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Variation in the floral structures of *Vitis*\*

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(WITH PLATES 1-3)

The genus *Vitis* has invited special attention botanically and horticulturally on account of its economic importance. The normal morphology of the flower is, of course, well known, and some observations have been made respecting variation in the different floral members. It would seem, however, that there is accessible no sufficient account of variation in the floral types. In the present paper the writer proposes to bring together some general facts and observations and especially to record some studies on the structural and numerical variation in the floral parts of certain species and varieties.

GENERAL FLORAL HABITS OF VITIS

The flower of *Vitis* presents a number of interesting variations, occurring both in the number and in the development of floral parts. In the flowers of many other genera where there is a multiplication of floral envelopes, there is often a complete or partial metamorphosis of some of the members into others, as in doubling, where stamens may be found showing a more or less complete transformation into petals. In *Vitis*, however, there occur either only completely developed floral members, or if there are modifications, they are in the direction of the suppression of certain members. There is, moreover, a close numerical relation

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between members of the floral organs in the several whorls; and this relation obtains when there occurs either an increase or decrease in the number of parts of the flower.

FLOWER TYPES: *Vitis* may be regarded as dioecious, polygamodioecious, or perfect. Individual vines of *V. vulpina* and *V. bicolor* occur in the wild in either the staminate or the perfect form. By staminate is meant forms in which no well-developed pistils are produced.

In the open the staminate plants occur in the greater number; of the 347 vines observed by the writer, 218 were staminate and 129 perfect. In these species the reflexed or recurved type of stamen was an invariable accompaniment of the perfect flower; that is, in no case were upright stamens found along with well-developed stigmas. Two wild vines, however, of *V. vulpina* were found in which the stigmas were partially developed. Yet the upright stamen form is to be regarded as signaling the typical perfect flower, since, as is shown later, pollen development in the reflexed stamen may be poor.

As has been observed by Engelmann ('94) and others, the cultivated varieties, on the other hand, have two distinct floral types which are quite constant for all of the individual vines of a variety. These types are both perfect forms, the one possessing upright and the other reflexed or recurved stamens. As might be expected, the staminate form is not found under cultivation, except in rare instances where it may be grown in order to pollinate some of the self-sterile varieties.

It may be of interest to consider briefly the significance of the perfect form of flower, in general. From the standpoint of the evolution of the floral forms, either we may regard the perfect flower as the original form, and the pistillate and staminate forms as being derived from this; or we may consider the original form to have had dichlinous flowers, and the perfect form to have been a later development.

There occur in the known species of *Vitis*, flowers (1) with stamens upright and pistils abortive (functionally staminate), (2) stamens upright and pistil fully developed and functional (perfect), and (3) stamens reflexed, pollen more or less abortive, and fully developed pistils (sometimes functionally pistillate).

Flowers possessing no stamens do not occur, or at least have not been recorded. Among these existent floral types which way is the evolution taking place? Goebel ('98) states "as a further peculiarity of the angiospermous flower that it is predominantly hermaphrodite, and unisexual flowers can be proved to be frequently the result of arrest of either the microsporophylls or the megasporophylls."

The perfect form of flower occurs in the cultivated varieties of many species of grape. In fact, this form of flower, according to Engelmänn, has, by some, been considered of taxonomic value in *V. vinifera*. As has been noted, however, in wild vines of *V. bicolor* and *V. vulpina* the perfect flower with upright stamens was not observed in 347 individuals. Nevertheless, Beach ('98 and '99) and Booth ('02) have shown that in many cultivated forms with perfect flowers, having reflexed stamens, the pollen is abortive to a variable extent, this often rendering the flower pistillate,—at least functionally. Under similar conditions, also, vines are found bearing flowers with partially developed stigmas; and functionally these may be considered on the border line between the perfect and staminate forms. (PLATE I, FIG. 9.)

Even taking into consideration these variations, there were observed to occur among the wild vines native to the region about Ithaca and Geneva, N. Y., only the staminate form and the perfect form with reflexed stamens. This would seem to indicate that the evolution is toward the dioecious habit.

In the genera closely related to *Vitis* there is a similar condition with respect to differentiation. According to Small, *Cissus* L. is perfect or sometimes polygamous, *Ampelopsis* Michx. mostly perfect, and *Parthenocissus* Planch. perfect or polygamo-monoecious. In this regard the degree of differentiation in *Vitis* and in the genera related to it is therefore considerable. These variations are both structural and functional. It is not clear which is the most primitive form, so that attempts to determine precisely the direction toward which evolutionary changes are now taking place would be largely speculation.

**THE FLOWER CLUSTER:** The branching habit of the grape is sympodial. The tendrils, or early in the growth of the shoot, the clusters, are the terminal growths of the stem. Upon further

elongation of the shoot new tendrils become terminal, while the older tendrils and clusters assume a lateral position upon the stem, opposite and alternating with the leaves. Intermediate forms between tendrils and flower clusters are common. Durand ('01) shows that in their origin and anatomical structure the grape tendrils and clusters are identical, and that they may change naturally one to the other. Tendrils frequently occur that bear a number of buds, the tendril retaining in such cases its irritability in the region of the buds and twining much in the same way as the normal tendril.

The flower clusters vary considerably, both in size and in number of clusters upon the cane, in the different varieties and species. Instances are common in the varieties of *V. Labrusca* in which five or more clusters are borne in succession on a single cane. This may be accounted for largely by the fact that in this species a tendril or cluster is usually borne opposite each leaf ("continuous tendrils"). In the other native species, which have no tendril or cluster for each third leaf ("intermittent tendrils"), the number of clusters per cane is reduced somewhat, the usual number being two or three.

The staminate cluster usually bears more flowers, has greater fragrance, and blooms earlier in the open than the perfect form. The flowers on the main axis of the cluster open commonly from one to four days or more earlier than those on the "shoulder." The blooming period of the different varieties and species varies much, and in the case of *V. vulpina* and *V. bicolor* the blooming periods rarely overlap, *V. bicolor* flowering last.

THE FLOWER: The grape flower is hypogynous. The calyx is represented by a narrow rim at the base of the flower. The normal perfect form has five green petals with five stamens opposite. Yellowish nectariferous glands occur between the stamens and are equal in number to them. There is a large sessile stigma. The carpels are from two to four in number, each usually with two ovules. The perfect form differs from the staminate merely in possessing a fully developed and functional pistil, this usually being abortive to the extent that no stigma is developed in the staminate flower.

Engelmann ('94) divides the pistil-bearing form into two types,

the "perfect" and the "imperfect hermaphrodites." This distinction was made as a result of the difference in the filaments; the "perfect hermaphrodite" having upright stamens (PLATE I, FIG. 1); and the imperfect the reflexed stamens, in which the filaments curl back and down, bringing the anthers below the plane of the stigma (PLATE I, FIG. 2). From the standpoint of self pollination this last mentioned position is an important consideration.

**THE COROLLA:** The corolla is gamopetalous; the united petals in the bud forming the "cap" (PLATE I, FIG. 3 and 5). In the opening of the flower the petals break away at the base and remain united at the tips. This is one of the characters distinguishing *Vitis* from *Cissus*, the latter opening by breaking at the apex instead of at the base.

**OPENING OF THE FLOWER:** In the bud the cohering petals completely enclose the stamens and pistil. The first evidence that the flower is opening is the breaking away of the petals at the base. In most cases the break occurs at the base of one petal, the small fracture in the epidermis thus formed permitting further drying out of the surrounding tissue. Other petals break away at the base, curling as they break, thus separating one from another along the shallow sutures between. When the petals are released at one side, those on the opposite side hold fast. With further drying out, the tension brings the cap off sidewise, until it finally hangs by one petal, which soon breaks away, allowing the cap to fall (PLATE I, FIG. 4 and 5). In other cases all the petals break away at about the same time, the individual petals gradually separating and curling up at the base, until they finally open wide and fall off. The cap may be only a few minutes in coming off, or it may remain partly open for several hours, depending upon the environmental conditions. Sometimes the cap breaks at the base and comes off almost instantly, the filaments gradually straightening out in the cases where the stamens are upright, or curling backward if the stamens are normally reflexed.

It is quite probable that the movements of the cap are primarily due to a drying out process rather than to pressure from the stamens. If the cap is removed, the separate petals soon curl up, as in the normal opening. In a very few cases the cap breaks

away at the top and the stamens extend through the slit. In some varieties this occurs more commonly at the beginning of the blooming season. The filaments are curled up under the cap before the flower opens and soon become straight and upright or reflexed (according to the flower type) when the cap is released or removed. In the wild staminate forms the filaments soon curl back, bringing the anthers near the base of the ovary (PLATE I, FIG. 6). In some cases the cap will hold a part of the stamens together while one or more may be released, the latter soon curling backward if the stamens are reflexed. The flower opens in much the same way in all of the flower types. Beach ('92) observed that in a number of varieties the anthers opened before the cap was thrown off.

#### SPECIAL VARIATION IN FLOWER PARTS

VARIATION IN THE STAMEN NUMBER: There are usually five stamens in the grape flower. In order to determine how constant the number of stamens per flower is, the flowers on a number of clusters were classified with respect to stamen number. This classification shows considerable variation in the number of stamens per flower, both above and below the normal number five, and also that the proportion of flowers having either more or less than five stamens was nearly constant for the clusters of each vine. This proportion was found to be quite characteristic for each vine without regard to the type of flower, variety, or species. In a total of 115 clusters counted, not a single vine was found in which the proportion of flowers for each stamen number was not quite constant. The proportion may differ materially in the different vines of a variety, as in Petite Sirah, a variety of *V. vinifera*; on one vine (TABLE I) there are more flowers having five stamens than six, while on an adjacent vine there are more having six stamens than five.

TABLE I gives in a summarized form the data for all of the counts made; it includes for various species and certain cultivated varieties the total number of flowers per cluster, the number of flowers in each cluster for each stamen number, and the necessary indications respecting the type of flowers. The number of stamens varies from 3 to 9, or in other words, two below the usual number

TABLE I

Variety or species	Wild or cultivated	Sex	Clusters counted per vine	Class frequency for no. of stamens per flower							Total no. of flowers per cluster
				3	4	5	6	7	8	9	
<i>V. aestivalis</i> .....	C	♂	1		16	208	88	11			323
".....	"	"	1		21	426	125	4			576
".....	"	"	2		14	391	147	8			560
<i>V. bicolor</i> .....	W	♂	1	1	63	450	37				551
".....	"	"	2		34	487	38				559
".....	"	"	3	2	45	355	20				422
".....	"	"	4		35	261	25				321
".....	"	"	5		28	279	8				315
".....	"	"	1		106	472	17				595
".....	"	"	2		38	205	9				252
".....	"	"	3		108	437	13				558
".....	"	"	4		61	408	8				477
".....	"	"	5		94	394	12				500
<i>V. vulpina</i> .....	W	♀	1		5	66	13				84
".....	"	"	2		3	89	9				101
".....	"	"	3		2	105	11				118
".....	"	"	4			112	16				128
".....	"	"	5		4	121	10				135
".....	"	"	1		3	77	13				93
".....	"	"	2		3	64	25				92
".....	"	"	3		4	144	18				166
".....	"	"	4		1	74	10				85
".....	"	"	5		1	86	13				100
".....	"	"	1		9	101	9				119
".....	"	"	2		6	86	7				99
".....	"	"	3		3	84	3				90
".....	W	♂	1		78	298	5				381
".....	"	"	2		86	279	6				371
".....	"	"	3		94	308	7				409
".....	"	"	1		49	362	20				431
".....	"	"	2		44	237	9				290
".....	"	"	3		60	203	13				276
".....	"	"	4		50	176	7				233
".....	"	"	5		121	294	9				424
".....	"	"	6		81	303	9				393
".....	"	"	7		69	240	6				315
".....	"	"	1		43	82	7				132
".....	"	"	2	I	28	140	8				177
".....	"	"	3		34	109	6				149
".....	"	"	4		15	113	23				151
".....	"	"	5		33	191	23				247
".....	"	"	6		35	92	8				135
".....	"	"	7		32	128	12				172
".....	"	"	8		33	190	21				244

44 DORSEY: VARIATION IN FLORAL STRUCTURES OF VITIS

Variety or species	Wild or cultivated	Sex	Clusters counted per vine	Class frequency for no. of stamens per flower							Total no. of flowers per cluster
				3	4	5	6	7	8	9	
<i>V. vulpina</i> . . . . .	W	♂	9	21	211	12					244
" . . . . .	"	"	10	28	118	4					150
" . . . . .	"	"	11	31	177	9					217
" . . . . .	"	"	12	26	194	8					228
" . . . . .	"	"	13	21	238	13					272
" . . . . .	"	"	14	18	259	15					292
" . . . . .	W	♂ ♀	1	23	427	127	2				579
" . . . . .	"	"	2	11	159	38	1				209
" . . . . .	"	"	3	32	372	65	1				470
" . . . . .	"	"	4	24	481	156					661
" . . . . .	W	♂	1	60	347	63					470
" . . . . .	"	"	2	29	325	72					426
" . . . . .	"	"	3	10	362	65					437
" . . . . .	"	"	4	18	348	91					457
" . . . . .	"	"	5	24	416	70					510
" . . . . .	"	"	1	9	328	190	9	2			538
" . . . . .	"	"	2	15	383	302	38				738
" . . . . .	"	"	3	23	209	81	2				315
" . . . . .	"	"	4	26	424	161	7				618
Concord ( <i>V. Lab.</i> ) . . . . .	C	♂	1	4	67	30					101
" . . . . .	"	"	2	2	32	22	2				58
" . . . . .	"	"	3	1	61	26	2				90
" . . . . .	"	"	4	3	75	9	1				88
Brighton ( <i>Lab., vin.</i> ) . . . . .	C	♀	1	13	74	38	2				127
" . . . . .	"	"	2	11	83	22	1				117
" . . . . .	"	"	3	7	76	32	3				118
Hybrid Franc ( <i>vin., rup.</i> ) . . . . .	C	♂	1	1	47	83	6				137
" . . . . .	"	"	2	1	34	106	6				147
" . . . . .	"	"	3	1	27	74	11	1			114
Jaeger No. 43 ( <i>vin.</i> ) . . . . .	C	♀	1		33	117	35	2			187
" . . . . .	"	"	2		22	123	47	1			193
Janesville ( <i>Lab., vulp.</i> ) . . . . .	C	♂	1		4	47	46	6	1		104
" . . . . .	"	"	2	1	5	59	56	6			127
" . . . . .	"	"	3		2	56	66	11	1		136
" . . . . .	"	"	4		3	32	32	2			69
" . . . . .	"	"	5		3	41	41	8			93
" . . . . .	"	"	6		1	41	47	8	1		98
Massasoit ( <i>Lab., vin.</i> ) . . . . .	C	♀	1	10	81	77	7				175
" . . . . .	"	"	2	7	56	50	6				119
" . . . . .	"	"	3	3	42	38	6				89
Norton ( <i>aest., Lab.</i> ) . . . . .	C	♂	1		1	18	46	18	2		85
" . . . . .	"	"	2		6	52	64	14	1		137



Variety or species	Wild or cultivated	Sex	Clusters counted per vine	Class frequency for no. of stamens per flower							Total no. of flowers per cluster
				3	4	5	6	7	8	9	
				Petite Sirah ( <i>vin.</i> ) * . . . . .	C	♂	1	2	172	93	
" " " . . . . .	"	"	2	6	195	88	3			292	
" " " . . . . .	"	"	3	2	118	47				167	
" " " † . . . . .	"	"	1	4	109	46	1			160	
" " " . . . . .	"	"	2	8	192	78	2			280	
" " " * . . . . .	"	"	1	1	73	111	5			190	
" " " . . . . .	"	"	2	4	88	128	4			224	
" " " . . . . .	"	"	3	5	83	106	1			195	
" " " † . . . . .	"	"	1	9	52	65	2			128	
Seibel No. 2 . . . . .	"	"	1		34	121	15			170	
" . . . . .	"	"	2		27	104	24	1		156	
" . . . . .	"	"	3		49	122	8			179	
" . . . . .	"	"	4		19	115	30	1		165	
<i>V. Labrusca</i> (small cluster)	W	♂	1	1	14	9				24	
Cross ( <i>Lab.</i> × <i>vin.</i> ) . . . . .	C	?	1	35	285	51	1			372	
" " " . . . . .	"	"	2	38	383	117	2			540	
" " " . . . . .	"	"	3	6	128	48	1			183	
Cross ( <i>Lab.</i> × <i>vulp.</i> ) . . . . .	C	♂ ♀	1	13	408	69	4			494	
" " " . . . . .	"	"	2	9	561	73	2			645	
" " " . . . . .	"	"	3	5	224	52	3			284	
" " " . . . . .	"	"	4	5	284	49	2			340	
" " " . . . . .	"	"	5	14	176	67	2			260	
" " " . . . . .	"	"	6	13	235	121	11			380	
Cross ( <i>Lab.</i> × <i>bic.</i> × <i>vin.</i> ) . . . . .	C	♂	1	1	41	105	8			155	
" " " . . . . .	"	"	2		18	60	6			84	
Cross ( <i>Lab.</i> × <i>vin.</i> ) . . . . .	"	"	1	4	139	77	8			228	
" " " . . . . .	"	"	2	3	159	181	35	1		379	
Cross ( <i>Lab.</i> × <i>vin.</i> × <i>bic.</i> ) . . . . .	"	"	1	63	260	15				338	
" " " . . . . .	"	"	2	115	413	24				552	
Total . . . . .			115	6	2,630	21,385	5,829	783	82	6	30,721

\* Counted in 1909.

† Counted in 1910.

and four above it. The highest number of flowers found in any cluster was 738, which occurred in a wild vine of *V. vulpina*. The staminate cluster usually has more flowers than either form of the perfect.

It will be seen from an inspection of TABLE I that the variation

in the stamen number has, in general, a definite direction in the flowers of each vine. In most cases the mode falls on five, but in some of the cultivated varieties, as in Jaeger No. 43 and Seibel No. 2, the mode is distinctly on six; while in Janesville there are only a few flowers having five stamens, with the number having six and seven practically equal, more having eight stamens than five, and three flowers having nine. This is a striking variation from the usual number five. Among those included in this table there were no flowers observed having double the number of stamens, the nearest approach to this being nine.

The summary of TABLE I, giving the total number of flowers for each stamen number, shows considerable variation in the number of stamens per flower in *Vitis*. The stamen number is variable in all the clusters included, whether of a species, variety, or cross. Out of a total of 30,721 grape flowers in which the stamens were counted, there are more (21,385) having five stamens than any other number; more (5,829) having six stamens than four, which is represented by 2,630 flowers; 783 have seven stamens and 82 have eight; while the two extremes are represented by much smaller numbers, 6 having nine stamens and 6 also three. The trend of the variation, therefore, is toward an increase in the number of stamens rather than a decrease.

VARIATION IN COROLLA NUMBER: The number of parts to the cap is usually the same as the number of stamens (PLATE I, FIG. 3 and 5). Exceptions to this occur where two small stamens are found opposite one petal, or where two filaments are united more or less throughout their entire length; but this occurs so seldom, and the relation between the petal and the stamen number is so close, that TABLE I may be regarded as showing fairly accurately the variation in the number of petals in the cap as well as the stamen number.

VARIATIONS IN THE NECTARIFEROUS GLANDS: The nectariferous glands vary much in color and size; they also correspond very closely in number with the stamens and petals. On some vines they are pale yellow while in other cases they are a dark yellow or yellowish green. On some of the cultivated varieties, as Concord and Worden of the blue varieties, and Diamond, Leader, or Pocklington of the green, they still persist in the mature berry

as yellowish or brownish dots around the base of the pedicel. In PLATE I, FIG. 7, 8, and 9, are shown some of the forms they assume in the staminate flower. In FIG. 7 (PLATE I) the nectariferous gland forms a distinct five-sided ridge around the abortive pistil; in FIG. 8 (PLATE I) the glands protrude distinctly between the stamens; and in FIG. 1 (PLATE I) they are shown in the perfect flower. Closely observed, this organ exhibits differences in almost every vine.

VARIATION IN THE PISTIL: Where the number of stamens varies either above or below the usual number five, changes result in both the external and internal structure of the ovary. Externally the number of lateral surfaces of the pistil vary and correspond in number to the stamens. Internally there is associated with an increase in the number of stamens a larger number of carpels, and likewise more ovules or seeds per berry. The number of carpels may be independent of the number of parts to the flower, but in general there seems to be a relation between them. In one cluster of Janesville, in which the seeds were counted, there were for each stamen number, 4 berries that had five stamens, and all had two carpels; of the 29 berries that had six stamens 22 had 2 carpels and 7 had three; 23 had seven stamens, and of these 15 had 2 carpels and 8 had 3; 5 berries had eight stamens, one of which had 2 carpels and 4 had three. In the staminate flowers this relation, of course, would not hold.

STRUCTURAL VARIATION IN THE STIGMA: A careful distinction does not seem to have been made by previous writers on this subject between the stigma and pistil. Engelmann ('94) observes that "the sterile plants do bear male flowers with abortive pistils, so that while they never produce fruit themselves they may assist in fertilizing the others." Booth ('02) states that "all of the staminate flowers, so called, which I have observed, have small abortive pistils; which also conforms with the observations of Engelmann. Others report staminate flowers with no trace of pistil remaining." In the same publication he states further that "there is a vine on this station which bears both staminate and hermaphrodite flowers. Mr. N. B. White, Norwood, Mass., reports that he has a male (?) *Rip.* × *Lab.* vine which has fruited twice in the last thirty years, the pistils evidently varying in

strength but being generally too weak to produce fruit." Munson ('99) mentions that it is clear that the staminate vine can not bear since it has no pistil, "unless the vine changes its action from producing purely staminate flowers to bearing pistillate flowers, which in two or three instances only, in all my observation, I have known to occur."

In the instance mentioned by White, the stigma probably had a development similar to that shown in FIG. 10, PLATE 2, which is a photograph of two clusters from one cane of a Marian  $\times$  Pocklington cross, which grew in the vineyard of the New York State Experiment Station. It will be seen from this photograph that the flowers of this vine are functionally so nearly midway between the pistillate and perfect forms that on the same cluster some pistils have sufficient stigmatic tissue to permit of pollen germination, while others do not. During the three seasons in which the writer had the opportunity to observe this vine some clusters bore fruit each season. In PLATE 2, FIG. 15-18, there are shown photomicrographs of median sections of four pistils from this vine. Flowers with a similar stigmatic development have been observed by the writer on two wild vines of *V. vulpina* and also in a number of crosses at the New York State Experiment Station, in which *V. Labrusca*, *V. bicolor*, *V. vulpina*, and *V. vinifera* occurred.

The series of median sections included (PLATES 2 and 3, FIG. 11-24) shows practically all gradations in stigmatic development between the truly perfect and the staminate forms. Even the purely staminate forms represented (PLATE 3, FIG. 19-24) in the sections show an abortive pistil with no stigmatic tissue, yet having carpels and rudimentary ovules. The statement of Booth ('02) that all staminate flowers observed have small abortive pistils is corroborated. By following the series, then, it will be seen that the seed coats in the ovules are not fully developed in staminate forms and only partially so in some of the intermediate forms with small stigmatic surfaces. This fact is significant in that it indicates, that there is not a complete segregation of the pistillate and staminate forms but a suppression of pistil development in the case of the staminate flowers.

Median sections through the pistils of some of the intermediate

forms are shown in PLATE 2, FIG. 15-18; these show different stages of stigmatic development occurring on different vines. The seed coats in the ovules show considerable development in PLATE 2, FIG. 14-18. The material, with the exception of PLATE 3, FIG. 21-24, was all fixed just after the flower was completely open, so there is probably not more than one or two days' difference in their relative ages; the others were fixed before blooming, to show the relative position of the anthers, filaments, and pistils in the bud. The crouched position of the filaments will be noted in PLATE 3, FIG. 22. In many flowers, however, the filaments are even more crouched and bent than in this instance.

SOME ABNORMALITIES OF THE PISTIL: Cases are rarely observed in which one or more anthers of a flower may be found with the filament adhering to the side of the pistil, the tissue of both filament and pistil being united. In this way the stigmatic tissue and the anthers, sometimes partly abortive or deformed, are brought into very close contact. Some abnormalities of this nature have been observed where the stigmatic and anther tissues are intermingled, the pollen being to all appearances normal. This adherence is probably due to a lack of differentiation in the meristem and does not seem to be a case similar to that observed by Chamberlain ('97) in *Salix petiolaris*, in which microsporangia were found in the placenta of the ovary, as well as stigmas developing on stamens.

Some vines bear flowers with distinctly pinkish stigmas. The writer has observed this in a few wild vines of both *V. vulpina* and *V. bicolor*, and also in a number of cultivated varieties, as in the R. W. Munson. The stigma is distinctly lobed in some vines, both cultivated and wild, the lobes generally corresponding to the carpels. In varieties like the Goff, where many grapes on a cluster show distinct sutures, varying in number from one to three or four, this tendency can be seen soon after blooming; and in a few extreme cases the pistil may be nearly separated into two parts. In outline the stigmatic surface varies much, being oval, flaring or flat. Under favorable conditions the stigma may become receptive before the corolla opens. This condition was observed by the writer in both Concord and Hubbard Seedless.

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#### SUMMARY

*Vitis* is dioecious, polygamodioecious, or perfect. The flower forms which occur are the staminate, and the perfect (1) with upright and (2) with reflexed stamens. Individual vines either within the variety or species are quite distinct with respect to these flower forms. In *Vitis* the flower forms resemble those of the closely related genera, *Cissus* L., *Ampelopsis* Michx., and *Parthenocissus* Planch. The direction of the evolutionary changes in the flower forms is not entirely clear.

The typical staminate cluster is larger than either form of the pistil-bearing. The typical grape flower is 5-merous, although about 30 per cent show a variation from this plan. The petals, nectariferous glands, and stamens correspond closely in number. The dehiscence of the corolla seems to result largely from a drying-out process rather than from being pushed off by the straightening out of the filaments.

The number of stamens per flower was found to vary from three to nine, the variation being independent of the flower form, variety, or species. The flowers from different clusters of the same vine show in general the frequency of distribution that is characteristic of the vine. Clusters from different vines may have different arrays. When the stamens are increased or decreased, the petals and nectariferous glands, in general, correspond in number. An increase in the number of stamens is associated with an increase in the number of carpels. In short, the numerical relations of the members of the floral whorls are commonly maintained.

In occasional vines the stigma is, throughout, only partially developed. This condition may be regarded as an intermediate form between the pistil-bearing and the staminate forms, both in structure and function. The staminate flowers have rudimentary pistils, in which the stigmas and ovules are abortive.

The variations in the flower of *Vitis* may be grouped into two classes: first, meristic, which would include differences in the number of the organs per flower; and, second, functional, including variations in the extent of development of the pollen, stigma, and ovules.

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#### Explanation of plates 1-3

##### PLATE 1

- FIG. 1. The perfect flower with upright stamens.
- FIG. 2 and 6. The perfect flower with reflexed stamens; FIG. 6, wild *Vitis vulpina*.
- FIG. 4 and 5. The position of the stamens and corolla in different stages in the opening of the grape flower.
- FIG. 3 and 5. United petals forming the "cap," also differences in the number of petals in the corolla.
- FIG. 7, 8, and 9. Different forms of nectariferous glands in staminate flowers

##### PLATE 2

- FIG. 10. Photograph of two clusters from the same cane of a Marian X Pocklington cross, showing enlargement of the pistil in cases where only partially developed stigmas were present.

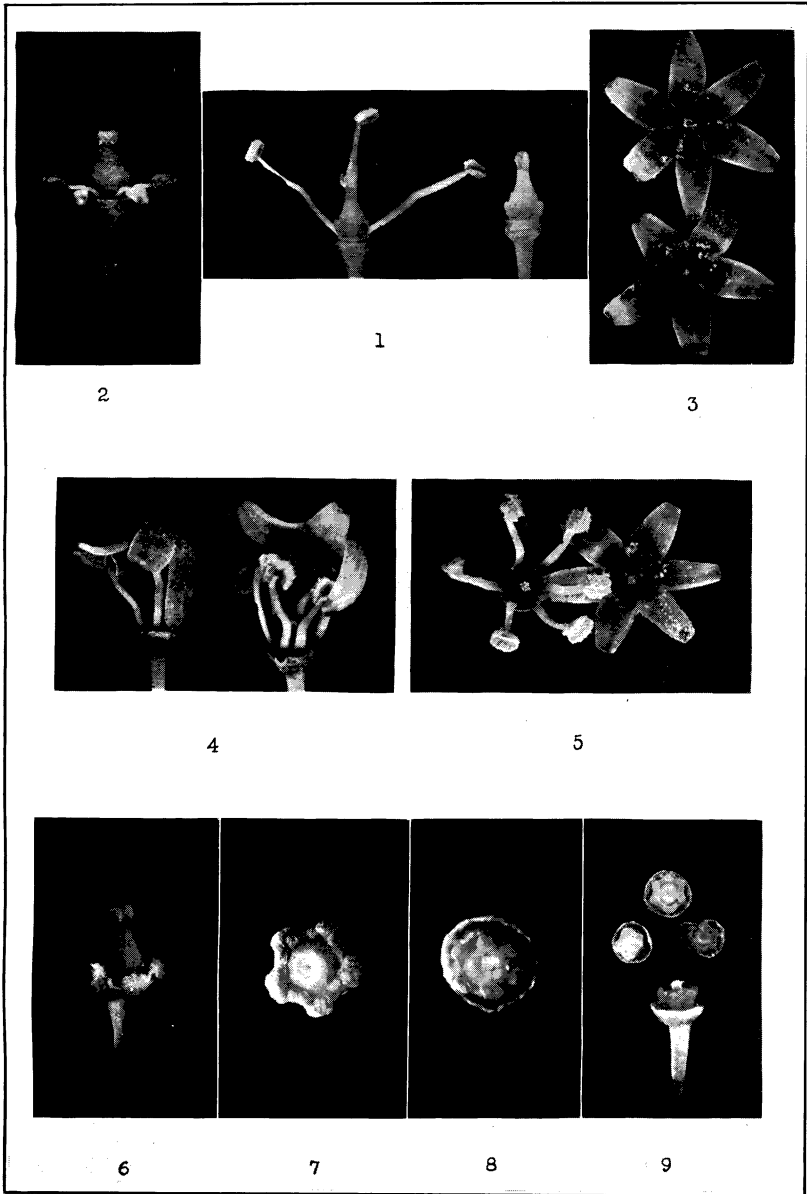
FIG. 11-18. A series of photomicrographs of median sections through pistils having stigmatic tissue developed in different degrees.

PLATE 3

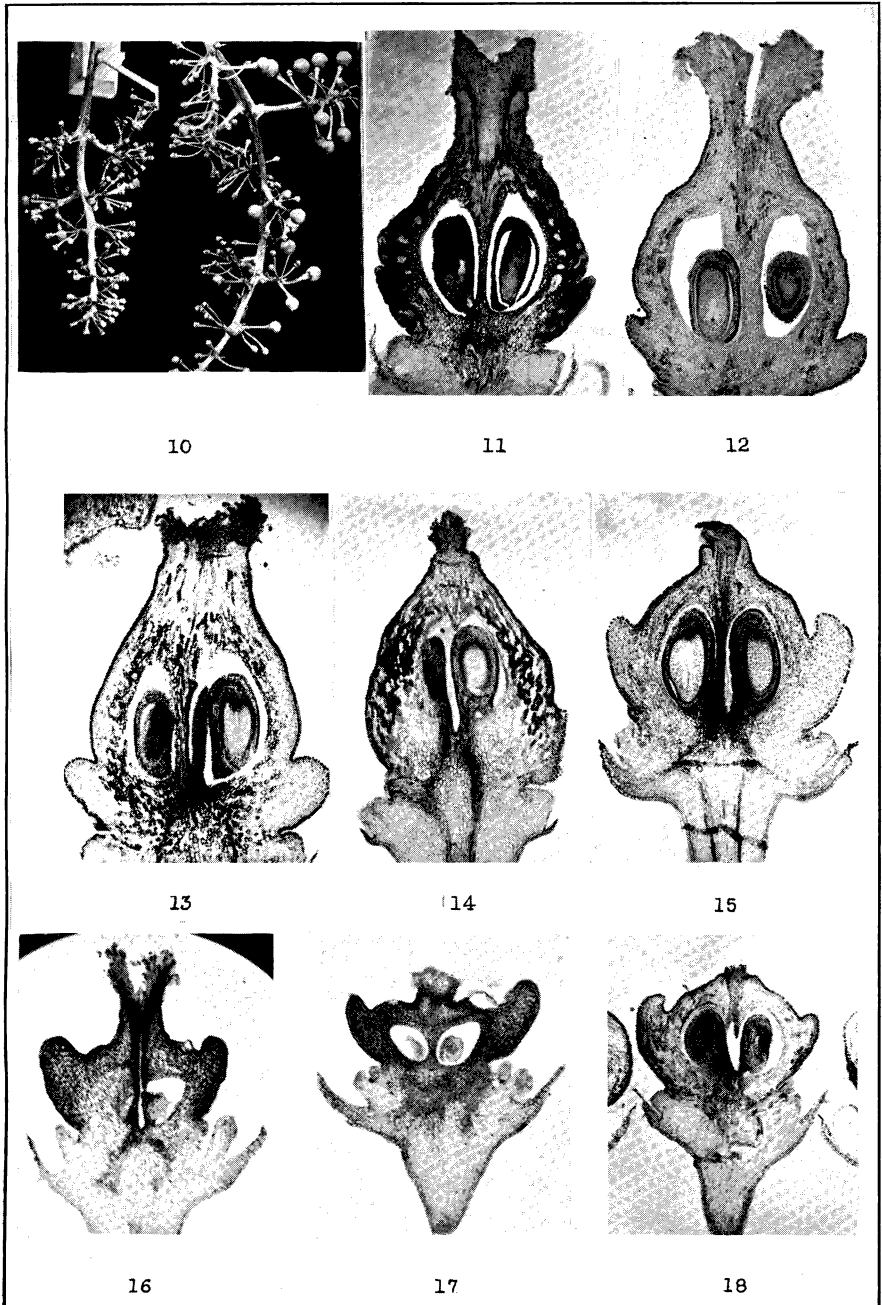
FIG. 19-24. A continuation of the series 11-18, PLATE 2, showing median sections through the pistils of the grape; these would usually be classed as staminate flowers.

FIG. 21, 22, 23, and 24 are median sections of unopened buds showing the relative position of the calyx, corolla, stamens, and pistil. The crouched position of the filaments is shown in FIG. 22.

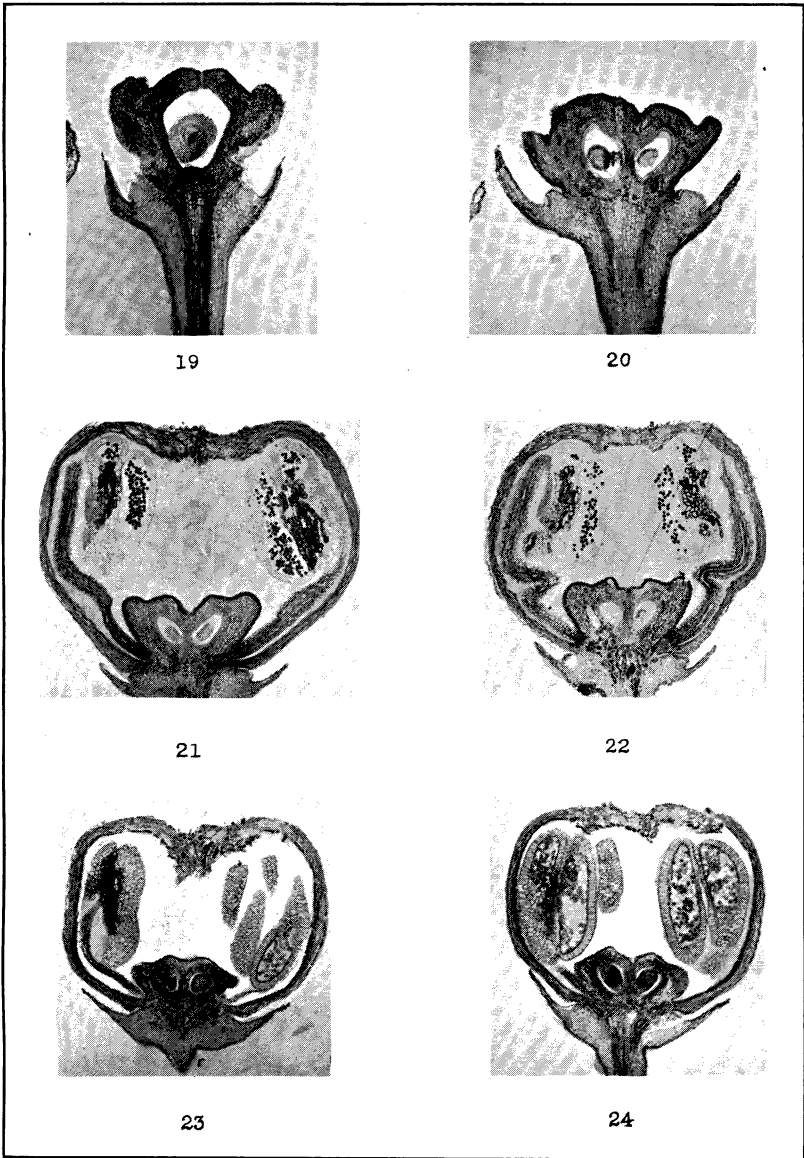




DORSEY: VARIATION IN FLORAL STRUCTURES OF VITIS



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