Journal of the Minnesota Academy of Science

Volume 29 | Number 1 Article 17

1961

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ARISAEMA TRIPHYLLUM, JACK-IN-THE-PULPIT, IN MINNESOTA, ESPECIALLY AT THE CEDAR CREEK NATURAL HISTORY AREA[1]

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Arisaema triphyllum (L.) Schott is a member of the Araceae, or Arum family and is distributed widely in temperate regions of North America, from Nova Scotia to Florida, Ontario, Minnesota, Kansas and Louisiana. Various aspects of this species have been investigated by many botanists since the last decade of the 19th century. Several taxonomists have treated the Jack-in-the-Pulpit in different ways since Linneaus described it first in 1753, under the name *Arum triphyllum*, in his Species Plantarum. In 1940 Fernald considered this North American genus, *Arisaema* to consist of three species: (1) *A. triphyllum* (L.) Schott, with its form *pusillum* (Peck) Fernald, (2) *A. stewardsonii* Britton, and (3) *A. atrorubens* (Ait.) Blume with its two forms, f. *zebrinum* (Sims.) Fernald, and f. *viride* (Engler) Fernald. More recently, Huttleston (1949) studied this group in a more comprehensive way, from taxonomic, ecologic and cytologic points of view. He considered the eastern American Jack-in-the-Pulpit, *A. triphyllum* (L.) Schott, in the broad sense, to consist of three major subspecies: subsp. *triphyllum* Huttleston, subsp. *stewardsonii* Huttleston and subsp. *pusillum* Huttleston. The distribution of these three subspecies in Quebec, Canada, was discussed by Raymond (1949). Bowden (1940) reported the somatic chromosome number of this species as 2n=56, and Huttleston (1949) observed 2n=56 (rarely 28) in his subsp. *triphyllum*, 2n=28 in subsp. *stewardsonii* and 2n=28 in subsp. *pusillum*. The meiotic division was studied by Atkinson (1899). The development of the embryosac was worked out in detail by Mottier (1892), Gow (1908) and Pickett (1913). The formation of flower buds was investigated by Foerste (1891), and the stigma and pollen by Rowlee (1895). MacDougal (1901) and Rennert (1902) compared the anatomy of the seed, and the germination and development of seedlings with those of *A. dracontium*. The root system of the mature plant was described by Rim-

[1]Acknowledgment. The author expresses his cordial thanks to Dr. Donald B. Lawrence, Department of Botany, University of Minnesota for his kind guidance, encouragement and critical readings of the manuscript. Grateful acknowledgment also is made to Dr. Gerald B. Ownbey for permission to examine many valuable specimens of *Arisaema* in the Herbarium of the Department of Botany, University of Minnesota, for kind suggestions regarding preparation of distribution maps, and for criticizing the manuscript.

bach (1900). A disease inflicted by the common systemic rust, *Uromyces caladii* Farl. has been studied by Rice (1934), Pady (1939), and others. Sex and sex-reversal are most interesting features of this species. Observations on change of sex-expression from one year to another, and detailed experimental works on sex-reversal have been reported by Atkinson (1898), Gow (1913), Schaffner (1921, 1922a,b, 1925, 1926) and Camp (1932). Schaffner's studies in particular are of interest. Camp presented a diagram of the normal life history of this species showing relations between size of the corm, its catalase activity, and sex-expression. A comprehensive review of the first 24 years of botanical work on *Arisaema triphyllum,* other than taxonomic, was made by Pickett (1915), with the addition of his own new findings, and illustrated with many beautiful drawings and photographs.

The present paper is concerned with distribution in Minnesota, with variations in purple pigmentation, sex, quantitative differences between male and female plants, and fruit- and seed-fertility of this species as observed in 1960 at the Cedar Creek Natural History Area, Minnesota.

DISTRIBUTION IN MINNESOTA: In Minnesota two species of *Arisaema, A. triphyllum* and *A. dracontium* (L.) Schott, are found. Moore and Tryon (1946) reported three species of *Arisaema, A. atrorubens* (Ait.) Blume, *A. stewardsonii,* Britton, and *A. dracontium,* in their checklist of Minnesota vascular plants. But in the present study, Huttleston's terminology is followed. This considers *A. triphyllum* of Minnesota to have two subspecies: (1) subsp. *triphyllum* Huttleston, and (2) subsp. *stewardsonii* Huttleston. A study was made of the distribution of the two species (*A. triphyllum* and *A. dracontium*, in Minnesota based upon the herbarium specimens * of the Department of Botany, University of Minnesota. Of the 135 specimens examined, 129 were *A. triphyllum* and 6 were *A. dracontium.* The collections of the former consist of 126 specimens of subsp. *triphyllum* and 3 of subsp. *stewardsonii.* Collection locality of each specimen was plotted on the map as shown in Figure 1. However, each mark does not necessarily represent a single specimen. For example, there were 13 specimens from Hennepin County but these are shown by only 6 dots. Since herbarium specimens are not collected at random, density of marks does not show the frequency in nature of these species in Minnesota. Localities of 4 specimens of subsp. *triphyllum* and 2 of *A. dracontium* could not be ascertained because of the lack of description of the exact locality.

Arisaema triphyllum subsp. *triphyllum* is differentiated from subsp. *stewardsonii* by the following characters according to Huttleston (1949). (1) Spathe-tube of the former is smooth or obscurely fluted with broad flanges at tops, but that of the latter is green with very prominent white flutings or ridges, with narrow or moderately broad flanges at tops. (2) The former usually grows in moist, but not

*The specimens had been recently examined and annotated by Donald G. Huttleston, a specialist in this genus.

wet, locations along water course; the latter is found in wet, boggy locations. (3) The somatic chromosome number of the former is 56 (rarely 28), but that of the latter is always 28. Subspecies *triphyllum* has been collected from most of the counties of Minnesota as show in Figure 1. Three specimens of subsp. *stewardsonii* which were collected in swamps, were found in only three counties: Koochiching, Itasca and Isanti. *Arisaema dracontium* occurs only in the southeast corner of Minnesota, in Winona and Houston Counties.

In 107 specimens of subsp. *triphyllum,* the following three color phase variations of the inner-upper part of the spathe were observed (15 specimens were excluded because they were fruiting plants in which the spathe colors are gone):

Type A—Pale green with no stripes .....21 specimens

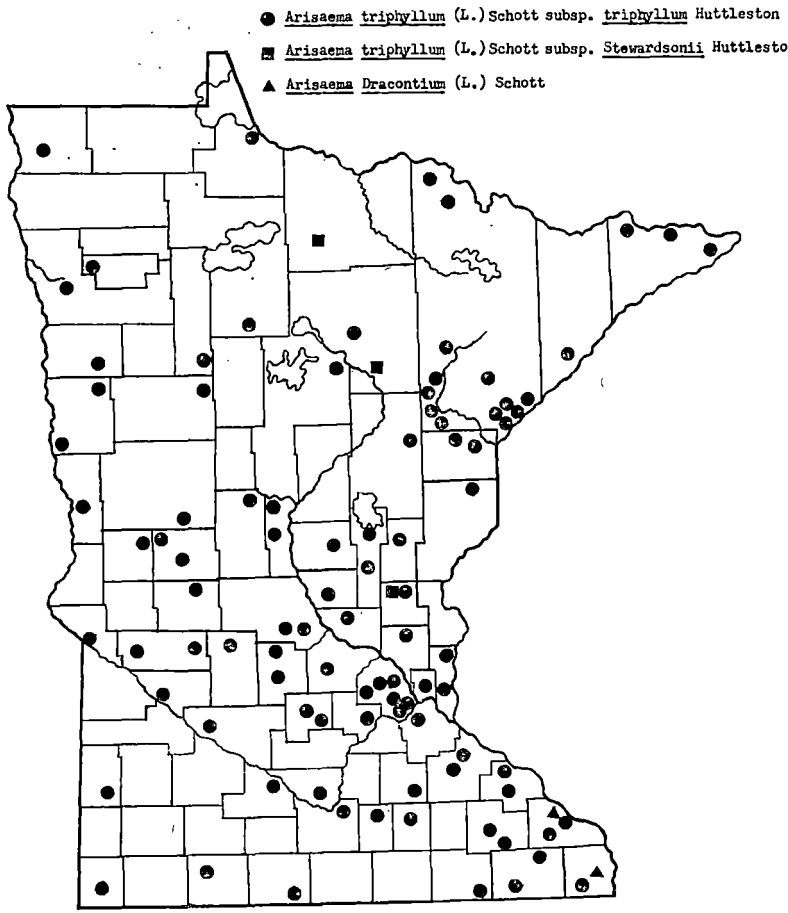

Fig. 1. Distribution of *Arisaema* in Minnesota based upon the herbarium specimens at the University of Minnesota, Minneapolis.

Type B—Pale green with light purple stripes....69 specimens
Type C—Pale green with deep purple stripes....17 specimens

Distribution of these three variants is shown in Figure 2. In this figure each specimen was plotted by one mark. As may be seen, type B is the most common in Minnesota. Type A is distributed rather at random. Types A and B were found at the same place in some counties. Distribution of type C is the northeastern part of the state, known as the Arrowhead Country: St. Louis, Lake and Cook counties, and in Carlton, Itasca and Pine counties, characterized by evergreen forest. Extensive field observations, and ecological and genetical experiments on such plants will be necessary before one can

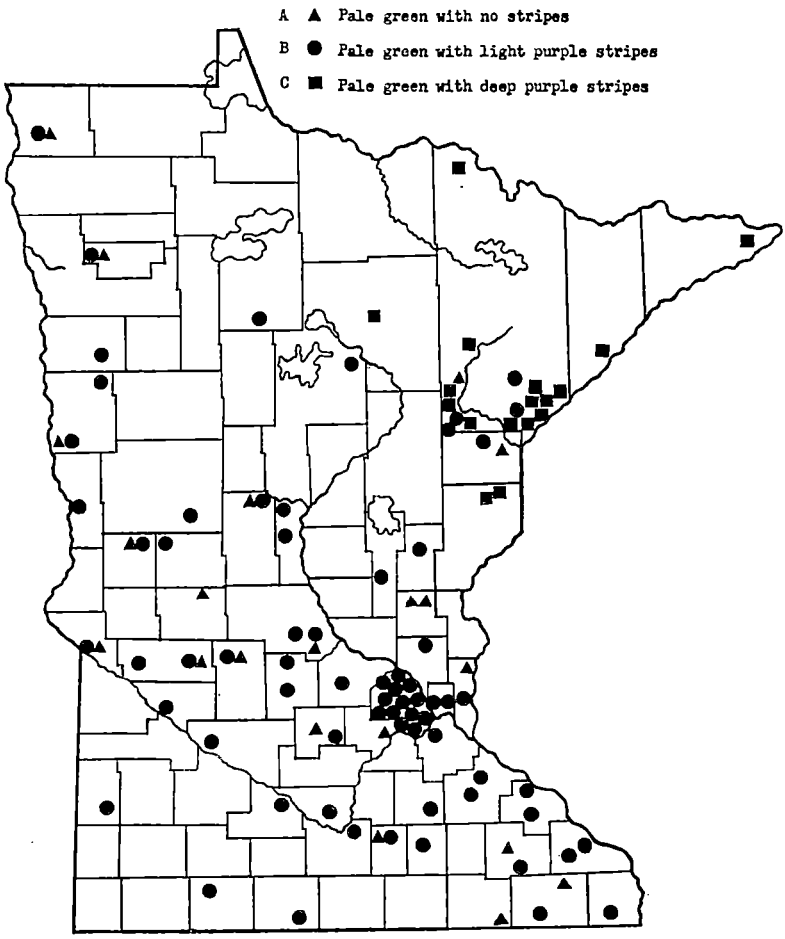

Fig. 2. Distribution of three color phase variations of the spathe of *Arisaema triphyllum* subsp. *triphyllum* in Minnesota.

hope to ascertain what specific factors govern the distribution of plants with deep colored spathes.

THREE OBSERVATION-STATIONS IN THE CEDAR CREEK NATURAL HISTORY AREA. *Arisaema triphyllum* is usually found in the moist forests. In this area *A. triphyllum* subsp. *triphyllum* has been recorded as *A. atrorubens* f. *zebrina* by Moore (1952). The following studies were mainly carried out at three Stations in the Cedar Creek Natural History Area, Anoka County, Minnesota, located 30 miles north of Minneapolis, in the period from April 13 to September 11, 1960. Some ecological characteristics of the Stations are shown in Table 1. Simply stated, Station I is swamp, Station II is transitional from swamp to upland, and Station III is upland, all three in deciduous forest.

TABLE 1. Ecological Descriptions of Three Stations in the Cedar Creek Natural History Area.

Station No.	I	II	III
Location	Low land ca. 25 m southwest from the southwest side of the field laboratory	Lowland ca. 650 m west from the laboratory, near the Lawrence cottage	Upland immediately south of the old road between the laboratory and the Lawrence cottage
Edaphic condition	Wet swamp on peat	Moist swamp, swamp margin and poorly drained upland	Mesic upland with well drained sandy soil
Representative trees forming the canopy	Black ash, white birch, alder. red maple, tamarack and poison sumac	American elm, alder, white birch and tamarack	Oak, white birch, aspen, Juneberry and cherry

Variations in purple pigmentation:

Color variation in plant parts is one of the most characteristic variations in the natural populations of this species. Bract sheath, stem, petiole, peduncle and flower show many color phase variations. Most plants in the Cedar Creek Natural History Area were purple colored. Plants having no purple color at all except very slightly colored spathe and purple anthers were only rarely found. Of the 119 plants observed, only 3 were of this type.

Color variations in inflorescence and flower parts, spathe, spadix, anthers and stigmata, were observed at Station II and III (Figure 3). As shown in Figure 3, four degrees of pigmentation, deep colored colored, slightly colored and no purple color, were found. Plants at Station II showed more diversity than those at Station III. Generally, the plant having purple color in spathe, in spadix and in anthers (male plant), and no purple color in stigmata (female plant), are most common in this Area. Plant having colored stigmata were found rarely.

Sex:

Arisaema triphyllum is often referred to as a dioecious species with male (staminate) and female (carpellate) plants. But sex of

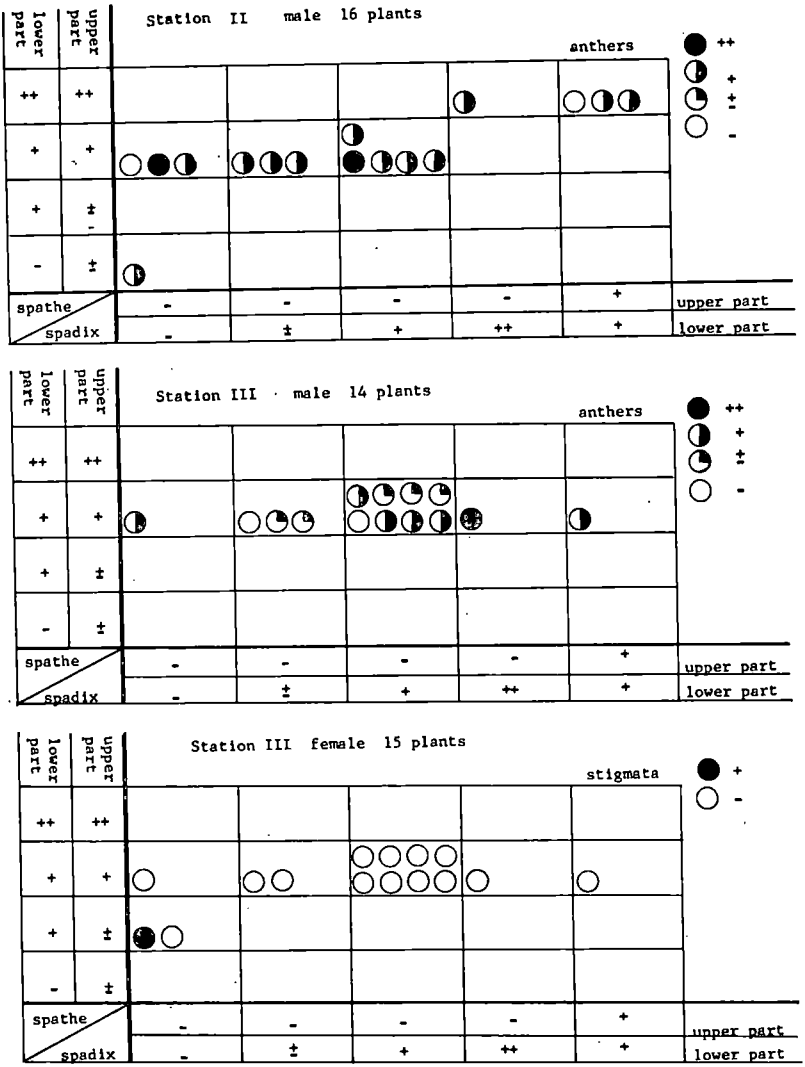

Fig. 3. Color variations in spathe, spadix, anthers and stigmata at the Cedar Creek Natural History Area.
++ deep colored + colored ± slightly colored −no purple color

this species has been shown elsewhere in its range to change with age during the normal life span, and also to change with environmental conditions. Moreover, considerable numbers of the plant bear inflorescences which have both male and female flowers, i.e. intermediate or monoecious, in natural conditions. These phenomena have been studied extensively by several authors as discussed previously. A male inflorescence consists of many male flowers without

petals and calyces. Each male flower usually consists of 2, 3, or 4 anthers with very short and thick filaments. A female inflorescence is an aggregate of ovaries without petals and calyces. Flowers in the male inflorescence start to bloom (i.e. the time of anthesis or pollen shedding) from the middle part of the inflorescence toward both upper and lower extremities. In the female inflorescence, the time when the flower is ready for pollination is not easily detected because of the lack of a good indicator such as pollen shedding in the male. However, it seems likely that the order of flowering is similar in the female inflorescence.

TABLE 2. Number of flowers in male and female inflorescence.

Station No.		II	III	
Sex		male	male	female
No. of plants observed		16	14	16
No. of flowers per inflorescence	Range	26–54	39–59	43–112
	Average	41.1	44.9	64.6

The number of flowers per inflorescence in male and female plants as observed at Stations II and III is shown in Table 2. Range and average number of flowers are greater in female than in male. In the course of this study three types of inflorescences, male, intermediate and female, were found in the Cedar Creek Natural History Area as shown in Figure 4. In intermediate inflorescences, termed

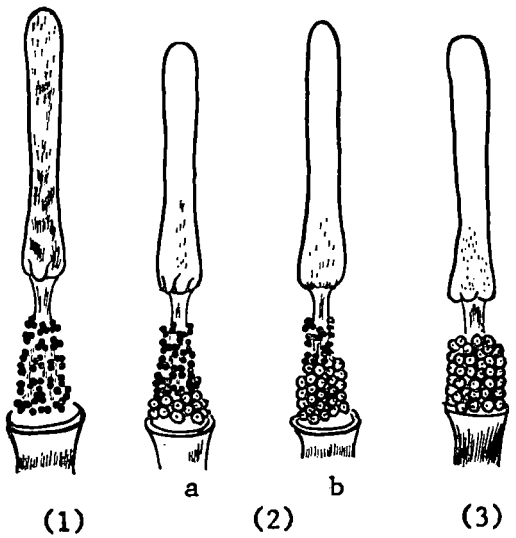

Fig. 4. Three types of inflorescence in *A. triphyllum* at the Cedar Creek Natural History Area.
(1) male (2) intermediate (3) female
a. predominantly male
b. predominantly female

"predominantly male", more male flowers than female flowers occurred and in "predominantly female" inflorescences the reverse was observed.

On June 1, random samplings of inflorescence were made at Stations I, II, and III. These were collected in two polyethylene bags, one for plants with one leaf and the other for plants with two leaves. The sex of each inflorescence in each collection was subsequently examined in the laboratory. The results are presented in Table 3. Frequency of male plants at Station I was very high (89.4% of total plants collected at that Station) but that of female plants was very low (4.2%). To the contrary, almost equal numbers of male and female plants were collected at Station III. The proportion of male and female plants at Station II was intermediate between Stations I and III. Considering the ecological descriptions of the three Stations as shown in Table 1, Station I would seem to have lower oxygen and nutrient levels, except perhaps for nitrogen, and to have higher moisture as compared with Station III. At each station several intermediate plants (2.6-9.1%) were found. In total, the proportion of male plants was 71.4%, of intermediate 5.9%, and female 22.7% in the populations studied. Similar results were obtained by Schaffner (1922). He observed 1874 plants in five different ecological habitats. Of them, 1163 (62.1%) were male, 267 (14.2%) were intermediate and 444 (23.7%) were female plants. He pointed that there is a large fluctuation in sex ratios for the different habitats, and that the male (staminate) plants are always much in excess as compared with either the female (carpellate) or the intermediate individuals. Of the 88 plants with only one leaf, in the Cedar Creek study, 87.5% were male plants, and of the 31 plants with two leaves 67.7% were female plants as shown in the last column of Table 3. Although Schaffner (1922) stated that both one-leaved and two-leaved plants were either staminate or carpellate in about equal proportions, observations of the present study show that the plants with but a single foliage leaf were usually males, those with two foliage leaves were usually females.

Seven intermediate inflorescences, 4 predominantly male and 3 predominantly female, were collected at the three stations. The proportion of male and female flowers in each inflorescence was ascertained as shown in Table 4. It is estimated that such intermediate plants may be of intermediate age within the whole life span, between the single foliage leaf male condition of youth and the two foliage leaf female condition of the old plants, or else they may be in a labile condition induced by the environmental factors. Atkinson (1898) seems to have been the first to report that some plants produced totally male inflorescence, others produced totally female inflorescences, and still others produced flowers of both sexes on the same inflorescences. Gow (1913), Pickett (1915), Schaffner (1921, 1922, 1925), and Camp (1932) noted this also, in careful observations on successive seasonal sex-reversals, and in some cases in controlled experiments as well. In the present obervations, male

TABLE 3. Frequency of male, intermediate, and female plants in relation to number of leaves per plant in the Cedar Creek Natural History Area. Percentages are shown in parentheses.

Station No.		I	II	III	Total
Plants with one leaf:					
male		37 (97.4)	29 (82.9)	11 (73.3)	77 (87.5)
	predom. male	1	0	2	3
intermediate		(3.6)	(2.8)	(20.0)	(5.7)
	predom. female	0	1	1	2
female		0	5 (14.3)	1 (6.7)	6 (6.8)
Subtotal		38	35	15	88
Plants with two leaves:					
male		5 (55.6)	0	3 (16.7)	8 (25.8)
	predom. male	1	0	0	1
intermediate		(22.2)			(6.5)
	predom. female	1	0	0	1
female		2 (22.2)	4 (100.0)	15 (83.3)	21 (67.7)
Subtotal		9	4	18	31
Total:					
male		42 (89.4)	29 (74.3)	14 (42.4)	85 (71.4)
	predom. male	1	1	2	4
intermediate		(6.4)	(2.6)	(9.1)	(5.9)
	predom. female	2	0	1	3
female		2 (4.2)	9 (23.1)	16 (48.5)	27 (22.7)
Total		47	39	33	119

flowers in the intermediate inflorescence always occupied the upper part of the inflorescence in both predominantly male and predominantly female types. Pickett (1915) and Schaffner (1921) found examples of the reverse arrangement and also cases of male and female flowers irregularly mixed in a single inflorescence, as well as the condition of male flowers above as in the present study.

TABLE 4. Proportion of male and female flowers in the intermediate inflorescence. Percentages are shown in parentheses.

	Station No.	Male flowers	Female flowers	Total
Predom. male:				
one plant	II	41 (93.2)	3 (6.8)	44
two plants	III	41 (78.8)	11 (21.1)	52
	III	37 (74.0)	13 (26.0)	50
one plant	I	39 (65.0)	21 (35.0)	60
Average		39.5 (76.7)	12.0 (23.3)	51.5
Predom. female:				
no plants	II	none	none	none
one plant	III	1 (1.6)	61 (98.4)	62
two plants	I	8 (13.8)	50 (86.2)	58
	I	11 (18.3)	49 (81.7)	60
Average		6.7 (11.2)	53.3 (88.8)	60.0

Quantitative differences between male and female plants:

Twelve quantitative characters of 29 male and 9 female plants at Station II were measured on May 25. Range and average of each character in both sexes is shown in Table 5. Of the 9 female plants, 4 had a second leaf but that leaf was not measured. Order of leaflets of the first (larger) leaf was designated as first, second and third from the left hand side, as viewed from above. Female plants are larger in length of outermost bract, petiole, leaf, spathe and spadix, and especially the stem of female plants is notably longer (11.2cm) than that of male (3.7cm). One exception is the length of peduncle which is greater in male (8.9cm) than in female (6.1cm). With that exception, it is concluded that female plants are larger than male plants. As Camp (1932) clearly pointed out, usually plants of this species as they pass through life are at first immature non-flowering (asexual), then male, in still later years intermediate (monoecious), and finally female in the normal life history of this species. He assumed this to be true because he found that plants producing male flowers arise from corms characteristically light in weight, while those producing female flowers are heavy. Plants in a transitional or monoecious stage have an intermediate corm weight. He pointed out further that plants with the larger size of corm result in larger plant bodies and are female plants. Also as mentioned above, plants with two leaves were mostly female and those plants should be able to produce larger amounts of photosynthetic products as compared with the plants with one leaf which were mostly male individuals as shown in Table 3.

TABLE 5. Range and average values in centimeters of the quantitative characters in male and female plants at Station II as observed May 25.

Sex	Male		Female	
No. of plants observed	29		9	
	Range	Average	Range	Average
Length of bract sheath	3.5–10.5	6.0	6.0–12.5	8.7
Length of stem	0.5– 8.5	3.7	6.0–17.0	11.2
Length of petiole	7.0–21.0	14.3	11.0–18.5	15.7
Length of 1st leaflet	5.0–10.3	7.1	7.5–13.0	9.5
Width of 1st leaflet	2.4– 7.0	3.9	4.3– 7.2	5.5
Length of 2nd leaflet	5.4–10.2	7.2	7.6–12.5	9.5
Width of 2nd leaflet	2.1– 6.6	4.0	4.0– 7.2	5.7
Length of 3rd leaflet	4.5–10.0	7.2	7.2–13.0	9.8
Width of 3rd leaflet	2.5– 6.5	3.9	4.0– 7.0	5.5
Length of peduncle	3.5–14.0	8.9	3.5–10.0	6.1
Length of spathe	7.0–11.0	8.4	8.3–11.5	10.2
Length of spadix	2.8– 4.1	3.1	3.5– 5.0	4.1

Fruit- and seed-fertility:

In September, fruits of this species became mature with very beautiful vermillion color. Fruit- and seed-fertility of several plants at the three Stations were observed on September 11. Table 6 shows natural fruit- and seed-fertility of 12 plants collected. Several fruits

TABLE 6. Fruit- and seed-fertility of 12 plants collected at three Stations in the Cedar Creek Natural History Area as observed Sept. 11.

Plant No.	Station No.	No. of fruits fallen	No. of intact fruits on inflorescence	No. of fruits with seeds Percentages in parentheses	No. of fruits without seeds	No. of seeds per fruit					Average No. of seeds per fruit	Seed-fertility in percent
						1	2	3	4	5		
1	I	0	57	38 (66.7)	19	35	3	0	0	0	1.1	15.3
2	I	0	72	41 (56.9)	31	22	11	7	1	0	1.7	20.4
3	I	2	85	16 (18.8)	69	14	2	0	0	0	1.1	4.5
4	I	0	62	33 (53.2)	29	19	10	4	0	0	1.6	17.5
5	I	0	50	5 (10.0)	45	4	1	0	0	0	1.2	2.6
6	I	0	73	60 (82.2)	13	23	22	11	4	0	1.9	33.8
7	I	1	77	30 (39.0)	47	17	6	7	0	0	1.7	13.8
8	I	1	62	27 (43.6)	35	26	1	0	0	0	1.0	9.6
9	II	4	53	31 (58.5)	22	28	3	0	0	0	1.1	13.7
10	II	0	48	28 (58.3)	20	18	10	0	0	0	1.4	16.8
11	II	0	45	20 (44.4)	25	13	7	0	0	0	1.4	12.8
12	III	2	67	65 (97.0)	2	19	27	8	9	2	2.2	45.5
Total			751	394 (52.5)	357	238	103	37	14	2		
%					(47.5)	(60.4)	(26.1)	(9.4)	(3.6)	(0.5)		
Average			62.5	32.8	29.7						1.6	17.6

(1-4) of 5 plants had already fallen from the inflorescence to the ground at that time. These fruits were excluded from the further calculations. Fruit-fertility was calculated by the following formula:

$$\frac{\text{Number of fruits with seeds}}{\text{Number of intact fruits on inflorescence}} \times 100$$

Fruit-fertility of each plant is decidedly variable and relatively low and the average of all plants showed 52.5%. Fruits without seeds were mostly underdeveloped ones compared with seeded fruits and the average proportion is 47.5% of all the fruits. On the contrary, average number of seeds per fruit of each plant is very similar, ranging from 1.0 to 2.2, and 1.6 as the average of 12 plants. In order to calculate seed-fertility, number of ovules per ovary in three female inflorescences which were collected in spring, were counted under the dissecting microscope. Results are shown in Table 7. Unexpectedly, the ovary contained 3 to 7 ovules, and 4.7 ovules per ovary was the average. Gow (1908) stated that the ovary of *Arisaema* contains one to six erect, orthotropous ovules and the averafe number was found to be four, counting over three hundred ovaries. Hence, seed-fertility percent was calculated using the following formula based on the average number of ovules per ovary:

$$\frac{\text{Number of total seeds}}{\text{Number of intact fruits on inflorescence} \times 4.7} \times 100$$

The values of seed-fertility are shown in the last column of Table 6, and are decidedly variable as are also those of fruit-fertility of each plant (average: 17.6%).

TABLE 7. Number of ovules per ovary in three inflorescences collected in the Cedar Creek Natural History Area.
Percentages are shown in parentheses.

Plant No.	Total No. of ovaries	No. of ovules per ovary					Average
		3	4	5	6	7	
1	110+1*	12 (10.9)	34 (30.9)	40 (36.4)	18 (16.4)	6 (5.4)	4.8
2	61	12 (19.7)	35 (57.4)	14 (22.9)			4.0
3	60	4 (6.7)	9 (15.0)	21 35.0)	21 (35.0)	5 (8.3)	5.2
Total	231	28 (12.1)	78 (33.8)	75 (32.5)	39 (16.9)	11 (4.7)	4.7

*An abnormally large ovary with 23 ovules in it. Irregularity of shape suggests that it resulted from the fusion of 4 ovaries. It is excluded from the tabulation.

Number of seeds per seeded fruit and seed-fertility are evidently very low compared with the number of ovules per ovary. Of 394 seeded fruits, 60.4% contained only one seed, 26.1% contained two seeds and the remaining 10.5% are 3 to 5 seeded fruits. Of 231

ovaries examined, 12.1%, 33.8%, 32.5%, 16.9% and 4.7% of them contained 3, 4, 5, 6, and 7 ovules, respectively. The relationship between number of seeds and ovules is shown in Figure 5. The former showed the so-called J-shaped distribution which falls off very sharply but the latter is fairly symmetrical in distribution. Means of both curves are very different as mentioned previously. Edwards (1933) observed a tendency of natural seed-setting in *Peltandra virginica* (L.) Kunth., another genus of the Araceae, similar to that of the present study. He noticed that many factors may influence the numbers of seeds that may ripen in the fruits of a given species, important among them being the number of ovules laid down during the development of flower and the number of these that are fertilized. From present observations, the developmenal process of fertilized ovules in the ovary should be examined in detail to clarify the factors causing such peculiar distribution of seed number in fruits. It may be assumed that one of the factors would be something like developmental competition for food among the fertilized ovules during the young stage of fruit development. Further studies are needed. According to the literature, geographical

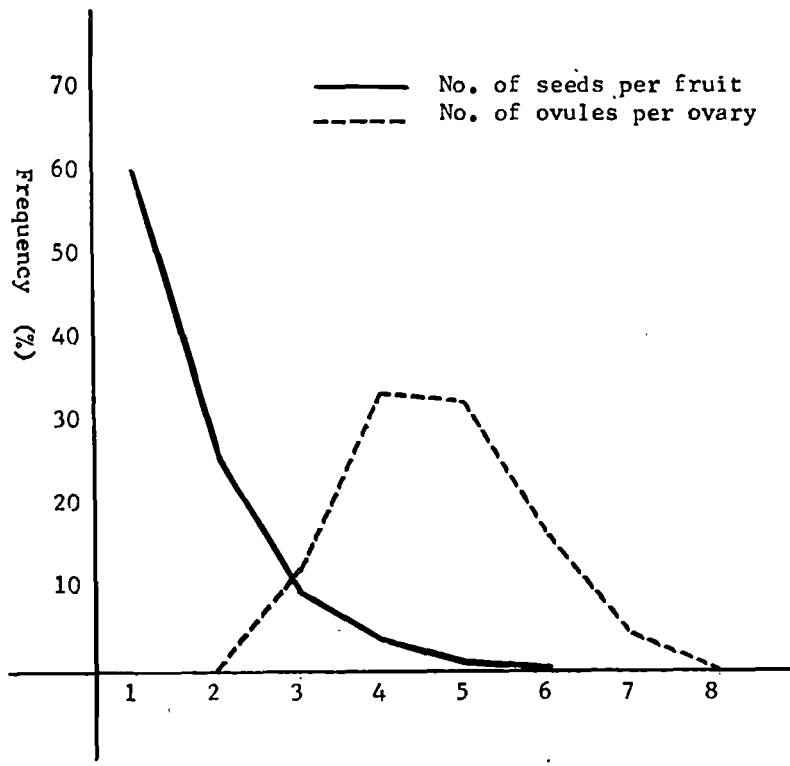

Fig. 5. Comparison of average number of seeds per fruit and average number of ovules per ovary.

distributions of *Peltandra virginica* and *Arisaema triphyllum* are wide and both are common in North America. Judging from the geographical distribution of both species, this tendency toward the production of one-seeded fruits does not seem to put the species at any conspicuous disadvantage as mentioned by Edwards (1933). Propagation by vegetative means is of course important in both these genera.

SUMMARY. In Minnesota two species of *Arisaema, A. triphyllum* with two subspecies: subsp. *triphyllum* and subsp. *stewardsonii*, and *A. dracontium*, are found. The distribution map of these species based upon the herbarium speciments was presented. *Arisaema triphyllum* subsp. *triphyllum* is most common in Minnesota; *A. dracontium* occurs only in the southeast corner of the state. In specimens of subsp. *triphyllum*, three color phase variations of the spathe were observed; pale green with no stripes (Type A), pale green with light purple stripes (Type B) and pale green with deep purple stripes (Type C). Type B is most common in Minnesota. Type A is distributed at random. Type C is only found in the northeast part of the state.

The following observations were carried out at three observation Stations in the Cedar Creek Natural History Area, Minnesota.

Color variations in inflorescence and flower parts were very characteristic. Generally, the plants having purple color in spathe, in spadix and in anthers (male plant), and no purple color in stigmata (female plant), are most common in this area.

Flowers in the male inflorescence start to bloom from the middle of the inflorescence toward both upper and lower extremities. Range and average number of flowers per inflorescence are greater in female than in male. Three types of inflorescence, male, intermediate (monoecious) and female, were found. Proportions of these types differed among the Stations according to the environmental conditions. In total, the proportion of male plants was 71.4%, of intermediate 5.9%, and female 22.7% in the populations studied. The plants with a single foliage leaf were usually males, and those with two foliage leaves usually females.

Of 12 quantitative characters measured, all are greater in female than in male except length of the peduncle.

Fruit- and seed-fertility of each plant were decidedly variable and low, and the average of 12 plants showed 52.5% and 17.6%, respectively. On the contrary, average number of seeds per fruit of each plant was very uniform, ranging from 1.0 to 2.2 and with 1.6 as the average. The ovary contained 3 to 7 ovules and 4.7 ovules per ovary was the average. Number of seeds per fruit was very different from the number of ovules per ovary. It is assumed that one of the factors causing such prominent differences would be something like developmental competition for food among the fertilized ovules during the young stage of fruit development.

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