

42. **Yasuhisa Saiki** : Application of Statistics on the Field of Plant Internal Morphology. IV.*¹ On Japanese Aconites. (2).

(Shizuoka College of Pharmacy*²)

As shown in Fig. 1 in previous paper, Japanese aconites possess commonly stone cells at in their these cortices, and their existence or absense are described to be the distinctional character in many literatures. However, a few individuals of many kinds include any stone cells even inside the tissues of endodermis, besides a few other kinds have no stone cells in cortical parts, so their feature is not thought to be exact.

Therefore, the author planned to study their feature stochastically, and next two stone cell indexes were created :

SIO (stone cell index of outside).....number of stone cells existed in cortex, corresponding to 1 mm. of endodermis in cross-section.

SII (stone cell index of inside).....number of stone cells existed in the most external 10 layers of central cylinder, corresponding to 1 mm. of endodermis in cross-section.

Statistical Method

Measuring Method—Thickness of section is decided 30 μ in consideration of error concerned by different thicknesses, because diameter of stone cell is about 50 μ in longitudinal section. Microscopic observation is performed 100-times of magnify, and using ocular lens ($\times 10$) inserted with a square micrometer. As the method, paralleling lateral lines of micrometer to endodermis, number of stone cells are counted inside (central cylinder) and outside (cortex) of endodermis lain between both sides of longitudinal lines of micrometer. Besides the observations are carried over three departed parts in a tuberous root, and an average is obtained from observed values of a root. Next, true length of interval lain between both side lines of micrometer is measured, then the average is converted to value of SII or SIO.

Sampling Method—Difference of SIO, produced by various sectional levels in a tuberous root, is shown in the experimental part. As the result, values of SIO are influenced obscurely by some differences of cut portions, however portion of small diameter has large value generally. So, in case comparing each individual, there is the question whether portions of same diameter are used or morphologically similar portions are done. However, variation of SIO happened by sizes of roots maintains the opinion that latter portions may be used, as shown in the experimental part. So a section is sampled at random in interval of tuberous root that inserted between the largest portion in diameter and the portion of 2/3 times of the largest, for accurate experiment.

On values of SII, thus experiment was not performed, however same sections are used for measuring because above relation is thought.

Furthermore, in old tuberous roots injured by worm-bite or diseases, the phenomenon which the inner parenchyma of injured tissue changes to stone cells is often observed, so thus injured tuberous roots are used in order to prevent an inaccuracy by morbid stone cells.

On Mother and Daughter Tuberous Roots—Higashi¹⁾ reported on distinction among mother and daughter roots of same Manchurian species. However in Japanese kinds,

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1) Higashi : Shōyakugaku Zasshi, 4~5, 24~40 (1950, 1951).

significant distinction is not present among both roots of a species. The facts are natural in consideration of growth process as mentioned in previous paper. Therefore, sampling is carried out for mixture of mother and daughter roots of each species as study of cambium.

Stochastic Method of SIO—Values of SIO seem to belong to almost normal distribution, so are treated stochastically by usual calculations. As the method, rejecting limits²⁾ and fiducial intervals³⁾ of means are used in order to compare each distributional state. Calculation and theory of these methods are omitted for precise descriptions as of many text books of statistics.

Stochastic Method of SII—Values of SII do not belong distinctly to normal distribution, for actually many individuals of many kinds do not possess stone cells inside the endodermis and have them occasionally. Therefore these values for many kinds seem to belong to distribution being alike Poisson's type, but there are some cases for which the types of distribution can not be decided briefly. Accordingly study of SII is impossible to use a method of normal distribution. So they are studied stochastically by use of next method. The experimental values of SII are separated in three ranks which consist of three ranges of 0, 0.1~5.0 and 5.1 then three rates of occurrence in each rank are required, furthermore fiducial limits⁴⁾ of three rates are calculated.

Results and Conclusion

Real statistical values of Japanese aconites collected in each districts are shown in the experimental part, and these totalities are listed in Table I and II.

Next, as considering the experimental results, rejecting intervals of SIO are intricate among many kinds, besides values of SII are doubled in fiducial intervals of three occurrence rates among species, so many Japanese aconites are thought to be difficult to distinguish by features of stone cells and it is impossible generally to distinguish anatomically a few individuals of each aconite.

TABLE I. Stochastic Values of Stone-cell Index of Outside (SIO) of Confidence 95%

Name of plant	Mean (\bar{x})	Fiducial interval	Rejecting interval
<i>Aconitum sachalinense</i>	10.2	8.67~11.5	0.47~18.7
<i>A. yesoense</i>	7.92	6.66~9.18	0 ~18.2
<i>A. lucidusculum</i>	6.31	5.20~7.42	0 ~14.7
<i>A. subcuneatum</i>	8.38	7.27~9.49	0.38~16.4
<i>A. Zuccarinii</i>	9.80	8.63~11.0	3.0 ~16.6
<i>A. aizuense</i>	6.48	4.83~8.13	0 ~16.7
<i>A. Mazimai</i>	1.51	0.84~2.18	0 ~7.0
<i>A. Okuyamai</i>	7.87	6.41~9.35	0.44~15.3
<i>A. iwatekense</i>	4.20	2.81~5.59	0 ~12.7
<i>A. spp.</i> (Shimoburo)	10.95	9.1 ~12.8	0.9 ~21.1
<i>A. spp.</i> (Iwaya)	8.70	7.2 ~10.2	1.1 ~16.3
<i>A. spp.</i> (Akataki)	0.93	0.40~1.46	0 ~3.4
<i>A. spp.</i> (Sōma)	4.84	3.76~5.92	0 ~11.2
<i>A. japonicum</i>	2.28	1.75~2.81	0 ~6.8
<i>A. deflexum</i>	14.9	12.5 ~17.3	1.7 ~28.1
<i>A. senanense</i>	13.6	9.1 ~18.1	0 ~31.6
<i>A. sanyoense</i>	9.86	8.72~11.0	3.0 ~16.7
<i>A. grossidentatum</i>	4.16	1.84~6.48	0 ~11.9
var. <i>shikokianum</i>	3.47	2.59~4.35	0 ~9.6
<i>A. crassipes</i>	4.99	3.44~6.54	0 ~11.2
<i>A. kiusianum</i>	4.44	3.02~5.86	0 ~10.8

2) For example, Torii, Takahashi, Dohi: "Suikeigaku" 39~44.

3) *Ibid.*: 38.

4) Narumi, Sakai: "Sūri-Tōkeigaku-Yōsetsu," 2nd Ed., 197. Baifūkan, Tokyo.

TABLE II. Rates of Occurrence in each Class of Stone-cell Index of Inside (SII), at confidence (98%)

Name of plant	Rate of Occurrence Value of SII		
	0	0.1 ~5.0	5.1~
<i>Aconitum sachalinense</i>	0.66~0.92	0.08~0.34	0 ~0.10
<i>A. yesoense</i>	0.81~0.98	0.02~0.19	0 ~0.07
<i>A. lucidusculum</i>	0.64~0.90	0.09~0.34	0.00~0.11
<i>A. subcuneatum</i>	0.88~1.00	0.00~0.12	0 ~0.09
<i>A. Zuccarinii</i>	0.77~0.97	0.03~0.23	0 ~0.13
<i>A. aizuae</i>	0.83~1.00	0.00~0.17	0 ~0.06
<i>A. Mazimai</i>	0.93~1.00		0~0.07
<i>A. iwatekense</i>	0.88~1.00		0~0.12
<i>A. Okuyamai</i>	0.73~0.99	0.01~0.27	0 ~0.17
<i>A. spp.</i> (Shimoburo)	0.85~1.00		0~0.15
<i>A. spp.</i> (Iwaya)	0.76~1.00	0.00~0.24	0 ~0.17
<i>A. spp.</i> (Akataki)	0.79~1.00		0~0.21
<i>A. spp.</i> (Sōma)	0.77~0.99	0.01~0.23	0 ~0.13
<i>A. japonicum</i>	0.79~0.97	0.03~0.21	0 ~0.06
<i>A. deflexum</i>	0.10~0.58	0.13~0.63	0.13~0.63
<i>A. senanense</i>	0.63~1.00	0.00~0.37	0 ~0.26
<i>A. sanyoense</i>	0.88~1.00		0~0.12
<i>A. grossidentatum</i>	0.63~1.00		0~0.37
var. <i>shikokianum</i>	0.76~0.96	0.03~0.25	0.00~0.13
<i>A. crassipes</i>	0.55~0.99	0.01~0.45	0 ~0.26
<i>A. kiusianum</i>	0.30~0.85	0.10~0.45	0.01~0.29

However, by method of fiducial interval it can be compared from same reason of previous paper by use of average of same materials.

As the results of studying the values of SIO by use of this method, many following facts are recognized.—At first in aconites of Hokkaidō district *A. lucidusculum* NAKAI has so small values of SIO to distinguish easily from other species namely *A. sachalinense* FR. SCHM. and *A. subcuneatum* NAKAI. However *A. yesoense* NAKAI is not distinguished from these 3 species by averages of SIO.

Next in kinds of northern Honshū, *A. Mazimai* NAKAI has the least values, so it can be distinguished from the other kinds, *A. iwatekense* NAKAI and undecided species of Sōma area. However, latters have little values so are distinguished from the other species of same district. The other species namely *A. subcuneatum* NAKAI, *A. Okuyamai* NAKAI, *A. Zuccarinii* NAKAI and unidentified species growing at Shimoburo and Iwaya in Shimokita Peninsula have large values and are able to be distinguished each other.

At last in kinds of southern Japan, *A. japonicum* THUMB. has small values so it is distinguished from the other species of same district except *A. grossidentatum* NAKAI and *A. grossi.* var. *shikokianum* NAKAI. Distinctions among *A. grossidentatum*, *A. grossi.* var. *shikokianum*, *A. crassipes* NAKAI and *A. kiusianum* NAKAI are impossible, but these four kinds are separable from the group having larger values namely *A. sanyoense* NAKAI, *A. senanense* NAKAI and *A. deflexum* NAKAI. *A. sanyoense* is distinguished from *A. deflexum*.

Rates of occurrence in each rank of SII are not distinguished generally too, however some species for examples *A. deflexum* have large values of SII and also other some species namely *A. sachalinense* *A. lucidusculum* and *A. kiusianum* have large rates in rank of 0.1~5.0 so are separable from many kinds.

However above mentioned results are not considered difference by localities in some species by same reason of previous paper. The SIO distinctions among each locality of same species are small and non-significant from results of study of *A. japonicum*, *A. kiusianum* and *A. grossidentatum* var. *shikokianum* etc., so these values seem to differ considerably by kinds.

On the contrary at SII occurrence rates differ in each locality in some species namely *A. gross.* var. *shikokianum*, *A. japonicum* and *A. kiusianum* etc. Therefore these values may be used as matter of reference.

Experimental

Difference of Values of SIO, by Sectional Levels—Studied materials: *A. Mazimai* NAKAI in habitat of Sado Island. A root is observed on sectional intervals of ca. 1 mm., gradually from thickest portion to root tip. Following values show orderly each maxima of diameter (mm.) and values of SIO in each bracket.

(22, 0.8)	(20, 0.2)	(20, 1.8)	(21, 1.7)	(20, 2.0)	(19, 0.8)	(17, 0.8)
(17, 2.6)	(17, 1.2)	(16, 3.2)	(16, 1.8)	(12, 3.6)	(12, 5.4)	(11, 3.8)
(10, 4.4)	(9, 7.4)	(9, 8.6)	(9, 5.4)	(8, 5.8)	(8, 5.3)	(7, 6.0)
(6, 3.2)	(6, 4.7)	(6, 4.0)	(5, 2.4)	(5, 4.7)	(5, 4.7)	(4, 6.0)

Variation of SIO happened by Different Sizes of Roots in Morphologically Similar Portion—Studied materials: *A. Mazimai* NAKAI in Sado Isl. Cut portion: Interval between the largest portion and the one of 2/3 times of the largest in diameter of root.

large sizes: mean of diameters (mm.)	21.8	\bar{x} ...	1.32	s^2 ...	2.13	$\sum(x-\bar{x})^2$...	42.6	n ...	20
small sizes: mean of diameters (mm.)	16.4	\bar{x} ...	1.26	s^2 ...	1.26	$\sum(x-\bar{x})^2$...	23.9	n ...	20
variance ratio: $F=2.13/1.26=1.78 < F_{19}^{19}(0.05)=2.16$									\therefore non-significant.

$$\text{test of means: } t = \frac{1.32 - 0.81}{\sqrt{\frac{42.6 + 23.9}{20 + 20 - 2} \cdot \frac{1}{20} \cdot \frac{1}{20}}} = 1.22 \ll t_{38}(0.05) = 2.02 \quad \therefore \text{ non-significant.}$$

On Mother and Daughter Roots—Studied material: *A. japonicum* THUNB, growing at Mt. Takakusa in Shizuoka Pref.

SIO: mother root	\bar{x} ...	1.97	s^2 ...	4.68	n ...	35
daughter root	\bar{x} ...	1.22	s^2 ...	2.39	n ...	20
$F=4.68/2.39=1.96 < F_{19}^{34}(0.05)=2.05$			$t=0.5 \ll t_{53}(0.05)=2.00$			\therefore non-significant.

SII: values of all roots are 0.

Statistics of each Species

Aconitum sachalinense FR. SCHMIDT*³

Studied material: Localities of Uryū-Kitamoshiri and Wakkanai, in Hokkaidō.

SIO: n (number of samples)....45 \bar{x} (mean)....10.19 s^2 (variance)....23.5 $t_{44}(0.05)$2.02

fiducial limits of confidence of 95%, $10.19 \pm \sqrt{\frac{23.5}{45}} \times 2.02 = 8.67$ and 11.5

rejecting limits of same confidence, $10.19 \pm \sqrt{\frac{23.5 \times 46}{45}} \times 2.02 = 0.47$ and 18.7

SII: n (number of samples)....45 k_1 (number of individuals in rank of 0)....35
 k_2 (number of ones in rank of 0.1~5.0)....10 k_3 (number of ones in rank of 5.1~)....0
 fiducial limits of occurrence rate in rank of 0, of confidence of 98%,

$$n_1 \dots 2(45 - 35 + 1), \quad n_2 \dots 2 \times 35 \quad F_{20}^{22}(0.01) = 2.11$$

from these values, lower limit $L_1 = \frac{35}{(45 - 35 + 1) \times 2.11 + 2 \times 35} = 0.66$

$$n'_1 \dots 2(35 + 1) \quad n'_2 \dots 2(45 - 35) \quad F_{20}^{72}(0.05) = 2.57$$

from these values, upper limit $L_2 = \frac{2.57(35 + 1)}{2.57 \times (35 + 1) + 45 - 35} = 0.92$

calculations of other ranks are skipped.

Aconitum yesoense NAKAI

Studied material: Localities of Sapporo, Hidaka-Urakawa, Iburi-Kutchan, Oshima-Mori.

SIO: n65 \bar{x}7.92 s^217.5 SII: n65 k_160 k_25 k_30

Aconitum lucidusculum NAKAI

Studied material: Localities are Jōzankei, Ishikari-Kanayama, Furano, Kitami-Oketo, and Shirataki, in Hokkaidō.

SIO: n57 \bar{x}6.31 s^218.1 SII: n57 k_145 k_211 k_31

Aconitum subcuneatum NAKAI

Studied material: Localities are Yoichi in Hokkaidō, Imabetsu and Fukaura in Aomori Pref.

*³ Methods of calculation are shown only in this species.

- SIO : $n \dots 51$ $\bar{x} \dots 8.38$ $s^2 \dots 16.3$ SII : $n \dots 51$ $k_1 \dots 50$ $k_2 \dots 1$ $k_3 \dots 0$
Aconitum Zuccarinii NAKAI
 Studied material : Locality is Hibara in Fukushima Pref.
 SIO : $n \dots 33$ $\bar{x} \dots 9.80$ $s^2 \dots 11.68$ SII : $n \dots 33$ $k_1 \dots 31$ $k_2 \dots 2$ $k_3 \dots 0$
Aconitum aizuense NAKAI
 Studied material : Localities are Sukayu and Towada in Aomori Pref.
 SIO : $n \dots 37$ $\bar{x} \dots 6.48$ $s^2 \dots 24.6$ SII : $n \dots 37$ $k_1 \dots 36$ $k_2 \dots 1$ $k_3 \dots 0$
Aconitum Mazimai NAKAI
 Studied material : Commercial products in Sado, Island and natives of Nyūkawa in Sado Island.
 SIO : $n \dots 67$ $\bar{x} \dots 1.51$ $s^2 \dots 7.72$ SII : $n \dots 67$ $k_1 \dots 67$ $k_1, k_2 \dots 0$
Aconitum Okuyamai NAKAI
 Studied material : Localities are Okuyamadera and Hirashimizu in Yamagata Pref.
 SIO : $n \dots 25$ $\bar{x} \dots 7.87$ $s^2 \dots 12.5$ SII : $n \dots 25$ $k_1 \dots 23$ $k_2 \dots 2$ $k_3 \dots 0$
Aconitum iwatekense NAKAI
 Studied material : Localities are Miyako, Kawai and Tōno in Iwate Pref.
 SIO : $n \dots 36$ $\bar{x} \dots 4.20$ $s^2 \dots 18.27$ SII : $n \dots 36$ $k_1 \dots 36$ $k_2, k_3 \dots 0$
Aconitum spp. A
 Studied material : Locality is Shimoburo at Shimokita Penin. in Aomori Pref.
 SIO : $n \dots 28$ $\bar{x} \dots 11.0$ $s_2 \dots 23.2$ SII : $n \dots 28$ $k_1 \dots 28$ $k_2, k_3 \dots 0$
Aconitum spp. B
 Studied material : Locality is Iwaya of Shimokita Peninsula in Aomori Pref.
 SIO : $n \dots 25$ $\bar{x} \dots 8.70$ $s^2 \dots 12.9$ SII : $n \dots 25$ $k_1 \dots 24$ $k_2 \dots 1$ $k_3 \dots 0$
Aconitum spp. C
 Studied material : Locality is Akataki at Shimokita Peninsula in Aomori Pref.
 SIO : $n \dots 20$ $\bar{x} \dots 0.93$ $s^2 \dots 1.28$ SII : $n \dots 20$ $k_1 \dots 20$ $k_2, k_3 \dots 0$
Aconitum spp. D
 Studied material : Localities are Ishikawa and Namie in Fukushima Pref.
 SIO : $n \dots 33$ $\bar{x} \dots 4.84$ $s_2 \dots 10.1$ SII : $n \dots 33$ $k_1 \dots 31$ $k_2 \dots 2$ $k_3 \dots 0$
Aconitum japonicum THUNBERG
 Studied material : Localities are Mt. Takakusa in Shizuoka Pref. and Mt. Hakome in Kanakaga Pref.
 SIO : $n \dots 73$ $\bar{x} \dots 2.28$ $s^2 \dots 5.21$ SII : $n \dots 73$ $k_1 \dots 66$ $k_2 \dots 7$ $k_3 \dots 0$
Aconitum deflexum NAKAI
 Studied material : Locality is beach of Lake Suwa in Nagano Pref.
 SIO : $n \dots 20$ $\bar{x} \dots 14.9$ $s^2 \dots 39.8$ SII : $n \dots 20$ $k_1 \dots 6$ $k_2 \dots 7$ $k_3 \dots 7$
Aconitum senanense NAKAI
 Studied material : Localities are Mt. Shirouma, and Mt. Tateyama in northern Japan Alps.
 SIO : $n \dots 15$ $\bar{x} \dots 13.6$ $s_2 \dots 65.7$ SII : $n \dots 15$ $k_1 \dots 14$ $k_2 \dots 1$ $k_3 \dots 0$
Aconitum sanyoense NAKAI
 Studied material : Locality is Mt. Mafuji in Shizuoka Pref.
 SIO : $n \dots 35$ $\bar{x} \dots 9.86$ $s^2 \dots 11.9$ SII : $n \dots 35$ $k_1 \dots 35$ $k_2, k_3 \dots 0$
Aconitum grossidentatum NAKAI
 Studied material : Locality is Tanigumi in Gifu Pref.
 SIO : $n \dots 10$ $\bar{x} \dots 4.16$ $s^2 \dots 10.5$ SII : $n \dots 10$ $k_1 \dots 10$ $k_2, k_3 \dots 0$
Aconitum grossidentatum NAKAI var. *shikokianum* NAKAI
 Studied material : Localities are Motoyama in Kōchi Pref. and Saijō in Ehime Pref.
 SIO : $n \dots 48$ $\bar{x} \dots 3.47$ $s^2 \dots 9.68$ SII : $n \dots 48$ $k_1 \dots 42$ $k_2 \dots 5$ $k_3 \dots 1$
Aconitum crassipes NAKAI
 Studied material : Locality in Mt. Ibuki in Shiga Pref.
 SIO : $n \dots 15$ $\bar{x} \dots 4.99$ $s^2 \dots 7.81$ SII : $n \dots 15$ $k_1 \dots 13$ $k_2 \dots 2$ $k_3 \dots 0$
Aconitum kiusianum NAKAI
 Studied material : Localities are Kakutō in Miyazaki Pref. and Takeda in Ōita Pref.
 SIO : $n \dots 31$ $\bar{x} \dots 4.44$ $s^2 \dots 14.9$ SII : $n \dots 31$ $k_1 \dots 21$ $k_2 \dots 7$ $k_3 \dots 3$

Difference Produced by Habitats—SIO : a) *A. grossidentatum* NAKAI var. *shikokianum* NAKAI... Fiducial interval of confidence of 95% (other species are compared in this, too). Saijō 2.34~5.14, Motoyama 2.04~4.54, so two ranges are very close, therefore difference is non-significant.
 b) *A. kiusianum* NAKAI...F.I. : Kakutō 3.19~8.87, Takeda 1.95~4.65, non-significant.
 c) *A. Mazimai* NAKAI...F.I. : Nyūkawa 0~4.18, commercial product 0.71~2.07, non-significant.

d) *A. japonicum* THUNB.F.I. : Mt. Takakusa 1.22~2.16, Mt. Hakone 2.71~5.13, Two ranges depart, so difference is significant.

e) *A. iwatekense* NAKAIF.I. : Miyako 0.29~3.81, Kawai 7.48~9.44, significant.

SII : For many species, distinctions by habitats are non-significant. However a few following species possess significant distinctions. a) *A. japonicum* : Mt. Takakusa n54, k_154, Mt. Hakone n19, k_112. b) *A. grossidentatum* var. *shikokianum* : Saijō n19, k_119, Motoyama n29, k_123. c) *A. kiusianum* : Kakuto n13, k_13, Takeda n18, k_118.

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Summary

As second feature of stone cells studies stochastically, the two indices namely SII and SIO are created. For stochastic method of SIO rejecting and fiducial intervals were used, however SII fiducial intervals of occurrence rates in three ranks are calculated. The studied results are shown in Table I and II.

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43. Yasuhisa Saiki : Application of Statistics in the Field of Plant Internal Morphology. V.*¹ On Japanese Aconites. (3).

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In previous papers, statistical studies were performed on forms of cambium rings and number of stone cells in tuberous roots of Japanese aconites. So the author intends to consider in combining these results.

All distribution ranges of each specific value, namely rejectancial ellipses of E/C and $\log_{10}(S^2/C)$, rejecting limits of SIO fiducial intervals of occurrence rates of SII, are crossed among most species, so basic distinctions among many Japanese aconites are hardly observed. Besides those the existence of other conspicuous features in internal structure of tuberous roots are not considered. Determination of species by microscopic study seems almost impossible generally in single or a few samples, however in some species, for example *Aconitum subcuneatum* NAKAI, considerable different distinctions are observed.

On the contrary, the methods of fiducial interval of mean are able to argue distinction on increasing the number of samples, and increasing more samples the more accurate ranges are obtained, and then slight differences are detectable. However 20~30

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*² Oshika, Shizuoka (齋木保久).