CHAPTER II

HISTORICAL

1. Distribution of Alkaloids in Rutaceae.

The family Rutaceae comprises about 150 genera with 1600 species. Of the four important subfamilies, Rutoideae and Toddalioideae are almost equally versatile in producing alkaloids. With one exception, Flindersioideae is known to produce furoquinolines and pyroquinolines. Aurantioideae is the only known source of simple quinolines (Pakrashi and Bhattacharyya, 1965; Grundon, 1979).

Alkaloids of diverse structural types have been encountered in Rutaceae as shown below :-

Quinolines

Furoquinolines (Furanoquinolines)

Pyroquinolines (Pyranoquinolines)

Acridines

Quinazolines

Carbazoles

Protoberines

1,2-Benzophenanthridines

Aporphines

Protopines

Canthinones

Imidazoles

Oxazoles

Benzyl-isoquinolines

Indoloquinolines

Amines or Amides

(Price, 1963; Pakrashi and Bhattacharyya, 1965; Grundon, 1979; Cordell, 1980)

In genus *Evodia*, there are 5 groups of alkaloids which have been reported.

Acridines

Benzyl-isoquinolines

Furoquinolines

Indoloquinolines

Quinolines

(Price, 1963; Grundon, 1979; Pakrashi and Bhattacharyya, 1965)

2. The Occurrence of Alkaloids in *Evodia* spp.

Botanical source	Plant part*	Alkaloid(s)	Category**	Reference
Evodia alata F. Muell.	b, l	Evoxanthine	A	Johns and Lamberton, 1966; Gell *et al.*, 1955.
	b, l	Evolatine	B	Johns and Lamberton, 1966.
	l	Evoxine	B	Johns and Lamberton, 1966.
	b	Kokusaginine	B	Johns and Lamberton, 1966; Gell, *et al.*, 1955.
	b	Melicopidine	A	Johns and Lamberton, 1966; Gell, *et al.*, 1955.

Botanical source	Plant part*	Alkaloid(s)	Category**	Reference
Evodia alata	b	Skimmianine	B	Johns and Lamberton, 1966;
F. Muell.				Diment *et al.*, 1967.
	l	2,3,4-Trimethoxy-10-methyl acridone	A	Johns and Lamberton, 1966; Gell *et al.*, 1955.
E.belahe	b	Dictamnine	B	Rondes *et al.*, 1968.
Baillon.	b	Evolitrine	B	Rondes *et al.*, 1968.
	b	Kokusaginine	B	Rondes *et al.*, 1968.
E.elleryana	l	Evellerine	B	Johns *et al.*, 1968.
F.Muell	l	Confusameline (7-o-Dimethy evolitrine)	B	Johns *et al.*, 1968.
	l	Skimmianine	B	Johns *et al.*, 1968.
E.littoralis	l	Dictamnine	B	Cooke and Haynes, 1954.
Endl.	l	Evolitrine	B	Cooke and Haynes, 1958.
	l	Kokusaginine	B	Cooke and Haynes, 1958.
E.meliaefolia	l	Berberine	F	Price, 1963.
Benth.	l			
E.rutaecarpa	l, fr	Dehydroevodiamine	D	King *et al.*, 1981.
Benth.	fr	Dihydroevocarpine	C	King *et al.*, 1981.
(Juss.)	fr	Rutaecarpine	D	King *et al.*, 1981.
	l, fr	Hydroxyevodiamine (Rhetsinine)	D	Tschesche and Werner, 1967.
	fr	Evocarpine	C	Tschesche and Werner, 1967.
	fr	Evodiamine	D	Tschesche and Werner, 1967.

Botanical source	Plant part*	Alkaloid(s)	Category**	Reference
E.rutae carpa Benth. (Juss.)	fr	Wuchuyine	D	King *et al.*,1981.
	fr	7-Carboxy-8,13,13b,-14-tetrahydro-14-methylindolo[2',3':3,4]pyrido[2', 1-b]-quinazoline-5(7*H*)-one	D	Danieli, 1979.
	fr	14-Formyl dihydro rutaecarpine	D	Kamikado, 1978.
	fr	1-Methyl-2-nonyl-4(1H) quinolone	C	Kamikado, 1978.
	fr	1-Methyl-pendecyl-4(1H) quinolone	C	Kamikado, 1976.
	fr	1-Methyl-2-undecyl-4(1H) quinolone	C	Kamikado, 1976.
E.xantho xyloides F.Muell.	b	Evoxanthidine	A	Prager *et al.*, 1962.
	l	Evoxine	B	Prager *et al.*, 1962.
	l	Evoxoidine	B	Prager *et al.*, 1963.
	l	Evoxanthine	A	Prager *et al.*, 1962.
	l	Evodine	B	Eastwood *et al.*,1955.
	l	Evolidine	E	Eastwood *et al.*,1955.
	l	Anhydrevoxine	B	Dryer, 1970
	b, l	Kokusaginine	B	Hughes *et al.*, 1952.
	b, l	Kogusagine	B	Hughes *et al.*, 1952.
	l	Melicopidine	A	Prager *et al.*, 1962; Hughes *et al.*, 1962.

Botanical source	Plant part*	Alkaloid(s)	Category**	Reference
E.xantho	l	Xanthevodine	A	Prager *et al.*, 1962.
xyleides	b, l	Xanthoxoline	A	Prager *et al.*, 1962.
F.Muell.				

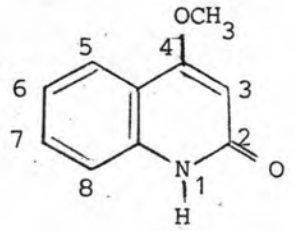
*Plants parts are indicated as follows :- l, leaves; b, bark; fr, fruits.

**The structural categories to which the alkaloids belong are indicated as follows :- A, Acridine; B, Furoquinoline; C, Quinoline; D, Indoloquinazoline; E, Peptide alkaloid; F, Benzyl-isoquinoline.

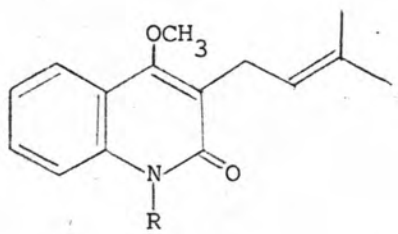
3. Chemical Nature of Isoprenoid Quinoline Alkaloids (3-prenyl-2-quinolone).

4-Methoxy-3-prenyl-2-quinolone alkaloid was first prepared in connection with the synthesis and biosynthesis of quinoline alkaloids (furoquinoline and pyroquinoline alkaloids), but soon afterward prenyl derivatives were identified as constituents of Rutaceous plants (Grundon, 1979).

The basic structure and numbering system of 3-prenyl-2-quinolone alkaloids are shown below :-



Simple quinoline

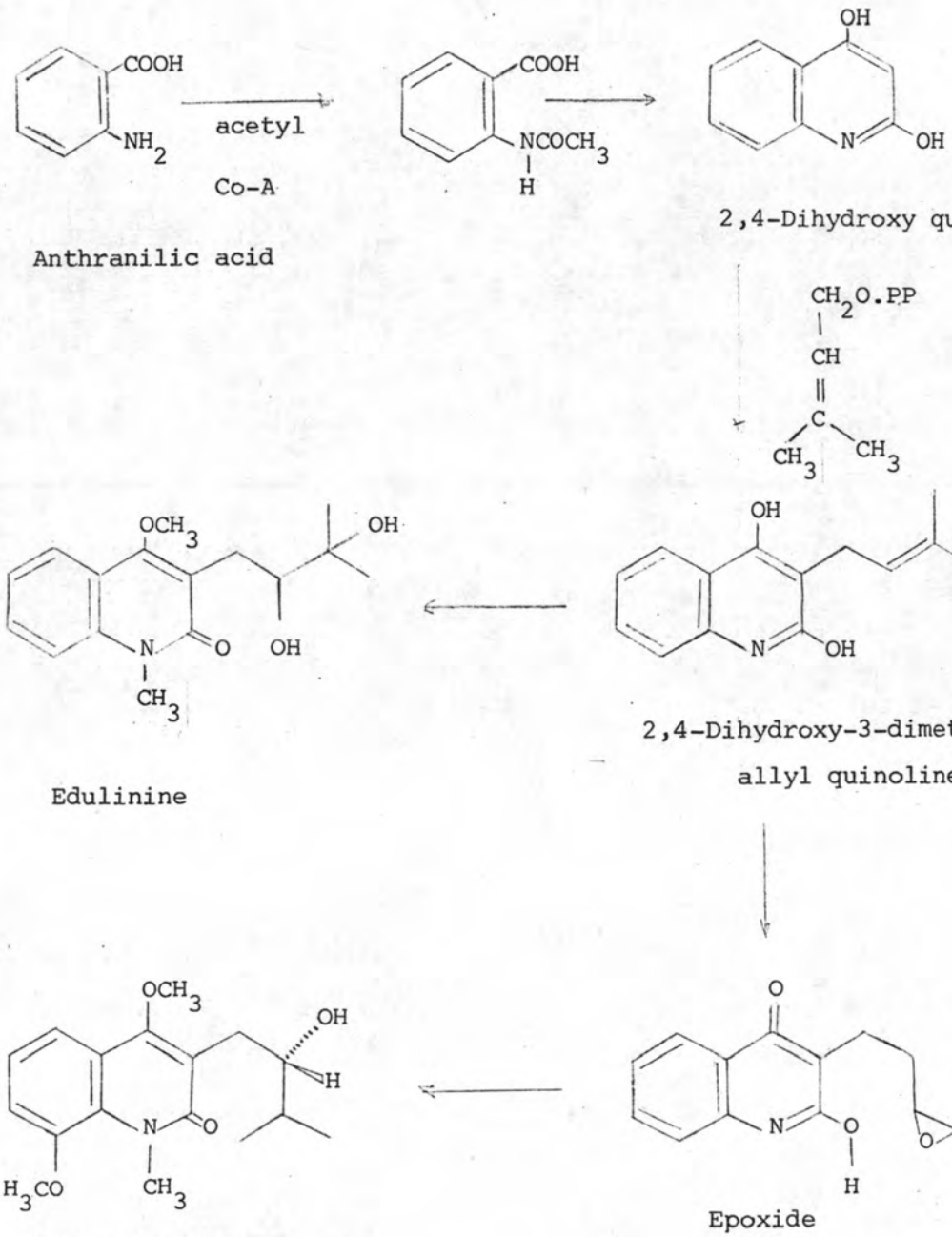


3-Prenyl-quinoline

R = H, Atanine

Atanine, the isolated alkaloid from *Fagara xanthoxyloides* Lam. by Eshiett and Taylor is one of the 3-prenyl-2-quinolone alkaloids which has an isoprenoid side chain attached at the C-3 position (Eshiett and Taylor, 1966).

3.1 Biosynthesis of 3-Prenyl-2-quinolone Alkaloid.

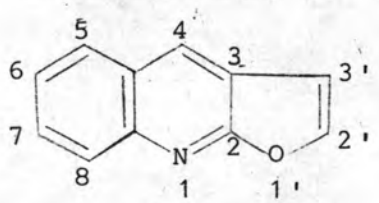


Scheme I. Biosynthesis of 3-Prenyl-2-quinolone Alkaloids.

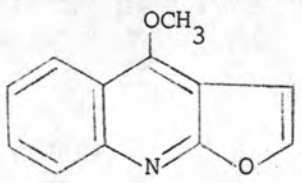
The biosynthetic pathway leading to 3-prenyl-2-quinolone alkaloids was recently accepted. The quinoline moiety was derived from a condensation between anthranilic acid and acetic acid leading to a 2,4-dihydroxy quinoline intermediate. Then the intermediate condensed with dimethylallyl pyrophosphate or mevalonic acid to produce 3-prenyl quinoline alkaloid i.e. 2,4-dihydroxy-3-dimethyl-allyl quinoline which has structure related to hydroxy lunacridine, edulinine, orixine and nororixine. 2,4-Dihydroxy-3-dimethylallyl quinoline could be oxidised to the epoxide which appeared as the direct precursor of lunacridine, pilokeanine; etc. (Colona, 1971; Collins and Grundon, 1969; Colline *et al.*, 1974; Grundon, 1979).

4. Chemical Nature of Furoquinoline Alkaloids.

All the naturally occurring tricyclic furoquinolines are linear and the simple system is a derivative of the furo 2,3-b quinoline (1), and the simple member is dictamnine (2).



(1)

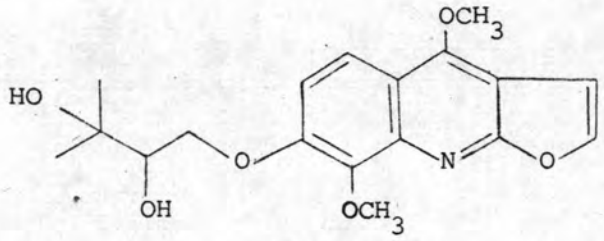


(2)

Common additional groups are oxygen function at C-6, C-7 and C-8 positions which may be methyl or isopentenyl ether. A hydroxyisopropyl group is common in the dihydrofuroquinolines. The aromatic ring is frequently substitued with $-OCH_3$ at one or

more positions and less so with a $-O-CH_2-O-$ bridge at 6, 7 or 7, 8 positions.

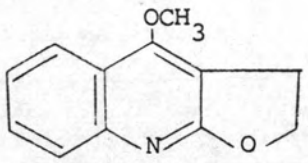
In a few cases, e.g. evoxine (3), usually position 7 is substitued with isopentenyl ether. In limited cases, the -2-or-3- positions of the furan ring (usually dihydro) are variously substituted by alkyl or hydroxy alkyl side chain (Pakrashi and Bhacharyya, 1965; Cordell, 1981).



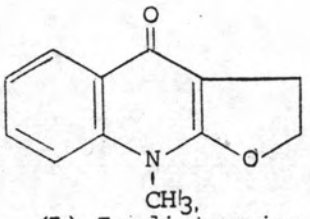
(3) Evoxine

The common furoquinoline alkaloid, dictamnine was first isolated by Thomas in 1923, and found quite widely in the Rutaceae. Being a very weak base, it does not form a derivative with methyl iodide but rather undergoes isomerisation to isodictamnine (5), and a similar reaction is observed with dimethyl sulphate or diazomethane. Crucial information about the linear structure of dictamnine came by oxidative degradation with potassium permanganate to the acid, dictamnic acid (6).

Hydrogenation of dictamnine (2) over palladium affords 2,3-dihydro dictamnine (4). A platinum oxide catalyst causes fission of the dihydrofuran ring to give 3-ethyl-4-methoxy-2-quinolone (7) as shown in the following structures (Cordell, 1981; Grundon, 1979).



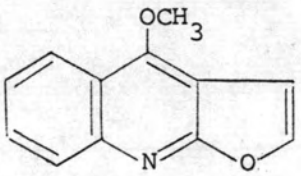
(4) 2,3-Dihydro dictamnine



(5) Isodictamnine

H_2Pd

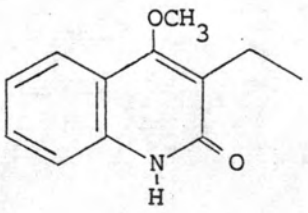
CH_3I



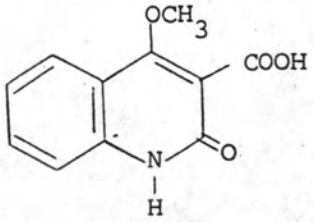
Dictamnine

H_2Pt

$KMnO_4$

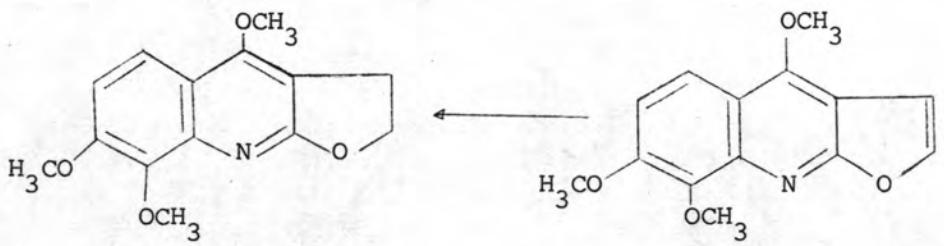


(7) 3-Ethyl-4-methoxy-2-quinolone



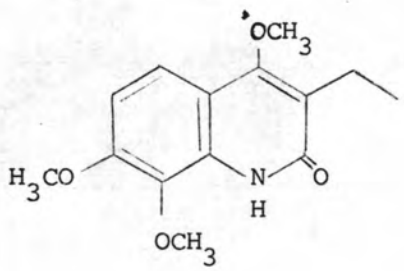
(6) Dictamnic acid

Skimmianine (8) is the most widespread furoquinoline alkaloid and closely resembles to dictamnine in its chemistry. The hydrogenolysis of skimmianine gave 3-ethyl-4,7,8-trimethoxy-2-quinolone (9), with palladium to give dihydroskimmianine (10) (Cordell, 1981).



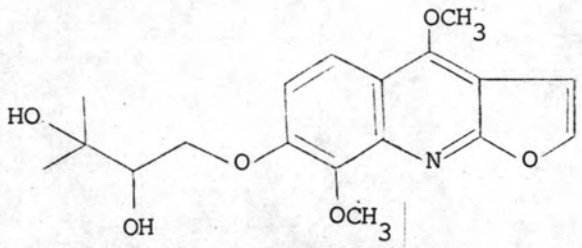
(10) Dihydroskimmianine

(8) Skimmianine

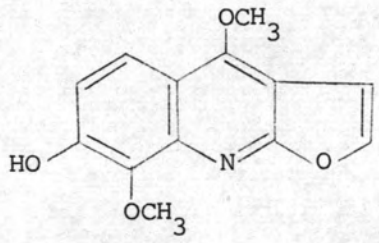


(9)

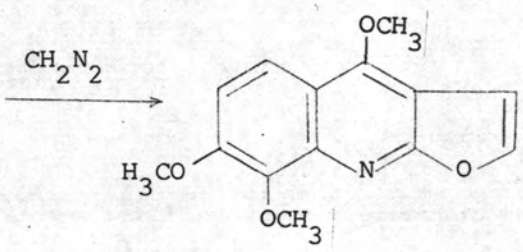
In evoxine (3), the hydrolysis with methanolic potassium-hydroxide gave a phenol (11) which on methylation affords skimmianine (8). Ethylation of phenel (11) gave a derivative (12) which was degraded to 7-ethoxy-8-methoxy-4-hydroxy-2-quinolone (13) (Cordell, 1981). The reaction is shown below :-



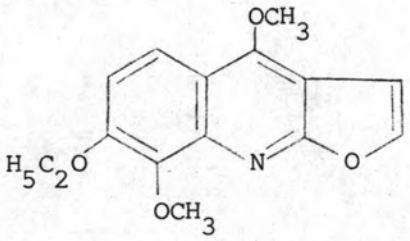
(3) Evoxine



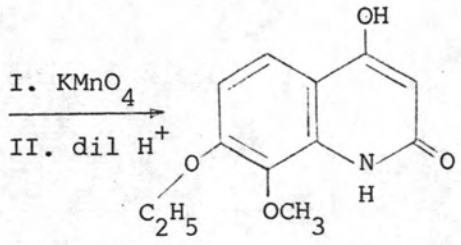
(11)



(8)



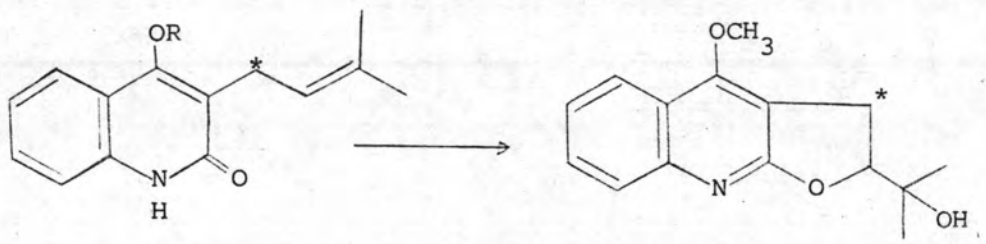
(12)



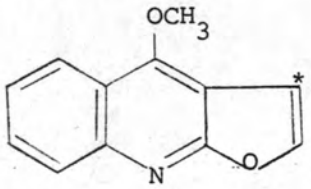
(13)

4.1 Biosynthesis of Furoquinoline Alkaloids.

By using the shrub *Skimmia japonica* Thunb., which contains dictamnine, (+)-platydesminium metho-salt (18) and traces of skimmiamine (8). The specific incorporation of the ^{14}C-labelled dimethylallyl quinolone (14) into dictamnine (2) indicated the isoprenoid origin of the furan ring of the furoquinoline alkaloids. In the same route of 3-prenyl quinoline biosynthetic pathway, furoquinoline alkaloids are derived from anthranilic acid as shown in scheme 2 (Grundon, 1981; Grundon and James, 1971; Schever, 1970; James *et al.*, 1974; Robinson, 1981; Finlayson and Prager, 1978).

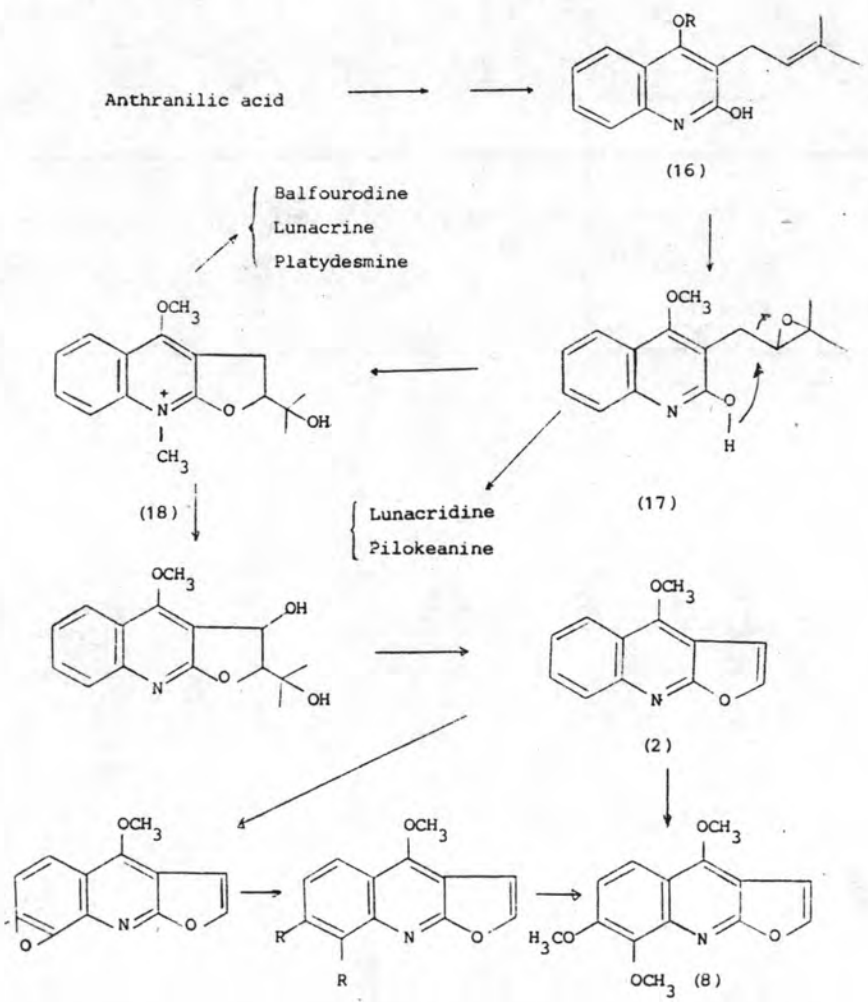


(14) (15)



(2)

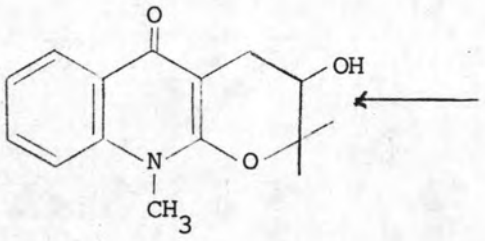
The mechanism of biosynthetic pathway, anthranilic acid condensed with acetic acid and mevalonic acid to 3-prenyl quinoline intermediate (16) which is closely related to alkaloids such as hydroxylunacridine, edulinine, orixine and nororixine. Compound 16 could be oxidised to the epoxide (17) which appears as the direct precursor of lunacridine, pilokeanine, etc. On the other hand, intermediate epoxide could cyclise, as indicated by arrows, to (+)-platydesminium metho-salt (18), a close precursor of platydesmine, balfourodine, etc. Elimination of the side chain as indicated in the scheme 2 would afford dictamnine (2) which would lead to skimmianine (8) (Colonna and Gros, 1971).



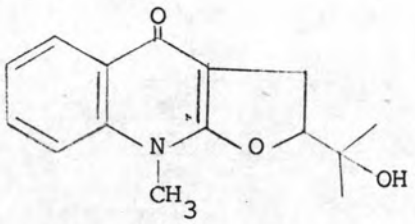
Scheme 2 Biosynthesis of Furoquinoline Alkaloids.

5. Chemical Nature of Pyroquinoline Alkaloids.

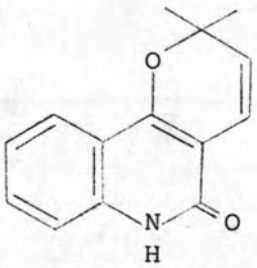
A linear type of pyroquinoline alkaloids (angular type called flindersine type) are identified as constituent of Rutaceous plants. Most of the structures of pyroquinoline alkaloids are dihydropyroquinolines (19) which closely related to dihydrofuroquinolines (20).



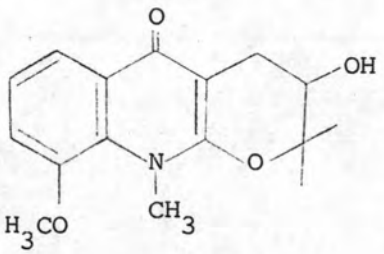
(19) Ribalinine



(20) Isoplatydesmine



(21) Flindersine



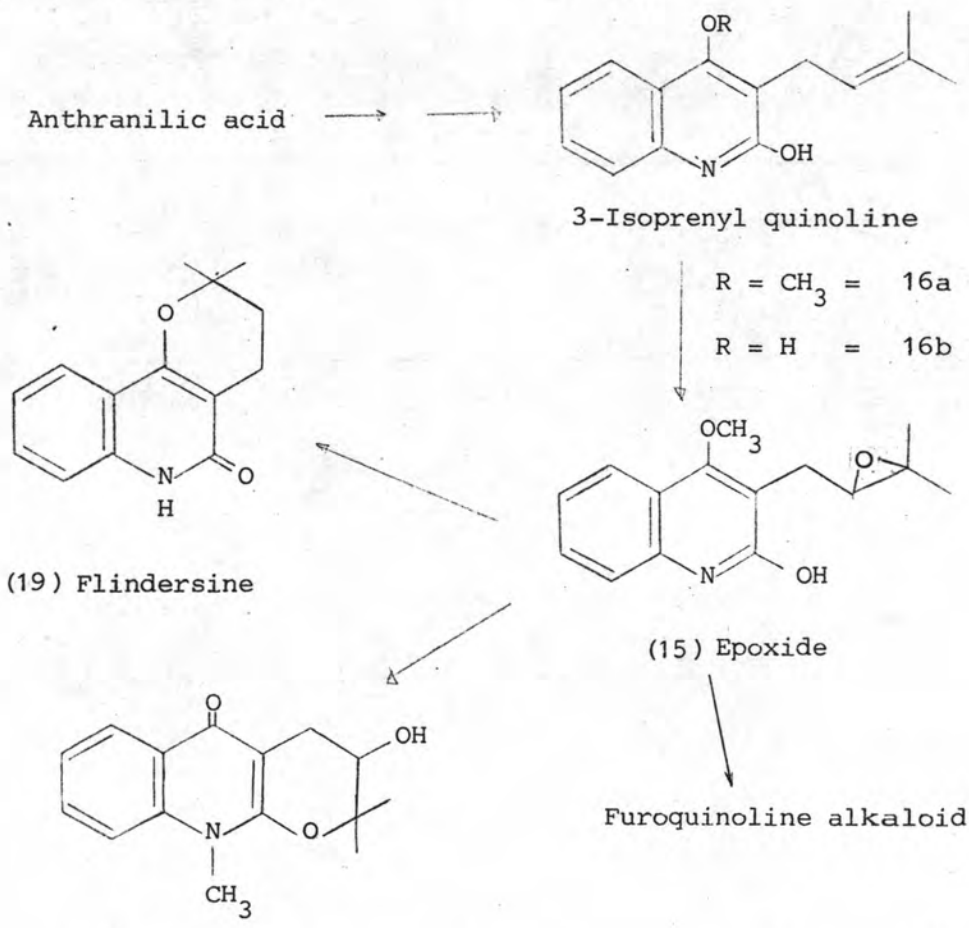
(22) Isobalfourodine

Ribalinine was first isolated from Argentinian *Balfourodendron riedelianum* Engl. In 1966 Bowman and Grundon synthesised ribalinine by the method developed for isobalfourodine (22) and Corral and Orazi prepared ribalinine by rearrangement of isoplatydesmine with acetic anhydride and pyridine. A key problem in this group of alkaloids is the distinction between furo and pyro isomers, and this is best solved by NMR spectroscopy. The hydroxy resonance of ribalinine appears as a doublet in dimethyl sulfoxide because of

spin-spin coupling with adjacent CH proton but as a singlet in the furo isomer (cf. balfourodine) (Corral and Orazi, 1967; Corral *et al.*, 1973; Bowman and Grundon, 1966; Grundon, 1979).

5.1 Biosynthesis of Pyroquinoline Alkaloids.

Bowman *et al.*, (1973) suggested that the biosyntheses of pyroquinoline alkaloids occur from a 3-isoprenyl quinoline which are known to be derived from anthranilic acid in 3-prenyl quinoline biosynthetic pathway. Epoxide is the intermediate by oxidative cyclisation, in which the pyran ring is fused to the heterocyclic system (see Scheme 3).

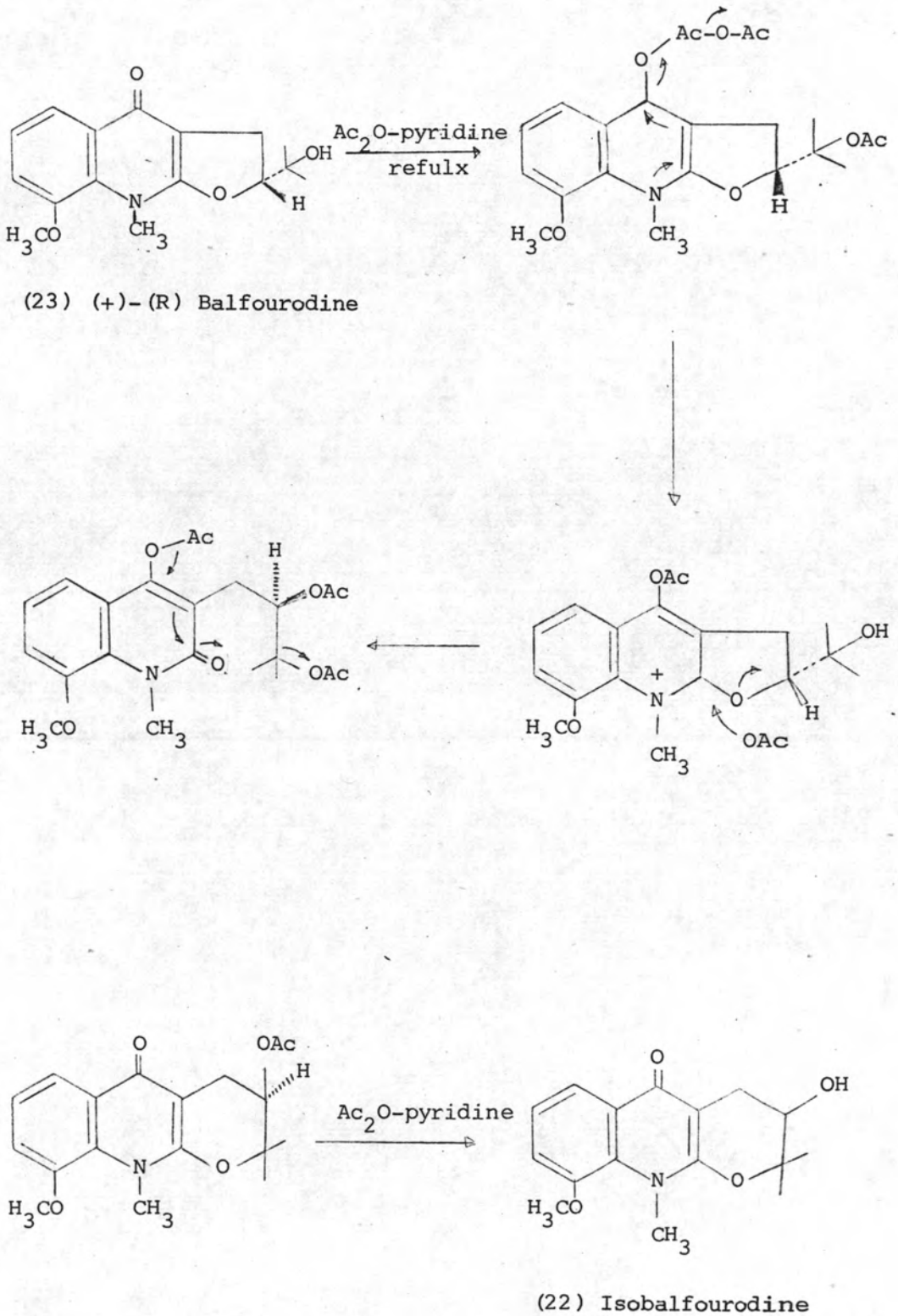


Scheme 3 Biosynthesis of Pyroquinoline Alkaloids.

Model for the biosynthesis route *in vitro*, reaction of the 3-isoprenyl-4-hydroxy-2-quinolone (16b) with D.D.Q. (2,3-dichloro-5,6-dicyanobenzoquinone) yielded flindersine (angular pyroquinolines) (21) rather than linear pyroquinoline alkaloids. But in plants, Bowman *et al.* believed that linear pyroquinoline alkaloids could be derived by this biosynthetic pathway (Bowman *et al.*, 1973).

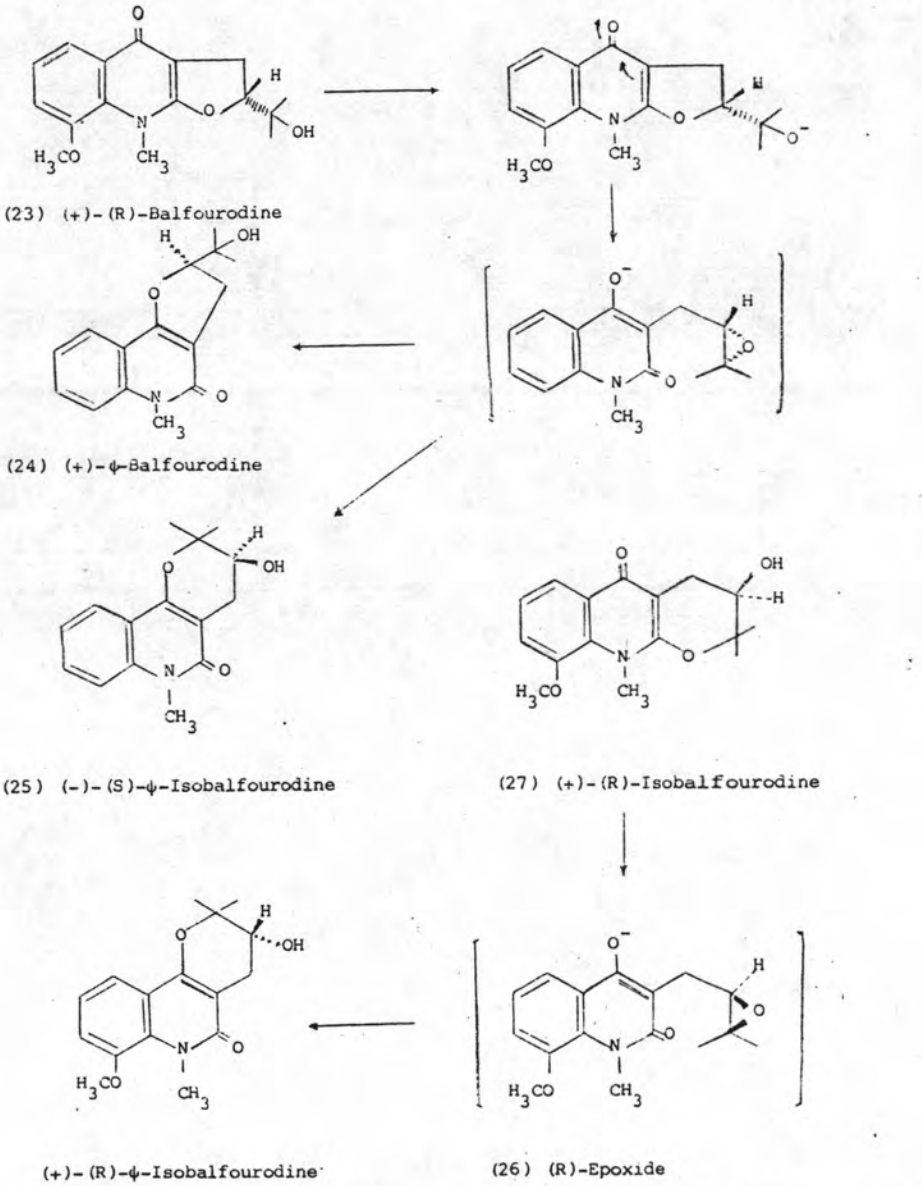
6. Rearrangement Reactions of Furoquinoline and Pyroquinoline Alkaloids.

Rearrangement reactions of dihydrofuroquinoline and dihydropyroquinoline alkaloids were studied in balfourodine (23) and isobalfourodine (22), (+) balfourodine was reported to rearrange by refluxing with acetic anhydride and pyridine into (+) isobalfourodine. A plausible mechanism implying retention of configuration was indicated in Scheme 4. The presence of a 4-carbonyl group appeared to be necessary for rearrangement (Grundon, 1979; Pakrashi and Bhattacharyya, 1965).



Scheme 4 Mechanism of the Balfourodine-Isobalfourodine acetate Rearrangement.

In base catalysed rearrangement, reaction of (+)-balfourodine (23) in dimethylformamide with sodium hydride at 50℃ or with sodium methoxide at 15℃ gave (+)-ψ-balfourodine (24) almost quantitatively, but when refluxed with methanolic potassium hydroxide, afforded (-)-ψ-isobalfourodine (25) as the only product. A similar Scheme involving an (R)-epoxide (26) can be applied to the rearrangement of (+)-isobalfourodine (27) as shown in Scheme 5 (Grundon, 1979).



Scheme 5 Base-catalysed Rearrangements of Balfourodine and Isobalfourodine.

7. Pharmacology

Although a number of plants containing 3-prenyl quinoline, furoquinoline and pyroquinoline alkaloids have been used medicinally, it is surprising that so few have been evaluated pharmacologically. Most of the pharmacologic studies have been carried out in Russia and details are difficult to obtain. In furoquinoline alkaloids, dictamnine causes smooth muscle and uterus contractions and increase heart muscle tone. Skimmianine and dubinidine have hypothermic and sedative activities. Evoxine and pteleatinium chloride show antimicrobial activities. Haplophyllidine and perforine display ataractic and sedative activies (Cordell, 1981; Openshow, 1967; Mitscher *et al.*, 1975).

The pyroquinoline alkaloids, khaplofoline and its N-methyl derivative have sedative action on C.N.S. (Ionescu *et al.*, 1970).

Wolters and Eilert studied the action of antimicrobial substance from callus cultures of *Ruta graveolens* L., they found that the furoquinolines, dictamnine, γ-fagarine and skimmianine have antimicrobial activities. Skimmianine showed only a poor activity, but γ-fagarine and dictamnine caused distinct growth inhibition of fungi (Wolters and Eilert, 1980).

Concerning to phototoxic activity, dictamnine, isodictamnine, 7-demethyl skimmianine, maculosidine and maculine are shown to be phototoxic to certain bacteria and yeaste in long wave UV light (Towers *et al.*, 1981; Tower and Abramowski, 1983).

8. 3-Prenyl-quinoline, Furoquinoline and Pyroquinoline Alkaloids Occurring in Ruraceae.

8.1 3-Prenyl quinoline alkaloids.

Atanine

Fagara zanthoxyloides Lam. (Eshiet and taylor, 1968)

Ravena spectabilis Engl. (Pual and Bose, 1968)

Bulfourolone

Balfourodendron riedelianum Engl. (Rapoport *et al.*, 1961)

Bucharidine

Haplophyllum bucharicum Litv. (Glasby, 1975)

3-Dimethylallyl-4-dimethylallyoxy-2-quinolone

Haplophyllum tuberculatum A. Juss. (Lavie *et al.*, 1968)

(+) Edulinine

Casimiroa edulis Llare et Lex. (Toube *et al.*, 1967; Iriarke *et al.*, 1956)

Citrus macroptera Montr. (Johns *et al.*, 1970)

Eriostemon trachyphyllus F. Muell (Lassak *et al.*, 1969)

Pelea barbigera Hillebr. (Higa *et al.*, 1974)

(-) Edulinine

Fagara mayu Engl. (syn. Zanthoxylum mayu Bert.) (Torres *et al.*, 1978)

Lunacridine

Lunasia costulata Mig. (syn *L. amara* Blanco.) (Goodwin, 1959; Clake, 1964)

Lunidine

Lunasia amara Blanco. var. rependa Lauterb. (Ruegger *et al.*, 1963)

Lunidine (cont.)

Ptelea trifoliata L. (Reisch, 1975)

Lunidonine

Lunasia amara Blanco. var. *rependa* Lauterb. (Glasby, 1975)

Hydroxylunacridine

Lunasia amara Blanco, (Goodwin *et al.*, 1959)

Hydroxylunidine

Lunasia amara Blanco. (Goodwin *et al*, 1959)

Ptelea trifoliata L. (Reisch, 1970)

Methylptelefolidine

Ptelea trifoliata L. (Reisch, 1970; Reisch *et al.*, 1945)

N-methylatanine

Melicope indica (Fauvel *et al.*, 1981)

Orixine

Orixa japonica Thunb. (Terasaka, 1960; Dennelly, 1972)

Orixinone

Orixa japonica Thunb. (Donnelly, 1972)

Presskimmianine

Dictamnus albus L. (Storer, 1973; Storer, 1972)

Ptelecortin

Ptelea trifoliata L. (Reisch *et al.*, 1972)

Ptelecortine

Ptelea trifoliata L. (Reisch *et al.*, 1975)

Ptelefolidine

Ptelea trifoliata L. (Reisch, 1970; Reisch *et al.*, 1975)

Ptelefoline

Ptelea trifoliata L. (Reisch, 1970)

Pteleoline

Ptelea trifoliata L. (Reisch *et al.*, 1972)

Pilokeanine

Platydesma campanulata Mann. (Werny, 1963)

3-Isopentanyl-4-isopentenyloxy-2-quinolone

Haplophyllum tuberculatum A. Jass. (Lavie *et al.*, 1968)

3-Isopentenyl-4-methoxy-7,8-methylenedioxy-2-quinolone

Ptelea trifoliata L. (Dreyer, 1969)

3,3-Diisopropyl-N-methyl-2,4-quinodione

Esenbeckia flava (Dreyer, 1980)

4,8-Dimethoxy-3-(3-methylbut-2-enyl)-N-methyl-2-quinolone

Glycosmis mauritiana Lam. (Tanaka) (Rastogi *et al.*, 1980)

4:6:8-Trimethoxy-3-(3:3-dimethylallyl)-N-methylquinoline-2-ol

Ptelea trifoliata L. (Reisch *et al.*, 1975; Reisch *et al.*, 1978)

8.2 Furoquinoline alkaloids.

Acronidine

Acronychia baueri Schott. (Lamberton and Price, 1953)

Acronycidine

Acronychia baueri Schott. (Lamberton and Price, 1953)

Melicope farena F. Muell. (Price, 1949)

Acrophyllidine

Acronychia haplophylla (F. Muell.) Engl. (Lahey *et al.*, 1969)

Acrophylline

Acronychia haplophylla (F. Muell.) Engl. (Lahey *et al.*, 1969)

Alkaloid F. I-A

Flindersia ifflaiana F. Muell. (Glasby, 1975)

Anhydrevoxine

Evodia xanthoxyloides F. Muell. (Dreyer, 1970)

Balfourodine

Balfourodendron riedelianum Engl. (Rapoport *et al.*, 1959)

Confusameline (7-O-demethylevolitrine)

Evodia elleryana F. Muell. (Johns *et al.*, 1968)

Melicope confusa (Merr.) Liv. (Grundon, 1979)

Choiyine

Choisya arizonica Standl. (Dreyer *et al.*, 1972)

C. mollis Standl. (Dreyer *et al.*, 1972)

C. ternata HB & K. (Johns *et al.*, 1967)

Dictamnine

Aegle marmelos Correa. (Pakrashi and Bhattacharyya; 1965)

Afragle paniculata Engl. (Pakrashi and Bhattacharyya, 1965)

Balfourodendron riedelianum Engl. (Pakrashi and Bhattacharyya, 1965)

Boenninghausenia albiflora Meissner. (Pakrashi and Bhattacharyya, 1965)

Casimiroa edulis Llave et Lex. (Iriarte *et al.*, 1956)

Decatropis bicolor (Zucc.) Radlk. (Dominguez *et al.*, 1971)

Dictamnus albus Linn. (Pakrashi and Bhattacharyya, 1965)

D. angustifolius Sweet. (Sultanov and Yunusov, 1969)

D. caucasicus Fisch. (Grundon, 1979)

Dictamnine (cont.)

Evodia belahe Baillon. (Rondest *et al.*, 1968)

E. littoralis Engl. (Cooks *et al.*, 1954)

Fagara mayu Engl. (Benages *et al.*, 1974)

Flindersia acuminata C.T. White. (Ritchie *et al.*, 1969)

F. dissosperma (F. Muell.) Domin. (Binns *et al.*, 1975)

F. maculosa Lindl. (Binns *et al.*, 1957)

F. pimenteliana F. Muell. (Bowden *et al.*, 1975)

F. pubescens Bail. (Hollis *et al.*, 1961)

Glycosmis arborea (Roxb.) DC. (Pakrashi and Bhattacharyya, 1963)

G. mauritiana Tanaca (Rastogi *et al.*, 1980).

G. pentaphylla (Retx.) Correa. (Chakraborty, 1962)

Halfordia kendack (Mntr.) Giull. (Crow *et al.*, 1968)

Haplophyllum bucharicum Litv. (Ubaidullaev *et al.*, 1973)

H. bungei Trautv. Grundon, 1979)

H. ramossisium Wed. (Grundon, 1979)

H. suaveolens (DC.) G. Don. (Ionescu *et al.*, 1970)

Helietta longifoliata Britton. (Grundon, 1979)

Hortia arborea Engl. (Pachter *et al.*, 1960)

Monnieria trifolia L. (Fouraste *et al* ., 1973)

Medicosma cunninghamii Hook. (Bianchi *et al.*, 1968)

Phlebalium nudum Hook. (Briggs *et al.*, 1958)

Pitavia punctata Molina. (Millan *et al.*, 1970)

Ptelea trifoliata L. (Kowalska *et al.*, 1967)

Ruta angustifolia Pers. (Grundon, 1979)

R. chalepensis L. (Grundon, 1979)

R. montana Dill. (Grundon, 1979)

Skimmia foremanii Hort. (Weinstein *et al.*, 1971)

S. japonica Thunb. (Boyd *et al.*, 1967)

S. repens Nakai. (Pakrashi and Bhattacharyya, 1965)

Zanthoxylum ailanthoides Sieb et Zucc. (Pakrashi and Bhattacharyya, 1965)

Z. alatum Roxb. (Pakrashi and Bhattacharyya, 1965)

Z. arnottianum Maxim. (Ishii *et al.*, 1974)

Z. belizense Ludell. (Najjar *et al.*, 1975)

Z. decaryi (Vaquette *et al.*, 1974)

6-8-Dimethoxydictamnine

Dictamnus caucasicus Fisch. (Glasby, 1975)

Dubinidine

Haplophyllum dubium Evg. Kor. (Yunusov *et al.*, 1956)

H. foliosum Vved. (Glasby, 1975)

Dubinine

Haplophyllum dubium Evg. Kor. (Bessonova *et al.*, 1969)

Dutadrupine

Dutaillyea drupacea Baill. (Baudevin *et al.*, 1981)

Evellerine

Evodia elleryana F. Muell. (Johns *et al.*, 1968)

Evodine

Evodia xanthoxyloides F. Muell. (Hughes *et al.*, 1952; Prager, 1962)

Evolatine

Evodia alata F. Muell. (Johns, 1966)

Monnieria trifolia L. (Moulis *et al.*, 1981)

Evolitrine

Acronychia pedunculata (Silva *et al.*, 1979)

Cusparia macrocapa Engl. (Rapoport *et al.*, 1960)

Evodia belahe Baillon. (Rondest *et al.*, 1968)

E. littoralis Endl. (Cooke *et al.*, 1954)

Melicope indica (Fauvel *et al.*, 1981)

Orixa japonica Thung. (Pakrashi and Bhattacharyya, 1965)

Phebalium nudum Hook (Briggs *et al.*, 1958)

Platydesma campanulata H. Mann. (Werny *et al.*, 1963; Johns *et al.*, 1968)

Evoxine (Haploperine)

Choisya ternata HB. & K. (Johns *et al.*, 1967)

Evodia alata F. Muell. (Johns *et al.*, 1966)

E. xanthoxyloides F. Muell. (Eastwood *et al.*, 1954)

Haplophyllum dubium Evg. et Kor. (Grundon, 1979)

H. latifolium Kar & Ker. (Nesmelova *et al.*, 1973)

H. hispanicum Spach. (Graundon, 1979)

H. obtusifolium Ldb. (Ubaidullaev *et al.*, 1973)

H. perforatum Kar & ker. (Grundon, 1979)

H. popovi Evg. et Kor (Grundon, 1979)

H. ramossisium V ved. (Grundon, 1979)

H. suaveolens (DC.) G. Don. (Ionescu *et al.*, 1970; Ionescu *et al.*, 1971)

H. tuberculatum (Forssk.) Adr. Juss. (Shamma *et al.*, 1979)

Monnieria trifolia L. (Moulis *et al.*, 1981)

Evoxoidine

Evodia xanthoxyloides F. Muell. (Eastwood, 1954)

γ-Fagarine (Aegelenine, 8-Methoxydictamnine)

Aegle marmelos Correa. (Pakrashi and Bhattacharyya, 1965)

Casimiroa edulis Llave et Lex. (Iriarte *et al.*, 1956)

Chloroxylon swietenia DC. (Vrkoc *et al.*, 1972)

Dictamnus albus L. (Grundon. 1979)

D. Caucasicus Fisch. (Asatiani *et al.*, 1972)

Fagara coco (Gill.) Engl. (Pakrashi and Bhattacharyya,1965)

F. mayu Engl. (Benages *et al.*, 1974)

Geigeria salicifolia Schott. (Johns *et al.*, 1966)

Glycosmis arborea (Roxb.) Correa. (Pakrashi and Bhattacharyya, 1965)

G. pentaphylla (Retz.) Correa. (Chakraborty and Barman, 1962)

Haplophyllum bucharicum Litv. (Ubaidullaev *et al.*, 1973)

H. pendicellatum Bge. (Yunusov *et al.*, 1956)

H. robustum Bge. (Fakhrutdinova *et al.*, 1965)

H. kowalenskyi Stscheg. (Isaev *et al.*, 1975)

H. Schelkounikovii Grossheim. (Isaev *et al.*, 1975)

H. tenue Boiss. (Isaev *et al.*, 1975)

H. villosum (Isaev *et al.*, 1975)

Hortia arborea Engl. (Pakrashi and Bhattacharyya, 1965)

Myrtopsis sellinggii (Hifnawy *et al.*, 1976)

Pitavia punctata Molina. (Millan and Silva, 1970)

Phebalium nudum Hook. (Briggs *et al.*, 1958)

Ravenia spectabilis Pl. (Openshaw, 1967)

Rata chalepensis L. (Grundon, 1979)

R. graveolens L. (Schneidev, 1965)

Skimmia japonica Thunb. (Grundon, *et al.*, 1974)

γ-Fagarine (cont.)

Thamnosma montana Torr. and Frem. (Dreyer. 1966)

Vepris stolzii Verdoorn. (Khalid *et al.*, 1982)

Zanthoxylum alatum Roxb. (Pakrashi and Bhattacharyya, 1965)

Z. tsihanimposa H. Perr. (Decaudain *et al.*, 1974)

Z. piperitum DC. (Abe *et al.*, 1973)

Flindersiamine

Araliopsis soyauxii Engl. (Vaquette *et al.*, 1976)

Balfourodendron riedelianum Engl. (Pakrashi and Bhattacharyya, 1965)

Esenbeckia febrifuga A. Fuss. (Dreyer, 1980)

Flindersia bennettiana F. Muell. (Grundon, 1979)

F. bourijotiana F. Muell (Grundon, 1979)

F. collina Bail. (Grundon, 1979)

F. cissosperma (Domin) F. Muell. (Binns *et al.*, 1957)

F. maculosa (F. Muell.) Lindl. (Binns 1957; Brown *et al.*, 1954)

F. pubescens Bail. (Hollis *et al.*, 1961)

F. xanthoxyla Domin. (Ritchie *et al.*, 1960)

Helietta longifoliata Brittor. (Grundon, 1979)

H. pavifolia (A. Gray.) Benth. (Kan-fan *et al.*, 1970)

Teclea sudanica A. Chew. (Pakrashi and Bhattacharyya, 1965)

Vepris bilocularis (Pakrashi and Bhattacharyya, 1965)

Folifinine

Haplophyllum foliosum Vved. (Grundon, 1979)

Foliminine

Haplophyllum foliosum Vved. (Grundon, 1979)

Folizine

Haplophyllum foliosum Vved. (Glasby, 1977)

Glycoperrine

Haplophyllum perforatum Kar. et Kir. (Akhmedzhanova *et al.*, 1975)

Halfordinine

Araliopsis tabouensis Aubrev. et Pellerg. (Fish *et al.*, 1976)

Halfordia schleroxyla F. Muell. (Crow *et al.*, 1968)

Melicope perspicuinervia Merr. & Perry. (Murphy *et al.*, 1974)

Haplatine

Haplophyllum latifolium Kar. & Ker. (Nesmelova *et al.*, 1976)

Haplophydine

Haplophyllum perforatum Kar. et Kir. (Akhmedzhanova *et al.*, 1975)

Haplopine

Aegle marmelos Correa. (Basu *et al.*, 1974)

Haplophyllum bucharicum Litv. (Ubaidullaev *et al.*, 1973)

H. dubium Evg. Kor. (Grundon, 1979)

H. foliosum Vved. (Grundon, 1979)

H. pedicellatum (Grundon, 1979)

H. perforatum (M.B.) Kar et Kir. (Pakrashi and Bhattacharyya, 1965)

H. robustum Bge. (Glasby, 1977)

Monnieria trifolia L. (Moulis *et al.*, 1981)

Zanthoxylum arnottianum Maxim. (Ishii *et al.*, 1974)

Z. microcarpum Griseb. (Boulware and Stermitz, 1981)

Haplophyllidine

Haplophyllum perforatum Kar. et Kir. (Faizutdinova *et al.*, 1969; Shakrov *et al.*, 1962)

Heliparvifoline

Helietta parvifolia (A. Gray.) Benth. (Chang *et al.*, 1976)

Hydroxylunacrine

Lunasia amara Blanco. (Goodwin *et al.*, 1959)

7-Hydroxy-4-methoxyfuro (2,3-b) quinoline (7-0-demethylevolitrine)

Evodia elleryana F. Muell. (Johns *et al.*, 1968)

(-) Hydroxylunine

Lunasia amara Goodwin *et al.*, 1959)

(+) Hydroxylunine

Prelea trifoliata L. (Glasby, 1975)

Ifflaiamine

Flindersia ifflaiana F. Muell. (Bosson *et al.*, 1963)

Isodictamnine

Dictamnus albus L.[(syn. *D. angustifolius* (Sweet.) Brit.)] (Gellert *et al.*, 1973)

D. caucasicus Fisch. (Asatiani *et al.*, 1972)

Helietta longifoliata Britton. (Chang *et al.*, 1976)

Isoflindersiamine

Helietta parvifolia (A. Gray) Benth. (Chang *et al.*, 1976)

Isomaculosidine

Dictamnus albus L. (Gillert *et al.*, 1973)

D. caucasicus Fisch. (Grundon, 1979)

Ptelea trifoliata L. (Mitscher *et al.*, 1975)

Isoplatydesmine

Araliopsis soyauxii Engl. (Vaquette *et al.*, 1976)

Pelea barbigera Hillebr. (Higa and Scheur, 1974)

7-Isopentenyloxy-γ-fagarine

Choisya ternata HB & K. (Grundon *et al.*, 1974)

Haplophyllum perforatum Kar. et Ker. (Bessonova *et al.*, 1975)

Ptaea aptera Perry (Dreyer, 1969)

Isoptelenine

Dictamnus caucasicus Fisch. (Grundon, 1979)

Kokusagine

Evodia xanthoxyloides F. Muell. (Hughes and Nill, 1949)

Lunasia amara Blanco. (Goodwin *et al.*, 1959)

Orixa japonica Thunb. (Pakrashi and Bhattacharyya, 1965)

Kokusaginine

Acronychia baueri Schott. (Lamberton and Price, 1953)

Araliopsis soyauxii Engl. (Vaquette *et al.*, 1976)

Balfourodendrom riedelianum Engl. (Openshaw, 1967)

Choisya arizonica Standl. (Dreyer *et al.*, 1972)

C. mollis Standl. (Dreyer *et al.*, 1972)

Evodia alata F. Muell. (Johns and Lamberton, 1966; Gell *et al.*, 1955)

E. belahe Baillon (Romdes *et al.*, 1968)

E. littoralis Endl. (Cooke and Haynes, 1954)

E. xanthoxyloides F. Muell. (Hughes and Neill, 1949)

Flindersia collina Bail. (Grundon, 1979)

F. maculosa Lindl. (Binns *et al.*, 1957; Brown *et al.*, 1954)

F. pubescens Bail. (Hollis *et al.*, 1961)

Kokusaginine (cont.)

Flindersia schottiana F. Muell (Hollis *et al.*, 1961)

Glycosmis pentaphylla (Retz.) Correa. (Grundon. 1979)

Halfordia kendack (Mntr.) Giull. (Crow and Hodgkin, 1968)

Haplophyllum suaveolens (DC.) G. Don (Grundon, 1979)

Helietta longifoliata Britton, (Grundon, 1979)

H. parvifolia (Benth.) A. Gray. (Dominguez *et al.*, 1971)

Lunasia amara Blanco. (Goodwin *et al.*, 1959)

Melicope confusa (Merr.) Liu. (Grundon, 1979)

M. perspicuinervia Merr. & Perry. (Murphy *et al.*, 1974)

Orixa japonica Thunb. (Openshaw, 1967)

Pelea barbigera Hillebr. (Higa *et al.*, 1974)

Phebarium nudum Hook. (Briggs and Cambie, 1958; Cambie, 1960)

Platydesma campanulata H. Mann. (Werny and Schever, 1963)

Ptelea aptera Perry. (Dreyer, 1969)

P. trifoliata L. (Openshaw, 1967).

Ruta chalepensis L. (Grundon, 1979)

R. Montana Dill. (Grundon, 1979)

R. graveolens L. (Pakrashi and Bhattacharyya, 1965)

Teclea unifoliata (Grundon, 1979)

Vepris ampody H. Perr. (Kan-Fan *et al.*, 1979)

V. bilocularis (Openshaw, 1967: Grundon, 1979)

Zanthoxylum pluviatile Hartley. (Corrie *et al.*, 1970)

Kokusaginoline

Orixa japonica Thunb. (Gibbs, 1974)

Lunacrine

Lunasia amara Blanco. (Goodwin *et al.*, 1957; Goodwin *et al.*, 1959)

Lunacrine (cont.)

Lunasia costulata Mig. (Clarke and Grundon, 1964)

L. quercifolia (Warb.) Lauterb & Kschum (Johnston *et al.*, 1958)

Lunasine

Lunasia amara Blanco. (Gibbs, 1974)

L. quercifolia Blanco. (Gibbs, 1974)

L. costulata (Warb.) Lauterb & Kschum. (Price,

Lunine

Lunasia amara Blanco. (Goodwin *et al.*, 1959)

L. quercifolia (Warb.) Lauterb & Kschum. (Johnstone *et al.*, 1958)

Maculine

Flindersia acuminata C. T. White. (Ritchie *et al.*, 1961)

F. bennettiana F. Muell. (Grundon, 1979)

F. dissosperma F. Muell. (Binns *et al.*, 1957)

F. maculosa (F. Muell.) Lindl. (Binns *et al.*, 1957; Brown *et al.*, 1954)

F. schottiana F. Muell. (Hollis *et al.*, 1961)

F. xanthoxyla Domin. (Pakrashi and Bhattacharyya, 1965)

Helietta longifoliata Brittor. (Chang *et al.*, 1976)

Esenbeckia febrifuga A. Fuss. (Dreyer, 1980)

Maculosidine

Balfourodendron riedelianum Engl. (Rapoport *et al.*, 1959)

Eriostemon brucei F. Muell. (Duffield *et al.*, 1963)

E. cocineus C.A. Gardn. (Duffield *et al.*, 1962)

E. difformis A. Cunn. (Duffield *et al.*, 1962)

Maculosidine (cont.)

Eriostemon thryptomenoides S. Moore. (Duffield *et al.*, 1963)

E. tomentellus Diels. (Duffield *et al.*, 1963)

Esenbeckia hartmanii H.B. & K. (Dreyer *et al.*, 1972)

Flindersia maculosa (F. Muell.) Lindl. (Binns *et al.*, 1957)

F. pubescens Bail. (Hollis *et al.*, 1961)

Philoteca hasseli F. Muell. (Duffield *et al.*, 1962)

Ptelea trifoliata L. (Grundon, 1979)

Maculosine

Flindersia dissosperma Domin. (F. Muell.) (Pakrashi and Bhattacharyya, 1965)

F. maculosa F. Muell. (Brown *et al.*, 1954)

Melineurine

Melicope lusioneura (Tilliquin *et al.*, 1983)

Medicosmine

Medicosma cunninghamii Hook. f. (Lamberton and Price, 1953)

6-Methoxydictamnine (Pteleine)

Helietta longifoliata Britton. (Chang *et al.*, 1976)

Platydesma campanulata Mann. (Werny *et al.*, 1963)

P. spathulatum (Glasby, 1975)

Ptelea trifoliata L. (Openshaw, 1967)

6-Methoxy-7-hydroxy dictamnine

Monnieria trifolia L. (Moulis *et al.*, 1981)

6-Methoxyisodictamnine

Dictamnus caucasicus Fisch. (Asatiani *et al.*, 1972)

Methyevoxine

Haplophyllum perforatum Kar. et Ker. (Akhmedzhavova *et al.*, 1975)

Myrtopsine

Myrtopsis sellingii (Hifnaway *et al.*, 1976)

N-Methylplatydesmine

Ruta graveolens L. (Glasby, 1975)

O^4-Methyl-balfourodinium

Balfourodendron riedelianum Engl. (Rapoport and Holden, 1959; Rapoport and Holden, 1960)

Nkolbisine (Montrifoline)

Teclea verdoorniana Exell. & Mendonca. (Ayafor and Okogun, 1982)

O-Methylhydroxyluninum

Ptelea trifoliata L. (Glasby, 1977)

O-Methylhydroxyptelefolonium

Ptelea trifoliata L. (Glasby, 1977)

O-Methylptelefoledonium

Ptalea trifoliata L. (Reisch *et al.*, 1973)

O-Methylptelefolonium

Ptalea trifoliata L. (Reisch *et al.*, 1973)

Perfamine

Haplophyllum perforatum Kar. et Kir. (Razakova *et al.*, 1976)

Perforine

Haploptulluj perforatum Kar. et Kir. (Faizutdinova *et al.*, 1969)

Platydesmine

Flindersia fournieri Panch. et Seb. (Tillequin *et al.*, 1980)

Geijera salicifolia Schott. (Johns *et al.*, 1966)

Melicope perspicuinervia Merr. & Perry (Murphy *et al.*, 1974)

Platydesma campanulata Mann. (Werny and Schever, 1963)

Skimmia japonica Thunb. (Boyd and Grundon, 1967)

Zanthoxylum belizense Lundell. (Najjar *et al.*, 1975)

Z. parviflorum Benth. (Diment *et al.*, 1967)

(+) Platydesminium

Choisya ternata HB. & K. (Sejourne *et al.*, 1981)

Skimmia japonica Thunb. (Boyd and Grundon, 1970)

Pteleine

Medicosma cunninghamii Hook. f. (Bianchi *et al.*, 1968)

Ptelea trifoliata L. (Glasby, 1975)

Ribaline

Balfourodendron riedelianum Engl. (Corral and Orazi, 1973)

Ribalinium

Balfourodendron riedelianum Engl. (Corral and Orazi, 1973)

(+)-Riedelianine

Balfourodendron riedelianum Engl. (Jurd and Wong, 1983)

Robustine

Dictamnus caucasicus Fisch. (Asatiani *et al.*, 1972)

Haplophyllum bucharicum Litv. (Ubaidullaev *et al.*, 1973)

H. dubium Evg. Kor. (Grundon, 1979)

H. pedicellatum Bge. (Grundon, 1979)

Robustine (cont.)

Haplophyllum foliosum Vved. (Faizutdinova *et al.*, 1967)

H. robustum Bge. (Fakhrutdinova *et al.*, 1965)

Zanthoxylum arnottianum Maxim. (Hisashi *et al.*, 1974)

Skimmianine

Acronychia baueri Schott. (Lamberton and Price, 1953)

Aegle marmelos Correa. (Pakrashi and Bhattacharyya, 1965)

Araliopsis sayauxii Engl. (Vaquette *et al.*, 1967)

Balfourodendron riedelianum Engl. (Openshaw, 1967)

Boronia ternata Endl. (Duffield *et al.*, 1963a)

Casimiroa edulis Llave. et Lex. (Iriarte *et al.*, 1956)

Chloroxylon swietenia DC. (Openshaw, 1967)

Choisya arizonica Standl. (Dreyer *et al.*, 1972)

C. mollis Standl. (Dreyer *et al.*, 1972)

C. ternata H.B. et K. (Johns *et al.*, 1967)

Citrus aurantium L. sub. sp. *amara* Engl. (Openshaw, 1967)

C. aurantium L. sub. sp. *natsudaidai* Hauata. (Openshaw, 1967)

C. unshiu Makino. (Openshaw, 1967)

Decatropis bicolor (Zucc.) Radlk. (Dominguez *et al.*, 1971)

Dictamnus albus L. (Openshaw, 1967)

D. angustifolius Sweet. (Brit.) (Grundon. 1979)

D. caucasicus Fisch. (Openshaw, 1967)

Skimmianine (cont.)

Diphasia klaineana (Grundon, 1979)

Eriostemon cocconeus C.A. Gardn. (Duffield *et al.*, 1962)

E. difformis A. Gunn. (Duffield *et al.*, 1962)

E. thryptomenoides S. Moors (Duffield *et al.*, 1963b)

E. tomentellus Diels. (Duffield *et al.*, 1963b)

Esenbeckia febrifuga Juss. (Grundon, 1979)

E. hartananii H.B. & K. (Dreyer *et al.*, 1972)

Euxylophora paraensis Hub. (Jurd and Wong. 1981)

Evodia alata F. Muell. (Johns *et al.*, 1966)

E. eleryana F. Muell. (Johns *et al.*, 1968)

Fagara angolensis Engl. (Openshaw, 1967)

F. capensis Thunb. (Openshaw, 1967; Calderwood *et al.*, 1970)

F. chalybea Engl. (Fish and Waterman, 1972)

F. coco (Gill.) Engl. (Deulofeu *et al.*, 1942)

F. leprieurii Engl. (Eshiett *et al.*, 1968; Fish and Waterman, 1971)

F. macrophylla (Oliv.) Engl. (Grundon, 1979)

F. mantsurica Honda. (Grundon, 1979)

F. mayu Engl. (Benages *et al.*, 1974)

F. okinawensis Nakai. (Grundon, 1979)

F. rubescens Engl. (Grundon, 1979)

F. viridis A. Chev. (Openshaw, 1967)

F. xanthoxyloides Lam. (Openshaw, 1967)

Flindersia bennettiana F. Muell. (Pakrashi and Bhattacharyya, 1965)

Skimmianine (cont.)

Flindersia bourjotiana F. Muell (Pakrashi and Bhattacharyya, 1965)

F. dissospermum Domin. (Binns *et al.*, 1957)

F. laevicarpa C.T. White et Francis. (Breen *et al.*, 1962)

F. maculosa (F. Muell.) Lidl. (Binns *et al.*, 1957)

F. pimenteliana F. Muell. (Bowden *et al.*, 1957)

F. pubescens Bail. (Hollis *et al.*, 1961)

Geijera salicifolia Schott. (Johns and Lamberton, 1966)

Gleznowia verrucosa Turz. (Grundon, 1979)

Glycosmis arborea (Roxb.) DC. (Pakrashi and Bhattacharyya, 1965)

Glycosmis mauritiana Tanaca. (Rastogi *et al.*, 1980)

G. pentaphylla (Retz.) Correa. (Pakrashi and Bhattacharyya, 1965)

Haplophyllum acutifolium (DC.) G. Don. (Grundon, 1979)

H. bucharicum Litwinow. (Openshaw, 1967)

H. bungi Trautv. (Grundon, 1979)

H. dubium Evg. Kov. (Grundon, 1979)

H. foliosum V ved. (Faizutdinova *et al.*, 1967)

H. kowalenskyi Stscheg. (Graundon, 1979)

H. latifolium Kar. & ker. (Nesmelova *et al.*, 1973)

H. obtusifolium Ldb. (Grundon, 1979)

H. pedicellatum Bge. (Grundon, 1979)

H. perforatum Kar. & Ker. (Pakrashi and Bhattacharyya, 1965)

H. popovii Evg. Kov. (Grundon, 1979)

Skimmianine (cont.)

Haplophyllum ramossisium Vved. (Grundon, 1979)

H. robustum Bge. (Fakhrutdinova *et al.*, 1965)

H. schelkovnikovii Grossheim. (Isaev and Bessonona, 1975)

H. suaveolens (DC.) G. Don. (Ionescu and Mester, 1970)

H. tenus Boiss. (Isaev and Bessonova, 1975)

H. villosum (Grundon, 1979; Isaev and Bessonova, 1975)

Helietta longifoliata Britton. (Grundon, 1979)

H. parvifolia (A. Gray) Benth. (Dominguze *et al.*, 1971)

Hortia arborea Engl. (Pachter *et al.*, 1960)

Lunasia amara Blanco. (Goodwin *et al.*, 1959)

Melicope confusa Merr. (Grundon, 1979)

M. fareana Engl. (Price, 1949)

M. perspicuinervia Merr. & Perry. (Murphy *et al.*, 1974)

Monnieria trifolia L. (Rouffiac *et al.*, 1969)

Muraya omphalocarpa Hayata. (Pakrashi and Bhattacharyya, 1965)

Orixa japonica Thunb. (Pakrashi and Bhattacharyya, 1965)

Phebalium nudum Hook. (Briggs *et al.*, 1958)

Philoteca hasseli F. Muell. (Duffield *et al.*, 1962)

Poncirus trifoliata Rafin. (Openshaw, 1967)

Ptelea aptera Perry. (Dreyer, 1969)

P. crenulata Greene. (Dreyer, 1969)

P. trifoliata L. Openshaw, 1967)

Ruta chalepensis L. (Grundon, 1979)

R. graveolens L. (Openshaw, 1967)

R. montana Dill. (Grundon, 1979)

Skimmianine (cont.)

Skimmia arisanensis Hayata. (Openshaw, 1967)

S. japonica Thunb. (Openshaw, 1967)

S. laureola Hook. (Sood *et al*, 1978)

Teclea unifoliata (Grundon, 1979)

Thamnosma montana Torr. et Fren. (Dreyer, 1966)

Toddalia aculeata Pers. (Grundon, 1979)

Verpis bilocularis (Openshaw, 1967)

Zanthoxylum ailanthoides Sieb. et Zucc. (Openshaw, 1967)

Z. alata Roxb. (Grundon, 1979)

Z. belizese Lundell. (Jajjar *et al.*, 1975)

Z. decaryi Vaquette *et al.*, 1974)

Z. dinklagei Waterb. (Fish *et al.*, 1975)

Z. paruiflorum Benth. (Diment *et al.*, 1967)

Z. planispium Sieb. & Zucc. (Pakrashi and Bhattacharyya, 1965)

Zanthoxylum piperitum DC. (Grundon, 1979)

Z. pluviatile Hartley, (Corrie *et al.*, 1970)

Z. rhetsa DC. (Openshaw, 1967)

Z. schinifolium Sieb. et Zucc. (Openshaw, 1967)

Z. tsihanimposa H. Perr. (Decaudain *et al.*, 1974)

Spectabiline

Ravenia spectabilis Engl. (Ralapata *et al.*, 1969)

(syn. *Lemonia spectabiline* Lidl.)

Euxylophora paraensis Hub. (Jurd and Wong, 1981)

1:2:3:4-Tetrahydro-2-isopropenyl-5:7-dimethylfuro-2,3-b quinolin-9-one

Ptelea trifoliata L. (Reisch *et al.*, 1970)

Tecleamine

Teclea ouabanguiensis Aubrev. & Perr. (Ayafor *et al.*, 1982b)

Tecleaverdoornine

Teclea ouabanguiensis Aubrev. & Perr. (Ayafor *et al.*, 1982b)

Tecleine

Teclea ouabanguiensis Aubrev. & Perr. (Ayafor *et al.*, 1982b)

8.3 Pyroquinoline alkaloids.

Folifine [(+) Ribalinine]

Haplophyllum foliosum Vved. (Faizutdinova *et al.*, 1967)

Heplobucharine

Haplophyllum bucharicum Litv. (Glasby, 1975)

Haplofoline

Haplophyllum foliosum Vved. (Bowman, 1966)

(+) Isobalfourodine

Balfourodendron riedelianum Engl. (Rapoport and Holden, 1960; Clarke and Grundon, 1964)

(-) Isobalfourodine (Lunacrinol)

Lunasia amara Blanco. (Goodwin *et al.*, 1959; Bowman, 1966)

Khaplofoline

Haplophyllum foliosum Vved. (Bowman, 1966)

H. suaveolens (DC.) G. Don. (Ionescu *et al.*, 1970)

N-Methyl khaplofoline

Almeidea guyanensis (Moulis *et al.*, 1983)

Haplophyllum suaveolens (DC.) G. Don. (Ionescu *et al.*, 1970)

Ribalinidine

Balfourodendron riedelianum Engl. (Corral *et al.*, 1973)

Haplophyllum glabrinum (Roza *et al.*, 1982)

Ribalinine [(-) Ribalinine]

Araliopsis soyauxii Engl. (Vaquetie *et al.*, 1976)

A. tabouensis Aubrev. et Pellegr. (Fish *et al.*, 1976)

Balfourodendron riedelianum Engl. (Corral *et al.*, 1973)

Fagara mayu Bert. et Hook. et Arn. (Torres *et al.*, 1978)[(syn. *Zanthoxylum mayu* (Bert.) Engl.)]

Pteleflorine

Ptelea trifoliata L. (Reisch *et al.*, 1975)

Neohydroxylunine

Ptelea trifoliata L. (Mitscher *et al.*, 1975)