REMARKS ON THE SYSTEM OF THE SPERMATOPHYTES

by

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For the group of plants treated in the “Compendium” I have used the name Spermatophyta. WETTSTEIN in his “Handbuch” remarks that this name is incorrect because in botany the word “sperma” is used for spermatozoids, and from the name Spermatophyta it might be concluded that by it “plants with spermatozoids” were meant. WETTSTEIN’s objection is not to be taken seriously however. Nobody will ever think of translating the name Gymnospermae by “plants with naked spermatozoids”! I did not like to use the name Phanerogamae for the group since the corresponding name “Cryptogamae” has lost all meaning. “Anthophyta” cannot be used, because the Pteridospermae have no flowers and it would even be advisable to use the term “Flower” only with regard to Angiospermae.

The classic division into Gymnospermae and Angiospermae has been given up. The Pteridospermae are fundamentally different from the Gymnospermae e.g. by the form of their leaves and by the absence of a strobilus. I consider them equal in rank to the subdivision Gymnospermae. The same may be said of the group which formerly under the name Gnetales or Gnetinae used to be considered as a subdivision of the Gymnospermae, but which, in my opinion, are even farther removed from the Gymnospermae than the Pteridospermae. They have obtained here the rank of a new subdivision under the name Chlamydospermae. I have distinguished therefore four subdivisions of the Spermatophyta namely Pteridospermae, Gymnospermae, Chlamydospermae and Angiospermae.

The division of the Gymnospermae in Classes is similar to that found in most modern handbooks. Some alterations however have been made in the system of the Coniferae. The division into the three families Taxaceae, Pinaceae (or Abietaceae) and Cupressaceae gives a perfectly wrong idea of the
great differences in form which are found within this Class. In conformity with Neger and Pilger I have distinguished seven groups, three of which (the Araucariales, the Podocarpales and the Pinales) are considered as Orders whilst of the remaining four groups two have been classed in the Order Cupressales and two in the Order Taxales. Not without some hesitation however; the distinction of seven orders could, surely, also be defended.

My division into seven groups is not connected with the preconceived opinion that the cone of the Pinaceae is not to be regarded as an inflorescence but as a flower. It seems to me that in this way the problem is not rightly formulated. It is more correct to ask ourselves whether the cone of the Pinaceae (and of the other Coniferae) is a uniaxial or a biaxial strobilus.

In the descriptions of the various groups I have not expressed an opinion in this controversy. When dealing with the Gymnospermae I have avoided the terms “Flower” and “Inflorescence” entirely and instead I have always used the term “strobilus”. In my opinion the most primitive form of this strobilus is to be found in the Araucariales and this order, also on account of other characters, ought to be the starting point in a discussion of the Coniferae. The Taxales, particularly the Taxaceae, have the most reduced strobilus and on that account they have been placed at the end of the Class. In passing I might mention that the macrostrobilus of the Araucariales is in my opinion uniaxial.

The subdivision Chlamydospermae has been divided into two Orders, of which the order of the Gnetales includes the families of the Ephedraceae and Gnetaceae, whilst Welwitschia forms an order of its own.

The division of the Angiospermae into Orders does not deviate considerably from the usual one and on the whole agrees most with the one given by Wettstein, especially as regards the Dicotyledons. The grouping of the orders however differs considerably. The coloured plate shows the principles which have lead to the new arrangement.

That plate needs an explanation.

The usual conception, which for the system of Wettstein for instance has been expressed by Janchen in the form of a phylogenetical tree, is considered by me to be incorrect. The idea of such a tree has been derived from human genealogy. If, starting from a given human couple, the successive generations are connected by lines, we obtain a figure resembling a tree. If we extend that figure for, let us say ten generations, the older
generations will all have died. The branches of the tree are then formed by individuals (families) who are not longer present; the ultimate branchlets of the tree only are still alive.

The resemblance between the phylogenetical tree and the genealogical tree however is very superficial. In biology part of the living (recent) forms are put on the bifurcations of the branches and in this way the biologists make clear (more or less deliberately) that these forms are older than the forms or groups which are found at the end of the branches. In order to give this tree a phylogenetical appearance in agreement with the human genealogical tree, Time has been included in the representation without taking into account, however, that we know nothing of the relative age of the groups. This mistake is perhaps most apparent in the phylogenetical tree of the Angiospermae, because fossil forms (ancestors?) are here practically unknown.

If we imagine to ourselves the system of the Angiospermae as a tree, we can only see the branchlets in leaf — the living forms — but with regard to the true nature of the trunk and the other branches we have no data and cannot reproduce anything. The latter can only be obtained from the study of fossil forms, and of these far too little is known. Therefore, the phylogenetical tree of the Angiospermae is — contrary to a human genealogical one — purely hypothetical, based upon morphological evidence of the living forms only, with neglect of the very important — but alas unknown — extinct groups. So the phylogenetical tree of the Angiospermae is a tree of which we know the foliage only; a tree, on the crown of which we look from above, but whose dense foliage does not allow us to see the structure of its branches. It might as well be a wood or a heap of leaves!

This consideration however puts an end to the idea that a tree could be used as a fit representation of the system of the Angiospermae.

Another representation, to which these objections cannot be made, is the following. One could imagine the Orders of the Angiospermae to be larger or smaller globes, the size depending on the number of families, and these globes we might arrange in space in such a fashion, that those, which resemble each other most, are brought closest together. One might carry this out by attaching a great number of differently sized balloons, filled with gas, to the floor of a room by means of strings. One might be able to reconstruct a representation in space with the lengths and the mutual distances of the strings. This construction of course would express our views concerning
the resemblance and consequently concerning the relationship.

If we have to draw this representation on a plate, on a plane surface, therefore the system of the globes must be projected on this surface. The globes now become discs and we are free to manoeuvre our projection-plane in such a fashion, that the discs cover each other as little as possible or, if it can be managed, not at all. It cannot be helped however, that the clearness of the representation is lost for the greater part on account of the loss of one of the three dimensions. As a compensation for that loss we may join the discs by means of lines.

Now imagine that the coloured plate has been carried out in this way.

The two broken lines running on the left side of the plate towards the broken circle segment, are a deliberate inconsistency in the representation. The broken circle segment, of course, is meant to represent a group of old, unknown Angiosperms, from which the Monocotyledons as well as the Dicotyledons have developed. In doing this we have allowed Time to enter surreptitiously. But the representation itself has not been changed by it. With the broken lines I only wish to express that I consider the Monocotyledons and the Dicotyledons to be parallel series, which already very early have each gone their own way and that I do not attach considerable phylogenetic importance to the resemblance between Helobiae and Ranales. When one should wish to do this, one can leave out the broken lines and the circle segment and draw a line from the disc Helobiae to the disc Ranales.

It goes without saying that the lines, connecting the discs, are not all of equal value. This value might be expressed by the thickness of the lines. Whilst I suppose that most taxonomists will agree with me as regards the connection Ranales-Rosales-Myrtales, some of them may object to the position and the connections of the Tricoccae and many even will think the connections Ranales-Ebenales, Rheadales-Batidales, Tubiflorae-Callitrichales and Tubiflorae-Hippuridales rather doubtful. As regards the latter two orders we have to keep in mind, that their place with the Tricoccae, respectively with the Myrtales, has satisfied nobody and that a number of their characters rather point to a relationship with the Tubiflorae. So we can better accept them as strongly reduced forms at the end of a series than give them a place on which they certainly have no right.

When treating the families in a book another dimension disappears from the representation; the bidimensional picture
has to become linear and with that again part of the clearness is lost.

Wettstein in his "Handbuch" rightly requires from a system "es soll einerseits der wissenschaftlichen Forschung gerecht werden, eine Darstellung der entwickelungsgeschichtlichen Beziehungen der Pflanzen zu einander zu geben, anderseits den praktischen Bedürfnisse nach Uebersicht entsprechen".

It seems to me however that in keeping upright the division of the Dicotyledons in Choripetalae (Archichlamydeae) and Sympetalae (Metachlamydeae), respectively in Monochlamydeae, Dialypetalae and Sympetalae, the mutual phylogenetic relations have been sacrificed to the practical need for clearness. It has now been generally accepted that the Monochlamydeae are no phylogenetic unity and all taxonomists agree on the polyphyletic origin of the Sympetalae. I think the time has come to express that view in the order in which the families are dealt with, and, naturally, I have taken the symbolic representation on the coloured plate as a basis for my sequence. Therefore I have divided the Dicotyledons into eight series, which may be read directly from the plate. I believe not to have taken away anything from the clearness in doing this, whilst the present views of phylogenetic relations are better expressed by it.

Of course the system of the Angiospermae will in future undergo a great many changes. Many families, when they will have been better and more fully studied, will have to be removed from one Order into another. But it does not seem to me that the time for a revolution of the present system has arrived yet. We can only progress by small steps and that is the reason why the arrangement given here is mainly conservative.

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SPERMATOPHYTA

ONDERAFD. I. PTERIDOSPERMAE
1. Fam. Lyginodendraceae
2. Fam. Medullosaceae

ONDERAFD. II. GYMNOSPERMAE
KLASSE CYCADINAE
Fam. Cycadaceae

KLASSE BENNETTITINAE
Fam. Bennettitaceae

KLASSE CORDAITINAE
Fam. Cordaitaceae

KLASSE GINKGOINAE
Fam. Ginkgoaceae

KLASSE CONIFERAE
ORDE ARAUCARIALES
1. Fam. Araucariaceae

ORDE PODOCARPALES
2. Fam. Podocarpaceae

ORDE PINALES
3. Fam. Pinaceae

ORDE CUPRESSALES
4. Fam. Cupressaceae
5. Fam. Taxodiaceae

ORDE TAXALES
6. Fam. Cephalotaxaceae
7. Fam. Taxaceae

ONDERAFD. III. CHLAMYDOSPERMAE
ORDE GNETALES
1. Fam. Ephedraceae
2. Fam. Gnetaceae

ORDE WELWITSCHIALES
3. Fam. Welwitschiaceae
ONDERAFD. IV. ANGIOSPERMAE

KLASSE MONOCOTYLEDONEAE

1. ORDE SPADICIFLORAE
   1. Fam. Araceae
   2. Fam. Palmae
   3. Fam. Cyclanthaceae
   4. Fam. Lemnaceae

2. ORDE PANDANALES
   1. Fam. Typhaceae
   2. Fam. Pandanaceae
   3. Fam. Sparganiaceae

3. ORDE HELOBIAE
   1. Fam. Aponogetonaceae
   2. Fam. Potamogetonaceae
   3. Fam. Najadaceae
   4. Fam. Scheuchzeriaceae
   5. Fam. Alismataceae
   6. Fam. Butomaceae
   7. Fam. Hydrocharitaceae

4. ORDE TRIURIDALES
   1. Fam. Triuridaceae

5. ORDE FARINOSAE
   1. Fam. Flagellariaceae
   2. Fam. Restionaceae
   3. Fam. Centrolepidaceae
   4. Fam. Mayacaceae
   5. Fam. Xyridaceae
   6. Fam. Eriocaulaceae
   7. Fam. Thurniaceae
   8. Fam. Rapateaceae
   9. Fam. Bromeliaceae
  10. Fam. Commelinaceae
  11. Fam. Pontederiaceae
  12. Fam. Cyanastraceae
  13. Fam. Philydraceae

6. ORDE LILIIFLORAE
   1. Fam. Juncaceae
   2. Fam. Stemonaceae
   3. Fam. Liliaceae
   4. Fam. Haemodoraceae
   5. Fam. Amaryllidaceae
   6. Fam. Velloziaceae
   7. Fam. Taccaceae
8. Fam. Dioscoreaceae  
9. Fam. Iridaceae  
10. Fam. Burmanniaceae  
11. Fam. Corsiaceae  

7. ORDE GLUMIFLORAE  
   1. Fam. Gramineae  
   2. Fam. Cyperaceae  

8. ORDE SCITAMINEAE  
   1. Fam. Musaceae  
   2. Fam. Zingiberaceae  
   3. Fam. Cannaceae  
   4. Fam. Marantaceae  

9. ORDE GYNANDRAE  
   1. Fam. Apostasiaceae  
   2. Fam. Orchidaceae  

KLASSE DICOTYLEDONEAE  


10. ORDE CASUARINALES  
    1. Fam. Casuarinaceae  

11. ORDE PIPERALES  
    1. Fam. Saururaceae  
    2. Fam. Piperaceae  
    3. Fam. Chloranthaceae  

12. ORDE SALICALES  
    1. Fam. Salicaceae  

13. ORDE GARRYALES  
    1. Fam. Garryaceae  

14. ORDE LEITNERIALES  
    1. Fam. Leitneriaceae  

15. ORDE JUGLANDALES  
    1. Fam. Juglandaceae  

16. ORDE JULIANIALES  
    1. Fam. Julianiaceae  

17. ORDE MYRICALES  
    1. Fam. Myricaceae  

18. ORDE BALANOPSIDALES  
    1. Fam. Balanopsidaceae
19. ORDE HYDROSTACHYALES
   1. Fam. Hydrostachyaceae

20. ORDE FAGALES
   1. Fam. Betulaceae
   2. Fam. Fagaceae

21. ORDE URTICALES
   1. Fam. Moraceae
   2. Fam. Cannabaceae
   3. Fam. Urticaceae
   4. Fam. Ulmaceae
   5. Fam. Eucommiaceae
   6. Fam. Rholpteleaceae

22. ORDE CENTROSPERMAE
   1. Fam. Chenopodiaceae
   2. Fam. Amaranthaceae
   3. Fam. Nyctaginaceae
   4. Fam. Phytolaccaceae
   5. Fam. Gyrostemaceae
   6. Fam. Achatocarpaceae
   7. Fam. Aizoaceae
   8. Fam. Portulacaceae
   9. Fam. Basellaceae
  10. Fam. Dysphaniaeae
  11. Fam. Caryophyllaceae

23. ORDE POLYGONALES
   1. Fam. Polygonaceae

24. ORDE CACTALES
   1. Fam. Cactaceae

25. ORDE PLUMBAGINALES
   1. Fam. Plumbaginaceae

26. ORDE PRIMULAES
   1. Fam. Theophrastaceae
   2. Fam. Myrsinaceae
   3. Fam. Primulaceae


27. ORDE PROTEALES
   1. Fam. Proteaceae

28. ORDE SANTALALES
   1. Fam. Olacaceae
   2. Fam. Opiliaceae
3. Fam. Oktoknemaceae
4. Fam. Grubbiaceae
5. Fam. Santalaceae
6. Fam. Myzodendraceae
7. Fam. Loranthaceae
8. Fam. Cynomoriaceae

29. ORDE BALANOPHORALES
   1. Fam. Balanophoraceae

Reeks Hamamelidales → Ranales → Ebenales. Orden 30—32.

30. ORDE HAMAMELIDALES
   1. Fam. Hamamelidaceae
   2. Fam. Platanaceae

31. ORDE RANALES
   1. Fam. Cercidiphyllaceae
   2. Fam. Trochodendraceae
   3. Fam. Ranunculaceae
   4. Fam. Lardizabalaceae
   5. Fam. Berberidaceae
   6. Fam. Menispermaceae
   7. Fam. Magnoliaceae
   8. Fam. Himantandraceae
   9. Fam. Calycanthaceae
  10. Fam. Lactoridaceae
  11. Fam. Annonaceae
  12. Fam. Eupomatiaceae
  13. Fam. Myristicaceae
  14. Fam. Gomortegaceae
  15. Fam. Monimiaceae
  16. Fam. Lauraceae
  17. Fam. Hernandiaeae
  18. Fam. Nymphaeaceae
  19. Fam. Ceratophyllaceae

32. ORDE EBENALES
   1. Fam. Sapotaceae
   2. Fam. Sarcospermataceae
   3. Fam. Hoplestigmataceae
   4. Fam. Ebenaceae
   5. Fam. Diclidanthraceae
   6. Fam. Symplocaceae
   7. Fam. Styracaceae
   8. Fam. Lissocarpaceae
Reeks Ranales → Aristolochiales → Rosales → Myrales.
Orden 33—36.

33. ORDE ARISTOLOCHIALES
   1. Fam. Aristolochiaceae
   2. Fam. Rafflesiaceae
   3. Fam. Hydnoraceae

34. ORDE ROSALES
   1. Fam. Crassulaceae
   2. Fam. Cephalotaceae
   3. Fam. Saxifragaceae
   4. Fam. Pittosporaceae
   5. Fam. Byblidaceae
   6. Fam. Brunelliaceae
   7. Fam. Cunoniaceae
   8. Fam. Myrothamnaceae
   9. Fam. Bruniaceae
  10. Fam. Roridulaceae
  11. Fam. Crossosomataceae
  12. Fam. Rosaceae
  13. Fam. Connaraceae
  14. Fam. Mimosaceae
  15. Fam. Papilionaceae

35. ORDE PODOSTEMALES
   1. Fam. Podostemaceae

36. ORDE MYRTALES
   1. Fam. Penaeaceae
   2. Fam. Geissolomataceae
   3. Fam. Oliniaceae
   4. Fam. Thymelaeaceae
   5. Fam. Elaeagnaceae
   6. Fam. Lythraceae
   7. Fam. Heteropyxidaceae
   8. Fam. Sonneratiaceae
   9. Fam. Crypteroniaceae
  10. Fam. Rhizophoraceae
  11. Fam. Alangiaceae
  12. Fam. Nyssaceae
  13. Fam. Lecythidaceae
  14. Fam. Combretaceae
  15. Fam. Myrtaceae
  16. Fam. Punicaceae
  17. Fam. Melastomataceae
  18. Fam. Oenotheraceae
  19. Fam. Trapaceae
20. Fam. Haloragaceae
21. Fam. Gunneraceae
22. Fam. Thelygonaceae

Reeks Rhoeadales → Parietales → Guttiferales → Ericales →
Capannulatae. Orden 37—45.

37. ORDE RHOEADALES
   1. Fam. Papaveraceae
   2. Fam. Capparidaceae
   3. Fam. Cruciferae
   4. Fam. Tovariaceae
   5. Fam. Resedaceae
   6. Fam. Moringaceae
   7. Fam. Bretschneideraceae

38. ORDE BATIDALES
   1. Fam. Batidaceae

39. ORDE SARRACENIALES
   1. Fam. Sarraceniaceae
   2. Fam. Nepenthaceae
   3. Fam. Droseraceae

40. ORDE PARIETALES
   1. Fam. Cistaceae
   2. Fam. Bixaceae
   3. Fam. Cochlospermaceae
   4. Fam. Tamaricaceae
   5. Fam. Fouquieraceae
   6. Fam. Frankeniaceae
   7. Fam. Elatinaceae
   8. Fam. Violaceae
   9. Fam. Canellaceae
  10. Fam. Flacourtiaceae
  11. Fam. Lacistemaceae
  12. Fam. Stachyuraceae
  13. Fam. Turneraceae
  14. Fam. Malesherbiaceae
  15. Fam. Passifloraceae
  16. Fam. Achariaceae
  17. Fam. Caricaceae
  18. Fam. Loasaceae
  19. Fam. Begoniaceae
  20. Fam. Datiscaceae
  21. Fam. Ancistrocladaceae

41. ORDE CUCURBITALES
   1. Fam. Cucurbitaceae
42. ORDE GUTTIFERALES
1. Fam. Dilleniaceae
2. Fam. Actinidiaceae
3. Fam. Ochnaceae
4. Fam. Strasburgeriaceae
5. Fam. Medusagynaceae
6. Fam. Eucryphiaceae
7. Fam. Caryocaraceae
8. Fam. Marcgraviaceae
9. Fam. Quinaceae
10. Fam. Theaceae
11. Fam. Guttiferae
12. Fam. Dipterocarpaceae

43. ORDE DIAPENSIALES
1. Fam. Diapensiaceae

44. ORDE ERICALES
1. Fam. Clethraceae
2. Fam. Pirolaceae
3. Fam. Ericaceae
4. Fam. Epacridaceae
5. Fam. Empetraceae

45. ORDE CAMPANULATAE
1. Fam. Campanulaceae
2. Fam. Goodeniaceae
3. Fam. Brunoniaceae
4. Fam. Stylidiaceae
5. Fam. Calyceraceae
6. Fam. Compositae


46. ORDE PANDALES
1. Fam. Pandaceae

47. ORDE MALVALES
1. Fam. Elaeocarpaceae
2. Fam. Chlaenaceae
3. Fam. Tiliaceae
4. Fam. Malvaceae
5. Fam. Bombacaceae
6. Fam. Sterculiaceae
7. Fam. Scytopetalaceae
8. Fam. Gonystylaceae

48. ORDE TRICOCCAE
1. Fam. Dichapetalaceae
2. Fam. Euphorbiaceae  
3. Fam. Buxaceae  
4. Fam. Daphniphyllaceae  

### 49. ORDE GERANIALES
1. Fam. Linaceae  
2. Fam. Humiriaceae  
3. Fam. Oxalidaceae  
4. Fam. Geraniaceae  
5. Fam. Limnanthaceae  
6. Fam. Tropaeolaceae  
7. Fam. Erythroxylaceae  
8. Fam. Malpighiaceae  
9. Fam. Zygophyllaceae  
10. Fam. Cneoraceae  

### 50. ORDE TEREBINTHALES
1. Fam. Rutaceae  
2. Fam. Simaroubaceae  
3. Fam. Burseraceae  
4. Fam. Meliaceae  
5. Fam. Tremandraceae  
6. Fam. Polygalaceae  
7. Fam. Trigoniaceae  
8. Fam. Vochysiaceae  
9. Fam. Anacardiaceae  
10. Fam. Sapindaceae  
11. Fam. Akaniaceae  
12. Fam. Aextoxicaceae  
13. Fam. Aceraceae  
14. Fam. Hippocastanaceae  
15. Fam. Coriariaceae  
16. Fam. Sabiaceae  
17. Fam. Melianthaceae  
18. Fam. Balsaminaceae  
19. Fam. Didieraceae  

### 51. ORDE RHAMNALES
1. Fam. Rhamnaceae  
2. Fam. Vitaceae

*Reeks Terebinthales → Celastrales → Umbelliflorae → Rubiales. Orden 52—54.*

### 52. ORDE CELASTRALES
1. Fam. Cyrillaceae  
2. Fam. Pentaphylacaceae  
3. Fam. Corynocarpaceae  
4. Fam. Aquifoliaceae
5. Fam. Celastraceae
6. Fam. Salvadoraceae
7. Fam. Staphyleaceae
8. Fam. Hippocrateaceae
9. Fam. Stackhousiaceae
10. Fam. Icacinaceae

53. ORDE UMBELLIFLORAE
1. Fam. Arallaceae
2. Fam. Cornaceae
3. Fam. Umbelliferae

54. ORDE RUBIALES
1. Fam. Caprifoliaceae
2. Fam. Rubiaceae
3. Fam. Adoxaceae
4. Fam. Valerianaceae
5. Fam. Dipsacaceae

55. ORDE LIGUSTRALES
1. Fam. Oleaceae

56. ORDE CONTORTAE
1. Fam. Desfontaineaceae
2. Fam. Loganiaceae
3. Fam. Buddleiaceae
4. Fam. Gentianaceae
5. Fam. Menyanthaceae
6. Fam. Apocynaceae
7. Fam. Asclepiadaceae

57. ORDE TUBIFLORAE
1. Fam. Convolvulaceae
2. Fam. Cuscutaceae
3. Fam. Polemoniaceae
4. Fam. Hydrophyllaceae
5. Fam. Lennoaceae
6. Fam. Boraginaceae
7. Fam. Nolanaceae
8. Fam. Solanaceae
9. Fam. Scrophulariaceae
10. Fam. Lentibulariaceae
11. Fam. Orobanchaceae
12. Fam. Gesneriaceae
13. Fam. Bignoniaceae
14. Fam. Pedaliaceae

Reeks Terebinthales → Ligustrales → Contortae → Tubiflora
→ Plantaginales. Orden 55—60.
Systeem der Angiospermae

15. Fam. Martyniaceae
16. Fam. Acanthaceae
17. Fam. Verbenaceae
18. Fam. Avicenniaceae
19. Fam. Labiatae
20. Fam. Globulariaceae
21. Fam. Phrymaceae
22. Fam. Myoporaceae
23. Fam. Columelliaceae

58. ORDE PLANTAGINALES
   1. Fam. Plantaginaceae

59. ORDE CALLITRICHALES
   1. Fam. Callitrichaceae

60. ORDE HIPPURIDALES
   1. Fam. Hippuridaceae