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VARIATION IN RAY FLOWERS OF ANTHEMIS COTULA AND OTHER COMPOSITES.

BY H. S. FAWCETT.

The object of this study was to determine the amount of variation occurring in the number of ray flowers of the Mayweed (*Anthemis cotula* L.), to compare the variations occurring in different localities, and also the variations in different plants of the same locality, and finally to compare this variation with that of a few other species of Compositæ.

For this study of Anthemis the plants of each locality were picked indiscriminately within a radius of perhaps 100 feet. The count of the available heads of each plant was kept separately for comparison, as shown in the appended tables.

The counting of the ray flowers was done very carefully, and in order to avoid possible error, those heads injured by insects or other causes were discarded. One thousand three hundred and ninety-four heads of Mayweed were counted from seven different localities; four localities in Iowa, two, four and forty-five miles apart, and three localities in Washington state, Seattle, Bellingham, and Hot Springs.

It will be seen by the tables that the predominating number of ray flowers in each locality was thirteen, with the exception of Seattle, where the number counted was not sufficient to give any evidence of a real difference. Tables and curves are shown for the entire number of heads counted, and also for those of each locality. It will be noticed that all these curves for the Mayweed are much steeper on the side below thirteen ray flowers, than above this number. This suggests the question, whether or not this indicates a shifting of the species from a lower to a higher number of ray flowers. It was also noticed that the plants of Anthemis growing in rich soil near barns had heads of greater variability in the number of ray flowers, than those in poorer soil; showing the theory to be true in this case, that more food causes greater variability.

The ray flowers of 1,160 heads of Yarrow (*Achillea millefolium* L.) were next counted, in four different localities, three localities in the Bitter Root mountains of western Montana about fifteen miles apart, and one at Ames, Iowa, just south of the College campus. In Achillea, heads containing five ray flowers greatly predominated, the entire variation being from two to seven. With one slight exception it will be noticed that the curves are steeper on the side above five than below that number. The curves for the three localities of the Bitter Root mountains are very similar in form and amount of variation. The ray flowers of these localities were much larger and purer white in color than those of Iowa.

In addition to the Mayweed and Yarrow, heads of three other species in the Bitter Root mountains were counted; *Senecio triangularis* Hook, *Aster adscendens* Lindl., and *Erigeron salsuginosus* Gray. In the curves for *Aster adscendens* it will be noticed that in nearly every case the line falls for odd numbers of ray flowers and rises again for even numbers. In this plant, as also in *Erigeron salsuginosus*, there seems to be no predominating number of rays as in Anthemis and Achillea.

The time element has not been taken into consideration in this study except in the case of Anthemis for Ames, where tables and curves are compared as between August and September. This time element according to Schull (1904) is a very important factor in variation. He says, in speaking of Asters, "There is a continuous and more or less regular change in the variable characters from day to day throughout the season."

The mean magnitude, the index of variability, and coefficient of variability, with probable error, has been worked out very carefully for each species and each locality with the exception of Erigeron, for which these would have been of little value.

The following formulæ have been used in working out the mean, the index of variability, the coefficient of variability, and the probable error.

$$A = \frac{E\,(V.f)}{n} \text{ where } A = \text{the } mean;$$

V = the frequency of a class, and n = the total number of variates.

$$O = \sqrt{\frac{E(x^2\ f)}{n}}\,\zeta \text{ where } O = \text{the index of variability}$$

(standard deviation), x = the deviation of a class magnitude from the mean, and ζ = the difference between the upper and lower limits of a class, which is unity in this case.

$$C = \frac{O}{A} \text{ where } C = \text{the coefficient of variability.}$$

$$E_A = .6745\frac{O}{\sqrt{n}}, \text{ and } E_O = 6745\,\frac{O}{\sqrt{2n}} \text{ where } E_A \text{ and } E_O$$

denote the probable error of mean and probable error index of variability respectively.

The subject of the variation of ray flowers in the Compositæ has been studied by a number of investigators in recent years. G. H. Shull (1902) studied the variation in the bracts, rays and disk florets of a number of species of Asters. W. S. Tower (1902) studied the variation of ray flowers of *Chrysanthemum leucanthemum*. Shull in the

June Bot. Gaz. for 1904 has a very complete paper on place constants for *Aster prenanthoides.*

The work for this paper was done in the summer and fall of 1904 under the direction of Prof. L. H. Pammel of the Iowa State College, Ames, from whom valuable suggestions were obtained. Acknowledgment must also be made of important suggestions from Prof. H. E. Summers of the same place, who first suggested the study of Anthemis. Valuable aid was rendered by Charlotte M. King, in constructing the tables and curves, and by Estelle D. Fogel in the mathematical work of the paper.

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PLATE XII.

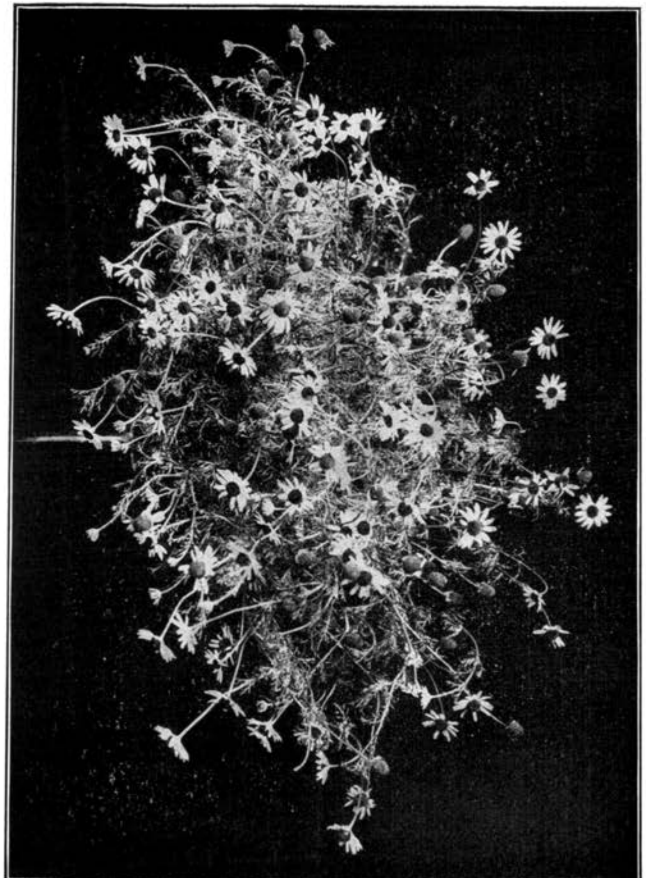

FIG. 1. Flowers of *Anthemis cotula*.

Shull, G. H. 1902. A quantitative study of variation in the bracts, rays, and disk florets of *Aster shortii* Hook., *A. Novæ-Angliæ* L., *A. punicens* L., and *A. prenanthoides* Muhl., from Yellow Springs, Ohio. Amer. Nat. 36: 111-152.

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PLATE XIII.

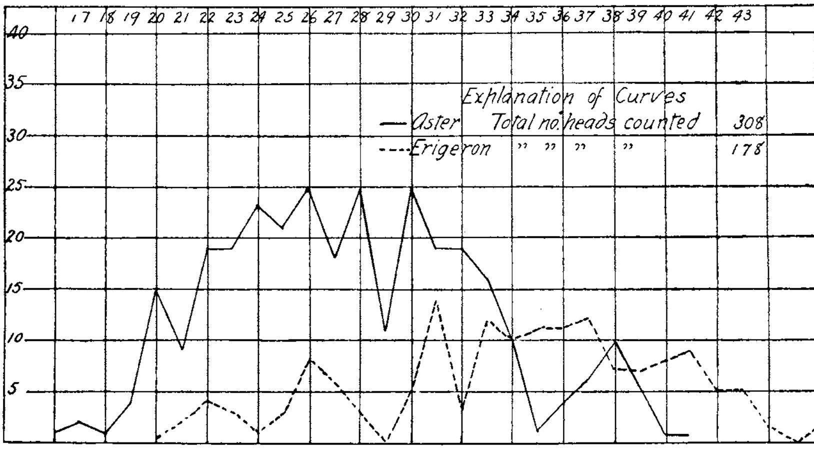

FIG. 1. Figures at the top indicate number of ray flowers per head, figures at the left the number of heads in each class.

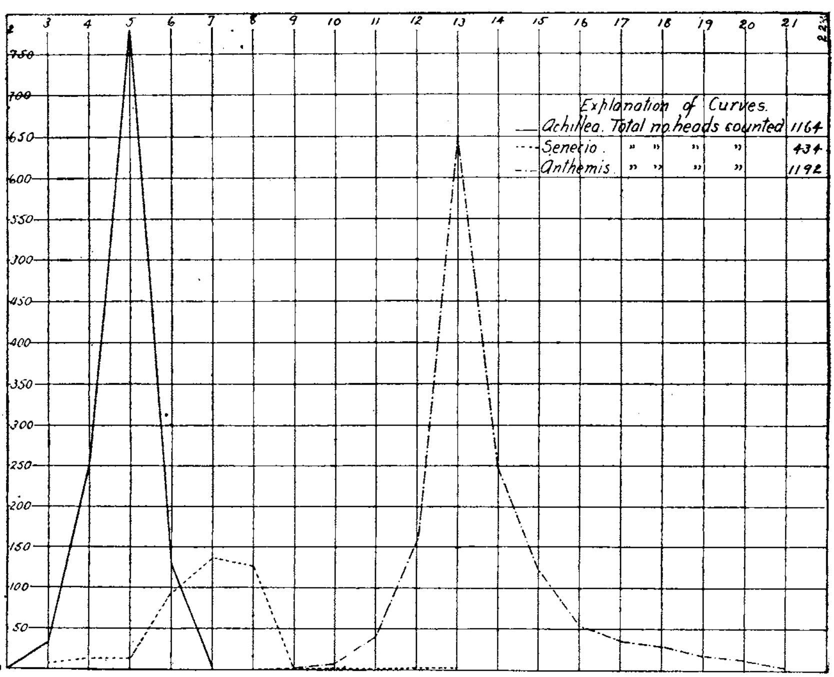

FIG. 2. Figures at the top indicate number of ray flowers per head, figures at the left the number of heads in each class.

PLATE XIV.

Plants.	Mean.	Index of variability.	Coefficient of variability.
Anthemis Cotula	13.6515 ± .03063	1.6950 ± .02166	.1241
Achillea Millefolium	4.7903 ± .01214	.6142 ± 00858	.1282
Senecio triangularis	6.6606 ± .05901	1.2386 ± .04173	.1859
Aster adscendens	27.6428 ± .1936	5.0381 ± .1401	.1818

Number of rays per head.

No. of heads.	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total.
Anthemis Cotula							1	2	9	42	160	649	247	125	55	37	30	18	13	4		.	1392
Achillea Millefolium	1	33	261	785	82	2																	1164
Senecio triangularis		6	13	45	95	136	127	5	2	1	2	2											434
Aster adscendens															1	2	1	4	15	9	19	19	------
Erigeron solsuginosus																			1	2	0	4	-----

	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	Total.
Aster adscendens (cont.)	23	21	25	16	25	11	25	19	19	16	10	1	4	6	10	3	1	1						308
Erigeron solsuginosus (cont.)	1	3	8	6	19	00	5	14	3	12	10	11	11	12	7	7	8	9	5	5	2	00	2	174

FIG. 1. Condensed table for all species studied.

Anthemis Cotula

Localities	No. of heads.	8	9	No. of rays. 10	11	12	13	14	15	16	17	18	19	20	21	Total	a	σ	C
Ames Ia south of College August				1	1	2	76	39	12	12	10	12	6	3		174	14 4310±.1008	1.972±.0713	.1366
Ames Ia. south of College 9/23/04				1	12	39	174	59	27	19	14	5	5	4	2	361	13.7174 ±.0619	1.7465±.0438	.1272
2 miles north of Ames				2	9	50	150	25	14	2						252	12.9405 ± 0381	.8955 ± 0269	.0692
6 miles north of Ames				2	5	18	69	37	31	15	10	11	5	6	2	211	14.388 ±.1018	2.157 ±.0708	.1422
Le Grand Iowa 45 miles from Ames			1		6	30	76	21	11	5	3	2	2			157	13.2930 ± 0788	1.4649 ±.0557	.1102
Hot Springs Wash 9/4/04		1	1	1	2	3	9	4	1							22	12.4090 ± .2400	1.6694 ± 1697	1344
Bellingham Wash. 9/6/'04				2	7	9	76	42	15	2						153	13.3202 ±.0556	1 0204 ± .0393	.0766
Seattle Wash. 9/9/'04						9	19	20	14	2						64	13.7031 ±.0906	1 0559 ± 0640	0770

FIG. 2. Shows variation in *Anthemis cotula* for different localities.

Plant	No. of rays 10	11	12	13	14	15	16	17	18	19	20	No. of heads on each plant.
No. 1	1		2	4	3	2	4	2	2	2	1	23
2		1		3	8		4	4	5			25
3				4								4
4				6								6
5				9								9
6				2	1							3
7				10	2							12
8				6	5	3						14
9				7	4	1						12
10				7	9	1						17
11				18	7	3						28
12						2	3	1	4			10
13							1	3	1	4	2	11
No. of heads in each class.	1	1	2	76	39	12	12	10	12	6	3	174 Sum

FIG. 2. *Anthemis cotula*, Ames, Iowa, showing individual variation.

Plant	No. of rays 10	11	12	13	14	15	16	17	18	19	20	21	Total no. of heads on each plant.
No. 1	1	3	9	14	2								29
2		1	3	6	1								11
3		1	3	10									14
4		2	1	18									21
5		1	1	18	4	1							25
6		3	5	10	8	7		1					34
7		1	3	12	6	1	2						35
8			1	8	2								11
9			2	4	2								8
10			2	17									19
11			2	19	3								24
12			1	2	3	1							7
13			1	7	6	3							17
14			3	12	5		1						21
15			2	2	4	6	12	11	5	4	4	2	52
16				5									5
17				8									8
18				1	6	5	1						13
19				1	2	3	3	3		1			13
Total no. of heads in each class.	1	12	39	174	59	27	19	14	5	5	4	2	361 Sum

FIG. 1. Figures at the top indicate number of rays, those at the left the number of heads, showing individual variation of *Anthemis cotula*.

PLATE XV.

PLATE XVI.

Plant No.	10	11	12	13	14	15	16	17	18	19	20	21	Total no. heads on each plant
1	2	4	11	13									30
2		1		5	5	6	7	2	5	2	1		35
3			2	11	5	1							19
4			4	7	2	1			1	1			16
5				2	2	2							6
6				2		4		1					7
7				2	4	3							9
8				2	5	4	1						12
9				3	1	5	1	2	1				13
10				3				2	3	1	4	2	15
11				4	1		1						6
12				15	11	2	1						29
13					1	2	1	1					5
14						1	3	2	1	1	1		9
Total no heads in each class	2	5	18	69	37	31	15	10	11	5	6	2	211 Sum

(Column heading: No. of rays.)

FIG. 1. *Anthemis cotula*, six miles north of Ames, showing individual variation.

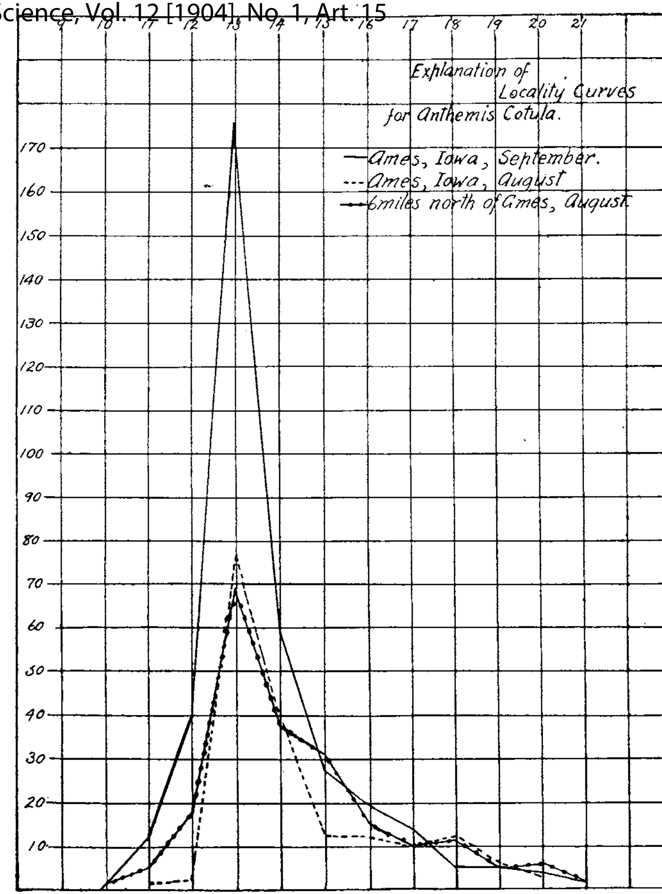

FIG. 2. Locality curves for *Anthemis cotula*. Figures at the top indicate the number of rays, those at the left the number of heads.

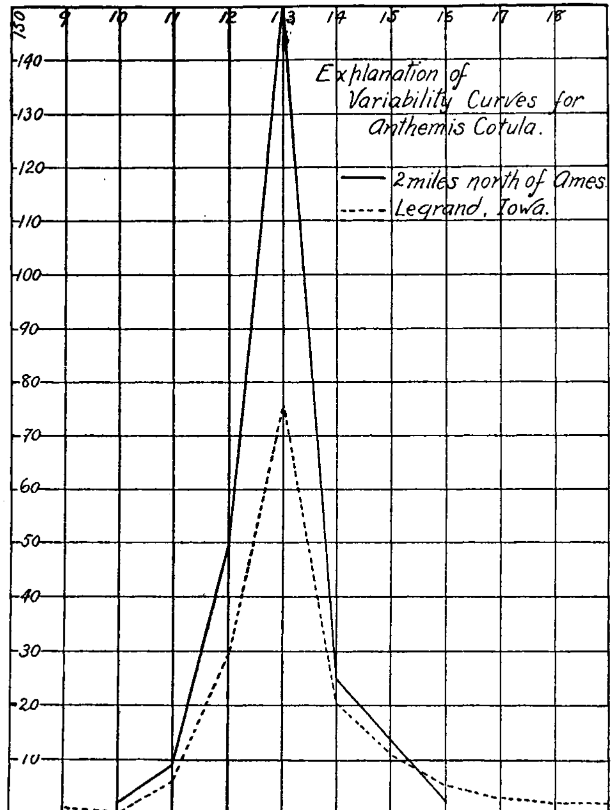

FIG. 2. Variability curves for *Anthemis cotula*.

Plant	No. of rays. 10	11	12	13	14	15	16	Total no. heads on each plant.
No. 1	1	6	19	24	2			52
2	1		7	53	10	5		76
3		1	6	9	1			17
4		2	4	11	1	1		19
5			2	11	1			14
6			6	23	5			34
7			6	18	2	8	2	36
8				1	3			4
Total no. heads in each class / Sum	2	9	50	150	25	14	2	252

FIG. 1. Figures at the top indicate the number of rays, those at the left the number of heads. *Anthemis cotula*. Two miles north of Ames.

PLATE XVII.

PLATE XVIII.

Plant	No. of rays. 10	11	12	13	14	15	16	Total no. heads on each plant.
No. 1	1	7	2	1				11
2	1		4	10	3			18
3			1	12	1			14
4			1	2	2	3		8
5			1	3	5	2		11
6				1	2			3
7				1	4	1		6
8				1		2	1	4
9				4	2			6
10				5	2			7
11				5	4			9
12				13	3			16
13				4	1	1		6
14				5	3	1		9
15				7	6	1		14
16				2	4	4	1	11
Total no. heads in each class. Sum.	2	7	9	76	42	15	2	153

FIG. 1. *Anthemis cotula*, at Bellingham, Wash.

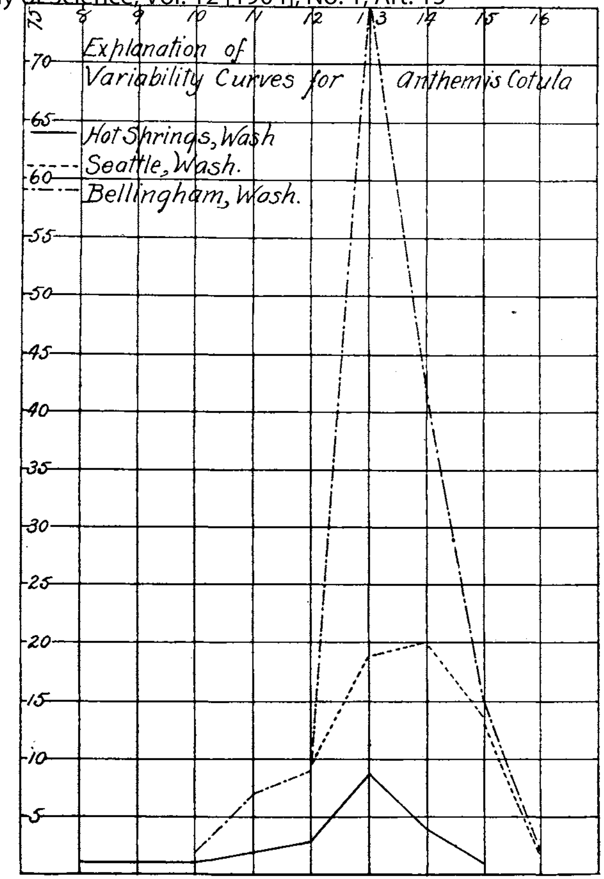

FIG. 2. Variability curves for *Anthemis cotula*, for different localities.

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PLATE XIX.

Plant	No. of rays: 2	3	4	5	6	Total no. heads on each plant.	No. of rays: 3	4	5	6	Total no. heads on each plant.
No. 1	1	1	6	25	3	36	1		12		13
2		1	6	12		19	1	3	21	3	28
3		2	3	3		8	1	23	4	1	29
4			2	7		9	2	5	4		11
5			1	10	3	14	4	11	8		23
6			3	14	1	18	6	23	32		61
7			5	15	7	27	14	66	44		124
8			7	17	5	29		1	6		7
9			8	42	3	53		1	7		8
10				8		8		4	18		22
11				7		7		9	19		28
12				18		18		10	13	1	24
13								2	26	2	30
Total no. heads in each class.	1	4	41	177	22	246 Sum	29	158	214	7	408 Sum

FIG. 2. *Achillea millefolium*, Castle Rock, Nez Perces Trail, Montana and Ames.

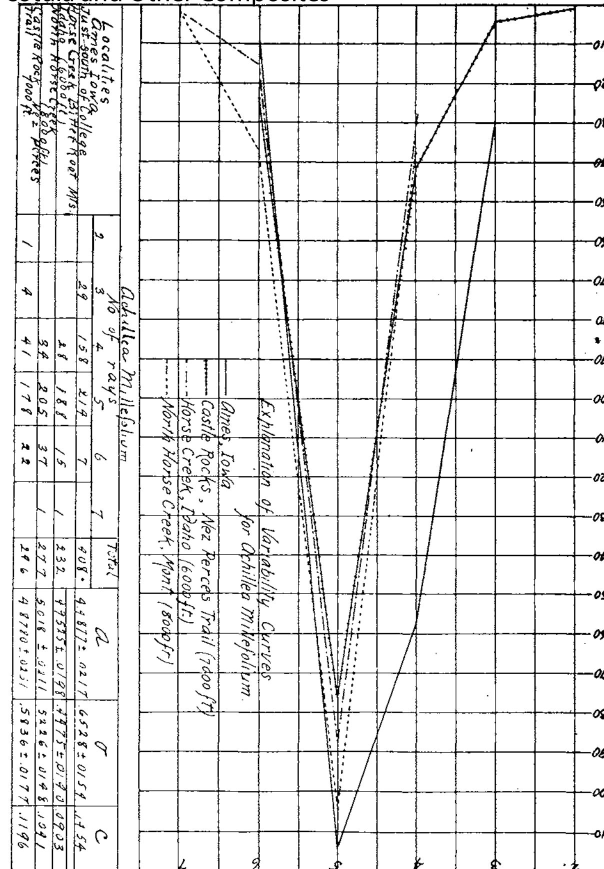
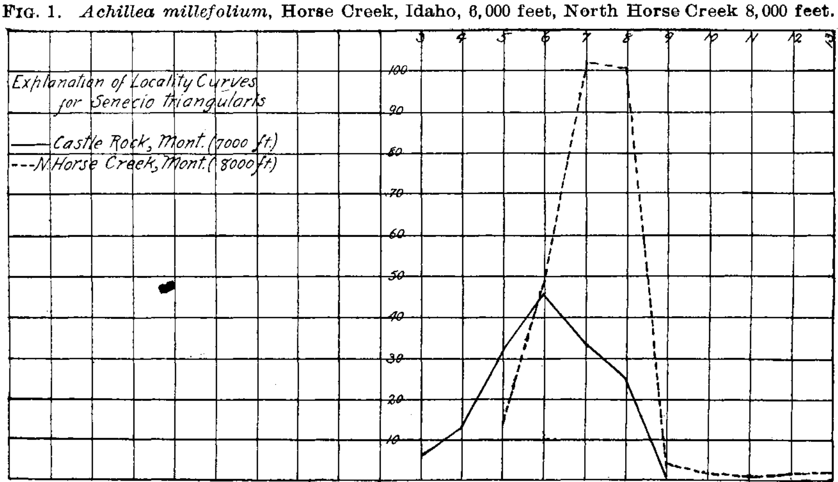


FIG. 1. Variability curves for *Achillea millefolium*, different localities.

PLATE XX.

Plant	No. of rays 4	5	6	7	Total no heads on each plant	No. of rays 4	5	6	7	Total no heads on each plant
No. 1	12	7			19	1	25	2		28
2	7	51	5	1	64	3	9	4		16
3	8	44	3		55	4	11	2		17
4		8			8	7	4			11
5		9			9	9	35	4	1	48
6		9			9	10	56	1		67
7		14	4		18		14	8		22
8		17	1		18		24	7		31
9		29	2		31		24	9		33
Total no heads in each class / Sum	28	188	15	1	232	34	205	37	1	277

FIG. 1. *Achillea millefolium*, Horse Creek, Idaho, 6,000 feet, North Horse Creek 8,000 feet.



Senecio triangularis

Localities	3	4	5	6	7	8	9	10	11	12	13	Total	A	σ	C
Castle Rock, Mont (7000 ft)	6	13	32	46	34	26	1					158	6.0822 ± .0717	1.3381 ± .0507	.2200
N. Horse Creek, Mont (8000)			13	49	102	101	4	2	1	2	2	276	7.2391 ± .0462	1.1392 ± .0327	.1435

FIG. 2. Locality curves for *Senecio triangularis*.