Botany. — *"On plants which in the natural state have the character of eversporting varieties in the sense of the mutation theory."* By Dr. W. BURCK. (Communicated by Prof. J. W. MOLL).

(Communicated in the meeting of March 31, 1906).

An investigation of the causes of Cleistogamy [1]) showed that: 1 plants with closed flowers originated by mutation from plants with chasmogamic flowers and 2 that they occur in the natural state, partly as constant, partly as ever-sporting varieties.

In the course of this investigation the question arose whether other wild-growing plants do not also have the character of ever-sporting varieties.

Especially those plants were thought of that have bisexual and unisexual flowers in one and the same individual or in which by the side of bisexual, unisexual individuals are found and also those plants among the dioecious ones that possess rudimentary stamens or ovaries, from which may be inferred that they originated from plants with bisexual flowers.

The agreement between unisexual, cleistogamic and filled flowers pointed to the same origin, while the resemblance in the manner in which unisexual flowers occur among the hermaphrodite ones and closed flowers among the chasmogamic ones, justified the assumption that in the monoecious and dioecious as well as in the cleistogamic we have ever-sporting and constant varieties.

This summer I tried to confirm this conception in a twofold manner, firstly by cultivating the gyno-monoecious *Satureja hortensis* and secondly by studying the different forms in which one and the same andro-monoecious Umbellifer can occur in nature with regard to the number of male flowers in proportion to that of the bisexual ones and to the place which the male flowers occupy on the principal and secondary axes.

To the results of the culture experiments I shall return afterwards when I shall have had an occasion to repeat these experiments on a larger scale and with more species. I will here only mention that they showed that a gyno-monoecious *Satureja hortensis* begins its period of flowering with producing bisexual flowers only, that not until later, when the plant has grown stronger, a few female flowers appear among the bisexual ones, that their number gradually increases

[1]) Die Mutation als Ursache der Kleistogamie. Recueil des Travaux Botaniques Néerlandais Vol. II. 1905.

in the following days until a definite maximum is reached, after which it gradually decreases again until at the end of its flowering-period the plant again produces bisexual flowers only.

Hence the female flower follows the law of periodicity established by DE VRIES for the occurrence of anomalies of various nature with other plants and it may in this respect be put on a line with such anomalies. It may be compared with the increased number of leaflets of *Trifolium pratense quinquefolium*, with the filled flowers of *Ranunculus bulbosus semiplenus*, with the ramified spikes of *Plantago lanceolata ramosa*, etc.

In what follows I shall give the results obtained with the andro-monoecious Umbelliferae.

The investigations of BEIJERINCK [1]), SCHULZ [2]), KIRCHNER [3]), MAC LEOD [4]), LOEW [5]), WARNSTORF [6]), and others on the sexual relations of the Umbelliferae have shown that by far the most species are andro-monoecious and that besides in some of them forms occur with female or with female and asexual flowers. Male flowers appeared in this family to be as common as bisexual ones. Male individuals are rare, however. Until now *Trinia glauca* was considered the only Umbellifer in Europe, known in the male form. From SCHULZ's notes it appears, however, that in the environs of Halle a. S. also male plants of *Oenanthe fistulosa* [7]) and *Sium latifolium* [8]) occur, while in this country also *Heracleum Sphondylium* can occur in the male form.

Far less general are female flowers. SCHULZ only mentions them for (*Eryngium campestre*)? [9]), *Trinia glauca*, *Pimpinella magna*,

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[1]) BEIJERINCK, Gynodioecie bei Daucus Carota L. Nederlandsch Kruidkundig Arch. Tweede serie 4e Deel 1885, p. 345.

[2]) AUGUST SCHULZ, Beiträge zur Kenntniss der Bestäubungseinrichtungen und Geschlechtsvertheilung bei den Pflanzen. Bibliotheca botanica. Bd. II 1888, Heft 10 und Bd. III 1890, Heft 17.

[3]) O. KIRCHNER, Flora von Stuttgart und Umgebung 1888.

[4]) J. MAC LEOD, Over de bevruchting der bloemen in het Kempisch gedeelte van Vlaanderen. Botanisch Jaarboek Dodonaea 1893 en 1894.

[5]) E. LOEW, Blütenbiologische Floristik des mittleren und nördlichen Europa sowie Grönlands. 1894.

[6]) C. WARNSTORF Blütenbiologische Beobachtungen aus der Ruppiner Flora im Jahre 1895. Verhandlungen des botanischen Vereins der Provinz Brandenburg Bd. XXXVIII. Berlin 1896.

[7]) SCHULZ, Beitr. I p. 47.

[8]) SCHULZ, Beitr. I p. 48.

[9]) In his note concerning this plant on page 42 of his first paper, female flowers are not mentioned. So this is perhaps an error in the general summary at the end of the second paper.

P. saxifraga and *Daucus Carota*, for which latter plant BEIJERINCK had already found them before.

In the long list of 66 European Umbelliferae in the Blutenbiologische Floristik of LOEW no more than 16 species occur that are only known as bisexual plants whereas 40 are andromonoecious. It has appeared since that with three of the plants mentioned as bisexual also male flowers are found. Of *Anethum graveolens, Aethusa Cynapium* and *Heracleum Sphondylium* namely, WARNSTORF found andromonoecious forms in the environs of Neu-Ruppin; also in this country they occur in this form. Of the 66 Umbelliferae that were studied, the following remain of which until now no other than bisexual plants are known:

Laserpitium pruthenicum, Peucedanum venetum, Crithmum maritimum, Silaus pratensis, Seseli Hippomarathrum, S. annuum, Anthriscus vulgaris, Bupleurum longifolium, falcatum, tenuissimum and *Pleurospermum austriacum*, to which list I think must be added: *Eryngium maritimum, Berula angustifolia, Conium maculatum* and *Helosciadium nodiflorum*.

It is probable that of some of these plants andro-monoecious forms will be found when they are examined over a larger part of their region of occurrence, especially since it has appeared that the different forms in which Umbelliferae can occur, are often spread over very different and widely distant parts, so that, even though the species mentioned be only known as hermaphrodite plants in a part of Europe, the possibility must be granted that they occur in other forms elsewhere.

Of *Sium latifolium* e. g., no other but the andro-monoecious form is found in a great part of Middle Europe and until now only in the environs of Halle a/S accompanied by the male form, evidently only in a few specimens. Only in our country the bisexual form is known.

Of *Pimpinella magna* the bisexual plant is only found in southern Tyrol and Italy, the andro-monoecious on the other hand in the whole of Middle Europe, while in southern Tyrol and Italy the same plant also occurs with female and with female and asexual flowers.

Of *Oenanthe fistulosa* the andro-monoecious plant is found everywhere, the male one until now only in the environs of Halle.

Of *Aethusa Cynapium* the hermaphrodite plant is known in the whole of Middle Europe, the andro-monoecious one only in the neighbourhood of Neu-Ruppin and of my residence.

Of *Daucus Carota* the andro-monoecious form is generally found,

the bisexual one until now only in Flanders [1]) and in this country [2]).

So it is not at all unlikely that of those species which until now are known as bisexual only, later other forms will also be found, and similarly it may be assumed that of the large number of Umbelliferae of which now only the monoecious form is known, on closer examination also the hermaphrodite or unisexual forms will be found.

Meanwhile it is a very remarkable fact that by far the most Umbelliferae are andro-monoecious and that exactly these forms are most generally spread.

Where male individuals are found they only occur in very limited numbers as rare occurrences among the great majority of andro-monoecious individuals.

This also holds for the hermaphrodite plants, at any rate for *Daucus Carota, Sium latifolium* and *Heracleum Sphondylium*. Where these and andro-monoecious plants occur together the number of bisexuals is far less than that of the andro-monoecious ones. [3])

This general occurrence of andro-monoecious forms gives a very peculiar character to the family of the Umbelliferae. Nowhere in the vegetable kingdom these forms are so prominent as here.

In other families with species that are rich in forms, as the *Labiatae, Alsineae, Sileneae* and others, where gyno- and andro-monoecious and female and male forms occur together with bisexual ones, a similar preponderance of monoecious plants is not found with a single species.

The rule is there that where the three forms occur together the monoecious flowers are a minority with respect to the bisexual and unisexual ones.

Next is conspicuous with the monoecious Umbelliferae the great variety that may be observed in the occurrence of the male flowers in the umbels of different order and the many mutually different forms in which consequently one and the same andro-monoecious plant may occur.

Sometimes an individual is found which among the large number of bisexual flowers has a relatively small number of male ones, another time one in which the number of male flowers is not much

[1]) J. Staes. De bloemen van Daucus Carota L. Botanisch Jaarboek, Dodonaea Jaargang I. 1889. p. 132.

[2]) I shall soon treat elsewhere the different forms in which the Umbelliferae, occurring in this country, are met.

[3]) Male Umbelliferae and exclusively bisexual species are very rare also outside Europe. (See Drude Umbelliferae. Engler und Prantl. Die natürl. Pflanzenfamilien III. Teil, Abt. 8. p. 91).

less than that of the bisexual ones, and then again an individual in which the male flowers are more numerous than the others, and between these a long series of gradual transitions and intermediate forms is found.

Not unfrequently the number of male flowers is greatly in excess of the bisexuals. I met in this country plants of *Heracleum Sphondylium* in which the inner umbellules of the umbel of the first order and all other umbels of higher order were exclusively male and similar plants are also found of *Pastinaca sativa* and *Daucus Carota*. They are found spread among other individuals in which the proportion of male to bisexual flowers is more favourable to the bisexuals or where the number of males is even very small.

Some Umbelliferae are only known in an almost male form. *Echinophora spinosa* e. g. has one bisexual flower in the middle of the umbel; all other flowers are male. Also with *Meum athamanticum* and *Myrrhis odorata* we may observe in the specimens cultivated in this country in botanical gardens, how also there the bisexual flower is superseded, so that the umbellules often do not contain more than one such flower.

An investigation of the andro-monoecious Umbelliferae shows us at once that there is a certain regularity in the way in which the male flowers occur. In the first place, when they appear for the first time in an umbel of a certain order, their number as compared with that of the bisexual flowers increases as we come to umbels of higher order; and secondly, if in the peripheral umbellules some male flowers occur among the bisexual ones, their part in the constitution of the umbellules becomes greater as the umbellules are more distant from the periphery.

Of *Daucus Carota, Pastinaca sativa* and *Heracleum Sphondylium* whole series of specimens may be collected in the neighbourhood of my residence, beginning with such which in all the umbels contain only bisexual flowers up to forms which are almost or entirely (H. Sphondylium) male. Among these specimens are found in which the male flowers already appear in the very first umbel of the plant by the side of other specimens in which the andro-monoecious character only appears in the umbels of the second order or later still in those of the third or fourth order. Now it is a constant rule that if they appear for the first time in an umbel of a certain order they will also appear in the umbels that develop later and that their number in proportion to that of the bisexual flowers in the successive umbels goes on increasing.

Specimens which in no respect revealed their andro-monoecious character during the whole summer, which only late in summer produced male flowers in the umbels of the third or fourth order or sometimes entire male umbels, are found connected by intermediate forms with specimens which already in the very first umbels contain male flowers.

Concerning the part occupied by male flowers in the constitution of the peripheral and central umbellules, it must be remarked in the first place that with all Umbelliferae whose umbels reach a certain size, the peripheral umbellules consist of a larger number of flowers than those that occupy the middle part of the umbel. In some species those central umbellules may be very poor in flowers; with *Daucus Carota* the central umbellules often even consist of only one flower.

When it was stated that the part occupied in the umbellules by the male flowers becomes greater the more they are placed near the centre of the umbel, this must be so understood that as the umbellules become more distant from the periphery the number of bisexual flowers decreases and does so much more rapidly than the number of male flowers. Hence the inner umbellules are often entirely male while the outer ones bear a number of bisexual flowers.

This rule is not without exception, however. There are namely Umbelliferae in the umbels of which the central umbellule occupies the top of the principal axis of the umbel and may consequently be distinguished as the top-umbellule.

Such top-umbellules are especially found with *Carum Carvi* and *Oenanthe fistulosa* and occasionally, although not so regularly, also with *Daucus Carota*. For such a top-umbellule now the rule does not hold that the part occupied by the male flowers is greater than in the surrounding umbellules. Such an umbellule contains a greater quantity of bisexual flowers. With *Carum Carvi* I often found no male flowers in the top-umbellule when all others, as well the peripheral as the more inwardly situated umbellules had some of them. In other specimens the number of male flowers in this top-umbellule was smaller than in the other.

Of *Oenanthe fistulosa* the umbels of the second order are in this country much larger than those of the first order; they consist of five to eight umbellules and agree in their constitution almost entirely with that, indicated by SCHULZ for the umbellules of the first order. Here as a rule a top-umbellule can be very easily distinguished; it contains only a few (7 to 9) male flowers, but is for the rest entirely

hermaphrodite, while the side-umbellules are generally exclusively male.

With *Daucus Carota*, where the umbellule as was remarked above, often consists of no more than one flower, this latter is very often hermaphrodite, also when the surrounding umbellules consist entirely of male flowers.

It must still be remarked for the andro-monoecious Umbelliferae that both sorts of flowers as a rule occupy a fixed place in the umbellule.

In by far the most Umbelliferae the bisexual flowers are found near the edge and the male ones in the middle.

Only a few make an exception to this rule; with *Oenanthe fistulosa* and *Sanicula europaea* the opposite is found and with *Astrantia* the bisexual flowers as a rule occupy a definite zone between the peripheral and central male flowers. Advancing from the circumference to the centre we find there first one or two whorls of male flowers, then a whorl of bisexual ones and finally at the centre male flowers again.

But although it may be the rule for all other Umbelliferae that in all the umbellules, containing the two forms of flowers, the hermaphrodite ones are placed at the edge and the male ones in the middle, an exception must be made for those Umbelliferae which in the middle of the umbellules develop a top-flower, for this latter is as a rule bisexual.

Such top-flowers are e.g. regularly found with *Chaerophyllum* and with *Meum*; in each umbellule of *Chaerophyllum temulum* and *Meum athamanticum* bisexual marginal flowers and a bisexual top-flower are found and for the rest male flowers.

Also with *Aegopodium Podograria*, *Carum Carvi* and *Daucus Carota* bisexual top-flowers are found in the umbellules, but in these species this top-flower is not always found in all umbellules.

No extensive argument will be needed to understand that the two forms of flowers, found in the same individual of the plants mentioned, may be considered, like the two flowers of a cleistogamic plant, as two antagonistic characters which mutually exclude each other and that consequently these plants may be compared with ever-sporting varieties, originated by mutation, the existence of which was shown by DE VRIES.

Every andro-monoecious Umbellifera of which we compare a number of individuals among themselves, affords an opportunity for noticing that the two antagonistic characters evidently fight for

supremacy, in which combat now one, then the other gains an advantage.

But if of a species which is rich in forms we mutually compare a fairly complete series of andro-monoecious forms, we are struck by the circumstance that between these and the ever-sporting varieties known until now, there is this important difference that while with other ever-sporting varieties the original specific character is always more conspicuous than the racial character, here very often the opposite takes place.

We met in what precedes plants like *Myrrhis odorata, Meum athamanticum* or forms of *Pastinaca sativa, Heracleum Sphondylium* and *Daucus Carota,* where the specific character had been entirely superseded by the racial character, and this raises the question whether the andro-monoecious Umbelliferae, looked upon as races originated by mutation, must be placed on a line with the above-mentioned gyno-monoecious *Satureja hortensis* and other ever-sporting varieties.

We know from the theory of mutation that the interaction of two antagonistic characters may show itself in more than one way and that a character originated by mutation may be inherited in a different degree in various plant-species, by which process various races are formed.

To a race in which the anomaly comes only little to the front, much less than the normal character, and which consequently is hereditary in a small degree only, DE VRIES has given the name of a half-race, and the abnormal character he has called *semi-latent.* That, however, among these half-races important differences may occur in the measure in which the character is semi-latent, clearly appeared from the statistical investigation of the half-races, e.g. of *Trifolium incarnatum quadrifolium* and *Trifolium pratense quinquefolium.*

It may be imagined that there exist races in which the two antagonistic characters possess nearly the same degree of heredity so that then it is often difficult, under favourable circumstances, to settle whether the specific or the racial character is more prominent and sometimes even, when the conditions of life are very favourable, the anomaly gets the upper hand. In such a race as well the specific character as the anomaly are then to be considered as *semi-active.* The statistical investigation of the anomalies has not yet revealed that such races really exist.

But it may be further imagined that between these latter races which DE VRIES called middle-races and the constant varieties, in which the specific character is latent and the anomaly active, there

exist still other races in which the *normal character* is semi-latent to a different degree.

DE VRIES thinks such cases possible, but until now they have not yet been noticed [1]). Now the question arose to me whether in the andro-monoecious Umbelliferae we may not have such races in which the specific character has become semi-latent? [2])

Let us start our speculations with one of those Umbelliferae of which besides andro-monoecious ones also hermaphrodite and male forms are known, e. g. *Heracleum Sphondylium.*

As was remarked above, *Heracleum Sphondylium* appears in a great part of Middle Europe as a hermaphrodite plant. In the environs of Neu-Ruppin at the same time forms are however found which are only bisexual in the umbels of the first order, whose umbels of the second order are composed on half bisexual and half male umbellules and whose umbels of the third order are exclusively male, and which in consequence may be considered to produce about as many male as bisexual flowers.

In this country now I found besides the hermaphrodite and the Neu-Ruppin middle forms a great variety of forms which may be considered either as gradual transitions of those middle forms to perfectly hermaphrodite ones or as gradual transitions of those middle forms to perfectly male individuals, which latter occur also in this country.

If we now *for the present* consider this andro-monoecious plant which is so rich in forms as an ever-sporting variety, and if we compare its properties with those of *Trifolium pratense quinquefolium*, which has first been extensively dealt with by DE VRIES, and later has been investigated in all its details by Miss TAMMES [3]), so that of this race the properties are most completely known, then we begin with asking what peculiarities *Heracleum* should present if its monoecious form represented an ever-sporting variety.

Then we should observe:

1. that a strongly developed specimen, e.g. a plant with umbels of the first to the fourth order, produces more male flowers than an individual which has not succeeded in getting beyond the formation of umbels of the first and second order.

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[1]) DE VRIES, Mutationstheorie, I, p. 424.

[2]) In my article on cleistogamic plants I already briefly raised the question whether Ruellia tuberosa, Impatiens noli tangere, Impatiens fulva, Amphicarpaea monoica, Viola spec. div. are not in this condition.

[3]) Bot. Zeit. 1ste. Abt., Heft XI, 1904.

2. that plants on fertile soil produce on the whole more male flowers in proportion to the bisexual ones than plants on less fertile soil.

3. that the male flowers only appear at a stage in which the plant has grown stronger, that they gradually increase in number as the individual grows stronger and gradually decrease in number again when the plant has passed its highest point of development.

4. that in each umbel as well as in each umbellule which contains both forms of flowers, the male flowers are preferably found in those places which are most favourable with respect to nutrition.

It is not difficult to show that observation does *not* confirm these four points.

Let us in the first place consider point 4.

There can be no doubt that (excepting the just mentioned terminal umbellules and terminal flowers) the peripheral umbellules are more favourably placed with regard to nutrition than the more inwardly situated umbellules, and that in each umbellule the flowers at the circumference also occupy a more favourable position than those in the middle. This is seen not only by the inner umbellules being less rich in flowers but also in the flowers becoming smaller the further they are distant from the periphery; often the central flowers do not reach their normal development or the setting of the fruit does not take place. We see here the same with the umbels as with long-drawn inflorescences like those of *Capsella Bursa pastoris* or *Pisum sativum*, that namely the last-formed flowers, at the top of the inflorescence, no longer reach their normal development on account of insufficient nutrition. Further every umbellule (not only a mixed one but also a purely hermaphrodite one) allows us to notice that the peripheral flowers are ahead of the central ones in their development.

And now we see with all Umbelliferae without exception:

that the peripheral umbellules retain their bisexual character longest,

that the male flowers always occur first at the centre of the umbel,

that where the umbellules are mixed, the number of bisexual flowers always decreases from the periphery to the centre,

that the inner umbellules often are already entirely male when the outer ones still contain bisexual flowers, and

that everywhere, except with *Oenanthe fistulosa, Sanicula europaea* and *Astrantia* the marginal flowers in the umbellules are bisexual and the central flowers male[1]).

[1]) I think an explanation may be found for the anomalous behaviour of these three genera. I cannot dwell on this point, however, in this short communica-

In other words, we may say *that as well in the umbel as in the umbellule the bisexual flowers always occupy the place which is most favourable with respect to nutrition.*

That terminal umbellules and flowers are placed most favourably is evident; it can be readily explained why a top-umbellule is often richer in bisexual flowers than other umbellules from the centre and why as a rule the top-flower of the umbellule is hermaphrodite.

That this position is by far the most advantageous can also be inferred from the fact that often the top-flower is the only bisexual one of the whole umbellule. So with *Meum athamanticum* e.g. it is very often found that in the umbels of the second order, the 6—8 inner umbellules possess no bisexual flowers at all; the only bisexual flower of these umbellules is the top-flower. [1])

So we see exactly the opposite from what we should observe if the andro-monoecious plant represented an ever-sporting variety like *Trifolium pratense quinquefolium.* It is not the *male* flower — the *anomaly* -- which is preferably found in the best places, but the *bisexual* flower, and on further examination of the above points 1, 2 and 3 we shall again see how it is this latter that depends on the nutritive conditions and in all respects behaves like a character in a semi-latent condition opposed to the active condition of the anomaly.

I pointed out already that with all andro-monoecious Umbelliferae the umbel of the first order shows the anomaly least.

With very many forms the male flower appears first in the umbels of the second order, with others in those of the third order, and sometimes it is the umbel of the fourth order in which the male flower appears first.

But where these flowers are already observed in the umbels of the first order their number is there always less than in the umbels of the second and higher orders.

The umbel of the first order consequently retains in all andro-monoecious Umbelliferae the pure racial character longest.

If we remember that the umbel of the first order is at the same time the terminal umbel of the plant and is extremely favourably placed at the end of the principal axis with regard nutrition, we cannot wonder at this, bearing in mind what was said when

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tion. I shall return to it elsewhere when exposing the differences between the forms occurring in this country and those that have been obsérved in other parts of Europe.

[1]) This reminds us of what may be noticed with *Echinophora spinosa.* Vide supra.

discussing point 4. We find the already stated conception confirmed that *the bisexual flower, being in a latent condition with respect to the anomaly, preferably occurs in the most favourable places.*

We may also assume that the plant during the flowering of its top-umbel, which only occurs after it has reached its full vegetative development, is also in the strongest stage of its growth, in a stage in which a good part of its nutritive material may be spent on the development of its top-umbel, while all umbels that bud forth later, are in less favourable conditions, first on account of their being placed on lateral axes of the second or higher order and secondly because a very great part of the nutritive material is spent on the ripening of the fruit of the first umbel during the development of the umbels of the second or at any rate higher orders. This would explain why in the umbel of the second order the semi-latent bisexual flower is no longer prominent in the same degree as in the terminal umbel, and why in the umbels of the third and fourth order it more and more gives way before the racial character.

This also explains why in very strong specimens the male flowers first appear in the umbels of the third order, and why often with *Sium latifolium, Daucus Carota* and others, not until late in summer, when the plant has already passed its highest point of development, male flowers and even male umbels appear in plants which in their umbels of the first and second or first, second and third order have exclusively produced bisexual flowers.

That in fact strongly developed specimens produce more bisexual flowers than weak specimens was already noticed by Mac Leod. With strong specimens — he says in his note on *Aegopodium Podagraria* — the umbels of the first order and with very strong specimens also those of the second order consist almost exclusively of hermaphrodite flowers, while with ordinary specimens the umbellules in the umbels of the first order consist partly and in those of the second order exclusively of male flowers. Also Schulz made the same remark with *Torilis Anthriscus* and *Pimpinella saxifraga* and personally I found the justness of his remark repeatedly confirmed with *Pimpinella magna, Aegopodium Podagraria, Aethusa Cynapium, Astrantia major* etc.

If now finally the numerical relations of the two flower-forms are examined in umbels of such species as are found in large numbers on soils of different constitution and fertility, the examination at once shows that the number of bisexual flowers in a fertile place is considerably greater than in a less fertile one. *Anthriscus silvestris* and *Chaerophyllum temulum* are plants which in our country are

very general as well on sandy soil (at the edge of the dunes) as on fertile claygrounds. Both plants can be best judged by the constitution of the umbels of the second order.

Of *Anthriscus silvestris* the average constitution is:

	on sandy soil	on clay ground
of the six outer umbellules	4-5☿+11-13♂	7-10☿+3-4♂
of the seven inner umbellules	2-4☿+ 8-11♂	6-7☿+4-7♂

And of *Chaerophyllum temulum:*

of the outer umbellules	15☿+10♂+1☿	20☿+7♂+1☿

while the 2 or 3 innermost umbellules of the plants on sandy soil are entirely male.

So the results are in perfect agreement with my observations on the influence of the fertility of the soil on the appearance of chasmogamic flowers with *Ruellia tuberosa* at Batavia and with those of GOEBEL on the chasmogamic flowers with *Impatiens noli tangere* in places of different fertility near Ambach [1]).

From what has been communicated here it appears that the andromonoecious Umbelliferae in the natural state have the character of ever-sporting varieties in which the racial character, the bisexual flower, is in a semi-latent condition.

By assuming this it becomes clear why the anomaly shows itself least in the terminal umbel, why, after it has once appeared, it increases in number in the umbels of higher order, why in each umbel the number of hermaphrodite flowers decreases from the periphery to the centre, why in each umbellule the bisexual flowers are placed at the circumference and the male ones at the centre and why with those species in which the umbels have a top-umbellule, this latter often has again relatively more bisexual flowers than the surrounding umbellules and finally why, where in the umbellules a top-flower is found, this is as a rule bisexual and holds out longest when the umbellules grow more and more male, so that it often still occurs in such umbellules where the bisexual marginal flowers have already had to give way to the male ones.

Although I am of opinion that many things plead for my conception, yet I am perfectly aware that *certainty* about the true nature of the race, about the influence of fluctuating variability on the numerical relations between bisexual and male flowers, about the question whether perhaps locally different varieties or ever-sporting varieties

1) GOEBEL. Die kleistogamen Blüten und die Anpassungstheoriën. Biol. Centralbl. Bd. XXIV. No. 24, p. 770.

may exist of one and the same Umbellifer and other related questions can only be obtained by culture experiments and statistical investigation.

Yet I thought it worth while to communicate these observations although they must only be considered as an exposition of the grounds why culture experiments were undertaken. It may be useful to indicate these grounds, first because they support my conception about the racial character of many cleistogamic plants, and further because in my opinion we may certainly expect that besides monoecious and cleistogamic plants, other plants in the natural state will turn out to have the character of races originated by mutation, so that this communication may to some extent draw attention to this point.

The culture experiments will from the nature of the case occupy a few years.

In the Ergänzungsband of Flora 1905, Heft I, p, 214, GOEBEL communicates as a sequel to his paper "Die kleistogamen Blüten und die Anpassungstheorien" the results of his continued culture experiments with cleistogamic species of *Viola*. The results of his experiments confirm his formerly pronounced opinion that the appearance of a cleistogamic or chasmogamic flower depends entirely on *nutritive conditions*. If these are favourable the chasmogamic flower is seen to appear; in the opposite case the cleistogamic one appears.

I communicated in my former article my objections to this conception. I will now only remark that the influence of the nutritive conditions shows itself in such a way that with favourable conditions the *semi-latent* character is developed, and with unfavourable is suppressed.

Now if in GOEBEL's experiments the chasmogamic flowering is suppressed when the plant is under unfavourable conditions, this is because *Viola* is an ever-sporting variety in which the chasmogamic flower is in a semi-latent condition. If the cleistogamic *Viola* belonged to one of the other ever-sporting varieties, if e.g. it were an ever-sporting variety like the gyno-monoecious form of *Satureja hortensis* or *Trifolium pratense quinquefolium* in which the *anomaly*: (the female flower and the composite leaf) is in a semi-latent condition, then under favourable nutritive conditions the anomaly, the *cleistogamic* flower and under less favourable conditions the *chasmogamic* flower would be fostered.