

I have been looking for fixity in zoological names, but that desirable condition seems further off than ever. It is all very well to indulge in these antiquarian researches, these games of taxonomic logomachy, if they be recognized as such, but the players fail to realize one thing: Names of animals and plants are but means for easy reference; nomenclature is not the end and object of all biological science.

The sanest word in all this discussion has, in my opinion, been said by Dr. Williston. This digging up of forgotten screeds means but the relegating of the great masters of the past to a secondary position; this framing of ex post facto laws offers a precedent for the future subject of that intolerable disease once known as the 'mihi itch' to set aside as lightly the laborious schemes of the sciolists of to-day.

Biologists may apparently be divided into two groups: One contains those who find great enjoyment in renaming things already well named and who regard names as the object of all science. The other group have something to tell us about animals and plants and they regard names merely as means of identification of the forms referred to. Certainly they have some rights which should be considered. Must they run through the gamut of *Triton*, *Triturus*, *Molge*, etc., every time the systematist changes his mind? Must I know the mental make-up—radical or conservative—of the biologist to know what he means when he refers to *Uca* or to *Acer saccharinum*? An article deals with *Esox*; does it treat of a pike or a needle fish?

The safest way for the morphologist or the ecologist is to stick to the well-accepted, time-honored names and to utterly ignore the vagaries of the nominalist. The question once was 'Who reads an American book?' If the present tendency continues it will soon be 'Who can read an American biological work?' It would be most desirable that at the coming Zoological Congress a morphologist or two should be added to the committee on nomenclature to act as a balance wheel.

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A CORRECTION

TO THE EDITOR OF SCIENCE: A statement on page 452 of SCIENCE of March 22 requires a rectification in the interest of the unprejudiced reader.

The sentence in question reads as follows:

These results show conclusively that magnesium sulphate in proper dilution is beneficial to the growth of seedlings, and that any inhibitory effects are due to the presence of excessive amounts, thus controverting Loew's theory that magnesium salts when alone in solution are always injurious to plant growth.

Permit me the following remarks regarding this remarkable sentence:

1. It is not a *theory* that magnesium salts act poisonously on plants; it is a *fact*.

2. Not only Loew, but also others have observed the same fact. Loew has merely furnished an explanation well in accord with certain observations.

3. The doses at which magnesium salts, applied alone, are poisonous for plants can *impossibly* be called *excessive*, since even at 0.02 per cent. a poisonous action of magnesium salts on algæ can be observed, while calcium nitrate is not in the least injurious for algæ at even 1 per cent.

4. It is a well-known fact that many compounds that act poisonously at a certain concentration can act in very high dilution as stimulants of growth.

5. It is erroneous to attribute this stimulating action to any nutritive quality of the poison.

The unprejudiced reader who desires some information as to the nutritive rôle of magnesium salts in plants and to the conditions under which this function can be performed, is kindly requested to consult Bulletin No. 45 of the Bureau of Plant Industry, 'The Physiological Rôle of Mineral Nutrients in Plants,' Washington, 1903.

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SPECIAL ARTICLES

THE BEHAVIOR OF THE SEEDLINGS OF CERTAIN VIOLET HYBRIDS

DURING the summer of 1906 I raised plants from the seeds of twenty-five different hybrids

of *Viola*, and also from the seeds of about twenty pure species. The behavior of these two classes of seedlings was surprisingly unlike; the offspring of the pure species resembled each other closely, but the offspring of the hybrids were often much unlike each other and unlike their immediate parents, reverting in some qualities to one parent of the hybrid and in other qualities to the other parent, and this in a great variety of ways.

The species involved in these experimental cultures all belong to the group commonly known as 'blue stemless violets,' of which *V. palmata*, *V. cucullata* and *V. sagittata* are familiar examples. Of this group there are about twenty species in the northeastern United States. I may not repeat here the proof, published elsewhere,¹ that these closely allied species, when growing together, freely interbreed. I will merely say that the facts to be presented in the present paper furnish most positive confirmation of the opinion that these anomalous plants are hybrids.

One of the corollaries of Mendel's law is that each pair of contrasting characters in a hybrid works out its effects, for the most part, independently of all other pairs. As in Newton's 'Law of the Coexistence of Motion,' the final result is but the summing up of the various component movements taken separately. It will be simpler for us, therefore, in describing the behavior of violet hybrids, to consider each pair of characters by itself, taking up, in order, the divergence that occurs in respect to leaf-outline, in respect to pubescence, in respect to size, and lastly in respect to color of capsules and of seeds.

1. A striking illustration of diversity in leaf-form was seen in the offspring of *Viola cucullata* $\times$ *septemloba*. This hybrid was published by Mr. Bicknell in September, 1904, as a species, *V. notabilis*. It has been found in five different stations, always growing with the reputed parents. In June, 1904, I received from New Jersey one of these plants that I have grown now for three seasons. From its cleistogamous capsules, which of necessity give pure cultures, I collected seeds in 1905 that

furnished the following summer ten vigorous plants. These bore in August and September an abundance of cleistogamous flowers that matured seeds; several plants bore also in the autumn petaliferous flowers.

The leaves of the parent species are very dissimilar, that of *V. cucullata* being broadly heart-shaped and pointed, that of *V. septemloba* (*V. Brittoniana*) primarily 3-parted, with the segments 2-4-lobed. The hybrids of these two species in all the five known stations exhibit a fair compromise in leaf-outline between the two quite unlike leaves of the parents, and closely resemble each other. They show about the same number of lobes as in *V. septemloba*, but the lobes are shorter and broader, the sinuses only half as deep. But in the offspring of this hybrid we have in addition to plants with this compromise leaf-form, plants with leaves but slightly lobed and showing the cordate base and acute apex of *V. cucullata*, and still other plants in which the leaf-outline is almost a complete reversion to *V. cucullata*. In the living plants that display, each, twelve or more leaves of these several patterns, the impression of dissimilarity is most striking.

Another marked case of diversity of leaf-outline in the progeny of the same hybrid was seen in *V. fimbriatula* $\times$ *septemloba*. This is Mr. Pollard's *V. Mulfordæ*, found first in 1902 at Hempstead Plains, Long Island. It has turned up during the past season in two other stations, but always in close proximity to the two parents. As before, the leaf of the hybrid is markedly intermediate between the very unlike leaves of the parent species; but not so with the leaves of several plants that I raised from this hybrid the past summer. The seedlings all came from the self-fertilized capsules of plants sent by Miss Mulford from the type station, but appeared most dissimilar in foliage, though growing side by side under the same cultural conditions. Some plants bore leaves like those of the parent hybrid; others bore leaves resembling those of *V. septemloba* in width, but those of *V. fimbriatula* in having only basal lobes; and still other plants were in leaf-pattern complete reversions to *V. fimbriatula*.

¹ See *Rhodora*, VI., 213-223; VIII., 6-10, 49-60.

2. I would speak, secondly, of diversity in hybrid seedlings as respects pubescence. When one parent is pubescent and the other glabrous, the hybrids of the first generation, such as we usually find in the field, are as a rule intermediate in this character, being *some-what* pubescent. In certain large colonies, where the plants appear to have been long established, and to have produced offspring, we find notable reversions. I have visited several stations where *V. fimbriatula* and *V. sagittata* grew in abundance, and where many plants were to be seen having the leaf-outline of *V. fimbriatula* with the glabrous character of *V. sagittata*; and conversely, many having the leaf-outline of *V. sagittata* with the hairiness of *V. fimbriatula*. Among cultivated seedlings of hybrids this reversion was seen in *V. fimbriatula* $\times$ *septemloba*, referred to above. The plants from Long Island and from Connecticut are all more or less pubescent; but among the five seedlings that I raised from the Long Island plant, two that in leaf-outline revert to *V. fimbriatula* are quite as glabrous as *V. septemloba*, retaining only the fine ciliation that appears on the margin of the leaves in both these species.

3. As respects diversity in size, I have a notable instance in the seedlings of *V. papilionacea* $\times$ *villosa*, two species that are respectively the largest and the smallest plants of the group. The mother plant was collected near Philadelphia by Mr. Witmer Stone. The five seedlings that I raised from it grew side by side under the same external conditions; but three of the plants had leaves twice as broad as the leaves of the other two.

4. One more particular in which I have found hybrid seedlings of *Viola* to differ from one another is in the color of the seeds and of the cleistogamous capsules. In about one half the species of this group these capsules are commonly blotched or dotted with purple. The hybrid of any of these with a green-fruited species bears ordinarily a capsule of an intermediate color. But in the offspring of the hybrid the capsule is frequently seen to have the pure green of the one grandparent, or the normal purple of the other.

But this color reversion is more strikingly

exhibited in the behavior of the seeds of some of these hybrid offspring. Our species of 'blue stemless violets' vary much in the color of the seeds; and these colors are quite constant in the same species, as seen in specimens growing a thousand miles apart. For example, *V. cucullata* and *V. papilionacea* have dark brown, almost black, seeds; *V. fimbriatula* has nut-brown seeds; *V. affinis*, *V. villosa*² and *V. septemloba* seeds of a light straw-color. Now, when two species with different colored seeds are crossed, the color of the seeds of the first-cross is usually a mean between the colors of the parents. In a hybrid from Ivy Hill Cemetery, Philadelphia, black-seeded *V. papilionacea* is crossed with pale-seeded *V. villosa*, and produces brown seeds. But in seven plants raised from these brown seeds, four had the dark-colored seeds of *V. papilionacea* and three the light-colored seeds of *V. villosa*. In five seedlings of one plant of *V. affinis* $\times$ *cucullata*, two bore seeds quite as pale as those of *V. affinis*; the remaining three, however, bore not the black seeds of the other grandparent, but the brown seeds of the mother-hybrid. This divergence in seed-color also appears in the seedlings of the two hybrids used to illustrate diversity in leaf-pattern. In ten seedlings of *V. cucullata* $\times$ *septemloba*, four ripened dark-colored seeds; six, light-colored seeds. In five seedlings of *V. fimbriatula* $\times$ *septemloba*, three bore the brown seeds of *fimbriatula* and two the straw-colored seeds of *V. septemloba*.

I am not yet able to state definitely what proportion of violet hybrids produce heterogeneous offspring. In some cases the number of plants raised was too small to admit of a satisfactory conclusion regarding this tendency. But in several instances there were strong indications that the hybrid was stable, and produced offspring quite like itself. The most noteworthy instance was that of *V. affinis* $\times$ *septentrionalis*, of which I raised twenty-four seedlings in 1904, and the past season from the seeds of these, many plants of a third generation. The meager pubes-

²The species here referred to is the *V. villosa* of recent authors, which is probably not *V. villosa* Walter.

cence, the brown seeds, the impaired fertility of the original hybrid plant, have remained unchanged.

Such behavior is by no means rare among blend-hybrids in other genera than *Viola*. Willow hybrids, for example, are said to produce stable offspring always like the parent hybrid. Dr. MacDougal states³ that "more than a thousand such fixed hybrids or hybrid species are known." In fact, de Vries is of the opinion that this procedure takes place in all hybrids between pure species—that is, species that differ from each other by no 'varietal' character. In such hybrids the differences of the parents are so thoroughly blended, that they do not disunite in the germ-cells, as in hybrids governed by the law of Mendel, and therefore the offspring simply repeat the form of the parent hybrid.

One further observation is of interest—a tendency in certain individual seedlings to recover from the marked impairment of fertility that characterizes nearly all violet hybrids. It is well known that partial or complete sterility is usually found in a hybrid, when the parent forms differ from each other in several or many characters; but that when the differences are few, especially when only one or two (as often between a species and its variety), there is seldom any loss of fertility. We are further taught by Mendel's law, that when the parents of the first cross differ in more than one character, the majority of the offspring will be hybrid in fewer characters than the parent; in fact, if the offspring be sufficiently numerous, there will be found a certain percentage⁴ of forms that have no hybrid character, but various combinations of the pure characters of the two parents; and

such forms, though often new, will prove stable when reproduced by self-fertilized seed. With this diminution, or entire loss of hybridity, we should naturally expect a partial or total recovery from the impairment of fertility produced in the first-cross. At any rate, it is an observed fact that many violet seedlings, whose hybrid parents produced seed from only about one tenth of their ovules, are themselves normally fertile.

We have, then, in our blue stemless violets a rather large group of closely allied species that freely interbreed, producing 'blend-hybrids,' that is, hybrids in which the differences of the parents appear in a compromise form. While it may occur in *Viola*, there has been observed no instance of what Mendel calls 'dominance'—the appearance in the hybrid in full force of a character of one of the parents to the suppression of the contrasting character of the other parent. Even differences in respect to pubescence, or in respect to color of capsules or of seeds, are in violet hybrids represented in an intermediate condition, though these differences in other genera usually give rise to dominance.

Nevertheless, in the behavior of their offspring many violet hybrids obey the Mendelian law of segregation. The compromise effected in the sporophyte stage between the conflicting characters of the parentage, is annulled when the plant passes into the gametophyte stage; the germ-cells are for the most part pure, and the offspring heterogeneous, consisting of reversions to the original species, of new and stable forms, and of various hybrid forms. This is by no means a novel phenomenon in the history of hybridism. Professor Castle says,⁵ "dominance is purely a secondary matter; it may, or may not, occur along with segregation." Professor Bateson says,⁶ "the applicability of the Mendelian hypothesis has, intrinsically, nothing to do with the question of the inheritance being blended or alternative." Numerous instances might be cited; but it may be questioned, if in any other group of plants the phenome-

³ 'Heredity, and the Origin of Species,' p. 8.

⁴ The average ratio of such forms to the whole number of offspring is expressed by the fraction $\frac{1}{2^n}$, where n is the number of differences between the parents of the first cross; this fraction also expresses the proportion of the forms that exactly resemble the parent hybrid; the remainder, or the offspring with reduced hybrid characters, will be, respectively, 0, $\frac{1}{2}$, $\frac{2}{4}$, $\frac{3}{8}$, $\frac{15}{16}$, etc., when the differences of the grandparents are, respectively, 1, 2, 3, 4, 5, etc.

⁵ Mark Anniversary Volume, p. 383.

⁶ 'Mendel's Principles of Heredity,' Smithsonian Report, 1902, p. 574.

non is more extensively and clearly exhibited than in *Viola*.

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FORMULAS FOR THE COMPARISON OF ASTRONOMICAL PHOTOGRAPHS

THE present paper contains formulas suitable for the direct comparison of rectangular coordinates measured on different astronomical negatives. The problem here involved supplements what may be called the fundamental transformations in the reduction of celestial photographs; *viz.*, the calculation of right-ascensions and declinations from rectangular coordinates, and rectangular coordinates from right-ascensions and declinations. The writer has published formulas for all these transformations in 'Tables for the Reduction of Astronomical Photographs,' Contrib. Obs. Col. Univ., No. 23. In these formulas the problem is solved by expansion into series, taking advantage of the fact that the photographs under consideration cover but a very small part of the sky, so that measured coordinates may be regarded as small quantities.

It is sometimes desirable to compare rectangular coordinates of the same stars measured on two different overlapping photographs without computing right ascensions and declinations. For instance, Donner used this method for strengthening his determination of plate-constants in his reduction of the astrophotographic catalogue plates ('Sur le Rattachement des clichés astrophotographiques,' *Acta Soc. Sci. Fenn.*, Tom XXI, No. 8). Another important application will doubtless occur in the calculation of the solar parallax from Eros observations by the diurnal method.

For these reasons, the writer has thought it desirable to expand directly the x and y of a star on one plate in terms of its x and y on a second plate. The resulting series, though clumsy in appearance, are rapidly convergent, and in most practical cases, convenient in use. As here given, all terms to the fifth order, inclusive, have been retained; but a table is attached to the formulas showing the declination at which any term may be omitted in

actual applications of the method. When this declination is greater than 75° , the table contains the number 75+. Inasmuch as we require a precision of $0''.01$ up to 75° declination, the table has been arranged so as to exclude only terms less than $0''.005$.

To obtain the desired expansions, we let:

x_1, y_1 , be the coordinates of a star on a correctly oriented plate whose center corresponds to the right-ascension α_1 and declination δ_1 on the sky.

x_2, y_2 , be the coordinates of the same star on a second correctly oriented plate whose center corresponds to the right-ascension α_2 and declination δ_2 on the sky.

$M_1, M_2, \dots, N_1, N_2, \dots$ be certain auxiliary quantities, constant for all stars on a given pair of plates.

If we now put:

$$d\alpha = \alpha_1 - \alpha_2, \quad d\delta = \delta_1 - \delta_2, \quad \delta = \frac{1}{2}(\delta_1 + \delta_2),$$

we can express x_2, y_2 , in terms of x_1, y_1 , as follows:

$$(1) \begin{cases} x_2 = x_1 + M_1 + M_2 x_1 + M_3 y_1 + M_4 x_1^2 + M_5 x_1 y_1 \\ \quad + M_6 y_1^2 + M_7 x_1^3 + M_8 x_1^2 y_1 + M_9 x_1 y_1^2, \\ y_2 = y_1 + N_1 + N_2 x_1 + N_3 y_1 + N_4 x_1^2 + N_5 x_1 y_1 \\ \quad + N_6 y_1^2 + N_7 x_1^3 y_1 + N_8 x_1^2 y_1^2 + N_9 y_1^3. \end{cases}$$

Expressions for the M 's and N 's, with the table mentioned above, are given at the end of the present paper. The writer is under special obligations to Mr. G. W. Hartwell, assistant in mathematics, Columbia University, for help in this part of the work. Demonstrations are omitted here, because the formulas can be verified satisfactorily by means of a numerical example, such as the following particularly unfavorable one. Let us assume two plates and an imaginary star such that:

$$\begin{aligned} \alpha_1 &= 0^\circ 0' 0''.00, & \alpha_2 &= 2^\circ 0' 0''.00, \\ \delta_1 &= 74^\circ 0' 0''.00, & \delta_2 &= 75^\circ 0' 0''.00, \\ x_1 &= +3600'', & \delta &= 74^\circ 30' 0''.00. \\ y_1 &= +3600'', \end{aligned}$$

The right ascension and declination of the imaginary star, which we will call A and D , can then be computed readily from $x_1, y_1, \alpha_1, \delta_1$, by means of our former series published in Contrib. Obs. Col. Univ., No. 23.