Chemotaxonomy of Flowering Plants

Volume III

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CHEMOTAXONOMY OF FLOWERING PLANTS

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ORDERS

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Ebenales: G. Bentham and J. D. Hooker, *Gen. pl.* 1862–83, v. II, p. vi. 1876.

B. and H. had **Eb.**, with *Sapot.*, *Eben.* and *Styrac.* (incl. *Symplocos*), in '*Heteromerae*' of '*Gamopetalae*'. Many authors have recognized an order **Eb.**, among them Wernham (1911, from **Parietales**?), Bessey (1915, from **Caryophyllales**), Rendle (1938), Gates (1940), Barkley (1940), Gundersen (1950, in '*Thea group*'), Pulle (1952, from **Clusiales**), Soó (1953), Boivin (1956, from **Annonales**), Benson (1957, from **Guttiferales** or **Violales**), Créte (1959, ditto), Emberger (in C. & E. 1960), Wagenitz (in *Syll.* 12, 1964, from **Guttiferales**), Thorne (1968, in '*Theiflorae*'), Cronquist (1968, in '*Dilleniidae*'), Hutchinson (1969) and Takhtajan (1969, in '*Ericanae*', from **Theales**).

If we add to these the authors of the **Diospyrales** and **Diospyrinae**, we come to a surprisingly close agreement as to families to be included: *Eben.* 21, *Sapot.* 21, *Styrac.* 17, *Symploc.* 16, *Lissocarp.* 10, *Hoplestigmat.* 8, *Sarcosperm.* 6, *Diclidanther.* 3, *Fouquieri.* 2.

The first 7 of these constitute the **Ebenales** of Wagenitz (in *Syll.* 12, 1964). Our task, then, is first of all to consider the chemistry of these 7 families, and we shall do this in the order in which Wagenitz places them. We include *Diclidanthera* in *Polygalaceae* (q.v.) and *Fouquieriaceae* in **Tubiflorae** (q.v.).

1. Chemistry of the Sapotaceae

This moderate-sized family (50/800) has been fairly well investigated. We have:

Carbohydrates

Sedoheptulose. Absent from *Bumelia lycioides* (Brown).

Lactose. Present in small amount in fruits of 3/3.

Maltose. Present in *Madhuca latifolia* (petals).

Raphides absent from all?

Aluminium not accumulated by 6/9 (Webb, MSS).

Alkaloids. Pyrrolizidine group in 2/3.

Hot-Water Test. I have: I—; II 1/1; III 2/2; IV 4/5.

Cyanogenic glycosides. Others have reported HCN from: *Calocarpum mammosum*; *Lucuma bonplandia, deliciosa, multiflora* (sds), *pomifera*; *Madhuca mottleyana*; *perhaps* from *Ganua mottleyana* and *Payena latifolia*; and *not* from *Sideroxylon myrsinoides.*

Using *HCN* (*Test A*) I have got *positive* results from: *Lucuma nervosa* and *Pouteria campechiana*; and *negative* results from: *Achras sapota, Mimusops elengi, Pouteria suavis*, and *Sideroxylon novo-zelandicum.*

Mucilage has not been reported? I have found none.

Cyclitols
d-Quercitol present in *Achras sapota*; *Butyrospermum parkii*; *Mimusops caffra, elengi* (all Plouvier).

Saponins (mostly yielding *bassic acid*) have been reported to be *present* in 7/10.

Using *Sap. Test A* on leaf-material I got *negative* results from *Achras sapota* and *Lucuma nervosa*; and *doubtful* results from *Mimusops elengi* and *Pouteria suavis*.

Tannins have been reported as *present* in *Achras, Argania, Chrysophyllum, Imbricaria, Mimusops* and *Pouteria*.

Using *Tannin Test A* on leaves I have: +++*Achras sapota, Lucuma nervosa* and *Mimusops elengi* (which all gave 4 reactions with '*Sap. Test B* (NH_3)').

HCl/Methanol Test. I have: 4, *Chrysophyllum oliviforme, Planchonella australe* (Isenberg and Buchanan reported a similar result for *Achras sapota*). 2–3, *Bumelia rotundifolia, Mimusops elengi, Sideroxylon novo-zelandicum*. 2, *Lucuma nervosa, Pouteria campechiana*. .

Leucoanthocyanins. Others have reported *positive* results for *Achras sapota, Argania sideroxylon, Mimusops elengi* and *Pouteria suavis* (weak). Using *L.A.* (*Test A*) on leaf-material I have *positive* results from *Chrysophyllum oliviforme, Lucuma nervosa* and *Mimusops elengi*.

Syringin Test. Using stem-material I have *negative* results for: *Chrysophyllum oliviforme, Lucuma nervosa* and *Mimusops elengi*. All developed red in xylem (in line with above). No raphides were seen in control sections.

Ehrlich Tests. Using leaf-material I recorded *negative* results for: *Lucuma nervosa, Mimusops elengi, Pouteri campechiana* and *Sideroxylon novo-zelandicum*. The Ehrlich spot was magenta in the first three.

Juglone Tests. I got only *negative* results with bark-material of: *Bumelia rotundifolia, Chrysophyllum oliviforme, Lucuma nervosa, Mimusops elengi* and *Pouteria campechiana*. Only very weak fluorescence was observed.

Seed-fats. See table 19.

Phenolic Acids, etc. See table 18.

Latex with Chicle, gutta, etc. is *present*.

Methyl salicylate is reported from *Sideroxylon* (1).

Coumarins are reported from 1/1.

Mangiferin occurs in 1/1.

2. Chemistry of the Sarcospermataceae

We know almost nothing of this tiny (1/8) family.

Raphides are *absent*?

Latex is *present*.

3. Chemistry of the Ebenaceae

We know a fair amount about the chemistry of this smallish family (4/450).

Carbohydrates

Sedoheptulose is *absent* from *Diospyros virginiana* (Brown).

Raphides are *absent* from all?

Aluminium. No accumulators? (Webb 0/8; Chenery 0/2; Y. and J. 0/1).

Alkaloids. None recorded?

Cigarette Test. Gibbs: I —; II 1/1; III —; IV —.

Hot-Water Test. Gibbs: I 2/2; II 3/4; III 1/1; IV 1/1.

Cyanogenic glycosides. Others have recorded HCN from *Diospyros aherni, discolor,* and *multiflora*; but *not* from *Maba humilis.*

Using *HCN (Test A)* I have a *doubtfully positive* result from: *Diospyros cargillia*; and *negative* results from: *Diospyros lotus*; *Euclea fructuosa, pseudebenus*; *Royena cordata, pallens, villosa.*

Mucilage has not been reported? I saw none.

Cyclitols

Shikimic acid is *absent* from *Diospyros* (1).

Saponins are said to be *present* in *Diospyros* (4), and *Maba* (1).

Using *Saponin Test A* on leaf-material I got a *doubtful* result from *Diospyros lotus.*

Tannins have been reported from *Diospyros* (at least .

Using *Tannin Test A* on leaves I have: + + + *Euclea pseudebenus*, + + *Diospyros lotus.* In line with this I recorded '*Sap. Test B* (NH_3)' as 3 for *D. lotus.*

HCl/Methanol Test. I have: 0, *Diospyros lotus, Royena cordata*; 0–1, *Royena lucida, Diospyros virginiana*; 1, *Diospyros cargillia, Euclea pseudebenus*; 2, *D. kaki, pentamera*; *Royena villosa*; 2–3, *D. discolor*; 3, *Euclea fructuosa, Royena* (*pallens*?).

Leucoanthocyanins. Others have recorded *positive* tests from: *Diospyros lotus, kaki.*

Using *L.A.* (*Test A*) on leaf-material I have *positive* results from: *Diospyros kaki*; *Royena cordata* (weak), *pallens.*

Syringin Test. Using stem-material I have *negative* results for: *Diospyros cargillia, discolor*; *Euclea fructuosa, pseudebenus*; *Royena cordata, lucida, pallens, villosa.* Some red colour was observed in the xylems of most of these. *No* raphides were seen.

Ehrlich Tests. Using leaf-material I got *negative* results from: *Diospyros cargillia* and *Royena lucida* (magenta).

Juglone Tests. Positive tests were recorded for: *Diospyros cargillia* (lvs, bk), *lotus* (lvs, bk), *pentamera* (bk); *Euclea pseudebenus* (lvs, bk);

Royena cordata (bk), *lucida* (lvs, bk), *pallens*? (lvs, bk). I got a *negative* test with *D. discolor*. See table 20.

Naphthalene derivatives, including naphthaquinones are common (see table 20).

Phenolic acids, etc. See table 18.

Methyl salicylate is recorded for *Diospyros* (4) and *Maba* (1 or 2).

Coumarins. Diospyros maritima (bk)?

4. Chemistry of the Styracaceae

This smallish family (11/150) has been little studied. We have:

Carbohydrates

Styracitol (1,5-*anhydro*-D-*mannitol*) is recorded from *Styrax obassia* (frt).

Raphides are *absent* from all?

Aluminium is *not* accumulated? (Chenery 0/6; Y. and J. 0/1).

Hot-Water Test. I got a I reaction with *Halesia carolina.*

Cyanogenesis. Others have reported *absence* of HCN from *Halesia carolina.* Using *HCN (Test A)* I got a *negative* result for *H. carolina* (shoot).

Cyclitols

Shikimic acid is *absent* from *Halesia* (1).

Saponins. Using *Saponin Test A* on leaf-material I got a *positive* result from *H. carolina.*

Tannins. Others report *presence* in *H. diptera.* Using *Tannin Test A* on leaves I recorded ++ for *H. carolina* (and 4 with '*Saponin Test B* (NH_3)').

HCl/Methanol Test. Isenberg and Buchanan reported 4 for *H. carolina.* I have: 2, *H. carolina, monticola.*

Leucoanthocyanins. Others have reported as *negative* tests on *H. diptera.* Using *L.A. (Test A)* on leaf-material I got a *positive* result for *H. carolina.*

Syringin Test. Using stem-material I got a *negative* test on *H. carolina.* Some red developed in the xylem. No raphides were seen in control sections.

Ehrlich Test. Using leaf-material I recorded as *negative* a test on *H. carolina* (dp magenta).

Juglone Tests. I recorded as *negative* a test on *H. carolina* (bk). Pale blue fluorescence was noted in the NH_3 layer under UVL.

Other. Gum benzoin in *Styrax* spp.

Benzofurans. Egonol and its glycosides in *Styrax* spp.

5. Chemistry of the Lissocarpaceae

We know nothing of this little family (1/2).

6. Chemistry of the Symplocaceae

This family is considered to consist of *Symplocos* (300–400) only by Wagenitz. Some taxonomists segregate a few small genera—Airy Shaw has *Cordyloblaste* (7). We know relatively little of the family.

Raphides. Absent from all?

Aluminium. This family is the most remarkable *accumulator* of Al. *Cordyloblaste* has perhaps 6 accumulators, *Symplocos* at least 20. Probably all are accumulators.

Alkaloids. Carboline group of *indole* alkaloids.

Hot-Water Test. Gibbs: I —; II 1/1; III —; IV 1/1 (and an oxalis-reaction).

Cyanogenic glycosides. Using *HCN* (*Test A*) I got a *negative* result with an unidentified species of *Symplocos*.

Cyclitols

Shikimic acid is said to be *absent* from *Bobua* (*Symplocos*) *myrtacea*.

Saponins are said to be *present* in *Symplocos spicata*.

HCl/Methanol Test. 1 ?, *Symplocos paniculata*; 2, *S. spicata*; 3, *S.* sp.

Syringin Test. Using stem-material I recorded as *negative*: *S. paniculata* (no red in xylem), *S.* sp. (some red). No raphides were seen in control sections.

Ehrlich Test. Using leaf-material I recorded as *negative* tests on: *S.* sp. and *S. spicata*. Both gave magenta Ehrlich spots, in line with positive *HCl/Methanol* tests above.

Juglone Tests. I recorded as *negative* tests on: *S.* sp. (lvs, bk), and *S. spicata*? (lvs). Little fluorescence was seen.

Seed-fats. See table 19.

Phenolic Acids, etc. See table 18.

Methyl salicylate is reported from *Symplocos* (1 or 2).

Lignans. A *lignan glycoside* occurs in *Symplocos* (1).

7. Chemistry of the Hoplestigmataceae

We know almost nothing of this tiny family (1/2).

Raphides are *absent*?

Aluminium is *not* accumulated? (Chenery 0/2).

Discussion

We have attempted to summarize what chemical information we have in tables 18 to 20. We know almost nothing of the *Sarcospermataceae*,

TABLE 18. *Chemistry of the Ebenales*

			Sapot.	*Sarco.*	*Eben.*	*Styrac.*	*Lisso.*	*Symploc.*	*Hopl.*
Carbohydrates									
Sedoheptulose			−1/1	.	−1/1	.	.	.	.
Lactose			+3/3	.	.	.	.	.	.
Raphides			Absent	Absent?	Absent	Absent	Absent?	Absent	Absent?
Al accumulation			None?	.	None?	None?	.	In all?	None?
Alkaloids									
Pyrrolizidine			In 2/3	.	Absent?	.	.	.	.
Carboline			.	.	.	.	.	Present	.
Hot-Water Test	Gibbs		(II)–IV	.	(I)–II–(IV)	I	.	II–IV	.
Cyanogenesis	Others		+3/6 ?2/2	.	+1/3 −1/1	−1/1	.	.	.
	Gibbs		+2/2 −4/4	.	?1/1 −3/6	−1/1	.	−1/1	.
Mucilage			Absent?	.	Absent?	.	.	.	.
Cyclitols									
d-Quercitol			+3/3	.	.	.	.	.	.
Shikimic acid			.	.	−1/1	−1/1	.	−1/1	.
Saponins	Others		Present	.	Present	.	.	Present	.
	Gibbs		?2/2 −2/2	.	?1/1	+1/1	.	.	.
Tannins	Others		Present	.	Present	Present	.	.	.
	Gibbs	+++	3/3	.	1/1	.	.	.	.
		++	.	.	1/1	1/1 .	.	.	.
'Sap. Test B (NH_3)'			4 (in 1/1)	.	3 (in 1/1)	4 (in 1/1)	.	.	.

HCl-Methanol Test		4–2	.	3–0	2	.	3–1	.
Leucoanthocyanins	Others	+4/4	.	+1/2	−1/1	.	.	.
	Gibbs	+3/3	.	+2/3	+1/1	.	.	.
Syringin Test		−3/3	.	−3/8	−1/1	.	−1/2	.
Ehrlich Test		−4/4	.	−2/2	−1/1	.	−1/2	.
Juglone Test		−5/5	.	+3/8	−1/1	.	−1/2	.
Naphthoquinones, etc.		.	.	Present	.	.	.	.
Latex		+	+	.	.	.	.	.
Methyl salicylate		+1/1	.	+2/5	.	.	+1/1	.
Phenolic acids, etc.								
Myricetin		+ to (−)	.	++ to (−)	−	.	−	.
Delphinidin		++ to (−)	.	+ to (−)	−	.	++	.
Ellagic acid		−	.	− to (+)	−	.	−	.
Quercetin		− to (+)	.	+ to (−)	++	.	+	.
Cyanidin		− to (+)	.	+ to (−)	− to Tr	.	+	.
Kaempferol		+ to (−)	.	+	+	.	−	.
Caffeic acid		− to (Tr)	.	−	+	.	Tr	.
p-Coumaric acid		−	.	+ to −	+	.	−	.
Sinapic acid		−	.	−	− to Tr	.	−	.
Ferulic acid		−	.	−	+ to Tr	.	−	.
Gentisic acid		+	.	+	+	.	.	.
p-OH-Benzoic acid		.	.	+	+	.	.	.

TABLE 19. *Fatty-acids of the seed-fats of the Ebenales (various authors)*

	Saturated					
	Lauric	Myristic	Palmitic	Stearic	Oleic	Linoleic
Sapotaceae (50/800)						
Achras sapota	2	6	13	12	**66**	1
Autranella congolensis	←———	22	———	→	**78**	.
Butyrospermum parkii		<1	7	39	**49**	4
Calocarpum mammosum	←———	37	———	→	**46**	19
Dumoria africana	.	.	.	46	**54**	.
Ganua mottleyana	.	.	10	18	**69**	2
Madhuca butyracea	.	.	**55**	4	41	4
M. latifolia	.	4	22	15	**46**	4
M. longifolia	.	.	28	14	**49**	9
Mimusops djave	.	.	4	35	58	1
M. elengi	.	.	11	10	**64**	14
M. heckelii	.	.	4	35	58	.
M. hexandra	.	.	19	14	**63**	3
Omphalocarpum boyankombo	←———	21	———	→	**79**	.
Palaquium formosanum	.	.	.	**60**	40	.
P. oblongifolium	.	.	6	**55**	38	.
Payena lancifolia	.	.	.	**58**	42	.
Sideroxylon cinereum	←———	14	———	→	**62**	24
S. ferrugineum	.	.	27	'Some'	**56**	15
S. tomentosum	.	.	11	18	**58**	13
Sarcospermataceae (1/8)	.	.	.	.	.	.
Ebenaceae (4/450)	.	.	.	.	.	.
Styracaceae (11/150)	.	.	.	.	.	.
Lissocarpaceae (1/2)	.	.	.	.	.	.
Symplocaceae (1/300–400) *Symplocos crataegoides*	.	.	11	'Little'	**55**	18
Hoplestigmataceae (1/2)	.	.	.	.	.	.

Lissocarpaceae and *Hoplestigmataceae*; not a great deal of the *Styracaceae* and *Symplocaceae*; more, but still not much, of the *Sapotaceae* and *Ebenaceae*!

What information we have would seem to be in line with the placing of these families in a single order.

If we try then to characterize each family we can do but little:

1. Do the *Sapotaceae* differ from the other families in having small amounts of *lactose*, in having *pyrrolizidine alkaloids* and *d-quercitol*?

2. Are the *Ebenaceae* unique in the order in giving a *positive juglone test* and in having *naphthaquinones* and other *naphthalene derivatives*?

3. Is *egonol* confined to the *Styracaceae*?

4. Is the *aluminium accumulation* and the production of *carboline alkaloids* peculiar to the *Symplocaceae* within the order?

Echiales: J. Lindley, *Nixus pl.* 1833.

L. had **E.**, with *Boragineae, Ehreti.* (incl. *Heliotropiceae*), *Cordi.* and *Hydrophylleae*—our *Boragin.* plus *Hydrophyll.*—as nixus 4 of '*Dicarpae*' of '*Monopetalae*'. In 1853 he had a more extended, and rather mixed, order which he described as intermediate between **Solanales** and **Bignoniales.**

See **Tubiflorae**

Echinocalyces: C(K). F. P. von Martius, *Consp. reg. veg.* 1835.

M. had **E.** with *Atherospermeae* and *Monimieae*—our *Monimiaceae* (q.v.).

Elaeagnales: Sir E. Ff. Bromhead, *Edinb. New Phil. J* 25: 127, 134. 1838.

Br. had **E.** with *Daphn., Penae., Prote., Elaeagn., Nysseae, Santal., Anthoboleae* and *Olac.*—families of our **Thymelaeales, Proteales** and **Santalales.** Barkley (1948) included only *Elaeagn.* and *Heteropyxid.*; while Benson (1957), Crété (1959) and Takhtajan (1969) all have **E.** with *Elaeagn.* only.

See **Thymelaeales**

Elytranthales: Ph. van Tieghem, *Ann. des Sci. nat.*, sér. 9, Bot. 6:134. 1907.

V.T. had **E.** in '*Loranthinae*'. In 1918 v.T. & Constantin also had **E.** with *Dendrophthoaceae* and *Elytranthaceae.*

See *Loranthaceae*

Empetrales: ?T. Nakai in *Hisi-Syokubutu*, 1930, p. 56.

I have not seen Nakai's treatment of this little order. Benson (1957) has **E.** with *Empetraceae* and obviously thinks it to be 'new'. He places it doubtfully between **Rhamnales** and **Callitrichales.**

See **Ericales**

Ephedrarieae: B. C. Dumortier, *Anal.* 1829, p. 11.

D. had **E.**, with *Casuarineae* and *Ephedraceae*, in his '*Julosepalae*'.

See **Casuarinales**

TABLE 20. *Juglone Tests on and Naphthaquinones, etc. of the Ebenales*

		Naphthaquinones								Other naphthalene derivatives							
	Juglone test	7-Methyl-juglone	Isodiospyrin	Lapachol	Plumbagin	5-OH-7-OMe-β-hydro-n.	Diospyrin	Diolmelquinone-A	Diosquinone	4,5,6-TriMeO-2-Me.n.	4,5-DiMeO-6-OH-2-Me.n.	4,5-DiOH-2-Me.n.	Diospyrol	4,5,6-TriMeO-2-naphthaldehyde	4,5,6-DiMeO-6-OH-2-naphthaldehyde	Unidentified	Unidentified
Sapotaceae																	
Bumelia rotundifolia	—	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chrysophyllum oliviforme	—	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lucuma nervosa	—	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pouteria campechiana	—	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Mimusops elengi	—	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Madhuca latifolia	—	.	.	+?	.	.	.	.	.	.	.	.	.	.	.	.	.
Sarcospermataceae	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Ebenaceae																		
Royena cordata	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
R. lucida	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
R. pallens (?)	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Euclea pseudebenus	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Diospyros cargillia	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
D. celebica	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.
D. chloroxylon	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
D. discolor	−	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
D. ebenum	.	+	.	.	+	+	.	.	.	.	.	.	.	.	+	+	.	.
D. lotus	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
D. maritima	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
D. melanoxylon	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
D. mespiliformis	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
D. mollis	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.
D. montana	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
D. pentamera	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
D. tricolor	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
D. virginiana	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
D. xanthochlamys	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Styracaceae																		
Halesia carolina	−	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lissocarpaceae	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Symplocaceae																		
Symplocos sp.	−	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
S. spicata	−	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hoplestigmataceae	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Epianthae: Fr. Klotzsch and A. Garcke, *bot. Erg. Wald.* 1862, p. 17.

Kl. and G. had **E.**, with *Diplarchi.*, *Diapensi.*, *Epacrid.*, *Sapot.*, *Styr.* (*sic*) and *Eben.*, as Kl. 10 of '*Gamopetala*'. We should put these families in **Diapensi.**, **Eric.** and **Eben.** (qq.v.).

Epichlamydeae: C. A. Agardh, *Classes pl.* 1825.

A. had **E.** with *Ulmaceae*, *Laurinae*, *Santalaceae*, *Elaeagneae*, *Thymeleae* and *Proteaceae*.

See **Thymelaeales**

Epigynae diplocarpae, etc.: C(K). F. P. von Martius, *Consp. reg. veg.* 1835.

Columelliaceae only.

Epigynae di-polyplocarpae: C(K). F. P. von Martius, *Consp. reg. veg.* 1835.

M. had *Sphenocle.*, *Campanul.*, *Lobeli.*, *Goodenovieae*, *Stylidieae* and *Scaevoleae*—essentially our **Campanulales** (q.v.).

Epigynae haplocarpae: C(K). F. P. von Martius, *Consp. reg. veg.* 1835.

M. included *Compositae*, *Calycereae* and *Dipsaceae*—an early association of these families.

Epigynae mono-oligospermae, etc.: C(K). F. P. von Martius, *Consp. reg. veg.* 1835.

M. included *Corneae*, *Hamamelideae*, *Alangieae*, *Bruniaceae* and *Rhizophoreae*—a mixed bag!

Epigynae oligocarpae juliflorae: C(K). F. P. von Martius, *Consp. reg. veg.* 1835.

M. included *Garryaceae*, *Betulineae*, *Cupuliferae* (*Corylaceae*) and *Balsamifluae*—mostly 'amentiferous' plants.

Epigynae pleiocarpae polyandrae: C(K). F. P. von Martius, *Consp. reg. veg.* 1835.

M. had **E.p.p.** with *Datisceae* only.

See *Datiscaceae*

Epigynae pleurotrophospermae: C(K). F. P. von Martius, *Consp. reg. veg.* 1835.

M. had *Homalineae*, *Belvisieae*, *Loaseae* and *Nopaleae* (*Cacteae*) in this mixed bag.

Epigynae polyplocarpae kionandrae: C(K). F. P. von Martius, *Consp. reg. veg.* 1835.

M. had *Aristolochieae* and *Rafflesiaceae* in his order—an early association of these families.

See **Aristolochiales**

Epigynae triplo (-pentaplo-) carpae etc.: C(K). F. P. von Martius, *Consp. reg. veg.* 1835.

M. associated *Valerianae*, *Sambucineae* and *Caprifoliaceae* here.

Equisetiformes: P. Horaninow, *Tetractys*, 1843.

H. had **E.**, with *Casuarinaceae* only, in '*Strobilanthae*', the other orders of which were gymnosperms!

See **Casuarinales**

Eremocarpae: C(K). F. P. von Martius, *Consp. reg. veg.* 1835.

M. had **E.**, with *Labiatae*, *Asperifoliae* and *Nolanaceae*, in '*Sympetalanthae*'.

See **Tubiflorae**

Ericales: J. Lindley, *Nixus pl.* 1833.

L. had **E.** as nixus 2 of '*Polycarpae*' of '*Monopetalae*'. He included *Pyrol.*, *Ericeae*, *Vaccinieae* and *Epacrideae*. Most taxonomists have an order **Ericales**, and there is reasonably good agreement, particularly in recent years, as to the major families involved. We may note: Bromhead (1838), B. and H. (1876), Wernham (1911, from **Geraniales**), Bessey (1915, from **Caryophyllales**), v.T. and C. (1918), Record (1932, related to *Theaceae*), Rendle (1938), Barkley (1948), Smith-White (1948), Gundersen (1950, in '*Thea group*'), Soó (1953), Boivin (1956, from **Theales**), Benson (1957), Crété (1959), Schultze-Motel (in *Syll.* 12, 1964, from **Guttiferales** or **Celastrales**), Thorne (1968, in '*Theiflorae*'), Cronquist (1968, in '*Dilleniidae*'), Hutchinson (1969, from **Theales**), Takhtajan (1969, in '*Ericanae*').

Others have equivalent orders—**Ericarieae**, **Ericiflorae**, **Ericinae**, **Ericoideae**, **Bicornes** and **Biforae** (qq.v.).

The frequency of occurrence of each family is: *Eric.* 34, *Epacrid.* 29, *Pyrol.* 22, *Clethr.* 18, *Diapensi.* 18, *Empetr.* 12, *Monotrop.* 8–9, *Lenno.* 8, *Vaccini.* 8, *Cyrill.* 5, several others once or twice.

Schultze-Motel (in *Syll.* 12, 1964) has *Clethr.*, *Pyrol.* (incl. *Monotrop.*), *Eric.* (incl. *Vaccini.*), *Empetr.* and *Epacrid.* in his order. He puts *Diapensiaceae* in an order **Diapensiales** (q.v.), *Lennoaceae* in **Tubiflorae** (q.v.), and *Cyrillaceae* in **Celastrales** (q.v.).

We shall deal first with the chemistry of the families of Schultze-Motel's order.

1. Chemistry of the Clethraceae

We know rather little of the chemistry of this small (1–2/30–120) family.

Raphides are *absent*.

Aluminium. I have no information, but *Clethra* does accumulate *cobalt*.

Hot-Water Test. Gibbs: I 1/1; II 1/3; III —; IV —.

Tannins. Using *Tannin Test A* on leaves I got: + +*Clethra acuminata* (control *orange*!), *alnifolia* (control *bright brown*), *fargesii* (control *slightly brown*); +*C. arborea*. Others have recorded *tannins* in some species of *Clethra*.

Phenolic Acids, etc. See table 21.

Juglone Test. I have recorded as *negative* a test on *C. alnifolia* (bk).

Cyanogenic glycosides. Others have reported HCN from two spp. of *Clethra* (sd), but *not* from a third sp.

Using *HCN* (*Test A*) I got only *negative* tests with shoots of *C. acuminata*, *arborea* and *fargesii*.

Mucilage. I observed none in carrying out *HCN* (*Test A*) (above).

Syringin Test. Using stem-material I got *negative* tests with: *C. acuminata*, *alnifolia*, *arborea* and *tomentosa*. Some red colour developed in the xylem in every case—in line with *HCl/Methanol* (3–4) and *L.A.* (*Test A*) results (below). No raphides were observed in the control sections.

HCl/Methanol Test. I got: 4, *C. acuminata*, *alnifolia*, *barbinervis*, *tomentosa*; 3, *C. arborea*.

Leucoanthocyanins. Using *L.A.* (*Test A*) on leaf-material I got only *positive* results from: *C. alnifolia*, *arborea*, *barbinervis* and *tomentosa*.

Cyclitols

Shikimic acid is recorded as *absent* from *Clethra* (1).

2. Chemistry of the Pyrolaceae

We have only a modest amount of information on this smallish (16/75) family.

Carbohydrates

Sedoheptulose is *absent* from *Chimaphila* (1) (Brown).

Raphides are *absent*.

Hot-Water Test. Gibbs: I —; II 1/2; III 1/1; IV —.

Tannins. Using *Tannin Test A* on leaves I have: + + +*Chimaphila umbellata*, *Pyrola rotundifolia* subsp. *maritima*; + +*P. chlorantha*, *elliptica*, *secunda*; +*Monotropa uniflora*.

Phenolic Acids, etc. See table 21.

Juglone Test. *Negative* in *Monotropa uniflora* (which showed blue fluorescence in the NH_3 layer).