in ratio. To ascertain whether the variation is inheritable or not, I have recorded the F_3 offspring of some F_2 derived from three crosses. The observation was made on the main stems of the plants in their apical part, because the mode of phyllotaxy is invariably disturved as soon as the buds make their growth. Of the total 2481 F_3 plants counted, 1251 were right-handed and 1230 left-handed, the former being proportionated 50.42%, or one half of the total. The data showing the relation between F_2 and F_3 on this point is given in the following table:

TABLE I

Character of F_2	Number of F_3 Pedigree	Result of F_3			Percentage of R. H.
		Right-handed	Left-handed	Total	
Right handed	46	518	500	1018	50.88
Left-handed	54	733	730	1463	50.10
Total	100	1251	1230	2481	50.42

$r = +0.008 \pm 0.014$

The result shows clearly the fact that dimorphism has nothing to do with inheritance in this case. COMPTON (4) made an observation on the right- and left-handedness of the first leaves of the seedlings of some Gramineae and found a somewhat unequal occurrence of dimorphism in *Zea Mays*, when the seeds were taken separately by the row from the ears and comparison is made

between the data from the odd and even orthostichies. He considered this unequality to be due to the different spatial relationship of the seeds on the cob. The Japanese morning glory being a left-twining climber, it is open to doubt whether the direction of phyllotaxy is more or less influenced by its twining and its equal ratio of dimorphism is thus disturbed. But we may soon see that such is not the case, as the actual count shows, when we think of the difference between the times at which the direction of phyllotaxy is determined and the twining of the stem begins, the former being far earlier than the latter.

The random nature of variation in the direction of phyllotactic twining of the Japanese morning glory is confirmed by the frequency distribution of the quotient of deviation by probable error in each F_3 pedigree as shown in the following table:

TABLE II

Dev. / P. E.		$-\infty$	-3	-2	-1	0	$+1$	$+2$	$+3$	$+\infty$	Total
Observed	From R.H. F_2	0	1	10	11	14	6	2	2		46
	From L.H. F_2	0	2	9	15	14	11	3	0		54
Total		0	3	19	26	28	17	5	5		100
Expected		2.15	6.70	16.15	25.00	25.00	16.15	6.70	2.15		100

$\chi^2 = 5.581$ $P = 0.590$

The "goodness of fit" is high. So the 1 : 1 ratio of the right- and left-handedness of phyllotaxy is not only the nature in the average data, but also it holds quite good in each pedigree.

The record above-cited was taken by the main stems of the plants. Then a question may arise as to whether the direction of phyllotaxy is fixed in one individual or not. Actually this is quite variable. To obtain a concrete evidence, I selected two hundred vigorous individuals of the Japanese morning glory and an observation was made on four stems each. The result thus gained is:

TABLE III

Number of R. H. in Each Four	0	1	2	3	4	Total
Observed	12	46	72	56	14	100
Expected	12.5	50	75	50	12.5	100

$\chi^2 = 1.360$ $P = 0.847$

From this table we learn the fact that the dimorphism in question occurs at random even in one individual, due to a mere chance variation.

II

An equal occurrence of the dimorphism of phyllotaxy is a general happening in the alternate-leaved plants, so far as my observation goes. For instance, an observation on *Helianthus tuberosus*, which grew in an abandoned field of our College, showed :

TABLE IV

Attaching Mode of Leaves on Stem		Observed Number	Percentage
Alternate	Right-handed	162	49.72
	Left-handed	164	50.28
Opposite		42	—
Whorled		4	—
Total		372	100.000

The Jerusalem artichoke propagates by its tubers. The young stems, which made their growth from the tubers, have generally opposite leaves, however, this condition is sooner or later transformed into an alternate state of leaves during their growth. My record was taken on August 26, 1926, so the transformation had already started, but it was not completed. Under such a circumstance, the nature of equality in the proportion of dimorphism in the alternate leaves, however, was evident.

The sweet poteto, *Ipomoea edulis*, is very abundantly cultivated in Japan, and my observation on this plant, which was yielded in our College, showed the following result :

TABLE V

Dimorphism	Observed Number	Percentage
Right-handed	281	49.47
Left-handed	287	50.53
Total	568	100.00

After this examination, I made another observation on an oak tree, *Quercus Vibrayeana*. The contents of its two hundred branches were:

TABLE VI

Dimorphism	Observed Number	Percentage
Right-handed	92	46
Left-handed	108	54
Total	200	100

With these and another unpublished data, I may draw a conclusion that the equality in the ratio of the dimorphism of phyllotaxy is a general occurrence in the alternate-leaved-plants. A further note that the variation is not inherited, but it is due to a random expression, may probably be added to the above conclusion.

SUMMARY

1. In *Pharbitis Nil*, the Japanese morning glory, the dimorphic variation of the right- and left-handedness of phyllotaxy occurs equally in ratio and the alternative condition is not inherited. The direction of phyllotaxy is also quite variable in one individual.

2. The equality in the ratio of the dimorphism of phyllotaxy is confirmed in some other plants and it seems to be a general phenomenon in the alternate-leaved plants.

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