

A RE-EXAMINATION OF CESALPINO'S CLASSIFICATION

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In all works dealing with the history of botany a more or less important place is allocated to CESALPINO's "De Plantis Libri XVI", (1583). This is easily comprehensible for even a cursory inspection of this book can not fail to impress us with the author's originality and his unusual gifts for analysis and exposition. The most important part of the work, viz. the books II-XVI, is devoted to a survey of the plants that were known at that time, and contains an attempt to arrive in a truly scientific way at a classification of the latter, and if the reader is acquainted with the earlier works in which a survey of the plant world is given, he will realize that CESALPINO was the first to make such an attempt. It is, however, not only the novelty of the enterprise that excites our admiration, but also the acumen with which it is carried into effect. Unfortunately, but few botanists seem to have read the book, and even the majority of the authors on the history of botany apparently did not deem this necessary. At least, most of them based their conclusions on the abstract given by LINNÉ in his "Classes Plantarum", and this abstract is, as I will show hereafter, very incomplete and in some respects even incorrect. A laudable exception to this rule is found in the essay on MORISON and RAY that VINES contributed to OLIVER's "Makers of British Botany"; VINES' survey of CESALPINO's system differs but in minor points from the one given below.

In SACHS' "Geschichte der Botanik", of which an English edition appeared under the title "History of Botany", an analysis of CESALPINO's work is found that deserves our special attention. It is true that SACHS' conclusions with regard to CESALPINO's classification are based on the abstract given by LINNÉ and are therefore untrustworthy, but his exposition differs from that of all earlier authors in the thoroughness with which he discusses the contents of the last three chapters of Book I, in which CESALPINO expounds the principles on which his classification is based, and in which he tries to justify their choice. It appears that SACHS was fully aware of the truly scientific spirit with which these chapters are imbued, and by which they tower high above all that ever before had been written on this subject. In fact, CESALPINO was in this respect so far ahead of his

time that for the next hundred years nobody seems to have understood him. SACHS certainly displayed a great admiration for CESALPINO's genius, but he was nevertheless not sufficiently impartial to do him full justice. The reason for this somewhat contradictory attitude is to be sought in his aversion for CESALPINO's philosophical standpoint.

CESALPINO was not only a gifted botanist, but he was also a philosopher who occupied himself with the Aristotelean doctrine. In fact, he was so well versed in the latter that he wrote a book on it, which was published under the title "De questionibus peripateticis". He showed himself in this work an adherent of the neo-scholastic school which at that time in the towns of northern Italy played a leading part in intellectual circles, and differed from the older scholastic schools by concentrating its attention especially on those works of ARISTOTLE that deal with the science of nature. However, it was, like its predecessors, inclined to place a too implicit faith in the words of the master, and it was mainly against this tendency that SACHS felt himself bound to do battle. This, of course, was his good right, but in his rationalistic zeal he sometimes overshot the mark. It certainly can not be denied that CESALPINO derived part of his ideas from ARISTOTLE, and it is not difficult to show that some of them were unfounded assumptions that led him astray, but in general the influence of ARISTOTLE on CESALPINO was by no means so disastrous as SACHS' exposition is apt to suggest. On the whole it is the form in which CESALPINO presents the results of his studies that reminds us of the Stagirite, and although this form may sometimes be objectionable, it should not blind us for the significance of the results themselves. Most of us will agree that in judging the scientific value of works written in the past we must leave the author's philosophical or theological orientation as much as possible out of consideration, as this value is, as a rule, but slightly influenced by these factors. When we place ourselves on this standpoint, the unusual vigour of SACHS' attack will strike us as out of all proportion to CESALPINO's offences.

The point against which SACHS' attack mainly is directed, is CESALPINO's use of the term "cor" or "heart" and his valuation of the functional importance that the part to which this term is applied, should possess. The part indicated as "cor" is the transition zone between the root and the shoot. This zone does not exactly correspond to the part that we nowadays know as the rootneck, for according to CESALPINO it extends upwards to the place where the cotyledons are inserted, which means that it includes the hypocotyl. From the fact that at this place in the undifferentiated embryo the separation between root and shoot is effected, CESALPINO somewhat hastily concludes that it must be the seat of an agency that directs the root downwards and the shoot upwards. To us it looks unlikely that this but vaguely differentiated zone, which moreover is absent in plants grown from cuttings, should be able to exercise a directing function, and we now know that in the shoot as well as in the root the direction of growth is not determined at this place but in the parts themselves,

viz. in their growing zones. However, we should not forget that the way in which in the embryo the separation between root and shoot is effected, remains to this day an unsolved riddle, and we should credit CESALPINO at least for having recognized that this separation presents a problem. Moreover, we should realize that CESALPINO's solution, although unacceptable to us, will have sounded plausible enough at a time when those who occupied themselves with biological problems, were inclined to draw a very close parallel between plants and animals, and who therefore, as the existence of such a directing influence in the centre of the animal body was generally accepted, could have no objection against the assumption of a similar directing agency in the centre of the plant body. As in the animal body this function was in CESALPINO's time thought to be performed by the heart, it was only natural that he transferred this name to the part of the plant body that in his opinion fulfilled a similar office.

Further on we will discuss CESALPINO's opinion that the characters on which the classification is to be based, should be derived from the number, position and general aspect ("numerus", "situs", "figura") of functionally important parts. For the moment it suffices to realize that from his point of view the transition zone between root and shoot certainly belonged to these parts, and that he will therefore have felt himself fully justified in using the position of this part in the seed, and eventually in the fruit, for the subdivision of some of his groups. However, he used it but sparingly, and the impression created by SACHS' exposition that it was one of the main principles of his classification is certainly wrong. In discussing the two main divisions of the woody plants he points out that in the first the seeds are attached in such a way to the pericarp that the "heart" is turned towards the outside ("semina eo modo sedent ut cor exterius vergat"), whereas in the second the seeds are inserted in such a way that the "heart" is turned towards the point of insertion ("semina eo modo sedent ut cor ad sedem vergat"), but he is well aware of the fact that this is no rule without exception, and the division is not based on this difference but on the number of seeds per fruit. Among the herbaceous plants he twice mentions a pair of groups that are said to differ in this way. They are discussed in book IV and in book XI, and in the summary given at the end of this paper they are numbered respectively 14 and 15, and 27 and 28. In group 14, which comprises the *Chenopodiaceae*, *Urticaceae* and *Cannabinaceae*, the rootlet is described as turned upwards ("seminis cor exterius"), and in group 15, the *Gramineae*, as turned downwards ("seminis cor inferius"). Of group 27, which comprises the *Boraginaceae*, it is said that the rootlet is found at the top of the "seed" ("cor in summo"), whereas in group 28, the *Labiatae*, the rootlet is said to be at its base ("in sede vim genitalem gerunt"); with "seed" in both families the nucule is meant, and "vis genitilis" is another term for "cor": it indicates the power of the rootlet to break through the testa. CESALPINO's words are quoted here in detail in order to make it clear that the position of the embryo plays but a subordinate part in his classification, and that SACHS

therefore attached too much weight to this point. It is perhaps not superfluous to add that the subsequent development of our knowledge in the field of Angiospermous morphology has shown that the position of the embryo in the seed, which proved to be correlated 1° with the structure of the ovule (atropous or anatropous) and 2° with the latter's position (ascending or descending), is in reality a much more valuable character than CESALPINO could have presumed, and it put SACHS entirely in the wrong. CESALPINO deserves adequate recognition for having been the first to draw the attention to this character.

CESALPINO's view that the characters on which the classification is to be based, should be taken from those parts that play an important part in the life of the organism, returns in the works of most of his successors. In fact, it maintained itself until it was superseded by the Darwinian view that these characters should on the contrary be taken from parts that are functionally of little or no importance. The adherents of the Darwinian variant of the evolution theory argued that the characters of functionally important parts are too much subject to the influence of natural selection to become stabilized, and that their taxonomic importance therefore can not be very great. It is easy to see that this dogmatic view does not agree with observed facts, for although it can not be denied that there are numerous characters of taxonomic importance of which we can hardly expect that they should prove of any value in the life of the organism, e.g. such characters as are presented by the relief of the pollen grains, there are also taxonomically important characters that are of the utmost functional importance, e.g. the colour of the chromatophores in the different groups of *Algae*, which determines the depth beneath the surface at which these organisms can live.

CESALPINO was probably well aware of the fact that the characters on which he based his divisions, were themselves on the whole of little or no importance to the life of the plants. At least he says nowhere that they are, but confines himself to the statement that they are taken from parts of functional importance. The same phrase is met with in the works of LINNÉ. It seems hardly probable that the latter would not have seen that the characters on which he based his sexual system, viz. the number of the stamens and carpels, their freedom or coalescence, etc., could hardly be of importance in the life of the plants, and the reproof that he received on this account, e.g. from SACHS, is in my opinion unfounded. It must, on the other hand, be admitted that the phrase "derived from parts that are functionally important" has very little meaning. The functions that according to CESALPINO are of importance in the life of the plant, are nutrition and reproduction, and as all parts of the plant are in one way or another involved in one of these functions, it seems impossible to find a character that is not taken from such a part.

The explanation of this at first sight rather puzzling attitude is indeed to be found in an exaggerated respect for the views of ARISTOTLE. As the latter had mainly confined his classificatory interest to animals, it is not very amazing that he saw no difference

between taxonomic and functional importance. Fishes are characterized by their adaptations to the life under water, birds by their ability to fly, mammals by the way in which they feed their young, the various groups of mammals by the adaptations shown by the organs with which they obtain their food and by those of the teeth with which they work on it, etc. However, as soon as this principle was applied to plants, it led to difficulties, as indeed it also does when more rigorously applied to the animal world. This is what CESALPINO, and afterwards LINNÉ, experienced, and it was in order to save the Aristotelean principle that they made the concession mentioned above: although the characters themselves need not play an important part in the life of the plant, the parts from which they are taken, should fulfill this condition. The concession, of course, does not really save the principle, for the functional importance of a part evidently rests on the functional importance of some of its characters, and if the principle was a sound one, those characters that are responsible for the functional importance of the part, should be chosen, not the indifferent ones. However, in judging the trials and errors of these pioneers in the domain of taxonomy, we should not forget that the need for such a "logical" justification was felt very strongly in their time, and that without this addition, which to us is hardly more than a literary embellishment of somewhat doubtful taste, their systems would not have been acceptable to their contemporaries.

The artificial nature of the arguments by means of which CESALPINO tried to make the choice of his characters acceptable, makes it probable that these characters were not, as it is customary to assume, chosen on account of a preconceived notion, but that they must have been brought to light by the analysis of natural groups, i.e. of groups of plants that are similar in habit. In this respect, at least, the method of the earlier taxonomists will not have differed from that of their modern colleagues. Their procedure, however, will have deviated from that of the later taxonomists herein that they will have started with a very small number of natural groups, perhaps with a single one, their experience in this field being insufficient to recognize at first sight more than a very few of them. They will have completed their classification by the establishment of groups based on characters of a kind that had been found serviceable for diagnosing the original groups. Experience has taught us that this does not necessarily lead to satisfactory results, and that this kind of classifications always contain a number of more or less heterogeneous groups. Another reason for the heterogeneity of the groups of the earlier taxonomists lies in the circumstance that the parts from which the characters were taken, were not always homologous. CESALPINO mistook small one-seeded fruits for seeds, and this explains why we find *Ficus* and *Opuntia* next to each other in the same group, and the *Ranunculaceae* and *Compositae* are placed in each other's vicinity because he saw no difference between fruits that develop inside a single flower and fruits that owe their origin to a flower-like inflorescence.

The best way to obtain an idea of the manner in which CESALPINO will have proceeded, will be that we attempt to reconstruct it. As stated above, it is impossible for us to assume that he arrived at his classification in the way expounded in the concluding chapters of book I. The arguments which according to this exposition lead to the choice of his characters, were merely arguments by which he tried to justify the choice after the latter had been made, and by which any other choice could have been justified as well. This is a curious logical flaw, for which, however, we should not blame CESALPINO too much, seeing that the phylogeneticists of our own time commit the same offence. They too place the theoretical interpretation of their systems, which are arrived at in exactly the same way as those of non-phylogeneticists, in front, and speak of a "phylogenetic method"!

CESALPINO'S starting point will have been one of the strikingly uniform groups such as the *Umbelliferae*, the herbaceous *Leguminosae*, the *Liliiflorae* or the *Compositae*. Let us suppose that he started with the *Liliiflorae*, i.e. with group 26 of the list given below. He will have noted that the representatives of this group are herbaceous plants provided with 3-locular fruits and with swollen underground parts. As a division of the herbaceous plants, the group he accepted from his predecessors and whose naturalness he did not doubt, on account of the nature of the underground parts could not appeal to him, he will have turned his attention to the structure of the fruit. His next step therefore will have been the examination of the remaining herbs with 3-locular fruits. He will have seen that these plants do not form a natural group, but that some of them nevertheless are very similar, and as the latter proved to possess a single seed in each cell, he will have divided these plants in two groups, one with one-seeded fruit cells and the other with several seeds in each cell. Therefore, as the presence of 3-locular fruits proved a useful character for diagnosing these three groups, he will have turned his attention towards plants that correspond with each other by the presence of another number of fruit cells. In this way he will have detected that the plants with 2-locular and those with 4-locular fruits form fairly uniform groups, and he will have noted that in the case of the plants with 2-locular fruits an even more natural arrangement could be obtained by dividing them according to the same set of characters that had proved useful for the subdivision of the plants with 3-locular fruits, viz. the presence of one or more than one seed in each fruit cell. This subdivision led in the plants with 2-locular fruits to the splitting off of such well-defined groups as the *Umbelliferae* and the *Cruciferae*. This success will have encouraged him to proceed in the same way.

Instead of starting with the *Liliiflorae* he may have begun with another natural group, e.g. the *Umbelliferae* or the *Compositae*, but as the final result would have been the same, this is a point of minor importance. However, it is also possible that he started with a comparison of two or three of the natural groups, but it seems more probable to me that he followed the first course, because that would

have led him to the discovery of a larger number of natural groups, and this, of course, would have encouraged him to proceed.

Our discussion of CESALPINO's classificatory effort would not be complete if we did not listen to what he himself has to say with regard to it in the concluding chapters of book I. As we have already seen, he tries in these three chapters to justify the choice of the characters on which his classification is based by pointing out that they are taken from those parts in which the two most important functions of the plant are located. These two functions are "nutrition" and "reproduction". "Nutrition" has in CESALPINO's vocabulary nearly the same meaning as it has in our own, but "reproduction" is for him exclusively the reproduction by means of seeds, and as there are plants that do not produce seeds, this function is a less general one than "nutrition", which obviously can nowhere be missed. For this reason the characters taken from the parts that perform an important function in the process of "reproduction" come after those taken from parts that are of importance in the process of "nutrition".

CESALPINO is of opinion that in order to carry out the processes comprised under the term "nutrition" the plant is provided with a root and a leafy shoot, the function of the root being the absorption of food from the soil, and that of the leafy shoot the assimilation of the absorbed food and the distribution of the products of this assimilation process over the various parts. Root and shoot show a corresponding differentiation: in one group of plants they are stronger and harder ("substantia habitior et durior"), whereas in the other group they are thinner and weaker. In this way he tries to justify the division of the plant kingdom in woody plants and herbaceous ones.

In view of the gradual transition between the woody condition and the herbaceous one, it is difficult to see how a critical investigator like CESALPINO could have acquiesced in this division. His own groups 6 and 17, the woody and the herbaceous *Leguminosae* differ in this point only, so that it seems impossible that he can have overlooked their near affinity. The unfortunate choice of this difference as a base for the main division, shows how easily one's judgment may be led astray by traditional conceptions. CESALPINO obviously accepted this time-hallowed division because apparently nobody had as yet found it necessary to test the value of this distinction. However, we should not blame CESALPINO too severely, not only because it would take more than a century before a system was evolved in which this almost entirely illusory difference was dropped, but also because, strange enough, the idea to use this vague difference for the subdivision of one of the major groups, viz. the *Angiospermae*, was revived in recent times, e.g. in the classifications proposed by HALLIER.

CESALPINO's division of his two main groups is said to be based on those parts in which the second important function of the plant is located, viz. the fruits and seeds. The plants that produce no seeds, are dealt with at the end of the herbaceous plants: they represent the lowest grade of differentiation. The existence of woody plants

without seeds could, of course, not shake this belief, as such plants were at that time unknown. It is worth while to see in which way these seedless plants are dealt with. CESALPINO begins with a group of plants whose vegetative parts are similar to those of the seedplants. These are the *Filicales*, *Equisetum* and the genera *Botrychium* and *Ophioglossum*. Then he passes on to the *Hepaticae* and the *Musci*, and these are followed by the *Lichenes* and the *Algae*, in which the genus *Lemna* and also some *Coelenterata* (*Corallium*, *Alcyonium*) are included, and he ends his enumeration with the *Fungi*. On the whole, therefore, a quite natural arrangement.

The differences in the fruits and seeds on account of which the two groups of seedplants are subdivided, are found in the number, the position and the general aspect of these parts, but CESALPINO does not bind himself to the sequence in which these attributes are here enumerated. Particulars with regard to this subdivision will be given further on and in the key to CESALPINO'S groups that is given at the end of this paper, but before discussing them, it seems appropriate to draw the attention to the fact that he occasionally used characters that have nothing to do with the fruits and seeds. Examples are the subdivision of the herbaceous *Leguminosae* on account of the presence or absence of tendrils, the subdivision of the plants with trilocular several-seeded fruits according to the presence or absence of swollen underground parts, the subdivision of the *Compositae* in three groups according to the general aspect of the capitula, and the creation of the group "*Junci*" (*Typha*, *Cyperus*, *Juncus*), which is dealt with in an appendix to the treatment of the *Gramineae*, on account of the uninodal flowering shoots. CESALPINO certainly was not so dogmatic as SACHS would induce us to believe!

With regard to the groups 1-3 of the woody plants CESALPINO remarks that they generally differ from the groups 4-11 by the position of the embryo in the seed. In the groups 1-3 the rootlet would, as a rule, be turned away from the hilum, in the groups 4-11 towards the latter. This, at least, is what his words imply, but because he regarded one-seeded fruits that are not provided with a distinct cavity, as seeds, the position of the rootlet is not everywhere described with regard to the hilum but sometimes, viz. in the one-seeded fruits, with regard to the base of the fruit.

That it occurred to CESALPINO to look towards the embryo when he found that the proper characters of the fruit and seed, viz. their number, position and general aspect, proved insufficient, is perhaps not so unexpected. A century later RAY came by the same trend of thought to the discovery of the two main types of embryo structure that are found in the *Angiospermae* viz. that with two cotyledons and that with a single one. However, as stated above, the position of the embryo inside the seed and with regard to the axis of the fruit is also of considerable importance, but before CESALPINO'S idea could bear full fruit, this position had to be more sharply defined.

However, the first subdivision of the woody plants is not based in the first place on the position of the embryo, but on the presence

of one or more seeds per fruit. The next subdivision is in both cases founded on the position of the fruit with regard to the parts for which CESALPINO uses the term "flos", which I have translated by "blossom" because it has a much wider meaning than is expressed by the term "flower". "Flos" comprises in CESALPINO'S delimitation all those parts by which the future fruits or groups of fruits originally are surrounded, with the exception of ordinary leaves. He uses the term therefore in flowers for the perianth with the stamens and in flower-like inflorescences for all accessory parts, i.e. for bracts, perianths and stamens, and with regard to the latter it is of no importance whether they are arranged round the pistils or in separate flowers. In the capitula of the *Compositae* the "blossom" comprises the involucre as well as the bracts, perianths and stamens of the individual flowers, and in bisexual catkins it comprises the bracts as well as the male flowers. A male catkin too falls under the notion "flos". It can, of course, hardly be expected that plants which are brought together on account of the position of such extremely heterogeneous parts will form natural groups, and they certainly will not do so when they are sufficiently numerous. Group 3 may serve as an example of such a heterogeneous group (see the list of genera included in this group in the catalogue of the groups given at the end of this paper).

The woody plants with several-seeded fruits are subdivided in the same way, and the second group, that with the "blossom" at the base of the pistil, is once more subdivided on account of the position the seeds occupy inside the fruit. Those in which they are inserted on one or more longitudinal placentae are arranged according to the number of these placentae or, as CESALPINO expressed it, according to the number of branches of the placenta. In most cases the number of placentae corresponds with the number of fruit cells, but this is no general rule, for in group 7 we encounter an *Apocynaceae*, i.e. a plant with a bilocular ovary, as well as *Salix* and *Populus*, which are provided with a unilocular ovary with two parietal placentae. The group with several placentae is split once more, viz. according to the consistency of the "fruit", in *Coniferae*, where it is a cone, and "*Mali*" (*Pyrus*, *Citrus*, *Punica*), where it is fleshy. The cone of the *Coniferae* was therefore regarded by CESALPINO as a single fruit with several cells, each provided with a "branch of the longitudinal placenta".

The main division of the herbaceous plants rests on the number of cells per fruit or on the number of fruits formed within the same perianth or involucre, and corresponds therefore more or less with the division of the several-seeded woody plants provided with longitudinal placentae according to the number of the latter, but whereas this difference was used in the woody plants in the third place, it comes here first. It leads to the distinction of five main groups, the last one being that without fruits or seeds. Three of the four others are subdivided according to the presence of one or more seeds in each cell, and in case there is but one seed per cell, by the

presence or absence of an open space between the seed and the pericarp. The fourth group is somewhat inconsistently subdivided according to the presence of four or more than four mericarps or fruits inside the "blossom". The group with the four mericarps is the one that is subsequently split according to the position the embryo occupies in the nucule, in *Boraginaceae* and *Labiatae*. The other one proves to be a very strange mixture, for it contains the *Compositae* as well as families like the *Ranunculaceae*, *Nymphaeaceae*, *Alismataceae*, the herbaceous *Rosaceae*, the *Geraniaceae* and *Malvaceae*. The next subdivision is based on the presence or absence of "blossom" on the individual fruits, and leads to the splitting off of the *Compositae*, the remaining plants being subdivided according to the presence of one or more than one seed per fruit or mericarp. The two groups that are formed in this way are still rather heterogeneous.

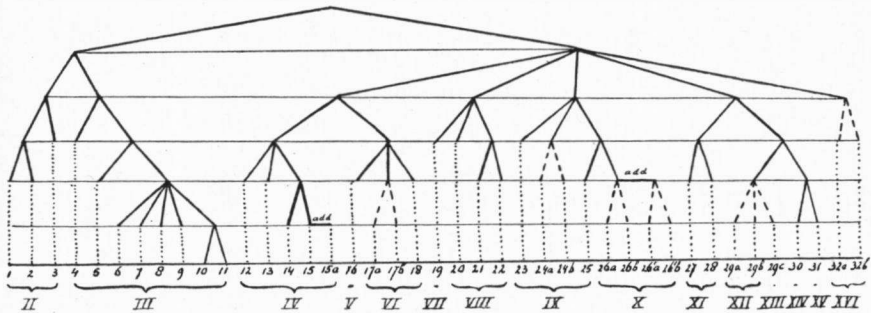


Fig. 1. Graphic representation of CESALPINO'S system showing the successive divisions. The final groups are indicated by arabic numbers; the books in which they are described by roman ones. The abbreviation *add* leads to groups that do not fit into the system, but are dealt with by CESALPINO in connection with the group by which they are preceded.

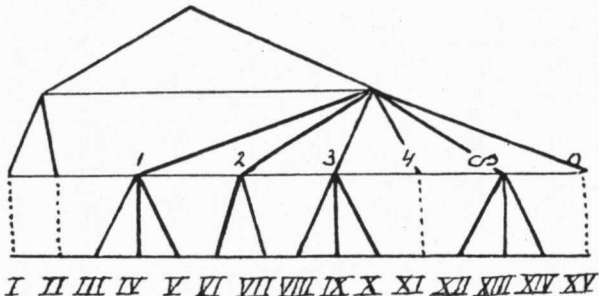


Fig. 2. Graphic representation of CESALPINO'S system based on the abstract of the latter given by LINNÉ. The arabic figures indicate the number of fruits or fruit cells formed by a flower or flower-like inflorescence. The roman numbers indicate the 'classes' which LINNÉ supposed to have been accepted by CESALPINO; they correspond to the books II-XVI.

Fig. 1 graphically represents the structure of CESALPINO'S classification. For comparison I have added in fig. 2 a diagram based on the abstract of his system given by LINNÉ. According to the latter

CESALPINO would have divided the plant kingdom into 15 "classes", of which the first two belong to the woody plants and the rest to the herbaceous ones. The 13 "classes" of the herbaceous plants would have been obtained by a first division into six groups according to the number of fruits or fruit cells per flower or flowerlike inflorescence followed by a further division of some of these primary groups. LINNÉ's exposition rests on the erroneous assumption that each of the books II to XVI contains a "class". In reality the number of CESALPINO's groups is more than twice as large, and they correspond in no way with the division in books, which apparently owes its origin to CESALPINO's wish to split the work in a number of more or less equal parts. Maybe the subject was originally treated by him in a course of lectures; in that case each of the books would contain the contents of a single lecture. In the diagram founded on my own interpretation of CESALPINO's classification I have indicated in which of the books his groups are dealt with, and this shows that some of the books deal with a comparatively large number of them, e.g. book III with 8, book IV with 4, but that the majority deals with 1-3 groups, and the books XII and XIII together with a single one.

The groups of higher order arrived at by the first two or three divisions can but rarely be regarded as natural ones. The artificiality of the main division, i.e. the division in woody and herbaceous plants, has already been discussed, but the results of his second division are hardly more satisfactory. The two main groups of the woody plants are both of a very heterogeneous composition, and the same applies to at least three of the five main groups in which the herbaceous plants are divided, viz. the first and second, respectively consisting of the groups 12-18 and 19-22, and the fourth, which contains the groups 27-31. In our eyes the whole set of consecutive divisions is no more than an artificial key to the 32 final groups which, themselves are for a large part quite acceptable. However, it is obvious that CESALPINO did not regard his divisions in this way, otherwise he would not have felt the need to justify the choice of the characters on which they rest. In this respect his classification can not be regarded as a success, but we should not forget that it would still take a long time before, starting with the distinction of the *Monocotyledones* and the *Dicotyledones* and via the separation of the *Gymnospermae* from the *Angiospermae*, for the seedplants a set of more or less satisfactory classes was evolved; even now the delimitation of the latter is in several instances far from convincing.

I will end this paper with a summary of CESALPINO's classification. I give it in the form of an identification key, for it is in this form, as I have pointed out, that its real significance is to be seen. Part of the terms used by CESALPINO have been replaced by their modern equivalents. The meaning of the term "blossom" has been explained above.

The key is followed by a survey of CESALPINO's groups. The way in which they are arrived at, is indicated by the use of brackets.

Key to CESALPINO's groups

- 1a. Woody plants
- 2a. with one-seeded fruits
- 3a. with superior "blossom"
- 4a. with coriaceous pericarp group 1
- 4b. with osseous endocarp group 2
- 3b. with inferior "blossom" group 3
- 2b. with several-seeded fruits (eventually with pseudocarps containing several seedlike fruits)
- 5a. without "blossom" or with superior "blossom" group 4
- 5b. with inferior "blossom"
- 6a. seeds inserted at the bottom of the fruit cavity group 5
- 6b. seeds inserted on one or more longitudinal placentae
- 7a. one placenta group 6
- 7b. two placentae group 7
- 7c. three placentae group 8
- 7d. four placentae group 9
- 7e. more than four placentae
- 8a. fruit a cone. group 10
- 8b. fruit fleshy group 11
- 1b. herbaceous and suffruticose plants
- 9a. fruit unilocular
- 10a. fruit one-seeded
- 11a. fruit not crowned with a persistent calyx and not enclosed within a perianth or involucre group 12
- 11b. fruit crowned with a persistent calyx group 13
- 11c. fruit enclosed within a perianth or involucre
- 12a. rootlet turned away from the hilum or from the base of the fruit. group 14
- 12b. rootlet turned towards the hilum group 15
- add.: plants with a uninodal flowering shoot ("Junci") group 15a
- 10b. fruit several-seeded
- 13a. fruit a berry group 16
- 13b. fruit a legume group 17
- a. plants with tendrils
- β. plants without tendrils
- 13c. fruit with a central placentae group 18
- 9b. fruit bilocular
- 14a. fruit a double caryopsis group 19
- 14b. fruit cells with a single free seed group 20
- 14c. fruit cells with several seeds
- 15a. dissepiment perpendicular to the plane of symmetry group 21
- 15b. dissepiment in the plane of symmetry group 22
- 9c. fruit trilocular
- 16a. fruit a triple caryopsis group 23
- 16b. fruit cells with a single free seed group 24
- a. plants with latex
- β. plants without latex

- 16c. fruit cells with several seeds
- 17a. subterranean parts not bulbous group 25
- 17b. subterranean parts bulbous group 26
 - a. "blossom" inferior
 - β. "blossom" superior
 - add.: "*Liliaceae*" without bulbs group 26a
 - a. "blossom" inferior
 - β. "blossom" superior
- 9d. fruit quadrilocular or more than 4 fruits inside an involucre or perianth
- 18a. fruit quadrilocular (splitting into 4 nucules)
 - 19a. rootlet pointing to the top of the nucule . . . group 27
 - 19b. rootlet pointing to the base of the nucule. . . group 28
- 18b. more than 4 fruits inside an involucre or perianth
 - 20a. each fruit originally provided with "blossom" group 29
 - a. "blossom" on all fruits ligulate
 - β. "blossom" marcescent
 - γ. "blossom" ligulate on the marginal fruits only
 - 20b. fruits with a common "blossom" (i.e. formed inside a perianth)
 - 21a. fruits with a single seed group 30
 - 21b. fruits with several seeds group 31
- 9e. without fruit and seed group 32
 - a. plants provided with root and shoot
 - β. plants without root and shoot.

CATALOGUE OF CESALPINO'S GROUPS

