Remarks on the Superposed Arrangement of the Parts of the Flower. By MAXWELL T. MASTERS, M.D., F.R.S., F.L.S.

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I. *Prefatory Remarks.*

THE alternate arrangement of the parts of the flower is so general that any exceptions to it are invested with peculiar interest. In the following paper I propose to allude to some of the real or apparent deviations from the rule, to offer some explanations concerning them, and to cite a few illustrations showing how considerable may be the amount of variation in this particular even among the genera of the same order. It is necessary, in the first instance, to say that for the purposes of this communication the term "superposed" is made use of in preference to the word "opposite," to which objection has been reasonably raised by Steinheil, Payer, and others*.

For conciseness' sake, and to avoid the employment of woodcuts condensed floral formulæ are employed: thus an ordinary pentamerous tetracyclic flower, such a one as Braun calls encyclic, may be represented as follows—

S	S	S	S	S	
	P	P	P	P	P,
St	St	St	St	St	
	O	O	O	O	O,

or, for brevity's sake, as

S 5
P 5
St 5
O 5,

the S representing the sepals, P the petals, St the stamens, O the ovaries or carpels, while × may stand for a staminode, and ∪ for a gland of the disk. Cohesion of the parts of the same whorl may be expressed by a line over the letters; thus S S S S S or S 5 may be taken to represent a so-called gamosepalous calyx of 5 sepals; while $\left| \begin{array}{l} P 5 \\ St 5 \end{array} \right.$ may be taken to indicate that the stamens are adherent to the petals.

* Payer, 'Eléments de Botanique,' p. 141.

As, for the most part, relations of position are alone discussed in the following remarks, so the figures or symbols referring to number, union, or disunion of parts are in general omitted as unnecessary for the present purpose. Unless otherwise stated, the formulæ here given have been always constructed from personal observation.

Superposition exists in a large number of diverse families. It may suffice to cite a few in which the phenomenon is most frequently met with or in which it is most apparent, *e. g.* :—

Berberidaceæ.	Sauvagesiaceæ.	Primulaceæ.
Menispermaceæ.	Sabiaceæ.	Myrsinaceæ.
Cistaceæ.	Simarubaceæ.	Plumbaginaceæ.
Malvaceæ.	Vitaceæ.	Lauraceæ.
Sterculiaceæ.	Rhamnaceæ.	Iridaceæ.
Tiliaceæ.	Celastraceæ.	Burmanniaceæ.
Hypericaceæ.	Olacaceæ.	Restiaceæ.
Ternstroemiaceæ.	Loranthaceæ?	
Guttiferaæ.	Sapotaceæ.	

II. *False Superposition.*

Before considering those cases where true superposition exists, mention must be made of instances of the apparent or false superposition which arises from the decussation or crossing of very closely crowded whorls. Some of the cultivated varieties of *Camellia*, as “Queen Victoria,” and specially “Lady Hume’s Blush,” afford good examples of this. In these *Camellias* it often happens that flowers of two different forms are produced. In the commoner case the sepals and petals are disposed in an imbricate or spiral manner, the stamens and carpels being replaced by petals. The arrangement is on the $\frac{1}{2}$ type; and the outline of the flower is circular. In the other and rarer form the petals and petaloid stamens are so arranged as to form a six-angled, six-rayed, or star-shaped flower. The petals are so evenly placed one over the other, that at first sight it appears as if the petals did not alternate with one another, but were superposed to each other. When, however, the flower is carefully pulled to pieces, it may be seen that the law of alternation is not really interfered with, and that the superposition is apparent rather than real. If

the buds be examined, or if the petals be carefully stripped off, it may be seen that the petals, instead of being arranged in a spiral manner, increasing in size from below or beneath upward, are disposed in cycles or whorls, each cycle consisting of three petals. The cycle is probably in this case merely a spiral depressed or undeveloped, owing to the arrest of development of the internodes between successive petals. The members of one cycle alternate in position with those of the next; and so it comes about that the pieces of the third whorl are placed immediately over those of the first, the members of the fourth over those of the second, and so on. The peculiar star-like form and the apparent superposition are therefore due to the substitution of a verticillate or cyclic for a spiral arrangement and to the alternation of parts of successive whorls. The thalamus of the ordinary *Camellia* flower is largely developed, thick and conical, or more or less dome-shaped; and, on a transverse section, the vascular bundles are seen to form a continuous or more or less broken ring surrounding a central medulla of stelliform cells. The thalamus of the star-like *Camellia* is more distinctly 6-sided than in the ordinary form, the sides being somewhat concave; and on transverse section the vascular bundles, especially near the upper extremity, may be seen to be arranged in six groups surrounding the central parenchyma. When the theory of chorisis was enunciated by Dunal, it met with great opposition, and, in this country, especially from Lindley. One of the arguments used by this eminent botanist in his 'Elements of Botany' (1847), p. 76, figs. 157, 158, was derived from the star-like *Camellia* to which allusion has just been made. Lindley assumed that the advocates of the theory of chorisis would consider this *Camellia* an illustration of their views. From the appearances presented on a superficial examination, it would not be unnatural to suppose that an upper petal placed apparently directly over a lower one was derived from the latter by the process of chorisis. Against such a supposition, Lindley argued that it was unreasonable to suppose that on one and the same individual plant the arrangement of the parts of different flowers should be different. It seemed to him contrary to nature that two diverse plans of floral construction should be followed in the same plant; and he therefore expressed his opinion that the example afforded by this *Camellia* "seems conclusive against reduplication having any existence in nature." No doubt Lindley was right in denying the existence of chorisis in this particular instance,

though he does not appear to have perceived on what the peculiar appearance which mimicked chorisis really depends.

The arrangement just alluded to, of decussating whorls, is, as is well known, a very common one. It is well seen in the case of the stamens of *Aquilegia*, which, as shown in the diagram given in the text-books, has the stamens arranged in ten ranks, those of one rank alternating with the next, and so on. In some *Berberidaceæ* (as in *Epimedium*), *Guttiferæ**, *Menispermaceæ* (e. g. *Synchosepalum*), some *Lauraceæ*, etc. the apparent superposition of parts may be explained on similar principles.

An appearance of superposition is also sometimes brought about by the circumstance that portions of the same phyllome are placed one above the other, as in the case of the divided stamens of *Mallows*. If a young flower of *Malope* be examined, the anthers may be observed as if arranged in ten vertical rows, there being in reality five branched stamens, each stamen with two marginal rows of anthers.

III. *True Superposition.*

This occurs in many different manners, and depends on various causes. Certain actual, or at least possible, modes of arrangement may here be cited, with illustrations. Other examples, together with the discussion of the causes producing them, will be given in the sequel.

1. Sepals superposed to sepals, as in flowers where there is a pleiotaxic calyx (Veg. Teratol. p. 371), as represented by the formula

S
S
S.

2. Petals superposed to sepals, thus—

S
P.

Planchon says such superposition may be considered a general rule in *Cistaceæ* (Bull. Soc. Bot. France, ix. 507).

3. Petals superposed to petals, as in pleiotaxic corollas—

S
P
P.

* See Aug. de St.-Hilaire, *Morphol. Végét.* 612; Planchon et Triana, *Ann. Sc. Nat. sér. 4*, xvi. p. 276.

It is doubtful whether or not some Sauvagesiaceæ should be included under this category*. In *Salvertia convalliodora* the staminodes are superposed to the petals and in *Rawsonia*, according to Harvey, Thes. Cap. xxxi., the disposition is

S
P
×
Sts.

If the calyx were pleiotaxic and its elements superposed, we might get such a formula as

S
S
P
P,

and so on.

4. Stamens superposed to petals, of which the simplest arrangement is

S
P
St.

This is met with in *Rhamnus*, *Vitis*, *Thomasia*, *Hermannia*, *Picramnia*, *Picrolemma*, and a large number of plants of various orders. In *Platytheca* there are two rows of stamens, the outer anteposed to the petals, the inner to the sepals—a most unusual arrangement.

S
P
St
St.

In *Commersonia* a similar disposition exists; but the inner row of stamens is here represented by staminodes.

In *Nitraria* we often meet with two stamens before each of the five petals thus

S
P
St St
St,

the double stamen being probably the result of lateral chorisis.

* For details relating to the very interesting structure of this order see Eichler in 'Flora Brasiliensis,' "Sauvagesiaceæ."

5. Stamens (or scales) superposed to stamens as, in *Cuscuta*—

S
P
St
×

and in some Laurels (*Cassylia* etc.)

St
St
St.

In some Lauraceæ, as in certain species of *Oreodaphne*, *Cassylia*, etc., there are two rows of stamens, the inner superposed to the outer, and having extrorse anthers, while the anthers of the outer row of stamens are introrse.

6. Stamens superposed to petals and to sepals—

S
P
St.

7. Carpels superposed to stamens,

S
P
St
O,

as in *Iris*, *Crocus*, etc. A similar formula would apply to the female flower of *Sedum Rhodiola*, substituting a gland (which is here an enation) for a stamen.

8. Carpels superposed to stamens and petals,

S
P
St
O,

as in *Gordonia* (*fide* Le Maout and Decaisne, Gen. Syst. ed. Hooker, p. 271), *Cathedra*, and some Menisperms, while in *Zygophyllum* the arrangement is

S P
St
×
O.

9. Carpels superposed to stamens, petals, and sepals—

S
P
St
O,

The arrangements from 4 to 9 inclusive may be complicated with pleiotaxy of one or all the whorls, which probably takes place in some double flowers. Berberidaceæ afford illustrations of this, as in *Epimedium*, the formula for which is

S
P
P
St.

The arrangement in this case, however, is due to an alternation of decussating whorls.

Usually in such cases the stamens and carpels, either or both, are more or less petaloid, or actually replaced by petals, so that their true nature is not at once obvious. In some Menispermaceæ, e. g. *Cissampelos*, *Cyclea*, etc., we have an arrangement as follows—

S
P
O,

the stamen, or stamens, being abortive or replaced by carpels in like numbers and position. Similarly in the male flower we have

S
P
St,

the carpel being deficient*.

IV. *The Causes of True Superposition.*

1. *Superposition of Whorls.*—Payer, in his 'Éléments de Botanique' (1847), p. 42, says that in the case of verticillate leaves, the leaves of a verticil are never superposed to those of the whorl immediately beneath, and that opposite leaves are in the same case. This remark can hardly be applied in the case of the flower, in which (in exceptional instances) the members of one verticil may be, to all appearance, placed immediately above those of the whorl beneath. It is possible that an examination in the earlier stages of the development of the plant might show that in their origin the primordial tubercles are not placed exactly over one another; but in the adult condition, and for all practical purposes,

* For details relating to the position of parts in the flowers of Menispermaceæ, see Miers, 'Contrib.' vol. iii.; Eichler, in Martius 'Flora Brasiliensis' (Menispermaceæ). *Abuta*, *Sychnosepalum*, *Cocculus*, *Cissampelos*, &c. See also for general details A. P. De Candolle, 'Théorie Élémentaire,' p. 153.

superposition of whorls does really occur. A marked instance of this is afforded by the monstrous Daffodil called in gardens *Narcissus Eystettensis*. This *Narcissus* is mentioned in Mr. Burbidge's monograph on *Narcissus*, where references to Herbert and Haworth are given. It is also well figured in the work just cited*, and was described by several of the older botanical writers, whose descriptions are noteworthy as showing that the morphological peculiarities of the plant were recognized by those observers†.

There are also other monstrous Daffodils in common cultivation in the country with a similar arrangement of parts, although from various mutations and substitutions of one organ for another the true position of the parts is not at once obvious. Such

* Burbidge, 'The *Narcissus*,' etc., with coloured plates of all known species 1875, p. 27, tab. x. D.

† Lobelius (1581) figures the plant under the name *Narcissus luteus multipliciflore* in his *Plantarum seu Stirpium Icones*. His figure was apparently copied by many later authors.

Dodonæus, in his *Stirpium Historiæ Pemptadis secundæ* lib. ii. p. 227, c. icon. (1583), describes and figures the same plant under the title *Narcissus silvestris multiplex*, and also alludes to a double white *Narcissus* to be hereafter mentioned. "Contingit vero," says Dodonæus, "et huic quod aliis quandoque floribus et candidis *Narcissus*, accidit ut, videlicet, floris foliola multiplicentur et talis quidem flos medio calyce caret compluribus foliolis medium occupantibus. Folia autem ac bulbi cum aliernis conveniunt; flos quoque totus luteus."

Dalechamp, *Hist. Gen. Plant.* ii. p. 1523 (1586), also alludes to the plant as *N. luteus multiplex* Dodonæi.

Our own Gerard, writing in 1597, in his *Herball*, p. 115, gives a figure (apparently reproduced from Dodoens or De l'Obel) of the double yellow Daffodil, which he says he received from Robinus, of Paris, who procured it by means of friends from Aurelia and other parts of France.

Clusius (1601) figures in his *Rariorum plantarum Historia*, p. 110, the *Narcissus* of which we are now speaking under the head of *Pseudo-Narcissus pleno flore* . . . "medio calyce caret, et ejus loco plurima folia externis illis omnino similia et pallida habet." By "calyce" the author means what we should now call the corona. A similar variety probably of what is now known as *Narcissus poeticus* is mentioned by the same author as *Narcissus plenus flore albo*.

Besler, in his 'Hortus Eystettensis,' (1613) tertius ordo, fol. 3, ii., gives an excellent figure of this *Narcissus* under the name of *N. silvestris stellatus*, with this description:—"Qui decussatis florum foliis, uno caule prodit acutioribus sub luteis *N. silvestris* et *stellatus* hic nominatur inodorus, habens oblonga carinata rotundiora et angusta folia; bulbum cepaceum."

Tabernæmontanus, in 1625, repeated Clusius's figure and mentioned the plant as "Josephstäblen." The same author in his *Nieuw Kreuterbuch*, lib. 2, p. 1003 (ed.

a one was described by the late Professor Morren*. The deviation from the ordinary alternate arrangement in the case of these Narcissi, and more especially in the case of that form called *N. Eystettensis*, arises from a different cause from that to which the appearances of the Camellias previously referred to are attributable. While in the Camellia the superposition is, as we have seen, apparent rather than real, in the Narcissi there is a true superposition of parts. The flower in question, *N. Eystettensis*, has a

1664), mentions the plant in question under the name "Gefüllt' Jacobstäblen," and as *Narcissus silvestris multiplex calyce carens*.

Parkinson, in his *Paradisus* (1629), p. 105 and p. 107, fig. 4, speaks of it as "*Pseudo Narcissus gallicus minor flore pleno*, or the lesser French double bastard daffodil," and states that it bears "one faire double flower thereon, of a pale yellow or lemon-colour, consisting of six rowes of leaves, every one growing smaller than other unto the middle, and so set and placed, that every leafe of the flower doth stand directly almost in all, one upon or before another unto the middle, where the leaves are smallest, the outermost being the greatest, which maketh the flower seeme the more beautifull; this and the greater kinde hath no trunk [corona] or shew of anything in the middle, as all or most of the other former bastard daffodils have, but are flowers wholly composed of leaves standing double even to the middle." Further on it is added that this "French double kinde [grows] about Orleance in France, where it is said to grow plentifully and is most usually called 'Robinus his Daffodill.'" The modern French Floras make no mention of the plant in a wild state. Parkinson, '*Paradisus*,' p. 89, f. 6, and p. 91, also alludes to the double white form already mentioned as "bearing one faire double snow white flower, very like in the fashion unto the pale yellow double Daffodill or bastard Daffodill of Robinus * * * for it is in the like manner laid open flat, and composed of six rowes of leaves, every rowe lying in order just opposite or one before another, etc." The name he gives to this is *Narcissus albus flore pleno Virginianus*, or the double white Daffodill of Virginia. If a *Narcissus* at all, it is probably a form of *N. poeticus*.

J. Bauhin, '*Historia Plant. Universalis*' (1651), p. 594, speaks of the plant now known as *N. Eystettensis* as *Bulbocodium flore pleno*, and repeats the figure of *Dodonæus* and *Lobelius*.

In Hales's '*Eden, or a compleat body of Gardening*' (1757), the present plant is described and figured as the Double Lemon Daffodill, the author giving an original illustration and avoiding the error of some of his predecessors, who supposed it to be a wild species, instead of an accidental monstrous condition perpetuated by cultivation. Philip Miller makes no mention of this variety in the eighth edition of his celebrated Dictionary.

* Bull. Acad. Roy. Belg. xx. pt. 2, p. 272, c. tab. The author here cited says, "L'opposition des organes pétaloïdes est ici de toute évidence; de sorte que si l'on admet le principe de M. Auguste de St.-Hilaire, ces cinq périanthes et ces cinq couronnes emboîtés les uns dans les autres seraient les résultats non de multiplications, mais bien de vrais dédoublements." See also Sweert, '*Flori-legium*' (1641), t. 26.

very short funnel-shaped flower-tube, from the edge of which six segments are given off, not three followed by three as in the normal flower. Within these six, and superposed to them, are six others; to these succeed in like manner as many more, and so on for many series. In the case of *N. Eystettensis* the corona is absent, as are also the stamens and pistil; but in the other double *Narcissi*, to which reference has been made, the corona is repeated, and the centre of the flower is occupied by a confused mass of imperfect and partly petaloid stamens and styles. The ovary, which is usually adnate to the tube of the flower (inferior), is in these flowers absent. The appearances presented, therefore, are due to a repetition of the perianthial whorl, to the complete or partial exclusion of the stamens and other parts of the flower. Further examination of very young buds is requisite before it can be stated definitely whether in this particular instance the repetition of parts is due to chorisism of preexisting organs, or to a distinct series of new growths from the receptacle. So far as I have seen, I am disposed to believe that the latter is the true method according to which these flowers are constructed.

Real superposition of whorls is also met with in some *Olacaceæ* (as in *Cathedra*),

S
P
St
O,

and in some *Menispermis* (*Cycllea*) represented by the formula

S
P
St

or, as in *Cissampelos**,

S
P
O.

Perhaps also the prevalent arrangement in *Restiaceæ*, where the three stamens are superposed to the three inner perianth-segments, may be referred to the same cause.

S
S
St 3
O 1-3

At any rate analogy affords no indication of the abortion of an outer row of stamens in these plants.

* For *Menispermaceæ* see Miers, 'Contrib.' vol. 3; Eichler, in Martius, 'Flora Brasiliensis'; *Olacineæ*, see Miers, 'Contrib.' vol. 1; Engler in 'Flora Brasiliensis'; and Mast, in Hook., Fl. Brit. India, i. p. 572.

The arrangements in *Lardizabala* and *Holboellia*,

S
P
St,

and *Epimedium*,

S
P
P
St,

may be attributable to the same cause or to chorisis*.

2. *Spiral arrangement of parts*.—In these cases the calyx forms a complete cycle followed by the corolla in the same manner. An illustration of this may be seen in the case of *Sabia*, wherein the sepals of the calyx are arranged on the $\frac{2}{5}$ plan, and the petals also; hence the first petal is over the first sepal, the second petal superposed to the second sepal, and so forth. Such flowers would fall under A. Braun's definition of hemicyclie. It may be well in this place to allude, in passing, to Payer's explanation of the passage of the decussate arrangement into the $\frac{2}{5}$ plan by the mere chorisis of one leaf, and to the views of the Rev. George Henslow (Trans. Linn. Soc. 1875, Botany, i. p. 37). The latter author deduces the spiral arrangement from opposite and decussate leaves.

3. *Enation, Chorisis*.—By Pfeffer † the petals of primroses are supposed not to be autonomous organs, but outgrowths from the stamens; hence the superposition of the latter to the former. The structure of *Samolus* and of *Monothea* (Le Maout and Decaisne, l. c. pp. 530, 533), as also of *Jacquinia* and *Clavija*, in Myrsinaceæ, with their rows of abortive stamens, by means of which the symmetry is restored, is contrary to the view advocated by Pfeffer. Again, though it is true that in young buds the stamens are seen to

* In some double varieties of Columbine (*Aquilegia*) grown in gardens from time immemorial, there is true superposition, the tubular petals being not only multiplied but ensheathed one within the other, or as the French say "emboîtés," like a "nest" of pill-boxes. There are other varieties in which petals are either not present or wherein they are represented by flat sepals arranged in like manner as in the Starry Columbines of the older writers, so called because the leaves of the flowers do stand so directly one by another. Where the overlapping is only partial, the term Rose Columbine is given (see Parkinson, 'Paradisus,' p. 272).

† In Pringsheim's Jahrbuch, vol. vii. p. 194.

be in advance of the petals, that appearance is due to the growth of the stamens overtaking that of the petals, and not to any outgrowth from the stamens. For instance, in *Lysimachia vulgaris*, as in some other Primulaceæ, I find that in the course of development the petals lag behind the stamens, and hence allow more room for the development of the latter. The pistil is developed in the shape of a cylindrical tube, and shows no sign of cohesion of carpels; but rather of a lack of separation of those organs. In some cases, however, the carpels do become separated.

A similar explanation to that given by Pfeffer in the case of Primroses has been offered with regard to some Hypericaceæ and Plumbaginaceæ; and by others in the case of those Malvales wherein the stamens are antipetalous, but, as it would seem, on questionable grounds. The history of development, so far as known, and the analogies with the structure of other Malvales render it more probable that the superposition is due to abortion or to some other cause rather than enation*.

The peculiar position of the styles of *Aristolochia*, superposed to the stamens, is explained by Payer on the supposition that the styles are mere outgrowths from the stamens to which they are superposed. (See Mast. in Journ. Linn. Soc. xiv. p. 488.)

It seems desirable to draw a distinction between Enation and Choris, although in the adult flower the difference between the two processes may not be always obvious †. By the process of choris the original organ is repeated, petal follows petal in the same way that the leaves of a book do. The process begins at a very early stage of development; and it is often difficult to ascertain whether the younger growths are independent productions from the floral axis, or secondary growths from the preexisting lateral organs. In the case of enation the process is subsequent to the first stages of development; development has made some progress before the outgrowth is observed. In the case of choris, the organ is repeated; in enation it generally happens that the new growth is of a different appearance from, and frequently has a different office to fulfil than that of, the part from which it springs. The scales before the petals in *Silene*, in *Corokia*,

* Van Tieghem (Recherches sur la structure du pistil, p. 14) considers that the petals of Mallows are stipulary appendages of the staminal leaves; so that, according to him, there are but two whorls in a mallow-flower—a sepaline whorl which bears both stamens and petals, and a carpellary whorl opposite to the sepals. See also this author's translation of Sachs's *Traité*, p. 622.

† Mast. *Vegetable Teratology*, p. 343, 443.

and in many Sapindaceæ probably, in some cases certainly, owe their origin to enation. The female flower of *Sedum Rhodiola* has a formula as follows—

$$\begin{array}{c} S \\ P \\ \times \\ O, \end{array}$$

from which it might be inferred that the scales $\times$ were representatives of an outer row of stamens, the second row (antipetalous) being supposed to be abortive. An examination of the flower in a young state shows, however, that the scale is a mere outgrowth or enation; for in the unopened bud it is very small, but increases rapidly as the flower opens, and serves as a honey-secreting organ.

Assuming, by way of illustration, that the petals of Primroses and of Plumbaginaceæ are formed as outgrowths from the stamens, they would afford illustrations of the process of enation, as do also the corona of Passion-flowers, the outgrowths from the surface of petals in various Caryophyllaceæ and Sapindaceæ, the appendages to the anthers in Asclepiadaceæ, &c. These outgrowths may occasionally assume the form of stamens; but, for all that, their mode of production may still be by enation rather than by independent formation. In a particular form of *Datura*, figured in my 'Vegetable Teratology,' p. 450, the arrangement of the parts was as follows—

$$\begin{array}{c} \overline{S\ 5} \\ P\ 5 \\ \times\ 5 \\ \overline{P\ 5} \\ St\ 5 \end{array}$$

Here the inner row of petals may have been formed by chorisis, while the petaloid outgrowths $\times$ were the products of enation from the outer surface of the inner petals, similar to those sometimes met with on the under surface of leaves.

4. *Abortion*.—Superposition is perhaps most frequently brought about by abortion or suppression of intermediate whorls. This is obvious in the case of *Vitis*, where the stamens are superposed to the petals, a second and outer row of antisepalous stamens being represented by five glands of the disk, as shown by the formula

S 5

P 5

5

St 5.

Owing to the abortion of the petals in *Amaranthaceæ*, *Chenopodiaceæ*, *Urticaceæ*, *Santalaceæ*, &c., an appearance of superposition of the stamens is brought about, though in truth this is in these cases their natural position.

In *Seetzenia* the arrangement, according to Le Maout and Decaisne, Gen. Syst. ed. Hook. p. 303, is

S 5

St 5

O 5,

owing probably to the abortion or suppression of a row of petals. Abortion or suppression of an outer row of stamens will probably account for the position of the stamens in the *Apostasiaceæ* and *Burmanniaceæ*.

5. *Pleiomery*.—When the members of successive whorls are not equal in number, but anisomerous, some of the additional parts must necessarily be superposed to others in the preceding whorls; thus in *Nigella*, where within a calyx of five sepals is a row of ten petals, some of those petals must be more or less superposed to the sepals. In *Casearia*, where there are no petals, but a calyx of five sepals, the staminal whorl may be thus represented—

S 5

St 10 × 10.

The formula for *Byrsanthus epigynus** is

S 5

P 5

× St × St

× St.

In such cases it becomes necessary to inquire to what cause the polymery is due. It may arise from branching of the stamen chorisis, or from interposition of parts. Cases of this kind occur in *Erythroxylon*, *Oxalis*, *Malpighia*, *Zygophyllum*, *Quassia*, *Melia*, many *Sapindaceæ*, *Saxifragaceæ*, *Crassulaceæ*, *Francoaceæ*, *Dionæa*, some *Combretaceæ*, *Melastomaceæ*, *Ericaceæ*, *Hypopitys*, *Bougainvillea*, *Tetragonia*, *Phytolacca*, *Alisma*, *Butomus*, etc.

* Mast. in Journ. of Linn. Soc. vol. xiii. p. 15.

6. *Interposition*.—In some of the cases last mentioned, as in *Rhododendron* and its allies, in Geraniales, *Dictamnus*, *Acer*, &c., subsequent to the formation of the primary stamens a secondary production of stamens is observed to take place. Sometimes these secondary stamens are in equal number with those first developed; at other times they are fewer in number. In the last instance it frequently happens that a stamen gets placed in front of a petal. The proper relative position of the carpels remains unaffected in most of these cases. Although much stress was laid on this phenomenon of interposition by Payer, whose views have been adopted by Sachs and others, yet it is a question whether some of these cases, *e. g.* in Geraniales, are not better explained on the supposition that the new growths are subdivisions of the primary stamens, as in Malvaceæ or *Hypericum*. See also the diagram of *Styrax* in Le Maout and Decaisne's Gen. Syst. ed. Hooker, p. 451, with its single row of isolated stamens, twice the number of the petals, and compare this with the figure of *Symplocos* with its branched stamens. By Chatin and Eichler* plants with a double andræcium, the outer whorl of which is superposed to the petals, are styled "obdiplostemonous." The outer stamens in these cases are regarded as outgrowths from the petals or as intercalated elements. Chatin further explains some of these instances by showing that while in the adult flower the stamens are in one row, in the young state they are in two.

7. *Substitution of one organ for another*.—The diagram for the female flower of *Xanthoxylum* shows the five carpels superposed to the five sepals, thus—

S 5
O 5.

In the male flower, according to the diagram in Le Maout and Decaisne's 'General System of Botany,' ed. Hooker, p. 324, the arrangement is

S 5
P 5
St 5
x.

It would seem, therefore, in this case as if the stamens in the female flowers were really replaced by carpels, the latter occupy-

* Eichler, 'Blüthendiagramme' (1875), p. 187; Chatin, 'Comptes Rendus,' 1856, p. 13, ex Eichler, *l. c.*

ing the position that stamens ordinarily fill, and which they do really occupy in the male flower.

8. *Torsion of the axis*.—This between two successive whorls, or torsion of the constituent elements of the whorl, may bring about an appearance of superposition. Such cases are not uncommon in the case of leaves; but I do not recall any instance in the case of the normal flower, except in certain cases of obvious monstrosity, as where the parts of the flower are displaced by a twisting of the axis, conjoined or not with a tendency of the parts to pass from a verticillate to a spiral arrangement*.

V. *Objects of the Diversities in mode of Arrangement.*

The alternate position seems to be in most instances a provision for ensuring space to closely packed organs, so as to prevent undue amount of pressure on the growing tissues. In cases where the development of the stamens lags behind that of the petals, the question of space is not of so much moment as under other circumstances. It may often be an advantage to the plant to have the stamen concealed in the cavity of the petal, as in *Blumenbachia* among Loasaceæ, *Scaphopetalum* in Byttneriaceæ, and in very many other instances, where such an arrangement may be beneficial either for protection's sake or in various manners connected with fertilization.

In other cases the existing arrangement may be a relic of some ancestral condition which has now lost its significance; or, on the other hand, could we but read it aright, it might offer a forecast of some future development.

VI. *Illustrations of the Relative Position of the Parts of Perianth and Androecium in various genera of Tiliaceæ and Olacaceæ.*

1. *Tiliaceæ*.—In illustration of the manner in which the relative position of the parts of the flower may vary within the limits of the same Natural Order, I may refer to some of the genera of Tiliaceæ and Olacaceæ which have come under my own observation. Other instances of a similar character relating to Malvales are specified in a paper published in the Journal of this Society†.

In Tiliaceæ in general the stamens are indefinite in number, but

* Some instances of this, especially amongst Orchids, are given in 'Vegetable Teratology,' p. 91 &c.

† "On some Points in the Morphology of the Malvales," Journ. Linn. Soc. vol. x. p. 18. See also Mast. in Oliver's 'Flora of Tropical Africa,' i. p. 177 (Malvaceæ, Sterculiaceæ, Tiliaceæ); and in Hook. Fl. Brit. India, i. p. 317.

are probably originally referable to five branched stamens, with or without staminodes, in a single or double whorl. The staminodes may be independent structures; but usually they are sterile portions of a branched or compound stamen.

In *Prockia* the arrangement is

S
Sts,

the superposition of the stamens being apparent rather than real, owing to the abortion or suppression of the petals.

A very frequent arrangement is that met with in *Glyphæa*, *Entelea*, *Triumfetta*, *Heliocarpus*, *Erinocarpus*, *Sloanea*, *Grewia*, *Corchorus*, *Desplatzia*, as also in *Kydia* among Malvaceæ:—

S
P
Sts.

Luhea only differs from this in the presence of a row of staminodes outside the stamens, thus—

S
P
× ×
Sts,

the staminodes being probably, therefore, simply sterile divisions of the stamen.

In *Hasseltia* and *Plagiopteron*, as in *Malope*, *Bombax*, *Eriodendron*, *Durio*, &c., among Malvaceæ, the stamens are superposed to the petals thus—

S
P
Sts ;

and the same arrangement holds good in the case of *Commersonia* and *Pentace*, with the addition of a row of antisepalous staminodes within the fertile stamens.

In *Aristotelia*, as in *Sidalcea*, among Malvaceæ, there are two rows of stamens thus arranged—

S
P
Sts
Sts,

the typical alternation being here not interfered with. *Brown-*

lowia is similar, except that the row of fertile stamens is here represented by five antipetalous staminodes, thus—

S
P
Sts
×.

Pityranthe differs from *Brownlowia* in the circumstance that the staminodes are superposed to the sepals —

S
P
Sts
×.

Corchoropsis has a third row to the andrœcium in the shape of an innermost row of five staminodes superposed to the sepals —

S
P
Sts
Sts
×.

Bocquillon, however, states that the staminodes are antisepalous*.

In some species of *Elæocarpus*, as in *E. parviflorus*, as also in the genus *Tilia* itself, the arrangement is as follows—

S
P
St
×
St
O.

In *Leptonychia*, formerly referred to Tiliaceæ, but now more fittingly placed among Byttneriaceæ, the disposition is as follows—

S
P
× ×
St St
×.

* In many cases the *outer* surface of the staminodes is dusted over with pollen in spite of the anthers being extrorse, which leads to the inference that the function of the staminodes corresponds with that of those organs in *Dombeya Mastersii*. See 'Gardener's Chronicle,' 1864, p. 14; Bot. Mag. t. 5639.

In *Sparmannia* the arrangement is similar, except that the fertile stamens are more numerous, and, together with the staminodes, are antisepalous, not antipetalous.

In *Honckenya* the arrangement, according to Bocquillon*, is

S
P
× ×
St St
St.

The same author gives the following arrangement to *Tilia*—

S 5
P 5
St 5
St 5
O 5.

The diversities in the relative position of the floral envelopes and of the parts of the andrœcium in Tiliaceæ seem therefore to be associated with abortion and suppression of petals, suppression or multiplication of stamens, or with subdivision of the individual stamens—some of the branches being fertile, others anantherous. But all these matters require to be investigated in fresh flowers and in various stages of development. This remark applies even more forcibly to the Olacaceæ.

2. *Olacaceæ*.—It must be premised that this order, as understood by Bentham and Hooker, is a rather heterogeneous conglomerate of genera, and that doubtless in course of time considerable re-arrangement will be found necessary; indeed this has already been partially effected by Miers, Baillon, and others †.

From the peculiarities of structure and arrangement in this order, from the occasional uncertainty as to what is to be considered calycode and what calyx, from the difficulty of accurately determining the relative position of the parts in pressed and dried flowers, from the few opportunities presented to the home botanist of examining fresh specimens of this order in gardens, and from other causes, it is unsafe to rely on the diagrams and descriptions given

* Bocquillon, 'Mém. sur le Groupe des Tiliacées,' 1867, p. 18.

† Miers in Lindley's 'Veg. Kingdom,' p. 444, and 'Contrib. to Botany,' i. p. 34; Baillon, 'Adansonia,' iii. 354; Engler in Martius, 'Flora Brasiliensis' (Olacineæ). See also Masters in Hook. Fl. Brit. India, i. p. 572.

by descriptive botanists, whose attention has not been specially called to the question of relative position.

For the purposes of this communication it matters relatively little whether the genera called Olacaceous are closely allied or not in their genetic affinities, as abstract relations of position are the main subjects now under consideration. This being the case, it is not necessary in the formulæ made use of to indicate any differences of adhesion, cohesion, or (except in some cases) number of parts. The position of the loculi of the ovary is also, in general, not indicated—because in most instances there is only a single cavity in the adult flower, or, if there be more than one, then it is difficult, if not impossible, among Olacaceæ, accurately to determine the relative position of the ovarian cavities from dried specimens. In *Emmotum*, according to Miers, there are three ovarian cavities, with indications of two others.

The simplest formula for this order is

S 5

St 5,

which is met with in *Lepionurus*, where we have a calyx of five sepals with five stamens superposed. That the superposition in this genus is due to suppression of the petals may reasonably be inferred from the fact that one of the most common of all floral arrangements is

S

P

St;

and this is found in many Olacaceous genera, such as *Mappia*, *Lasianthera*, *Gomphandra*, *Cardiopteris*, *Apodytes*, *Pteleocarpa*, *Phlebocalymna*, *Sarcostigma*, *Phytocrene*, *Miquelia*, &c.

The arrangement

S 5

P 5

St 5

occurs in *Aptandra*, *Agonandra*, *Strombosia*, *Schæpfia*, *Iodes*, and *Anacalosa*, and may, possibly, be accounted for by reason of the absence or suppression of an outer antisepalous series of stamens. In *Opilia* the arrangement is similar; but there is in this genus a row of staminodes superposed to the sepals and within the stamens—

S 5
 P 5
 St 5
 $\times 5$
 O 1.

Where there are four rows of parts, the arrangement is as just described ; or it may be as follows—

S
 P
 St

as in *Phlebocalymna*, where the antipetalous glands of the disk may be the representative of an antipetalous whorl of stamens.

In *Natsiatum* we meet with the arrangement

S 5
 P 5
 $\times 5$
 St 5,

there being in this genus a row of staminodes antipetalous and outside the fertile stamens. Baillon, indeed, describes the staminodes as “interposed” between the fertile stamens, thus—

S 5
 P 5
 St 5 $\times 5$.

But in the flowers examined by myself the sterile stamens appeared to be distinctly external to the fertile ones. It is possible, however, that the history of development may bear out Baillon's interpretation.

In the preceding examples (if the last one be excepted) the stamens, staminodes, and glands of the disk are isomerous with the petals in their respective whorls ; but in other Olacaceæ we get in the same whorl a larger number of stamens, or of stamens mingled with staminodes than of petals. The formula for *Ximenia*, *Ctenolophon*, and *Ptychopetalum*, for instance, is

S
 P
 St St,

there being usually ten stamens in a single whorl, five being antisepalous and five antipetalous. In *Ctenolophon*, as the five anti-

petalous stamens are longer than those superposed to the sepals, though all in the same row, it is possible that one set of five is interposed between the others. There is, however, little or no evidence in support of this opinion.

In the genus *Ola*x itself the arrangement varies in different species: thus in *O. zeylanica* and *O. scandens* the arrangement is sometimes

$$\begin{array}{c} S \\ P \\ St \times; \end{array}$$

and at other times, especially in the last-named species, it is

$$\begin{array}{c} S \\ P \\ \times \\ St; \end{array}$$

while Roxburgh, in his 'Coromandel Plants,' figures it as

$$\begin{array}{ccccc} S & S & S & S & S \\ & P & P & P & \\ St \times & St \times & St \times, & & \end{array}$$

there being, according to this author, three bifid petals and stamino-nodes interposed between the stamens.

In *Ola*x *nana*, *O. acuminata*, and *O. merguensis* the arrangement is

$$\begin{array}{c} S 5 \\ P 3 \\ \times 5 \quad St 3. \end{array}$$

In *O. Wightiana* the disposition is

$$\begin{array}{c} S 5 \\ P 5 \\ St 3 \times 5. \end{array}$$

It is possible that the arrangement in *Ptychopetalum* and *Ola*x is due to the existence of branched stamens, whereby the number of stamens is increased. This notion is borne out by the order of disposition in *Ochanostachys*, Mast., a newly described genus*, thus—

$$\begin{array}{ccccc} S & S & S & S & S \\ & P & P & P & P & P \\ St 3 & St 3 & St 3 & St 3 & St 3, \end{array}$$

* Mast. in Hook. Fl. Brit. India, i. p. 576.

the appearance of three stamens placed in front of each of the five petals being probably due to the branching of five antipetalous stamens.

Further examination, however, especially of fresh flowers, in the earliest stages of development is required before the explanation of the peculiarities in the structure of this, as of many other Olacaceous genera, can be satisfactorily determined.

The union of the calyx to the ovary seems a point of relatively little importance in this order. Sometimes it is partial; and the ovary is then, as it is called, "half superior." At other times it is complete; or in other instances it may not occur at all, when the ovary becomes wholly superior or free. In *Erythropalum* the calyx, which at one period is attached to the ovary, becomes subsequently detached from it; but these are matters beyond the limits of the present communication.

Note on Specimens of *Hibiscus* allied to *H. rosa-sinensis*, L., collected in E. Tropical Africa. By Dr. KIRK, F.L.S., H.B.M. Consul at Zanzibar. With Remarks by Professor OLIVER, F.R.S., F.L.S.

[Read June 3, 1875.]

THE first specimen of this singular *Hibiscus* was found at Kilwa; it was then leafless and growing on the dry rocky slope of a low hill-range just behind the town. The second was at the bottom of a damp mountain-glen in the Wanika hills behind Mombasa, where it grew in perpetual shade among Bignonias, Balsams, and Ferns. Nothing could have been more dissimilar than the situation of the two specimens, which were moreover separated by about 300 miles of latitude. The same plant, but of which variety I am unable to state, exists, however, at intermediate points; and I have little doubt that the difference of condition indicated by the two localities from which we have the only two specimens is quite sufficient to account for the variation observable in the specimens now made over to Kew.

I think it still an open question whether these can be considered the true wild form, and, again, if *H. rosa-sinensis* be an independent species. The differences seem very remarkable; at the same time we must keep in mind that Africa is now coming to be