CHAPTER II

HISTORICAL

The Genus *Strychnos*

1. Botanical Generalities

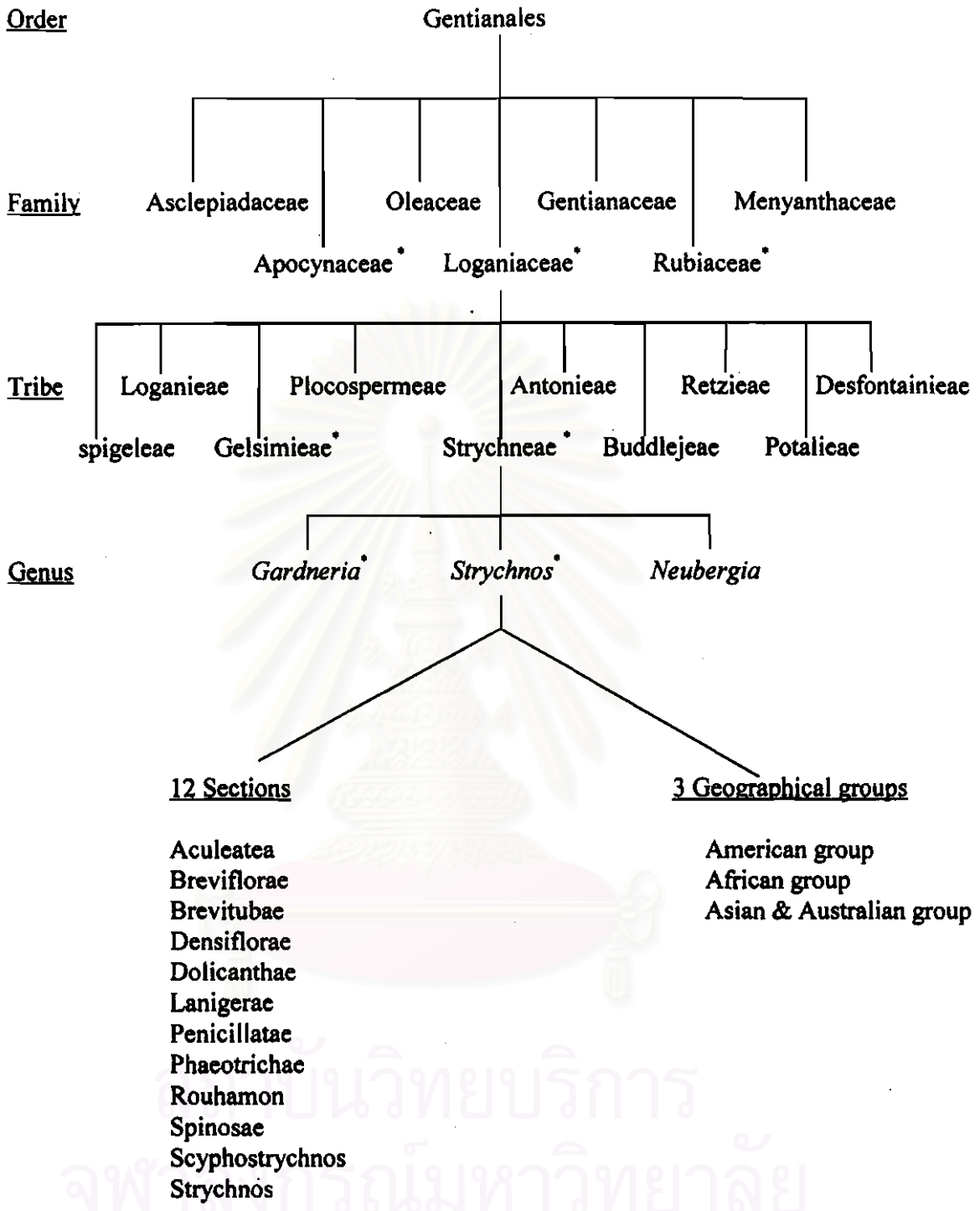
Strychnos L. is the largest of three genera belonging to the tribe Styrchneae, the other members of which are *Gardneria* Wall. And *Neuburgia* Bl. . It is also the largest of the entire family Loganiaceae and at the same time is regarded as the chemically most important. The genus is pantropical in distribution, comprising about 200 species which can be classified into three groups according to their geographical origin : one of African *Strychnos* with 75 species [11], one of *Strychnos* in central and south America with 70 species and 2 varieties [12], and the other of 44 species in Asia including Australia [1]. The members in the three groups are almost totally separated; *Strychnos potatorum* L.F. which belongs to both the Asian and the African groups is the only exception [1].

The genus *Strychnos* was first described in 1753 by Linnaeus who based it upon *S. nux-vomica* , the type species, and *S. colubrina*[13]. Plants in this genus are found ranging from lianas, scrambling or erect shrubs, and even trees. They possess some typical characteristics which make them recognizable, such as opposite leaves, limbs with three basal nerves and single, double, or quadruple curled tendrils in the case of climbers. One of excellent botanical descriptions for *Strychnos* has been given by Leenhouts [14] and it is repeated here as the following.

Usually lianas, sometimes shrubs or treelets; usually provided with axillary, single or double tendrils and sometimes with axillary thorns; stems and older branches in some species spiny. Stipules reduced to a mostly ciliate and straight rim connecting the leaf-bases. Leaves mostly inserted upon distinct leaf-cushions, 3-5(-7)-plinerved, i.e. apart from the midrib nearly always provided with one or a few pairs of nearly equally strongly developed basal nerves which do not fully reach the leaf apex; penninerved in a few African species. Some pairs of scale-like cataphylls are present at the base of new shoots, of inflorescence, and of the branches of the latter. Inflorescence terminal or axillary, thyrsoid. Bracts scale-like. Flower (4-)5-merous. Calyx nearly completely divided, lobes in Malasian spp. always broad, scale-like, and brown (in African and

American spp. Sometimes lanceolate and green), outside usually very sparsely hairy, ciliate rotate to salver-shaped, white to yellowish or greenish, thin-fleshy, always more or less thickened towards the lobes, the basal part included by the calyx much thinner, outside usually distinctly densely papillose, mostly glabrous, inside various hairy except the thin basal part; lobes valvate in bud, spreading to reflexed when open. Stamen exserted; anthers mostly slightly bifid at the base, intorse. Ovary 2-(in some African spp.1-) celled, with many ovules; style cylindric, stigma faintly 2-lobed. Berry usually globose or ellipsoid, the thin to thick shell in Malasian spp. always hard, outside smooth or minutely warty, globrous, orange to red when ripe; pulp fleshly, usually orange. Seeds 2-1, either lenticular, orbicular to elliptic and usually convex on one and concave on the other side with a silky or felty testa, or irregular castorbean-shaped and glabrous; endosperm bony.

Botanically, *Strychnos* species are organized into 12 sections based on combination of such features as the length of the corolla tube, the nature of the indumentum on the inner surface of the corolla, the arrangement of the tendrils, the shape and indumentum of the seeds, and the insertion of the stamens and indumentum of the pistils [15]. The taxonomic background of the *Strychnos*[16] and the membership of its species based on both botanical and geographical classifications[1,12,17] are summarized in Scheme 2.1 and Table 2.1, respectively.



Scheme 2.1 Taxonomic background of the *Strychnos*

* Taxon which is rich source of indole alkaloids

Table 2.1 *Strychnos* species

Section	Species in Africa	Species in America	Species in Asia & Australia
Aculeatae	*S. aculeata* Solered.		
Breviflorae	*S. afzelii* Gilg	*S. acuta* Prog.	
	S. angolensis Gilg	*S. atlantica* Krukoff & Barneby	
	S. campicola Gilg ex Leeuwenberg	*S. brachistantha* Standley	
	S. chromatoxylon Leeuwenberg	*S. brasiliensis* (Spreng.)Mart.	
	S. dolichothyrsa Gilg ex Onochie et Hepper	*S. castelnaeana* Wedd.	
	S. henningsii Gilg	*S. cerradoensis* Krukoff & Barneby	
	S. icaja Baill.	*S. fendleri* Sprague & Sandw.	
	S. malacoclados C.H.Wright	*S. fulvotomemtosa* Gilg	
	S. malchairii De Wild.	*S. grayi* Grisebach	
	S. mimfiensis Gilg ex Leeuwenberg	*S. malacosperma* Ducke & Froes	
	S. mitis S. Moore	*S. mattogrossensis* S.Moore	
	S. urceolata Leeuwenberg	*S. neglecta* Krukoff & Barneby	
		S. nigricans Prog.	
		S. oiapocensis Froes	
		S. pachycarpa Ducke	

(continued)

Section	Species in Africa	Species in America	Species in Asia & Australia
Breviflorae		*S. parviflora* Spruce ex Benth*S. parvifolia* A.Dc.	
		S. poeppigii Prog.	
		S. progeliana Krukoff & Barneby	
		S. rubiginosa A.Dc.	
		S. schultesina Krukoff	
		S. tarapotensis Sprague & Sandw.	
Brevitubae	*S. cuminodora* Leeuwenberg		*S. bicirrhosa* Lesch. et Wall.,
	S. cuniculina Leeuwenberg		*S. flavescens* King et Gamble
	S. johnsonii Hutch. et M.B.Moss		*S. luzonensis* Elmer
	S. mellodora S.Moore		*S. tetragona* A.W.Hill
	S. millepunctata Leeuwenberg		*S. umbellata* (Lour.)Merr
	S. samba Duvign.		*S. vanprukii* Craib
	S. xylophylla Gilg		*S. vitiensis* A.W.Hill
Densiflorae	*S. densiflora* Baill.		
	S. innocua Del.		
	S.hucens Bak.		
	S. madagascariensis Poir.		
	S. nigritana Bak.		
	S. pungens Solered		

(continued)

Section	Species in Africa	Species in America	Species in Asia & Australia
Densiflorae	*S. standtii* Gilg		
	S. zenkeri Gilg ex Bak.		
Dolichanthae	*S. asterantha* Leeuwenberg		
	S. barteri solered.		
	S. canthioides Leeuwenberg		
	S. gossweileri Exell		
	S. melastomatoides Gilg		
	S. odorata A.chev.		
	S. perninervis A.Chev.		
	S. tricalysioides Hutch. et M.B.Moss		
	S. xantha Leeuwenberg		
Lanigerae	*S. chrysophylla* Gilg		*S. andamanensis* A.W.Hill
	S. dinklagei Gilg		S. *borneensis* Leenh.
	S. fallax Leeuwenberg		*S. coriacea* Thwaites
	S. kasangaensis De Wild		*S. curtisii* King et Gamble
	S. memecyloides S.Moore		*S. hypogyna* C.B.Clarke
	S. moandoaensis De Wild		
	S. ngouniensis Pellegr		*S. minor* Dennst.
	S. panganensis Gilg		

(continued)

Section	Species in Africa	Species in America	Species in Asia & Australia
Lanigerae			*S. maingayi* C.B.Clarke
			S. myrioneura Gilg
	S. scheffleri Gilg		*S. oleifolia* A.W.Hill
	S. soubrensis Hutch. et Dalz.		*S. ovata* A.W.Hill
	S. splendens Gilg		*S. polyantha* Pierre ex Dop
	S. talbotiae S.Moore		*S. Polytrichantha* Gilg
			S. rufa C.B.Clarke
			S. thorelii Pierre ex Dop
			S. villosa A.W.Hill
Penicillatae	*S. bifurcata* Leeeuwenberg		*S. axillaris* colebr.
	S. diplotricha Leeeuwenberg		*S. benthamii* C.B.Clarke
	S. longicaudata Gilg		*S. dalzellii* C.B.Clarke
	S. matopensis S. Moore		*S. melanocarpa* Gilg et Bened
	S. mostueoides Leeeuwenberg		*S. ridleyi* King et Gamble
	S. myrtoides Gilg et Busse		*S. trichocalyx* A.W.Hill
	S. pentantha Leeeuwenberg		
	S. tchibangensis Pellegr.		
	S. trichoneura Leeeuwenberg		
Phaeotrichae	*S. phaeotricha* Gilg		

(continued)

Section	Species in Africa	Species in America	Species in Asia & Australia
Rouhamon	*S. boonei* De Wild.	*S. bicolor* Prog.	*S. potatorum* L.f.
	S. dale De Wild.	*S. cogens* Benth.	
	S. decussata (Pappe) ex Gilg	*S. duckei* Krukoff & Monachino	
	S. elaeocarpa Gilg ex Leeuwenberg	*S. glabra* Sagot ex Prog.	
	S. floribunda Gilg	*S. goiasensis* Krukoff & Barneby	
	S. gnetifolia Gilg ex Onochie et Hepper	*S. guianensis* (Aubl.) Mart.	
	S. ndengensis Pellegr	*S. hirsuta* Spruce ex Benth.	
	S. potatorum L.	*S. melinoniana* Baill.	
	S. retinervis Leeeuwenberg	*S. panurensis* Sprague & Sandw.	
	S. usambarensis Gilg	*S. subcordata* Spruce ec Benth.	
	S. variabilis De Wild.		
Spinosae	*S. cocculoides* Bak.		
	S. congolana Gilg		
	S. spinosa Lam.		
	S. ternata Gilg ex Leeuwenberg		
Scyphostrychnos	*S. camptoneura* Gilg et Busse		
Strychnos	*S. amazonica* Krukoff		*S. angustiflora* Benth.
	S. araguaensis Krukoff & Barneby		*S. cathayensis* Merr.
	S. asperula Sprague & Sandw.		*S. cheliensis* Hu

(continued)

Section	Species in Africa	Species in America	Species in Asia & Australia
Strychnos	*S. bahiensis* Krukoff & Barneby		*S. henryi* Merr. et Yamamoto
	S. barrnhartiana Krukoff		*S. ignatii* Berg.
	S. brachiata Ruiz & Pavon		*S. lucida* R.Br.
	S. bredemeyeri (Schultes) Sprague & Sandw.		*S. narcondamensis* A.W.Hill
	S. chlorantha Prog.		*S. nitida* G.Don
	S. colombiensis Krukoff & Barneby		*S. nux-blanda* A.W.Hill
	S. darienensis Seem.		*S. nux-vomica* Linn.
	S. diaboli Sandw.		*S. rupicola* Pierre ex Dop
	S. divaricans Ducke		*S. wallichiana* Steud. ex DC.
	S. erichsonii Rich. Schomb.		
	S. eugeniifolia Monachino		
	S. froesii Ducke		
	S. gardneri A.Dc.		
	S. javariensis Krukoff		
	S. jobertiana Baill.		
	S. krukoffiana Ducke		
	S. lobelioides Krukoff & Barneby		
	S. macrophylla Barb.Rodr.		
	S. medeola Sagot ex Prog.		

(continued)

Section	Species in Africa	Species in America	Species in Asia & Australia
Strychnos	*S. mitscherlichii* Rich.Schomb.		
	S. panamensis Seem.		
	S. peckii B.L.Robinson		
	S. pseudo-quina A.St.Hil.		
	S. pubiflora Krukoff		
	S. ramentifera Ducke		
	S. romeu-belenii Krukoff & Barneby		
	S. rondeletioides Spruce ex Benth.		
	S. sandwithiana Krukoff & Barneby		
	S. solerederi Gilg		
	S. solimoesana Krukoff		
	S. tabascana Sprague & Sandw.		
	S. tomentosa Benth.		
	S. toxifera Rob. Schomb.		
	S. trinervis (Vell.) Mart.		
	S. xinguensis Krukoff		

2. The Ethnobotany of *Strychnos* species

Plants in the genus *Strychnos* have long been known of their uses which can be classified into three major categories: the use as food, the use in medicine and the use for poisoning purpose. An account of the use of *Strychnos* species dealing with each category is given as follows.

Strychnos as food

The fruit pulp of some *Strychnos* species in Asia and Africa was recorded as being eaten by the inhabitants in these two continents. However, there were indications that the fruit pulp of other species without such records was also edible or at least was believed to be non-poisonous. The use of *Strychnos* as food seemed to be more important for African natives than for those in Asia [9,16].

Strychnos in medicine

The well-known representatives for *Strychnos* used in medicine are the two Asian species, *S. nux-vomica* L. and *S. ignatii* Berg., the seeds of which were introduced to the west and became available in European market in the names of "nux-vomica" and "Saint ignatius bean" respectively. The drugs possess similar properties, the former was, however, more popularly used. They both were employed in the treatment of various ailments as well as in poisoning. These drugs are also main sources of the alkaloid strychnine,which was once reputed of medicinal importance [9,13].

Besides nux-vomica and St. ignatius bean, another drug which was derived from Asian *Strychnos* and became known in Europe was "lignum colibrinum". The drug came into use during the second half of the 16th century as a febrifuge, anthelmintic, and antidote for poisoning. It was much recommended in the 17th century however the adverse effects of an overdose (trembling, stupor, convulsion, mania and vomiting) which were soon noticed, caused the drug to gradually go out of fashion. Early in the 19th century it was no, longer being imported into Europe, although it was still occasionally being recommended and it appeared in books on materia medica long afterwards. *Strychnos* species which were defined as sources of lignum colibrinum included *S. wallichiana* ex DC., *S. nux-vomica* L., *S. lucida* RBr. And possibly *S. minor* Dennst [17].

From the ethnobotanical information gathered by Bisset, 13 species of Asian *Strychnos* and 20 species of African *Strychnos* were stated to be used medicinally [9]. These species were employed in the treatment for a variety of ailments. Some major categories into which such uses and conditions treated can be devided are the followings: emetic; purgative; febrifuge (and malaria); analgesic and rheumatism, stimulant and tonic; abdominal and gastrointestinal complaints; chest and lung complaints; eye troubles; ear, nose and throat troubles; skin troubles; veneral diseases, aphrodisiac, abortifacient; epilepsy and insanity; worms and parasites; snake-bite and poisoning and miscellaneous uses.

There were some different between the uses in Asia and in Africa. While the major use of African *Strychnos* seemed to be as emetic and purgative, and the roots were the plant part which was most frequently found to be employed, Asian *Strychnos* were mainly used as a stimulant and tonic and the fruits (pulp and/or seeds) dominated the drugs [9,16].

Strychnos as poisons

Natives of the three continents , America, Africa and Asia, had their ancestral knowledge about the toxicity of *Strychnos* species. Several American *Strychnos* were employed in preparation of "curares", the aqueous extracts obtained from the root bark of the plants, which were used as an arrow poison by the south American indians. The drugs possess muscle-relaxant activity, causing the lethal effect through respiratory paralysis. The active principles of the drugs have been indicated to be water-soluble bases, the quaternary dimeric indole alkaloids [18,19]. The root bark of some Asian *Strychnos* was also employed in making arrow and dart poisons by the natives of South-East Asia. The Asian drugs have usually been found to have a convulsant action for which strychnine and its derivatives account [20,21]. However the curarizing activity has also been observed from some drugs derived from certain Asian species [22]. A few of African Strychnos were consumed as curarizing arrow poisons while some were found to exert convulsive effect [23,24,25].

In addition to employing as arrow and dart poisons, *Strychnos* species have been used in other poisoning purpose. The root bark of some African species was consumed as an ordeal poison [23]; Some in Asia were recorded as fish poison [9]. Nux-vomica and St.

ignatius bean which were employed in the treatment of various ailments were also used in bait to kill dogs, cats and rodents.

3. Chemical constituents of *Strychnos* species

The major constituents of *Strychnos* are alkaloids. Almost all of the bases are members of the indole group which is dominated by those containing a monoterpenoid unit in the molecule. More than 300 representatives of these so-called "terpenoid indole alkaloids" have been isolated from *Strychnos* species with a variety of structural skeletons. An account of the alkaloids found in the *Strychnos* is available in the next topic of "*Strychnos* alkaloids".

Other compounds found in the *Strychnos* species include lignans, iridoids, triterpenoids, steroids, flavonoids and miscellaneous substances. Except for the lignans and the iridoids, the information of which is given exclusively in the topic of "Lignans and iridoids of the *Strychnos* ", the non-alkaloidal components of *Strychnos* species are listed with their sources as shown in Table 2.2.

Table 2.2 Chemical constituents of *Strychnos* species*

Chemical Constituent	*Strychnos* species	Plant part	Reference
1. Triterpenoids			
Amyrin-lupeol	*S. potatorum*	seed	26
Filican-3-one	*S. dolichothrysa*	stem bark	27
Friedelin	*S. henningsii*	stem bark	28
Isomotiol	*S. potatorum*	leaf	29
Oleanolic acid	*S. potatorum*	seed	30
Oleanolic acid-3-*O*-β-acetate	*S. potatorum*	seed	30
2. Steroids			
Campesterol	*S. afzelii*	stem bark	31
	S. dolichothrysa	stem bark	32
	S. floribunda	stem bark	33
	S. potatorum	leaf bark	29
β-Sitosterol	*S. afzelii*	stem bark	31
	S. colubrina	entire plant	34
	S. dolichothrysa	stem bark	32
	S. floribunda	stem bark	33
	S. potatorum	seed	30
Stigmasterol	*S. afzelii*	stem bark	31
	S. dolichothrysa	stem bark	32
	S. floribunda	stem bark	33
	S. potatorum	seed	26

(continued)

Chemical Constituent	*Strychnos* species	Plant part	Reference
3. Falvonoids			
Hyperoside	*S. variabilis*	leaf	35
Isorhamnotin	*S. pseudoquina*	leaf	36
Kaempferol-3-robinobioside	*S. variabilis*	leaf	35, 37
Kaempferol-3-(4"-*cis*-*p*-coumaroyl)-robinobioside	*S. variabilis*	leaf	37
Kaempferol-3-(4"-*trans*-*p*-coumaroyl)-robinobioside	*S. variabilis*	leaf	37
Kaempferol-3- robinobioside-7-glucoside	*S. variabilis*	leaf	37
Quercetin-3-robinobioside	*S. variabilis*	leaf	37
Quercetin-3-(4"-*cis*-*p*-coumaroyl)-robinobioside	*S. variabilis*	leaf	35, 37
Quercetin-3-(4"-*trans*-*p*-coumaroyl)-robinobioside	*S. variabilis*	leaf	37
Quercetin-3- robinobioside-7-glucoside	*S. variabilis*	leaf	37
Quercetin-3-rhamnosyl-(1,6)-galactoside-7-glucoside	*S. variabilis*	leaf	38
Strychnobiflavone	*S. pseudoquina*	leaf	36
Variabiloside A	*S. variabilis*	leaf	37
Variabiloside B	*S. variabilis*	leaf	37
Variabiloside C	*S. variabilis*	leaf	37
Variabiloside D	*S. variabilis*	leaf	37
Variabiloside E	*S. variabilis*	leaf	38
Variabiloside F	*S. variabilis*	leaf	38
Variabiloside G	*S. variabilis*	leaf	38
Variabiloside H	*S. variabilis*	leaf	38
4. Benzenoids			
Cuchiloside	*S. nux-vomica*	fruit	39
Salidroside	*S. nux-vomica*	fruit	39
Syringic acid methyl ester	*S. dinklagei*	stem bark	40
5. Carbohydrates			
D-galactose	*S. potatorum*	seed	41
D-mannose	*S. potatorum*	seed	30
Strychnos mannogalactan	*S. potatorum*	seed	30
6. Fatty acids			
Lignoceric acid	*S. potatorum*	seed	42
Linoleic acid	*S. potatorum*	seed	42
Oleic acid	*S. potatorum*	seed	42
Palmitic acid	*S. potatorum*	seed	42
Stearic acid	*S. potatorum*	seed	42

***Strychnos* alkaloids**

The majority of compounds found in *Strychnos* species belong to the group of alkaloids, most of which are terpenoid indole bases which contain two structural elements in the molecule ; a β-carboline moiety arising from tryptamine and a C_9 or C_{10} monoterpenoid unit derived from secologanin. According to the structural characteristics of their skeletons, Kisakurek and Hesse have arranged the terpenoid indole alkaloids into 8 types [43] (Scheme 2.2). They are corynanthean-(C-), vincosan-(D-), vallesiachotaman-(V-), strychnan-(S-), and aspidospermantan-(A-) types with a nonrearrangeed secologanin moiety, together with eburnan-(E-), plumeran-(P-) and ibogan-(J-) types with a rearranged secologanin moiety. Another generally accepted classification has been outlined by Coune who organized the bases into groups according to their degree of metabolic evolution, determined by numbers and sites of cyclizations in the molecule [44] (Scheme 2.3).

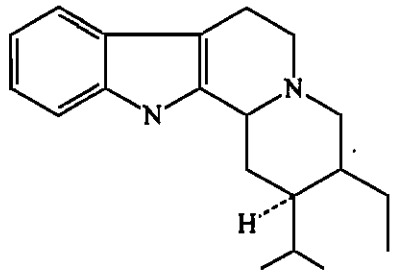
1. Classification of *Strychnos* alkaloids

The alkaloids of the *Strychnos* can be classified as shown in Scheme 2.4. The tepenoid indole bases isolated from *Strychnos* species have been so far found as members of 6 skeletal types, which are C-, D-, V-, S-, A-, and J-types, together with the groups of alkaloids whose skeletal type can not be clearly defferentiated. Dimeric alkaloids are also found, forming by the combination between two units of the same or the different types. The majority of the alkaloids belong to the S- and the C- types. However the former is much more abundant and it is this type of the bases which is regarded as the characteristic of the '*Strychnos* alkaloids'.

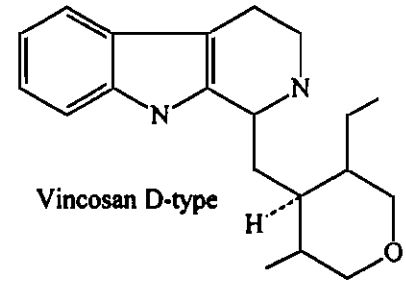
The terpenoid indole alkaloids found in *Strychnos* species can be organized into grups as the following.

I. Monomeric alkaloids

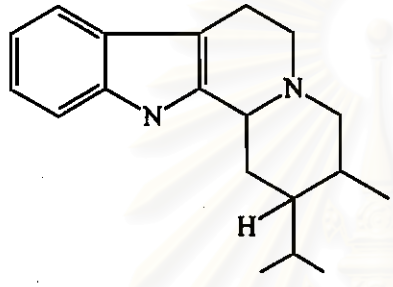
1. Corynanthean-(C-) type
   - 1.1 Corynanthean group *eg.* geissoschizine (1) , 16(R)-isositsirikine (2)
   - 1.2 Ajmalicine group *eg.* alstonine (3), serpentine (4)
   - 1.3 Yohimbine group *eg.* decarbomethoxydihydrogambirtannine (5)
   - 1.4 Sarpagine group *eg.* macusine B (6), normacusine B (7)
   - 1.5 Mavacurine group *eg.* mavacurine (8), *C*-fluorocurine (9)



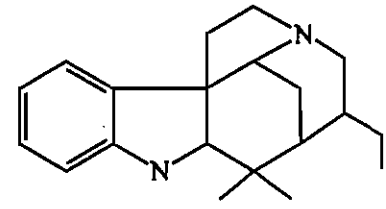
Corynanthean C-type



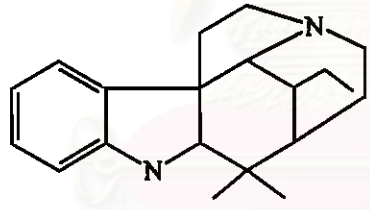
Vincosan D-type



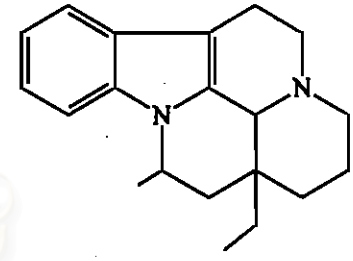
Vallesiachotaman V-type



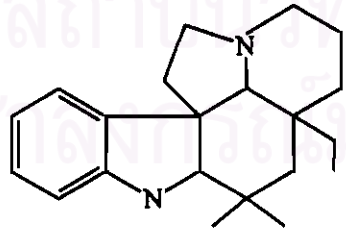
Strychnan S-type



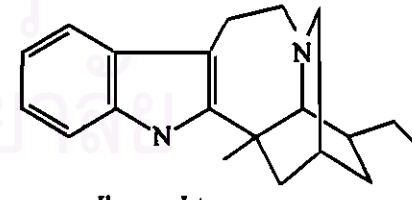
Aspidospermatan A-type



Eburnan E-type

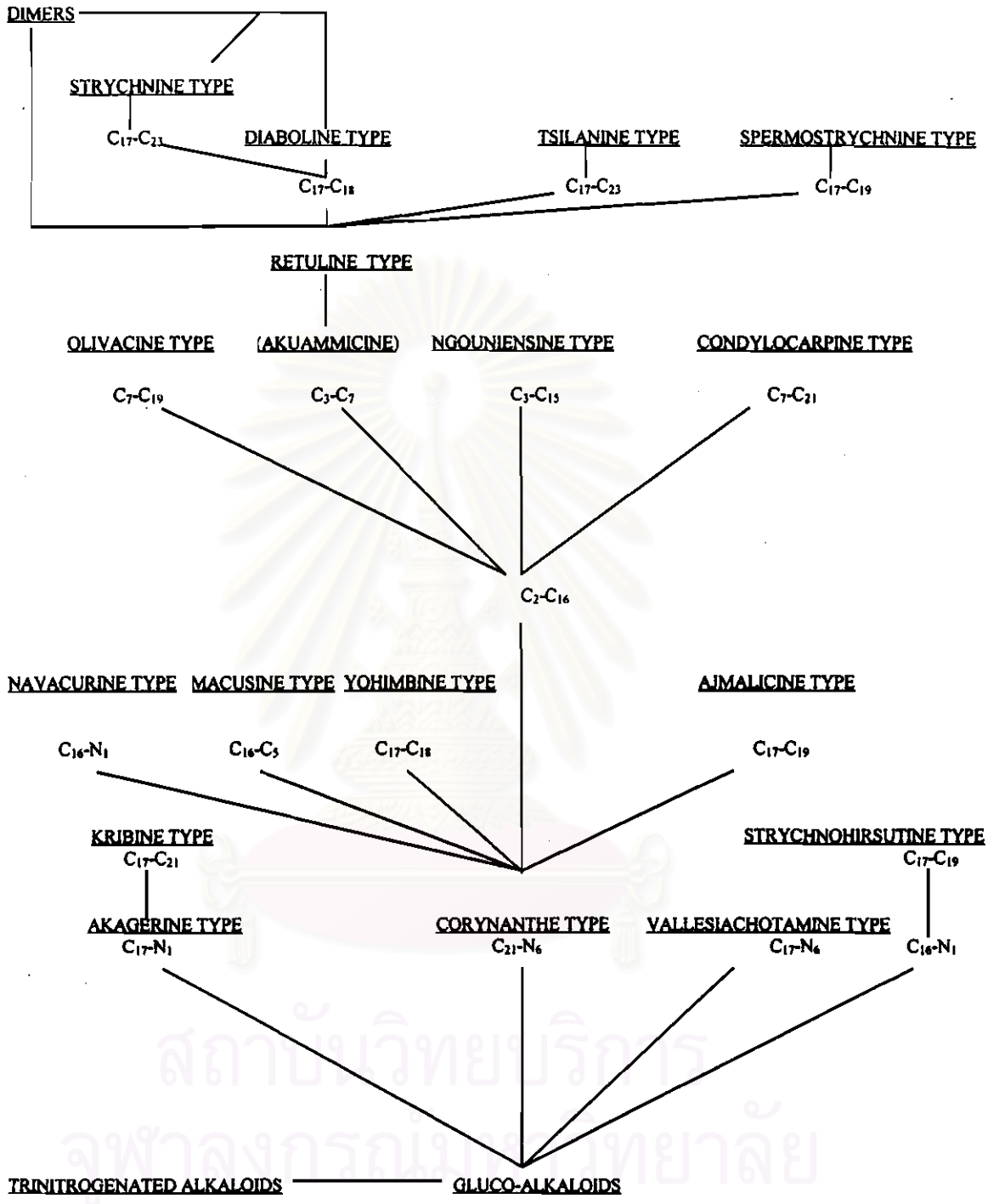


Plumeran P-type

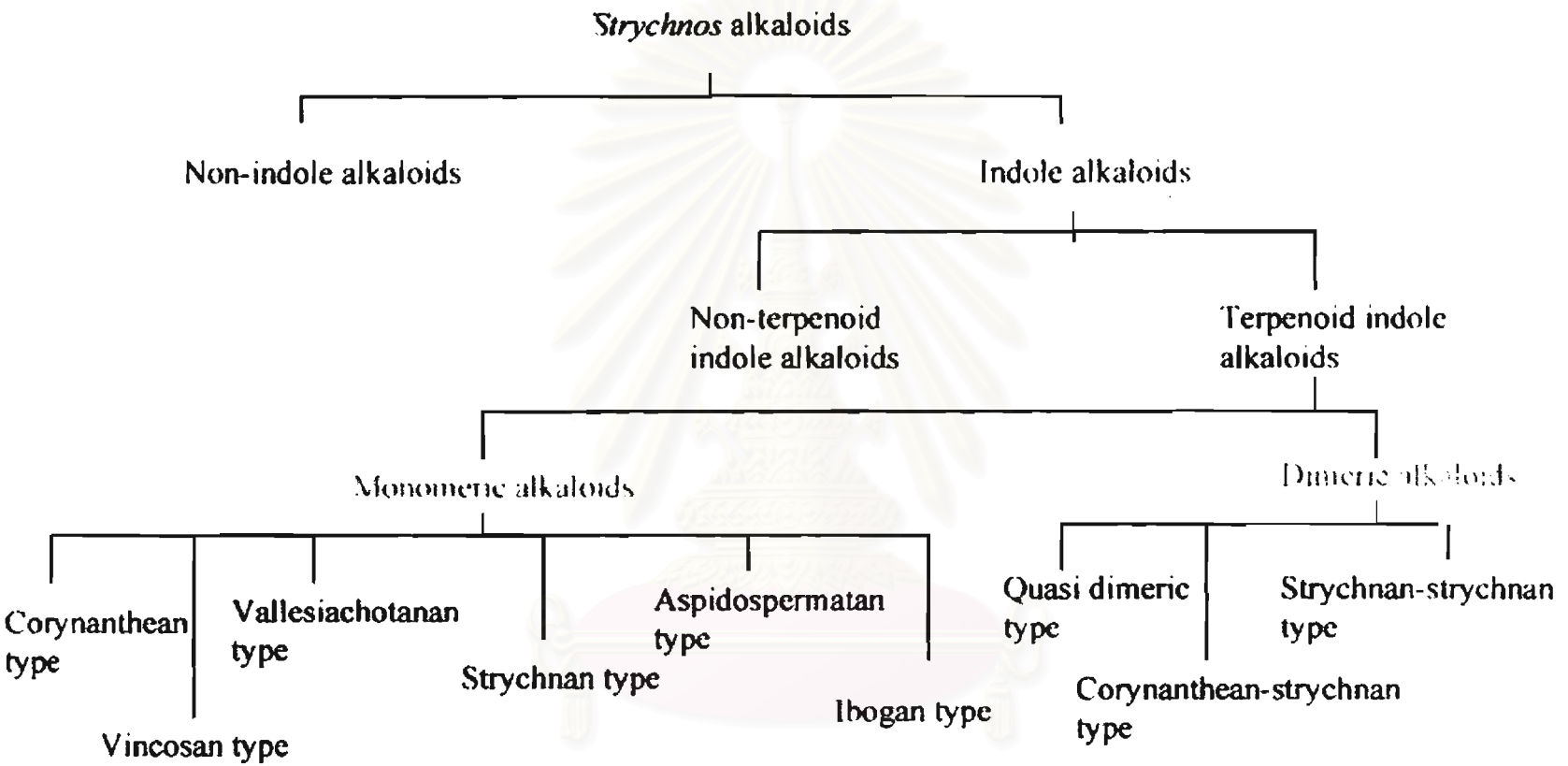


Ibogan J-type

Scheme 2.2 Main structural types of terpenoid indole alkaloids



Scheme 2.3 Biogenetic classification of terpenoid indole alkaloids



Scheme 2.4 classification of *Strychnos* alkaloids

1.6 Akagerine group *eg.* akagerine (10), kribine (11)

2. Vincosan-(D-) type

2.1 Strychtosidine group *eg.* dolichantoside (12), isodolichantoside (13)

2.2 Decussine group *eg.* decussine (14), camptoneurine (15)

3. Vallesiachotaman-(V-) type

3.1 Antirhine group *eg.* antirhine (16), N_b-methylantirhine (17)

3.2 Angustine group *eg.* angustine (18), angustoline (19), angustidine (20)

4. Strychnan-(S-) type

4.1 Retuline group

Normal series *eg.* retuline (21), isoretuline (22)

N-methyl-*sec*pseudo series *eg.* alvimine (23)

4.2 Diaboline group

Normal series *eg.* diaboline (24), Wieland-Gumlich aldehyde (25)

N-methyl-*sec*pseudo series *eg.* alviminine (26)

4.3 Tsilanine group

Normal series *eg.* tsilanine (27)

N-methyl-*sec*pseudo series *eg.* holstiine (28), holstiline (29)

4.4 Spermostrychnine group

Normal series *eg.* spermostrychnine (30), strychnospermine (31)

Pseudo series *eg.* strychnosplendine (32), splendoline (33)

N-methyl-*sec*pseudo series *eg.* isosplendine (34),

strychnobrasiline (35), strychnofendlenine (36)

4.5 Isostryshnine group

eg. isostrychnine (37), isobrucine (38)

4.6 Strychnine group

Normal series *eg.* strychnine (39), brucine (40), α-colubrine (41)

β-colubrine (42)

Pseudo series *eg.* pseudostrychnine (43)

N-methyl-*sec*pseudo series *eg.* icajine (44), novacine (45),

vomicine (46)

5. Aspidospermatan-(A-) type

5.1 Condylocarpine group *eg.* condylocarpine (47), tubotaiwine (48)

6. Ibogan-(J-) type

6.1 Ibogamine group *eg.* 17-hydroxyalloibogamine (49)

7. Unidentified group

7.1 Olivacine group *eg.* ellipticine (50)

7.2 Ngouniensine group *eg.* ngouniensine (51)

II Dimeric alkaloids

1.Quasi dimeric alkaloids (Corynanthean type with an additional β-carboline unit)

1.1 Usambarensine group *eg.* usambarensine (52), tchibangensine (53)

1.2 Strychnofoline group *eg.* strychnofoline (54), strychnophylline (55)

2. Strychnan-corynanthean type

2.1 Retuline-corynantheine group *eg.* longicaudatine Y (56)

2.2 Diaboline-corynantheine group *eg.* longicaudatine (57)

3. Strychnan-strychnan type

3.1 Retuline-retuline group

- Toxiferine group *eg.* toxiferine (58), *C*-alkaloid H (59), bisnordihydrotoxiferine (60)
- calebassine group *eg.* calebassine (61), *c*-alkaloid F (62), *C*-alkaloid A (63)
- Curarine group *eg.* curarine (64), *c*-alkaloid G (65), *C*-alkaloid E (66)
- Matopensine group *eg.* matopensine (67)

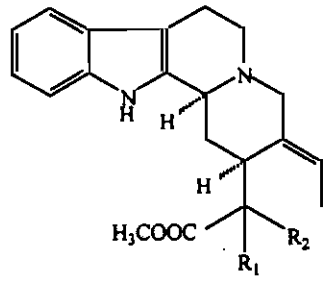
3.2 Retuline-diaboline group *eg.* dolichocurine (68)

3.3 Diaboline-diaboline group *eg.* caracurine II (69), caracurine V (70)

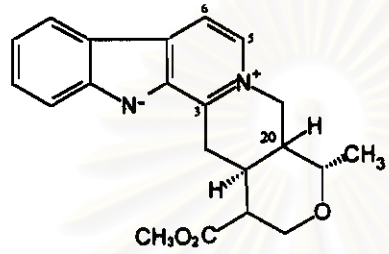
3.4 Isostrychnine-isodtrychnine group *eg.* sangucine (71)

4. Miscellaneous

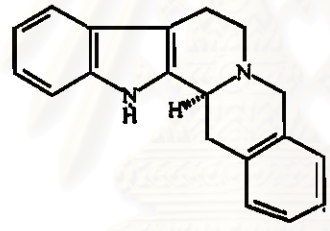
eg. janussine A (72), strellidimine (73)



	R_1	R_2
1	=CHOH	
2	βH	CH_2OH



3 20α- H
4 20β- H



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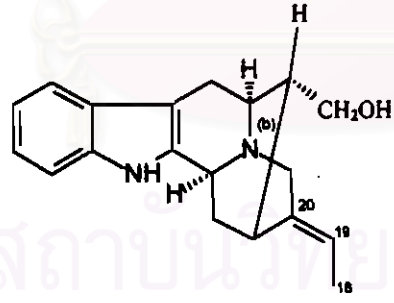
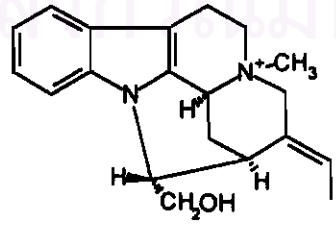


6
7 N_b- Me



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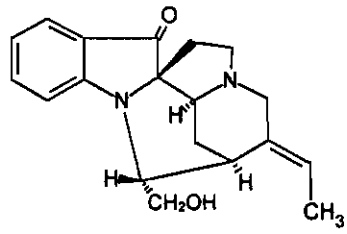

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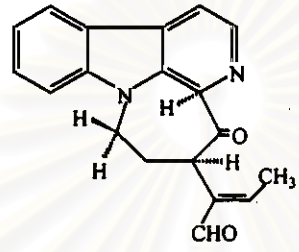

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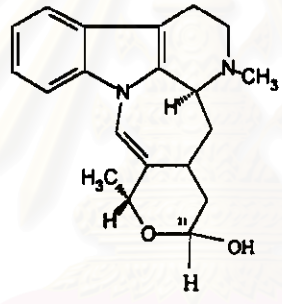

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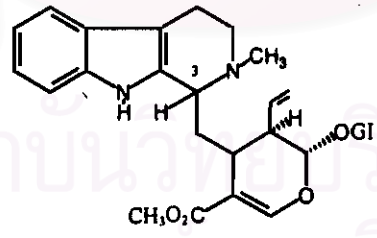
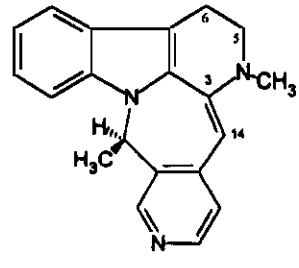


12 3α - H
13 3β - H



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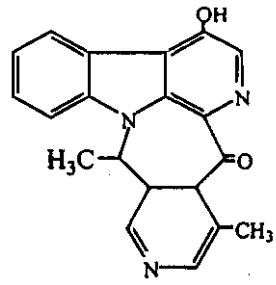

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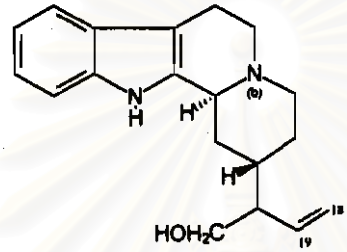
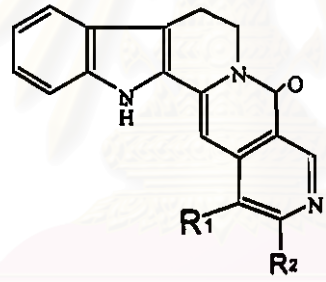
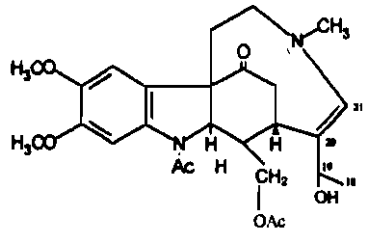


16
17 N_b-Me



	R_1	R_2
18	$CH{=}CH_2$	H
19	CH(OH)Me	H
20	H	Me

	R_1	R_2
21	CH_2OH	H
22	H	CH_2OH



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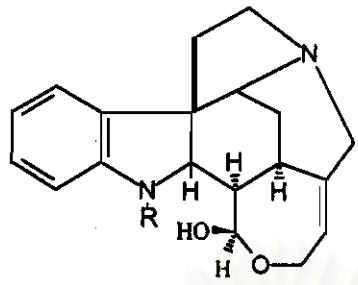
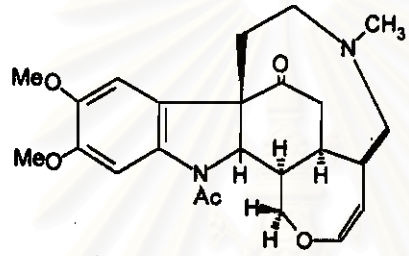


24 R=Ac
25 R=H



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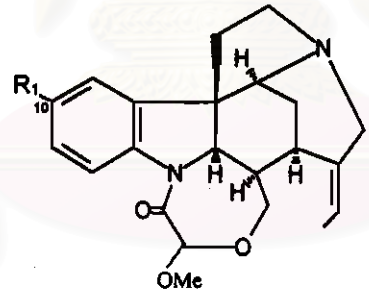

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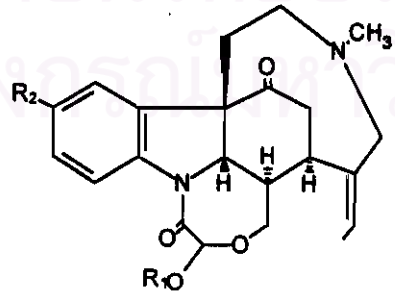
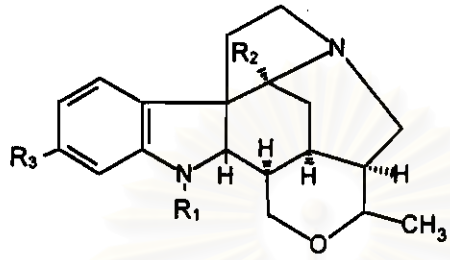
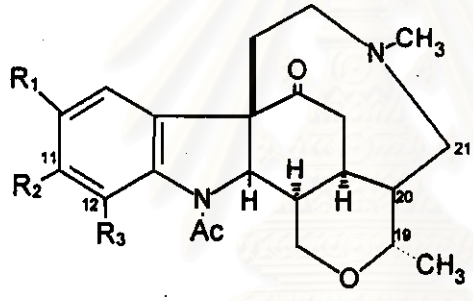


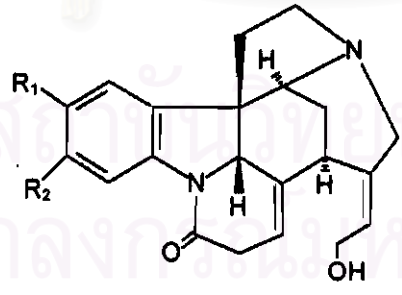
	R1	R2
28	H	H
29	Me	H



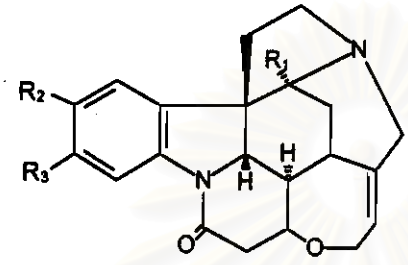
	R_1	R_2	R_3
30	Ac	H	H
31	Ac	H	OMe
32	H	OH	H
33	CO_2CH_2OH	OH	H



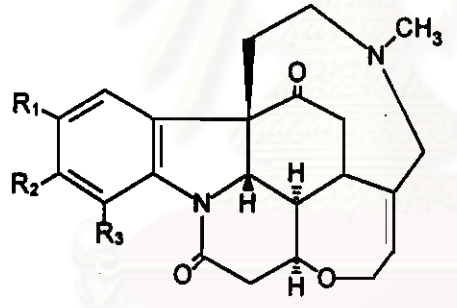
	19-Me	20H
34	α	α
35	β	Δ 20, 21
36	β	α



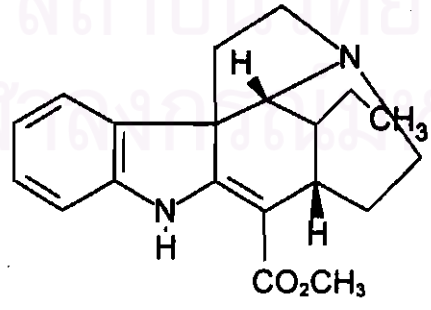
	R_1	R_2
37	H	H
38	OMe	OMe



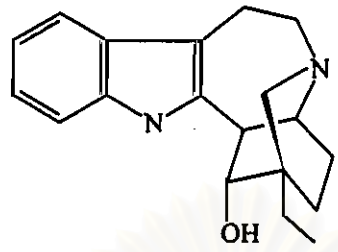
	R_1	R_2	R_3
39	H	H	H
40	H	OMe	OMe
41	H	OMe	H
42	H	H	OMe
43	OH	H	H



	R_1	R_2	R_3
44	H	H	H
45	OMe	OMe	H
46	H	H	OH



47 Δ 19, 20
48



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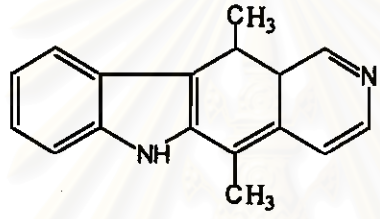

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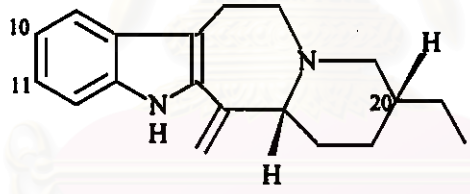

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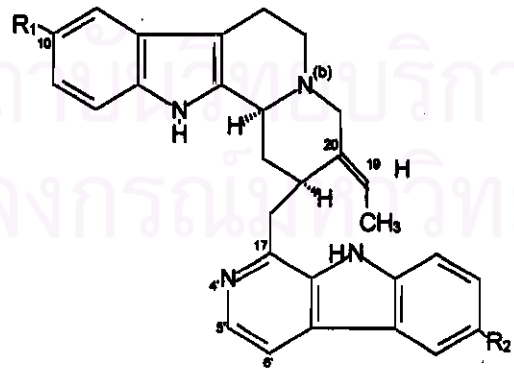
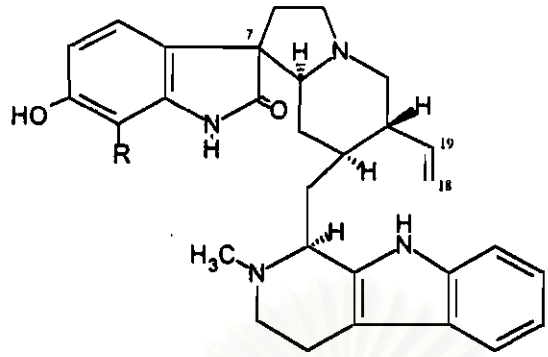
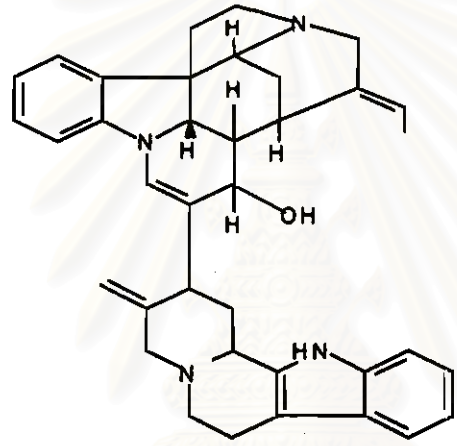
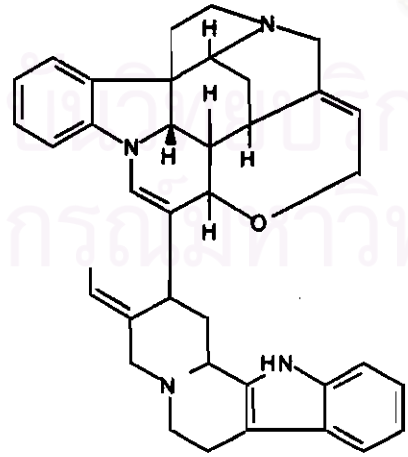


52

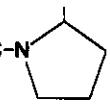
53 5',6' - dihydro







<u>54</u> R = H

<u>55</u> R = 

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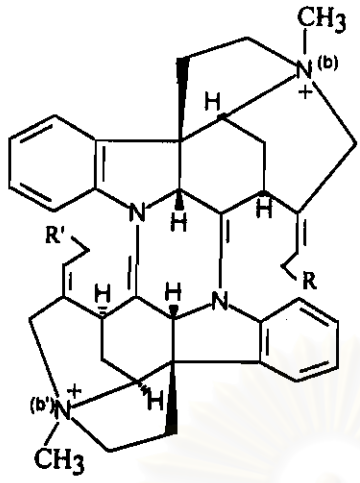
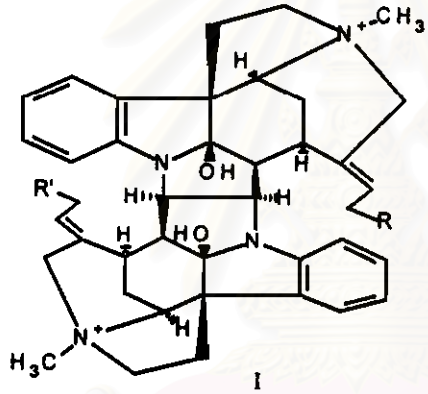
<u>57</u>

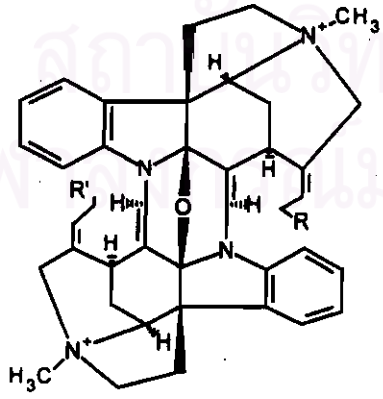


58	OH	OH	
59	H	OH	
60	H	H	N_b,$N_{b'}$ - demethyl

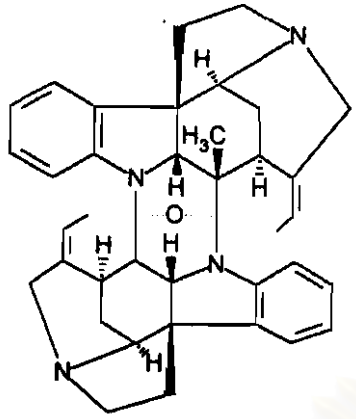


I

	R	R'
61	H	H
62	H	OH
63	OH	OH



	R	R'
64	H	H
65	H	OH
66	OH	OH



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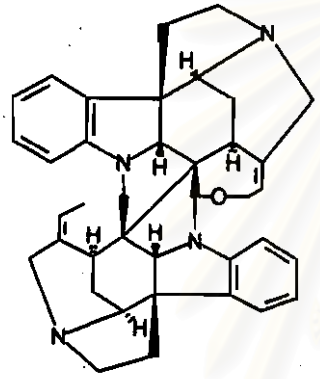

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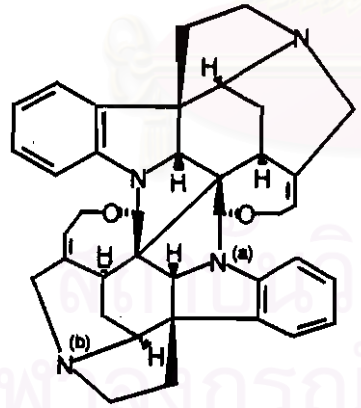

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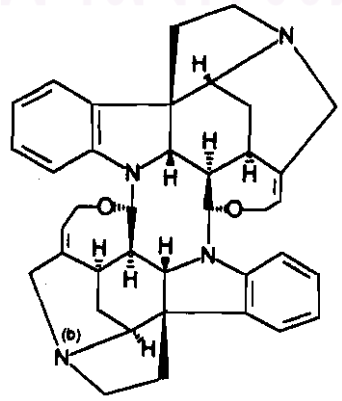

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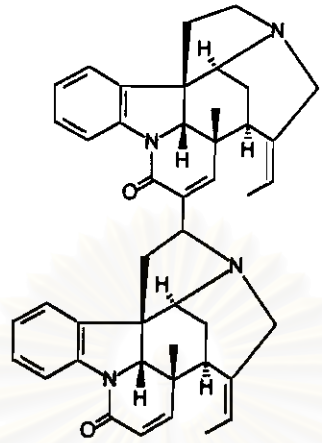

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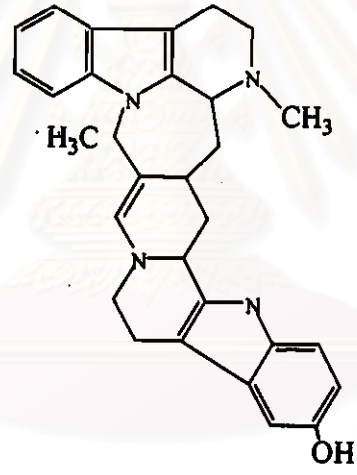

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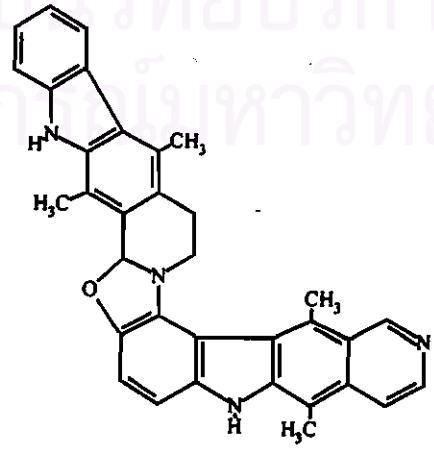

73

Table 2.3 Terpenoid indole alkaloids of *Strychnos* species

Alkaloid	Section	*Strychnos* species	Location	Reference
Monomeric alkaloid				
1. Corynanthean type				
1.1 Corynantheine group				
Geissochizine	Strychnos	*S. nux-vomica*	As	45
De-carbomethoxygeissochizine	Strychnos	*S. nux-vomica*	As	45
Geissochizal	Strychnos	*S. nux-vomica*	As	45
Geissochizol	Strychnos	*S. ignatii*	As	6
9-Methoxygeissochizol	Rouhamon	*S. guianensis*	Af	46
2,7-Dihydroapogeissochizine	Dolicanthae	*S. gossweileri*	Af	47
Dihydrocorynantheol	Brevitubae	*S. johnsonii*	Af	48
10-Hydroxy-N-methyl-corynantheol	Rouhamon	*S. usambarensis*	Af	49
Melinonine B	Rouhamon	*S. melinoniana*	Am	50
Nor Melinonine B	Strychnos	*S. nux-vomica*	As	51
	Strychnos	*S. ignatii*	As	52
Sitsirikine	Densiflorae	*S. pungens*	Af	53
(16R) - Isositsirikine	Lanigerae	*S. kasengaensis*	Af	54
	Penicillatae	*S. matopensis*	Af	55
	Densiflorae	*S. pungens*	Af	53
(16S) - Isositsirikine	Densiflorae	*S. pungens*	Af	53
Strychnorobigine	Lanigerae	*S. rubiginosa*	Am	56
Diploceline	Dolicanthae	*S. gossweileri*	Af	57
16-Epidiploceline	Dolicanthae	*S. gossweileri*	Af	58

(continued)

Alkaloid	Section	*Strychnos* species	Location	Reference
1.2 Ajmalicine group				
Ajmalicinal	Brevitubae	*S. johnsonii*	Af	48
Alstonine	Dolicanthae	*S. gossweileri*	Af	57
	Scyphostrychnos	*S. camptoneura*	Af	59
Serpentine	Scyphostrychnos	*S. camptoneura*	Af	59
1.3 Yohimbine group				
Yohim-19-ene	Brevitubae	*S. johnsonii*	Af	48
Decarbomethoxydihydrogambirtannine	Brevitubae	*S. johnsonii*	Af	48
	Rouhamon	*S. usambarensis*	Af	13
Decarbomethoxy-3,14,15,16,17,18-hexahydrogambirtannine	Brevitubae	*S. johnsonii*	Af	48
1.4 Sarpagine group				
Sarpagine	Strychnos	*S. lucida*	As	5
Macusine A	Strychnos	*S. toxifera*	Am	50
11-Methoxymacusine A	Breviflorae	*S. angolensis*	Af	60
Polyneuridine	Rouhamon	*S. potatonum*	Af	61
Macusine B	Rouhamon	*S. decussata*	Af	62
	Rouhamon	*S. usambarensis*	Af	63
	Strychnos	*S. brachiata*	Am	64
	Strychnos	*S. amazonica*	Am	65
	Strychnos	*S. ignatii*	As	52
	Strychnos	*S. toxifera*	Am	4
O-Methyl-macusine B	Rouhamon	*S. decussata*	Af	62
	Rouhamon	*S. usambarensis*	Af	63
	Strychnos	*S. ignatii*	As	52

(continued)

Alkaloid	Section	*Strychnos* species	Location	Reference
	Strychnos	*S. nux-vomica*	As	51
O-Methyl-dihydro macusine B	Rouhamon	*S. usambarensis*	Af	63
16-Epi-*O*-methyl macusine B	Strychnos	*S. nux-vomica*	As	51
Normacusine B (Tombozine)	Breviflorae	*S. dolichothrysa*	Af	66
	Breviflorae	*S. malacoclados*	Af	67
	Penicillatae	*S. mostueoides*	Af	68
	Lanigerae	*S. rubiginosa*	As	56
	Rouhamon	*S. potatorum*	Af	61
	Strychnos	*S. lucida*	As	5
	Strychnos	*S. nux-vomica*	As	51
	Strychnos	*S. trinervis*	Am	
Macusine C	Strychnos	*S. toxifera*	Am	50
Akuammidine	Rouhamon	*S. potatonum*	Af,As	61
	Strychnos	*S. lucida*	As	5
Vellosimine	Strychnos	*S. divaricans*	As	69
Erichsonine	Strychnos	*S. erichsonii*	Am	70
16-Epi-affinine	Strychnos	*S. erichsonii*	Am	70
16-Epi-*O*-acetylaffinine	Strychnos	*S. erichsonii*	Am	70
1.5 Mavacurine group				
C-mavacurine (Mavacurine)	Brevitubae	*S. pavifolia*	Am	71
	Lanigerae	*S. scheffleri*	Af	72
	Rouhamon	*S. melinoniana*	Am	71
	Rouhamon	*S. subcordata*	Am	71
	Rouhamon	*S. variabilis*	Af	73
	Strychnos	*S. amazonica*	Am	71
	Strychnos	*S. divaricans*	Am	71
	Strychnos	*S. froseii*	Am	71
	Strychnos	*S. macrophylla*	Am	71

(continued)

Alkaloid	Section	*Strychnos* species	Location	Reference
	Strychnos	*S. mitscherlichii*	Am	71
	Strychnos	*S. nux-vomica*	As	74,75
	Strychnos	*S. toxifera*	Am	71
Nor- mavacurine	Breviflorae	*S. mimfiensis*	Af	76
	Penicillatae	*S. longicaudata*	Af	76
	Rouhamon	*S. patatorum*	Af	61
C-fluorocurine (Fluorocurine)	Lanigerae	*S. scheffleri*	Af	73
	Rouhamon	*S. melinoniana*	Am	50
	Rouhamon	*S. variabilis*	Af	73
	Strychnos	*S. panamensis*	Am	50
1.6 Akagerine group				
Akagerine	Brevitubae	*S. jobertiana*	Am	77
	Densiflorae	*S. nigritiana*	Af	78
	Dolicanthae	*S. barteri*	Af	79
	Rouhamon	*S. decussata*	Af	80
	Rouhamon	*S. dale*	Af	81
	Rouhamon	*S. elaeocarpa*	Af	81
	Rouhamon	*S. floribunda*	Af	33
	Rouhamon	*S. usambarensis*	Af	82
	Strychnos	*S. gardneri*	Am	77
	Scyphostrychnos	*S. camptoneura*	Af	83
10-Hydroxyakagerine	Rouhamon	*S. decussata*	Af	84
	Spinosae	*S. spinosa*	Af	83
10-hydroxy-17-*O*-methyakagerine	Rouhamon	*S. decussata*	Af	80
17-*O*-Methylakagerine	Rouhamon	*S. dale*	Af	81
17-*O*-Ethylakagerine	Brevitubae	*S. johnsonii*	Af	48
Akagerine lactone	Brevitubae	*S. johnsonii*	Af	48
	Rouhamon	*S. decussata*	Af	84

(continued)

Alkaloid	Section	*Strychnos* species	Location	Reference
17-*O*-Ethylakagerine lactone	Brevitubae	*S. johnsonii*	Af	48
Dihydrocycloakagerine	Brevitubae	*S. johnsonii*	Af	48
Tetrahydroakagerine	Brevitubae	*S. johnsonii*	Af	48
Kribine	Densiflorae	*S. nigritiana*	Af	78
	Rouhamon	*S. dale*	Af	81
	Rouhamon	*S. elaeocarpa*	Af	81
	Scyphostrychnos	*S. camptoneura*	Af	86
	Spinosae	*S. spinosa*	Af	85
21-*O*-methylkribine	Rouhamon	*S. dale*	Af	81
	Rouhamon	*S. elaeocarpa*	Af	81
21-Epi-*O*-methylkribine	Rouhamon	*S. dale*	Af	81
	Rouhamon	*S. elaeocarpa*	Af	81
10-Hydroxy-21-*O*- methylkribine	Rouhamon	*S. decussata*	Af	80
10-Hydroxy-21-epi-*O*- methylkribine	Rouhamon	*S. decussata*	Af	80
2. Vincosan type				
2.1 Strycntosidine group				
Dolichantoside	Dolicanthae	*S. gossweileri*	Af	57
	Dolicanthae	*S. tricalysioides*	Af	87
Isodolichantoside	Dolicanthae	*S. gossweileri*	Af	58
2.2 Decussine group				
Decussine	Rouhamon	*S. decussata*	Af	88
	Rouhamon	*S. dale*	Af	62
	Rouhamon	*S. elaeocarpa*	Af	62
	Rouhamn	*S. floribunda*	Af	33

(continued)

Alkaloid	Section	*Strychnos* species	Location	Reference
3,14-Dihydrodecussine (Mostueine)	Brevitubae	*S. johnsonii*	Af	48
	Rouhamon	*S. decussata*	Af	62
	Rouhamon	*S. dale*	Af	62
	Rouhamon	*S. elaeocarpa*	Af	62
10-Hydro-3,14-dihydrodecussine	Rouhamon	*S. decussata*	Af	62
Rouhamine (5,6- dihydrodecussine)	Rouhamon	*S. decussata*	Af	62
	Rouhamon	*S. floribunda*	Af	33
Camptoneurine	Scyphostrychnos	*S. camptoneura*	Af	83
3. Vallesiachotaman type				
3.1 Antirhine group				
16,17-Dihydro-22-deoxystrictosamide	Rouhamon	*S. decussata*	Af	89
Vallesiachotamine	Dolicanthae	*S. tricalysioides*	Af	90
Isovallesiachotamine	Dolicanthae	*S. tricalysioides*	Af	90
Antirhine	Brevitubae	*S. johnsonii*	Af	48
	Rouhamon	*S. potatorum*	Af,As	61
	Scyphostrychnos	*S. camptoneura*	Af	83
N_b- Methylantirhine	Rouhamon	*S. usambarensis*	Af	91
	Scyphostrychnos	*S. camptoneura*	Af	92
Antirhine-N_b-methobromide	Scyphostrychnos	*S. camptoneura*	Af	83
18,19-dihydroantirhine	Rouhamon	*S. potatorum*	Af,As	61
Isoantirhine	Brevitubae	*S. johnsonii*	Af	48
Antirhine lactone	Brevitubae	*S. johnsonii*	Af	48
3.2 Angustine group				
Angustine	Strychnos	*S. angustiflora*	As	94

(continued)

Alkaloid	Section	*Strychnos* species	Location	Reference
	Scyphostrychnos	*S. camptoneura*	Af	83
Angustidine	Strychnos	*S. angustiflora*	As	94
	Penicillatae	*S. trichoneura*	Af	13,93
Angustoline	Breviflorae	*S. samba*	Af	13,93
	Dolicanthae	*S. odorata*	Af	13,93
	Dolicanthae	*S. xantha*	Af	13,93
	Lanigerae	*S. schefferi*	Af	13,93
	Penicillatae	*S. trichoneura*	Af	13,93
	Strychnos	*S. angustiflora*	As	94
Malindine	Rouhamon	*S. decussata*	Af	62
	Rouhamon	*S. usambarensis*	Af	91
Isomalindine	Rouhamon	*S. usambarensis*	Af	91
Nor-malindine	Brevitubae	*S. johnsonii*	Af	48
Nor-epi-malindine	Brevitubae	*S. johnsonii*	Af	18
4. Strychnan type				
4.1 Retuline group				
Retuline	Breviflorae	*S. henningsii*	Af	95
	Lanigerae	*S. kasengaensis*	Af	96
	Rouhamon	*S. variabilis*	Af	97
	Scyphostrychnos	*S. camptoneura*	Af	83
11-Methoxyretuline	Lanigerae	*S. kasengaensis*	Af	96
O-Acetylretuline	Breviflorae	*S. henningsii*	Af	28
	Densiflorae	*S. pungens*	Af	53
	Lanigerae	*S. kasengaensis*	Af	98
N^a-Deacetylretuline	Lanigerae	*S. kasengaensis*	Af	96
	Lanigerae	*S. pangarensis*	Af	96
	Penicillatae	*S. matopensis*	Af	55

(continued)

Alkaloid	Section	*Strychnos* species	Location	Reference
	Rouhamon	*S. potatorum*	Af, As	61
	Rouhamon	*S. variabilis*	Af	99
N^a -Deacetyl-18-hydroxyretuline	Penicillatae	*S. longicaudata*	Af	99
N^a - Deacetyl-18-O-acetylretuline	Penicillatae	*S. longicaudata*	Af	99
1,2 - Dehydrodesacetylretuline	Penicillatae	*S. longicaudata*	Af	99
23-Hydroxy-2,16-dehydroretuline	Penicillatae	*S. longicaudata*	Af	99
Retuline- N_b -oxide (*N*-Oxyretuline)	Breviflorae	*S. henningsii*	Af	50
	Scyphostrychnos	*S. camptoneura*	Af	83
Retulinal	Rouhamon	*S. variabilis*	Af	100
12-Hydroxyretulinal	Rouhamon	*S. variabilis*	Af	100
Isoretuline	Lanigerae	*S. kasengaensis*	Af	96
	Rouhamon	*S. variabilis*	Af	97
18-Hydroxy isoretuline	Breviflorae	*S. henningsii*	Af	101
11- Methoxy isoretuline	Lanigerae	*S. kasengaensis*	Af	96
	Rouhamon	*S. variabilis*	Af	102
O-Acetyl isoretuline	Lanigerae	*S. kasengaensis*	Af	96
	Rouhamon	*S. variabilis*	Af	102
11-Methoxy-O-acetylisoretuline	Rouhamon	*S. variabilis*	Af	102
N^a -Deacetyl isoretuline	Breviflorae	*S. henningsii*	Af	101
	Lanigerae	*S. kasengaensis*	Af	96
	Lanigerae	*S. sheffleri*	Af	72
	Rouhamon	*S. floribunda*	Af	33
	Rouhamon	*S. variabilis*	Af	97
N^a -Deacetyl-18-hydroxy isoretuline	Breviflorae	*S. henningsii*	Af	101
	Lanigerae	*S. kasengaensis*	Af	96
N^a -Deacetyl-17-*O*-acetyl-18-hydroxyl isoretuline	Breviflorae	*S. henningsii*	Af	101
N^a -Deacetyl-18-*O*-acetyl isoretuline	Lanigerae	*S. kasengaensis*	Af	96
Isoretulinal	Lanigerae	*S. kasengaensis*	Af	96
	Rouhamon	*S. variabilis*	Af	100

(continued)

Alkaloid	Section	*Strychnos* species	Location	Reference
12-Hydroxy isoretulinal	Rouhamon	*S. variabilis*	Af	100
16-Hydroxy isoretulinal	Rouhamon	*S. variabilis*	Af	103
N^a -Deacetyl isoretulinal	Rouhamon	*S. variabilis*	Af	54
Tsilanimbine	Breviflorae	*S. henningsii*	Af	101
18-Deoxy Weiland-Gumlich aldehyde	Breviflorae	*S. dolichothyrsa*	Af	66
	Breviflorae	*S. mimfiensis*	Af	104
	Lanigerae	*S. kasengaensis*	Af	96
	Penicillatae	*S. matopensis*	Af	50
	Strychnos	*S. amazonica*	Am	4
	Strychnos	*S. froesii*	Am	4
N-formyl-18-deoxy Weiland-Gumlich aldehyde	Densiflorae	*S. stuadtii*	Af, As	104
	Penicillatae	*S. matopensis*	Af	55
Strychnopivotine	Rouhamon	*S. variabilis*	Af	103
Fluorocurarine (*C*-Fluorocurarine)	Strychnos	*S. mitscherlichii*	Am	50
	Strychnos	*S. panamensis*	Am	106
Nor-*C*-fluorocurarine	Breviflorae	*S. dolichothyrsa*	Af	66
	Breviflorae	*S. mimfiensis*	Af	104
	Lanigerae	*S. ngouniensis*	Af	99
18-Hydroxy-nor-fluorocurarine	Lanigerae	*S. ngouniensis*	Af	99
18-*O*-Acetyl-nor-fluorocurarine	Lanigerae	*S. ngouniensis*	Af	99
12-Hydroxy-11-methoxy-nor-fluorocurarine	Lanigerae	*S. panganensis*	Af	98
12-Hydroxy-11-methoxy-*N*-acetyl-nor-fluorocurarimine	Lanigerae	*S. panganensis*	Af	98
Strychnofluorine	Dolicanthae	*S. gossweileri*	Af	105
Strychnozairine	Rouhamon	*S. variabilis*	Af	106
Tabascanine	Strychnos	*S. tabascana*	Am	4
	Strychnos	*S. alvimiana*	Am	107
Strychnosilidine	Breviflorae	*S. brasiliensis*	Am	4
	Strychnos	*S. tabascana*	Am	4
	Strychnos	*S. alvimiana*	Am	107

(continued)

Alkaloid	Section	*Strychnos* species	Location	Reference
Alvimine	Strychnos	*S. alvimiana*	Am	107
Strychnosiline	Breviflorae	*S. brasiliensis*	Am	4
	Strychnos	*S. alvimiana*	Am	107
Rosibiline	Rouhamon	*S. variabilis*	Af	103
Isorosibiline	Penicillatae	*S. matopensis*	Af	55
	Rouhamon	*S. floribunda*	Af	33
4.2 Diaboline group				
Diaboline	Breviflorae	*S. afzelii*	Af	108
	Breviflorae	*S. castelneana*	Am	109
	Breviflorae	*S. fendleri*	Am	110
	Breviflorae	*S. henningsii*	Af	111
	Breviflorae	*S. mimfiensis*	Af	104
	Penicillatae	*S. longicaudata*	Am	99
	Penicillatae	*S. matopensis*	Am	55
	Rouhamon	*S. potatorum*	As, Af	61
	Rouhamon	*S. pungens*	Am	53
	Strychnos	*S. cathayensis*	As	112
	Strychnos	*S. chlorantha*	Am	4
	Strychnos	*S. disboli*	Am	4
	Strychnos	*S. froesii*	Am	4
	Strychnos	*S. ignatii*	As	113
	Strychnos	*S. lucida*	As	6
	Strychnos	*S. jobertiana*	Am	77
	Strychnos	*S. nux-blanda*	As	113
	Strychnos	*S. nux-vomica*	As	50
	Strychnos	*S. panamensis*	Am	4
	Strychnos	*S. pseudo-quina*	Am	36
	Strychnos	*S. rondeletioides*	Am	4

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Alkaloid	Section	*Strychnos* species	Location	Reference
	Strychnos	*S. solerederi*	Am	4
Diaboline - *N*-oxide	Rouhamon	*S. potatorum*	As, Af	61
3-Hydroxydiaboline	Breviflorae	*S. castelnaeana*	Am	109
11 - Methoxydiaboline	Breviflorae	*S. angolensis*	Af	114
	Breviflorae	*S. dolichothyrsa*	Af	115
	Breviflorae	*S. henningsii*	Af	13
	Breviflorae	*S. malacoclados*	Af	116
	Breviflorae	*S. rubiginosa*	Am	56
	Breviflorae	*S. urceolata*	Af	115
	Densiflorae	*S. pungens*	Af	53
	Densiflorae	*S. staudtii*	Af	117
	Penicillatae	*S. matopensis*	Af	55
	Rouhamon	*S. potatorum*	Af,As	61
	Spinosae	*S. cocculoides*	Af	104
	Spinosae	*S. spinosa*	Af	118
	Strychnos	*S. pseudo-quina*	Am	36
	Strychnos	*S. brachiata*	Am	119
	Strychnos	*S. cathayensis*	As	112
	Strychnos	*S. gardneri*	Am	77
	Strychnos	*S. romeu-belenii*	Am	4
	Strychnos	*S. wallichiana*	As	120
11 - Methoxydiaboline -*N*-oxide	Breviflorae	*S. malacoclados*	Af	13
11 - Methoxy-neo-oxydiaboline	Densiflorae	*S. pungens*	Af	53
12-Hydroxy-11 - methoxydiaboline	Densiflorae	*S. pungens*	Af	53
	Densiflorae	*S. staudtii*	Af	117
	Lanigerae	*S. panganensis*	Af	98
	Rouhamon	*S. potatorum*	Af,As	61
	Spinosa	*S. spinosa*	Af	104
17-Epi-*O*-methyl-11- methoxydiaboline	Breviflorae	*S. angolensis*	Af	114

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Alkaloid	Section	*Strychnos* species	Location	Reference
19, 20-dihydro-11- methoxydiaboline	Breviflorae	*S. malacoclados*	Af	67
Ethyldiaboline	Breviflorae	*S. castelnaeana*	Am	50
2, 16 - Dehydrodiaboline	Breviflorae	*S. henningsii*	Af	13
11-Methoxy-2, 16 - Dehydrodiaboline	Breviflorae	*S. henningsii*	Af	13
Jobertine	Strychnos	*S. jobertiana*	Am	110
Henningsamine	Breviflorae	*S. fendleri*	Am	110
	Breviflorae	*S. henningsii*	Af	13
	Densiflorae	*S. pungens*	Af	48
	Rouhamon	*S. potatorum*	Af,As	61
11-Methoxyhenningsamine (Condensamine)	Breviflorae	*S. henningsii*	Af	13
	Densiflorae	*S. pungens*	Af	53
	Densiflorae	*S. staudtii*	Af	117
	Spinosae	*S. cocculoides*	Af	104
	Spinosae	*S. spinosae*	Af	104
	Rouhamon	*S. potatorum*	Af,As	61
12-Hydroxy-11-methoxyhenningsamine	Densiflorae	*S. pungens*	Af	53
	Densiflorae	*S. staudtii*	Af	117
Henningsoline	Breviflorae	*S. henningsii*	Af	13
	Lanigerae	*S. minor*	As	7
	Strychnos	*S. cathayensis*	As	112
Henningsoline-N_b-oxide	Lanigerae	*S. minor*	As	7
O-Acetylhenningsoline	Breviflorae	*S. henningsii*	Af	13
Weiland-Gumlich aldehyde (Caracurine VII)	Breviflor	*S. afzelii*	Af	108
	Breviflorae	*S. dolichothyrsa*	Af	115
	Lanigerae	*S. chrysophylla*	Af	50
	Lanigerae	*S. kasengaensis*	Af	96
	Penicillatae	*S. longicaudata*	Am	99
	Penicillatae	*S. matopensis*	Af	55
	Penicillatae	*S. mastueoides*	Af	68

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Alkaloid	Section	*Strychnos* species	Location	Reference
	Rouhamon	*S. subcordata*	Am	4
	Strychnos	*S. brachiata*	Am	119
	Strychnos	*S. froesii*	Am	4
	Strychnos	*S. jobertiana*	Am	4
	Strychnos	*S. toxifera*	Am	50
11-Methoxy Weiland-Gumlich aldehyde	Breviflorae	*S. angolensis*	Af	114
17-O-Methyl-11-Methoxy Weiland-Gumlich aldehyde	Breviflorae	*S. angolensis*	Af	114
Hemitoxiferine I	Strychnos	*S. toxifera*	Am	50
Alviminine	Strychnos	*S. alvimiana*	Am	107
4.3 Tsilanine group				
Tsilanine	Breviflorae	*S. henningsii*	Af	121
O-Demethyltsilanine	Breviflorae	*S. henningsii*	Af	121
10-Methoxytsilanine	Breviflorae	*S. henningsii*	Af	121
10-Methoxy-O-demethyltsilanine	Breviflorae	*S. henningsii*	Af	121
Holstiine	Breviflorae	*S. henningsii*	Af	95
Holstiline	Breviflorae	*S. henningsii*	Af	28
Rindline	Breviflorae	*S. henningsii*	Af	122
4.4 Spermostrychnine group				
Spermostrychnine	Aculeatae	*S. aculeata*	Af	123
	Breviflorae	*S. brasiliensis*	Am	4
	Breviflorae	*S. fendleri*	Am	110
	Breviflorae	*S. henningsii*	Af	95
	Penicillatae	*S. mostueoides*	Af	68
	Penicillatae	*S. psilosperma*	Aust	4
12-Hydroxy-11-methoxy spermostrychnine	Breviflorae	*S. brasiliensis*	Am	4

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Alkaloid	Section	*Strychnos* species	Location	Reference
23-Hydroxy spermostrychnine	Breviflorae	*S. henningsii*	Af	95
23-Hydroxy spermostrychnine-*N*-oxide	Breviflorae	*S. henningsii*	Af	95
19 Epi, 23-Hydroxy spermostrychnine	Breviflorae	*S. henningsii*	Af	95
17, 23-Hydroxy spermostrychnine	Breviflorae	*S. henningsii*	Af	95
Strychnospermine	Penicillatae	*S. psilosperma*	Aust	4
Strychnosplendine	Lanigerae	*S. splendens*	Af	13
N^a - Acetylstrychnosplendine	Aculeatae	*S. aculeata*	Af	123
	Breviflorae	*S. fendleri*	Am	110
	Breviflorae	*S. henningsii*	Af	111
	Lanigerae	*S. sheffleri*	Af	72
N^a -Acetyl-11-methoxyStrychnosplendine	Breviflorae	*S. henningsii*	Af	111
N^a -Acetyl-12-hydroxy-11-methoxystrychnosplendine	Breviflorae	*S. fendleri*	Am	110
O-Methyl-N^a-acetylstrychnosplendine	Aculeatae	*S. aculeata*	Af	123
	Lanigerae	*S. sheffleri*	Af	72
	Strychnos	*S. tabascana*	Am	4
Splendoline	Breviflorae	*S. henningsii*	Af	95
	Lanigerae	*S. splendens*	Af	13
Isostrychnosplendine	Lanigerae	*S. splendens*	Af	13
N^a-Acetyl-isostrychnosplendine	Aculeatae	*S. aculeata*	Af	124
	Lanigerae	*S. splendens*	Af	13
N^a-Acetyl-3-deoxy-isostrychnosplendine	Lanigerae	*S. splendens*	Af	4
Isosplendoline	Lanigerae	*S. splendens*	Af	4
Isosplendine	Aculeatae	*S. aculeata*	Af	123
	Lanigerae	*S. splendens*	Af	4
	Lanigerae	*S. soubrensis*	Af	126
Strychnofendlerine	Aculeatae	*S. aculeata*	Af	125
	Breviflorae	*S. fendleri*	Am	110
	Lanigerae	*S. sheffleri*	Af	72
	Lanigerae	*S. soubrensis*	Af	126

(continued)

Alkaloid	Section	*Strychnos* species	Location	Reference
	Penicillatae	*S. mostueoides*	Am	68
11-Methoxystrychnofendlerine	Breviflorae	*S. fendleri*	Am	110
12-Hydoxy-11-methoxystrychnofendlerine	Breviflorae	*S. fendleri*	Am	110
N^a -Deacetylstrychnofendlerine	Aculeatae	*S. aculeata*	Af	125
Strycnobrasiline	Breviflorae	*S. brasiliensis*	Am	127
	Breviflorae	*S. mattogrossensis*	Am	128
	Lanigerae	*S. sheffleri*	Af	72
	Lanigerae	*S. soubrensis*	Af	126
	Penicillatae	*S. mostueoides*	Am	68
14β-Hydroxystrychnobrasiline	Lanigerae	*S. soubrensis*	Af	126
10-Methoxystrychnobrasiline	Strychnos	*S. tabascana*	Am	50
10, 11-Dimethoxystrychnobrasiline	Breviflorae	*S. brasiliensis*	Am	127
12-Hydroxy-11-Dimethoxystrychnobrasiline	Breviflorae	*S. brasiliensis*	Am	127
	Breviflorae	*S. mattogrossensis*	Am	128
Deacetylstrychnobrasiline	Penicillatae	*S. mostueoides*	Am	68
4.5 Isostrychnine group				
Isostrychnine	Strychnos	*S. ignatii*	As	52
	Strychnos	*S. nux-vomica*	As	129
Isostrychnine-*N*-oxide	Strychnos	*S. nux-vomica*	As	130
19, 20 - Dihydroisostrychnine	Strychnos	*S. nux-vomica*	As	51
Protostrychnine	Strychnos	*S. ignatii*	As	52
	Strychnos	*S. nux-vomica*	As	129
Isobrucine	Strychnos	*S. nux-vomica*	As	130
Isobrucine-*N*-oxide	Strychnos	*S. nux-vomica*	As	130
4.6 Strychnine group				

(continued)

Alkaloid	Section	*Strychnos* species	Location	Reference
Strychnine	Breviflorae	*S. icaja*	Af	131
	Strychnos	*S. ignatii*	As	6,52
	Strychnos	*S. lucida*	As	5,113
	Strychnos	*S. nux-vomica*	As	132
	Strychnos	*S. panamensis*	Am	133
	Strychnos	*S. wallichiana*	As	134
Strychnine-*N*-oxide	Strychnos	*S. ignatii*	As	52
	Strychnos	*S. lucida*	As	135
	Strychnos	*S. nux-vomica*	As	136
	Strychnos	*S. wallichiana*	As	137
10-Hydroxystrychnine	Strychnos	*S. ignatii*	As	52
	Strychnos	*S. nux-vomica*	As	51
12-Hydroxystrychnine (4-Hydroxystrychnine)	Breviflorae	*S. icaja*	Af	4
	Strychnos	*S. nux-vomica*	As	51
	Strychnos	*S. wallichiana*	As	134,137
12-Hydroxystrychnine-*N*-oxide	Strychnos	*S. nux-vomica*	As	51
15-Hydroxystrychnine	Strychnos	*S. nux-vomica*	As	4
N^b-Methylstrychnine	Breviflorae	*S. icaja*	Af	131
10-Hydroxy-11-methoxystrychnine	Strychnos	*S. nux-vomica*	As	130
12-Hydroxy-11-methoxystrychnine	Strychnos	*S. nux-vomica*	As	51
	Strychnos	*S. wallichiana*	As	134
12-Hydroxy-11-methoxystrychnine-*N*-oxide	Strychnos	*S. nux-vomica*	As	51
Brucine	Strychnos	*S. ignatii*	As	138
	Strychnos	*S. lucida*	As	6
	Strychnos	*S. nux-vomica*	As	130
	Strychnos	*S. panamensis*	Am	133
	Strychnos	*S. wallichiana*	As	134,137
Brucine-*N*-oxide	Strychnos	*S. ignatii*	As	138
	Strychnos	*S. lucida*	As	6

(continued)

Alkaloid	Section	*Strychnos* species	Location	Reference
	Strychnos	*S. nux-vomica*	As	130
	Strychnos	*S. wallichiana*	As	134,137
α-colubrine	Strychnos	*S. nux-vomica*	As	132
	Strychnos	*S. gauthierana*	As	134
	Strychnos	*S. ligustrina*	As	6
β-colubrine	Strychnos	*S. lucida*	As	6,135
	Strychnos	*S. nux-vomica*	As	132
β-colubrine-*N*-oxide	Strychnos	*S. lucida*	As	135
Pseudostrychnine	Breviflorae	*S. icaja*	Af	139
	Strychnos	*S. ignatii*	As	52
	Strychnos	*S. lucida*	As	6,135
	Strychnos	*S. nux-vomica*	As	130
	Strychnos	*S. wallichiana*	As	134,137
Pseudobrucine	Strychnos	*S. ignatii*	As	138
	Strychnos	*S. lucida*	As	6,135
	Strychnos	*S. nux-vomica*	As	132
	Strychnos	*S. wallichiana*	As	134,137
3-Hydroxy-α-colubrine	Strychnos	*S. nux-vomica*	As	4
3-Hydroxy-β-colubrine	Strychnos	*S. lucida*	As	135
	Strychnos	*S. nux-vomica*	As	4
3-Methoxystrychnine (16-Methoxystrychnine)	Breviflorae	*S. icaja*	Af	139
3-Ethoxystrychnine (16-Ethoxystrychnine)	Strychnos	*S. ignatii*	As	4
3-Hydroxy-10, 11-dimethoxystrychnine	Strychnos	*S. nux-vomica*	As	51
3, 12-Dihydroxystrychnine	Strychnos	*S. nux-vomica*	As	51
3, 12-Dihydroxy-11-methoxystrychnine	Strychnos	*S. nux-vomica*	As	51
Icajine (*N*-methyl-*sec*-pseudostrychnine)	Breviflorae	*S. icaja*	Af	140
	Strychnos	*S. nux-vomica*	As	130
	Strychnos	*S. wallichiana*	As	134,137
Icajine-*N*-oxide	Strychnos	*S. wallichiana*	As	137

(continued)

Alkaloid	Section	*Strychnos* species	Location	Reference
15-Hydroxyicajine (14-Hydroxyicajine)	Strychnos	*S. wallichiana*	As	134
11-Methoxyicajine	Strychnos	*S. nux-vomica*	As	140
12-Hydroxy-11methoxy-icajine	Strychnos	*S. wallichiana*	As	134
10-or11-Methoxy-icajine	Breviflorae	*S. icaja*	Af	140
Vomicine	Breviflorae	*S. icaja*	Af	140
	Strychnos	*S. nux-vomica*	As	130
	Strychnos	*S. wallichiana*	As	134
Novacaine	Breviflorae	*S. icaja*	Af	140
	Strychnos	*S. nux-vomica*	As	130
	Strychnos	*S. wallichiana*	As	134,137
15-Hydroxynovacaine	Strychnos	*S. wallichiana*	As	134
N-Methyl-*sec*-pseudo-β-colubrine	Strychnos	*S. nux-vomica*	As	136
	Strychnos	*S. wallichiana*	As	137
19, 20α-Epoxy-10-methoxy-icajine	Breviflorae	*S. icaja*	Af	13
19, 20α-Epoxy-12-methoxy-icajine	Breviflorae	*S. icaja*	Af	140
19, 20α-Epoxy-12-hydroxy-11-methoxy-icajine	Breviflorae	*S. icaja*	Af	140
19, 20α-Epoxy-15-hydroxy-12-methoxy-icajine	Breviflorae	*S. icaja*	Af	140
19, 20α-Epoxy-10, 11-dimethoxy-icajine	Breviflorae	*S. icaja*	Af	140
19, 20α-Epoxy-11, 12-dimethoxy-icajine	Breviflorae	*S. icaja*	Af	140
19, 20α-Epoxy-15-hydroxy-10, 11-dimethoxy-icajine	Breviflorae	*S. icaja*	Af	140
19, 20α-Epoxy-12, 15-dihydroxy-11-methoxy-icajine	Breviflorae	*S. icaja*	Af	140
19, 20α-Epoxy-15-hydroxyicajine	Breviflorae	*S. icaja*	Af	13
19, 20α-Epoxy-vomicine	Breviflorae	*S. icaja*	Af	13
19, 20α-Epoxy-15-hydroxyvomicine	Breviflorae	*S. icaja*	Af	140
19, 20α-Epoxy-novacine	Breviflorae	*S. icaja*	Af	131
19, 20α-Epoxy-15-hydroxynovacine	Breviflorae	*S. icaja*	Af	131
N-Cyano-*sec*-pseudostrychnine	Strychnos	*S. ignatii*	As	138
	Strychnos	*S. wallichiana*	As	137

(continued)

Alkaloid	Section	*Strychnos* species	Location	Reference
N-Cyano-*sec*-pseudobrucine	Strychnos	*S. wallichiana*	As	137
N-Cyano-*sec*-pseudocolubrine	Strychnos	*S. ignatii*	As	138
5. Aspidospermatan Type				
5.1 Condylocarpine group				
Condylocarpine	Breviflorae	*S. dolichothyrsa*	Af	115
	Strychnos	*S. nux-vomica*	As	141
Tubotaiwine	Breviflorae	*S. angolensis*	Af	114
	Breviflorae	*S. dolichothyrsa*	Af	115
Tubotaiwine-*N*-oxide	Breviflorae	*S. mimfiensis*	Af	104
	Breviflorae	*S. mitis*	Af	104
Tubotaiwinal	Lanigerae	*S. ngouniensis*	Af	99
6. Ibogan type				
6.1 Ibogamine group				
17-Hydroxy-alloibogamine	Lanigerae	*S. ngouniensis*	Af	13
7. Untypified alkaloids				
7.1 Olivacine group				
Ellipticine	Lanigerae	*S. dinklagei*	Af	142
Ellipticine-*N*-oxide	Lanigerae	*S. dinklagei*	Af	142
9-Hydroxyellipticine (10-Hydroxyellipticine)	Lanigerae	*S. dinklagei*	Af	142
12-Hydroxyellipticine (18-Hydroxyellipticine)	Lanigerae	*S. dinklagei*	Af	142

(continued)

Alkaloid	Section	*Strychnos* species	Location	Reference
13-Oxoellipticine (17-Oxoellipticine)	Lanigerae	*S. dinklagei*	Af	142
13-Oxoellipticine-*N*-oxide	Lanigerae	*S. dinklagei*	Af	142
3, 4-Dihydroellipticine	Lanigerae	*S. dinklagei*	Af	142
7.2 Ngouniensine group				
1,2,3,4-Tetrahydroellipticine	Lanigerae	*S. dinklagei*	Af	142
Ngouniensine	Lanigerae	*S. ngouniensis*	Af	99
Epingouniensine	Lanigerae	*S. ngouniensis*	Af	99
Glucosylngouniensine	Lanigerae	*S. ngouniensis*	Af	99
Glucosylepingouniensine	Lanigerae	*S. ngouniensis*	Af	99
7.3 Miscellaneous group				
Brafouedine	Lanigerae	*S. dinklagei*	Af	143
Isobrafouedine	Lanigerae	*S. dinklagei*	Af	143
Flavopereirine (Melinonine G)	Penicillatae	*S. longicaudata*	Af	99
6,7-Dihydroflavopereirine	Rouhamon	*S. usambarensis*	Af	144
Strychnoxanthine	Dolicanthae	*S. gossweileri*	Af	145
Melinonine E	Rouhamon	*S. melinoniana*	Am	4
Strychnohirsutine	Rouhamon	*S. hirsuta*	Am	146
Tetrahydrostrychnohirsutine	Rouhamon	*S. hirsuta*	Am	146

(continued)

Alkaloid	Section	*Strychnos* species	Location	Reference
Dimeric alkaloids				
1. Quasi-dimeric alkaloids				
1.1 Usambarensine group				
Usambarensine	Lanigerae	*S. memecloides*	Af	13
	Rouhamon	*S. dale*	Af	13
	Rouhamon	*S. usambarensis*	Af	147
Usambarensine-N_b-oxide	Rouhamon	*S. dale*	Af	13
N^b-Methyl usambarensine	Rouhamon	*S. usambarensis*	Af	147
Tchibangensine (5',6'- dihydrousambarensine)	Penicillatae	*S. tchibangensis*	Af	148
	Rouhamon	*S. dale*	Af	13
	Rouhamon	*S. usambarensis*	Af	149
Tehibangensine- *N*-oxide	Rouhamon	*S. dale*	Af	13
N^b-Methyl tehibangensine	Rouhamon	*S. usambarensis*	Af	147
4',17- Dihydro-17α-tehibangensine	Lanigerae	*S. ngouniensis*	Af	99
	Rouhamon	*S. dale*	Af	13
4',17- Dihydro-17β-tehibangensine	Lanigerae	*S. ngouniensis*	Af	99
10'- Hydroxy-4',17- dihydro-17α-tehibangensine	Lanigerae	*S. ngouniensis*	Af	99
10'- Hydroxy-4',17- dihydro-17β-tehibangensine	Lanigerae	*S. ngouniensis*	Af	99
10,10'- Dihydroxy-17,4',5',6'-tetrahydrousambarensine	Rouhamon	*S. dale*	Af	13
10,10'- Dihydroxy- N^b-methyl -17,4',5',6'-tetrahydrousambarensine	Rouhamon	*S. dale*	Af	13
10 - Hydroxy-10'-methoxy-17,4',5',6'-tetrahydrousambarensine	Rouhamon	*S. dale*	Af	13

(continued)

Alkaloid	Section	*Strychnos* species	Location	Reference
10 - Hydroxy-10'-methoxy- N^b-methyl -17,4',5',6'-tetrahydrousambarensine	Rouhamon	*S. dale*	Af	13
10'- Hydroxy-10-methoxy- N^b-methyl -17,4',5',6'-tetrahydrousambarensine	Rouhamon	*S. dale*	Af	13
10,10'- Dimethoxy-3α,17α-(*Z*)- N^b-methyl -17,4',5',6'-tetrahydrousambarensine	Rouhamon	*S. dale*	Af	13
10,10'- Dimethoxy - N^b-methyl-3α,17α-(*Z*)- N^b-methyl - 17,4',5',6'- tetrahydrousambarensine	Rouhamon	*S. dale*	Af	13
Usambarine	Densiflorae	*S. nigritana*	Af	79
	Dolicanthae	*S. barrette*	Af	79
	Rouhamon	*S. usambarensis*	Af	149
Usambaridine Vi	Densiflorae	*S. nigritana*	Af	79
(10-Hydroxyusambarine)	Dolicanthae	*S. barteri*	Af	79
	Rouhamon	*S. usambarensis*	Af	149
Usambaridine Br	Rouhamon	*S. usambarensis*	Af	149
(11-Hydroxyusambarine)				
N^b-Methyl-10-hydroxyusambarine	Rouhamon	*S. usambarensis*	Af	150
N^b-Methyl -11-hydroxyusambarine	Rouhamon	*S. usambarensis*	Af	150
Nigritanine	Densiflorae	*S. nigritana*	Af	79
(18,19-Dihydrousambarine)	Dolicanthae	*S. barteri*	Af	79
	Rouhamon	*S. usambarensis*	Af	151
10-Hydroxynigritanine	Densiflorae	*S. nigritana*	Af	79
(18,19-Dihydrousambarine Vi)	Dolicanthae	*S. barteri*	Af	79
	Rouhamon	*S. usambarensis*	Af	13
11-Hydroxynigritanine (18,19-Dihydrousambarine Br)	Rouhamon	*S. usambarensis*	Af	13
Strychnopentamine	Rouhamon	*S. usambarensis*	Af	149
Isostrychnopentamine	Rouhamon	*S. usambarensis*	Af	149
Ochrolifuanine A	Rouhamon	*S. potatorum*	As	61

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Alkaloid	Section	*Strychnos* species	Location	Reference
Ochrolifuanine E	Rouhamon	*S. potatorum*	As	61
Strychnobaridine	Rouhamon	*S. usambarensis*	Af	13
1.2 Strychnofoline group				
Strychnofoline	Rouhamon	*S. usambarensis*	Af	149
Isostrychnofoline	Rouhamon	*S. usambarensis*	Af	149
Strychnophylline	Rouhamon	*S. usambarensis*	Af	152
Isostrychnophylline	Rouhamon	*S. usambarensis*	Af	152
Barterine	Dolicanthae	*S. barteri*	Af	13
10-Hydroxybarterine	Dolicanthae	*S. barteri*	Af	13
2. Strychnan-Corynanthean type				
2.1 Retuline-Corynantheine group				
Afrocurarine	Rouhamon	*S. usambarensis*	Af	153
Strychnofuranine	Penicillatae	*S. matopensis*	Af	13
Longicaudatine Y	Penicillatae	*S. longicaudata*	Af	99
	Penicillatae	*S. matopensis*	Af	55
Dihydrolongicaudatine Y	Rouhamon	*S. potatorum*	As	61
Longicaudatine F	Penicillatae	*S. longicaudata*	Af	99
(18-Hydroxylongicaudatine Y)	Penicillatae	*S. matopensis*	Af	55
Longicaudatine Z	Penicillatae	*S. matopensis*	Af	55

(continued)

Alkaloid	Section	*Strychnos* species	Location	Reference
2.2 Diaboline-Corynantheine group				
Longicaudatine	Breviflorae	*S. afzeli*	Af	154
	Breviflorae	*S. dolichothyrsa*	Af	154
	Breviflorae	*S. urceolata*	Af	154
	Penicillatae	*S. longicaudata*	Af	99
	Penicillatae	*S. matopensis*	Af	55
	Lanigerae	*S. chrysophylla*	Af	154
	Lanigerae	*S. ngouniensis*	Af	99,154
	Strychnos	*S. ignatii*	As	6
	Strychnos	*S. trinervis*	Am	155
Longicaudatine - *N*-oxide	Penicillatae	*S. matopensis*	Af	55
	Lanigerae	*S. chryscphylla*	Af	13
Dihydrolongicaudatine	Rouhamon	*S. potatorum*	As, Af	61
	Strychnos	*S. ignatii*	As	6
Guianensine	Rouhamon	*S. guianensis*	Am	160
3. Strychnan-S-type				
3.1 Retuline-Retuline group				
C-Toxiferine (Toxiferine V)	Strychnos	*S. froesii*	Am	4
	Strychnos	*S. toxifera*	Am	4
C-Alkaloid H	Strychnos	*S. trinervis*	Am	155
Bisnor-*C*-alkaloid H	Breviflorae	*S. afzelii*	Af	108
	Breviflorae	*S. dolichothyrsa*	Af	115,156
	Breviflorae	*S. malacoclados*	Af	13
	Breviflorae	*S. urceolata*	Af	156
	Penicillatae	*S. longicaudata*	Af	99

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Alkaloid	Section	*Strychnos* species	Location	Reference
	Penicillatae	*S. matopensis*	Af	55
Bisnor-*C*-alkaloid H-mono-*N*-oxide	Breviflorae	*S. afzelii*	Af	4
	Breviflorae	*S. dolichothyrsa*	Af	115
Bisnor-*C*-alkaloid H-di-*N*-oxide	Breviflorae	*S. dolichothyrsa*	Af	115
C-Alkaloid K	Penicillatae	*S. longicaudata*	Af	50
(*C*-dihydrotoxiferine)	Rouhamon	*S. usambarensis*	Af	13
	Strychnos	*S. panamensis*	Am	4
	Strychnos	*S. toxifera*	Am	50
Nordihydrotoxiferine	Rouhamon	*S. variabilis*	Af	97
Bisnordihydrotoxiferine	Breviflorae	*S. afzelii*	Af	108
	Breviflorae	*S. dolichothyrsa*	Af	157
	Breviflorae	*S. icaja*	Af	131
	Breviflorae	*S. malacoclados*	Af	13
	Breviflorae	*S. matopensis*	Af	55
	Breviflorae	*S. urceclata*	Af	108
	Lanigerae	*S. kasengaensis*	Af	96
	Lanigerae	*S. scheffleri*	Af	72
	Penicillatae	*S. longicaudata*	Af	99
	Rouhamon	*S. decussata*	Af	62
	Rouhamon	*S. clacocarpa*	Af	62
	Rouhamon	*S. floribunda*	Af	33
	Rouhamon	*S. potatorum*	As, Af	61
	Rouhamon	*S. pseudoquina*	Am	4
	Rouhamon	*S. variabilis*	Af	97
	Strychnos	*S. froesii*	Am	4
	Strychnos	*S. toxifera*	Am	4
	Strychnos	*S. trinervis*	Am	155
	Strychnos	*S. wallichiana*	As	120
Bisnordihydrotoxiferine mono-*N*-oxide	Breviflorae	*S. afzelii*	Af	108

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Alkaloid	Section	*Strychnos* species	Location	Reference
Bisnordihydrotoxiferine di-*N*-oxide	Breviflorae	*S. dolichothyrsa*	Af	157
Bisnordihydrotoxiferone	Strychnos	*S. trinervis*	Am	155
Matopensine	Lanigerae	*S. kasengaensis*	Af	96
	Penicillatae	*S. matopensis*	Af	55
Matopensine-*N*-oxide	Lanigerae	*S. kasengaensis*	Af	96
	Penicillatae	*S. matopensis*	Af	55
18-Hydroxymatopensine	Penicillatae	*S. matopensis*	Af	55
18,18'- Dihydroxymatopensine	Penicillatae	*S. matopensis*	Af	55
16-Methoxyisomatopensine	Penicillatae	*S. matopensis*	Af	55
16-Ethoxyisomatopensine	Penicillatae	*S. matopensis*	Af	55
C-alkaloid D	Strychnos	*S. mitcherlichii*	Am	4
Bisnor-*C*-Alkaloid D	Breviflorae	*S. dolichothyrsa*	Af	157
	Penicillatae	*S. matopensis*	Af	55
C-Calebassine	Rouhamon	*S. usambarensis*	Af	13
	Strychnos	*S. divaricans*	Am	4
	Strychnos	*S. mitcherlichii*	Am	4
	Strychnos	*S. solimoesana*	Am	4
	Strychnos	*S. trinervis*	Am	4
C-Alkaloid F	Strychnos	*S. panamensis*	Am	4
	Strychnos	*S. solimoesana*	Am	4
C-Alkaloid A	Strychnos	*S. toxifera*	Am	4
C-Curarine	Rouhamon	*S. usambarensis*	Af	153
	Strychnos	*S. divaricans*	Am	4
	Strychnos	*S. froesii*	Am	4
	Strychnos	*S. mitcherlichii*	Am	4
	Strychnos	*S. solimoesana*	Am	4
	Strychnos	*S. trinervis*	Am	4
Bisnor-*C*-Curarine	Breviflorae	*S. dolichothyrsa*	Af	157
	Penicillatae	*S. matopensis*	Af	55

(continued)

Alkaloid	Section	*Strychnos* species	Location	Reference
C-Alkaloid G	Strychnos	*S. panamensis*	Am	4
	Strychnos	*S. solimoesana*	Am	4
C-Alkaloid E	Strychnos	*S. froesii*	Am	4
	Strychnos	*S. solimoesana*	Am	4
	Strychnos	*S. tomentosa*	Am	4
Strychnobiline	Rouhamon	*S. variabitis*	Af	97
12'-Hydroxystrychnobiline	Rouhamon	*S. variabitis*	Af	97
Isostrychnobiline	Rouhamon	*S. variabitis*	Af	97
12'- Hydroxyisostrychnobiline	Rouhamon	*S. variabitis*	Af	159
16,17-Dehydroisostrychnobiline	Lanigerae	*S. kasengaensis*	Af	96
Panganensine R	Lanigerae	*S. panganensis*	Af	161
Panganensine S	Lanigerae	*S. panganensis*	Af	161
Panganensine X	Lanigerae	*S. panganensis*	Af	161
Panganensine Y	Lanigerae	*S. panganensis*	Af	161
3.2 Retuline-Diaboline group				
Dolichocurine	Breviflorae	*S. dolichothyrsa*	Af	66
Dolichothynine	Breviflorae	*S. dolichothyrsa*	Af	66
3.3 Diaboline-Diaboline group				
Caracurine II	Strychnos	*S. toxifera*	Am	4
Caracurine II dimethosalt	Strychnos	*S. toxifera*	Am	4
Caracurine V	Breviflorae	*S. afzelii*	Af	13
	Breviflorae	*S. angolensis*	Af	13
	Breviflorae	*S. dolichothyrsa*	Af	158
	Breviflorae	*S. malacoclados*	Af	13
	Breviflorae	*S. urceclata*	Af	108

(continued)

Alkaloid	Section	*Strychnos* species	Location	Reference
	Lanigerae	*S. chrysophylla*	Af	13
	Strychnos	*S. toxifera*	Am	4
Caracurine V mono-*N*-oxide	Breviflorae	*S. afzelii*	Af	13
	Breviflorae	*S. dolichothyrsa*	Af	158
Caracurine V di-*N*-oxide	Breviflorae	*S. dolichothyrsa*	Af	158
3.4 Isostrychnine-Isostrychnine group				
Sangucine	Breviflorae	*S. icaja*	Af	131
4. Miscellaneous				
Janussine A	Brevitubae	*S. johnsonii*	Af	48
Janussine B	Brevitubae	*S. johnsonii*	Af	48
Oxojanussine	Brevitubae	*S. johnsonii*	Af	48
Strellidimine	Lanigerae	*S. dinklagei*	Af	13

Af = Africa, Am = America, As = Asia, Aust = Australia

2. Biosynthesis of *Strychnos* alkaloids

Many studies on biosynthesis of terpenoid indole alkaloids have been carried out by means of *in vivo* tracer experiments and by using cell free systems [162-167]. The results obtained have suggested the biogenetic pathway as demonstrated in Scheme 2.5 . The overall process can be regarded as including 4 major steps: (1) the formation of tryptamine (74), (2) the formation of secologanin (75), (3) the condensation of tryptamine and secologanin and (4) the derivation of alkaloids with various skeletal types. The condensation product between tryptamine and secologanin, which is a key intermediate of a wide variety of the indole bases, hase been suggested by recent studies to be strictosidine (76), not its 3-β-epimer, vincoside (77), which was once assumed to pay such role [162,163]. This hypothesis is supported by the isolation of enzyme catalysing the condensation, called strictosidine synthase, which forms exclusively the 3α(S)strictosidine with a high degree of stereospecificity [163].

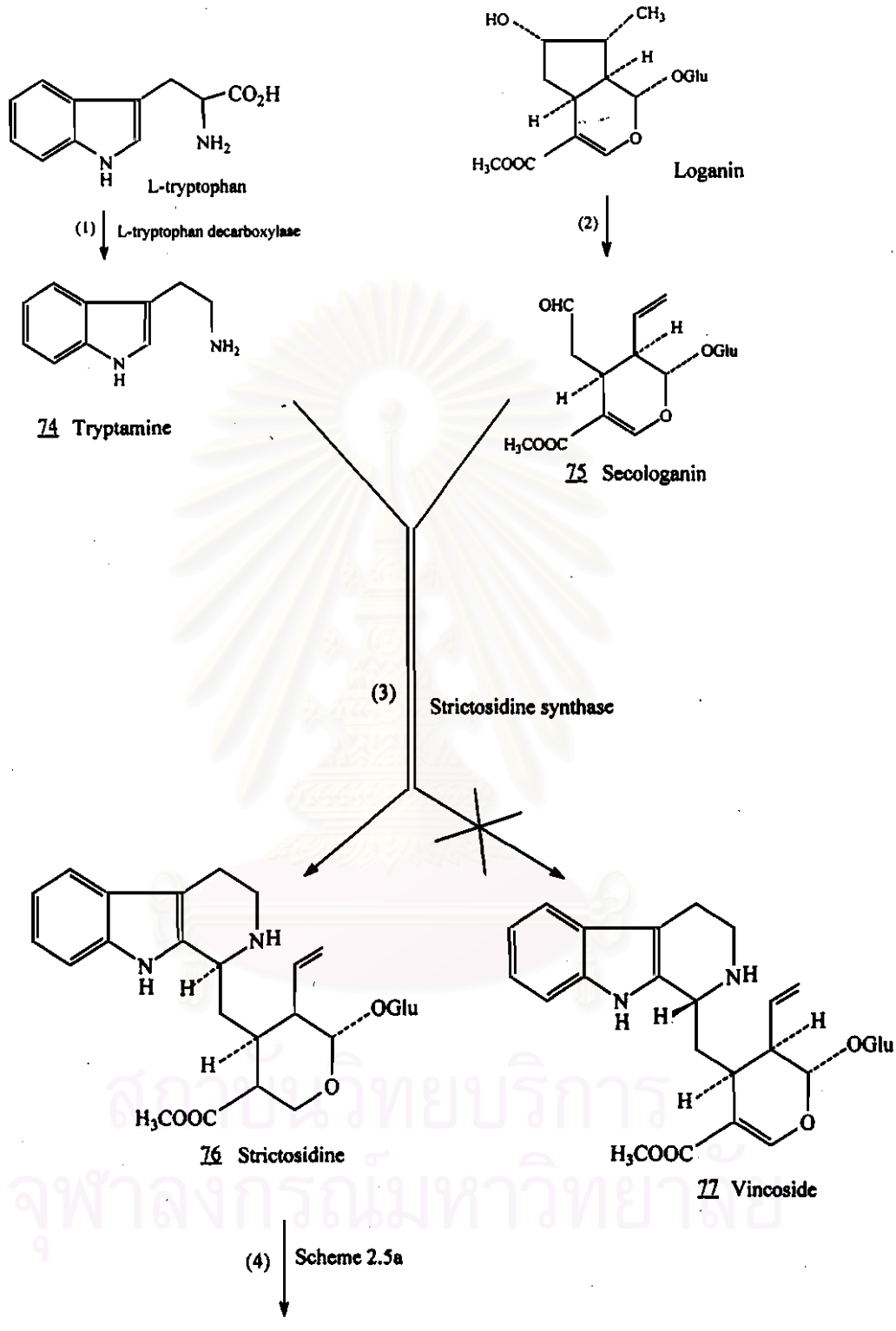
Like other terpenoid indole alkaloids, those isolated from *Strychnos* species are derived from strictosidine (76). Other key intermediates are proposed to, include 4,21-dihydro geissochizine (79), dehydro-preakuammicine (80) and Weiland-Gumlich aldehyde (82) Sheme 2.6 outlines the central alkaloid biogenetic pathway in *Strychnos* species [164-166] and indicates under the intermediates, those mentioned above and other hypothetical ones, some of the alkaloids and groups of alkaloids which may be considered to be derived from them.

Most of the indole alkaloids found in *Strychnos* species belong to the corynanthean and the strychnan types. As shown in Scheme 2.6, the bases of the corynanthean types are mainly derived from 4,21 dehydrogeissoschizine . The resuced derivative of this base, geissoschizine (1), has been postulated as an intermediate in the formation of the heteroyohimbine alkaloids in accord once with its incorporation in *Cathranthus roseus* into serpentine [165]. However more recent works have suggested that the more direct intermediate should be 4,21 dehydrogeissoschizine (79), to which geissoschizine (1) is convertible by the NADPH dependent reduction [162,166-167]. 4,21-Dehydrogeissoschizine is also considered as the important branch point in the biosynthesis of corynanthean-,ibogar-, aspidospermatan- and strychnan-types alkaloids (Scheme 2.7).

The C-mavacurine-group alkaloids of the corynanthean type are postulated to be derived from 4,21 dehydrogeissoschizine (79) *via* geissoschizine (1) by ring closure cetween C-16 and N_a [165] while those of the sarpagine groups are presumed to originate more directly from 4,21 dehydrogeissoschizine (79)[165,166]. However more information is still required for detail explanation of C_6-C_{15} bridge formation in the biosynthesis of these sarpagine derivatives.

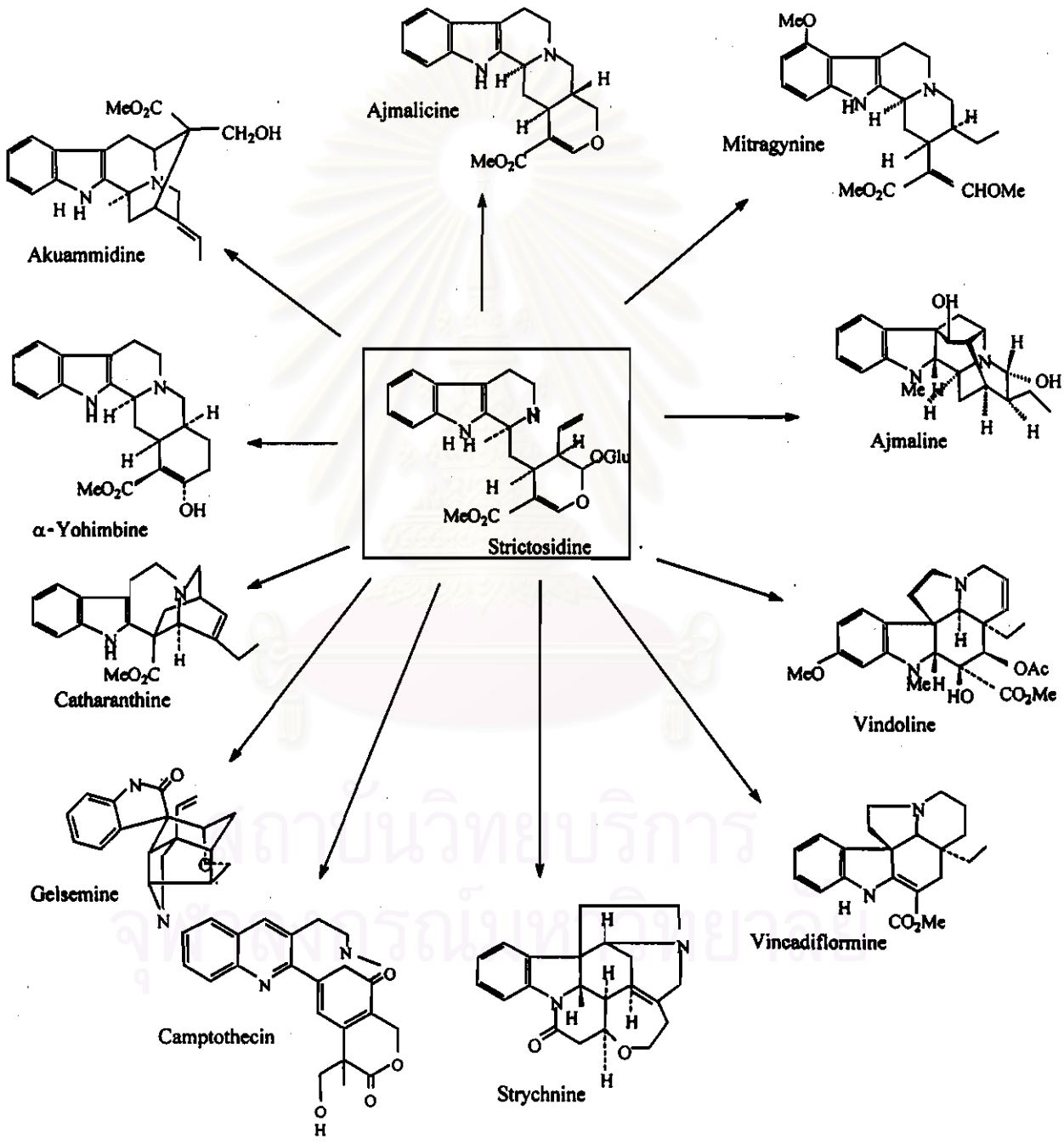
The next intermediate after 4,21 dehydrogeissoschizine in the biosynthetic pathway to strychnan-type alkaloids is presumed to be dehydro-preakuammicine (80). Loss of the carbomethoxy group from this base could afford the following intermediate, nor-*C*-fluorocurarine (81) which can be recognized as the starting point for a rather complicated grid of the strychnan-type biosynthesis .Schemes 2.8-2.10 demonstrate the biosynthetic routes through which the alkaloids of the six groups belonging to the strychnan type are formed, Scheme 2.8 is for those of the retuline group, Scheme 2.9 for those of the spermostrychnine and the tsilanine groups, and Scheme 2.10 for derivatives of diaboline, isostrychnine and strychnine [167].

Several biogenetic studies on the formation of strychnine (39) and its derivatives have been carried out. It is evedent that Weiland-Gumlich aldehyde (82) is a precursor of these bases but its N_a-acetyl derivative , diaboline (24), is not. Heimberger and Scott have proposed the existance of an aldol acid intermediate named prestrychnine (90) which can undergo lactamization and further cyclization to afford strychnine [164]. Their hypothesis has been supported by the isolation of protostrychnine (9), considerable as a partly cyclized prestrychnine [129]. According to this hypothesis the final stage of the biosynthetic pathway to strychnine could be established as shown in Scheme 2.11.

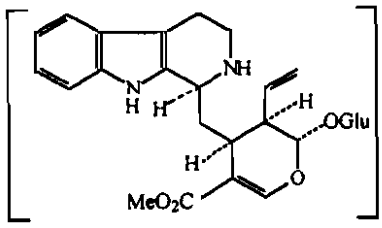


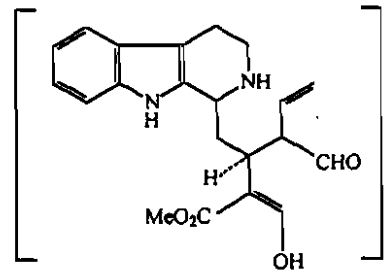
Alkaloids with various structural skeletons.

Scheme 2.5 Biosynthesis of terpenoid indole alkaloids



Scheme 2.5a Derivation of alkaloids with various types from strictosidine

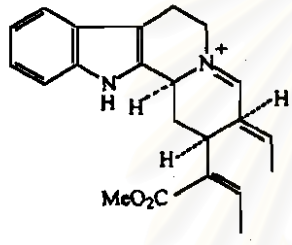


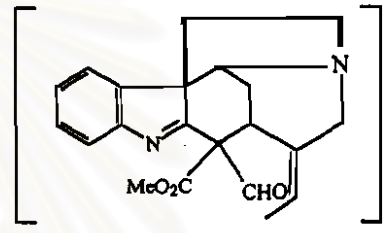


76 *Strictosidine*

Dolichanthoside
Angustine
S. decussata gluco-alkaloid

Intermediate (78)
Strychnohirsutine
Akagerine, Kribine
Antirhine
+1 Tryptamine:
Usambarance bases



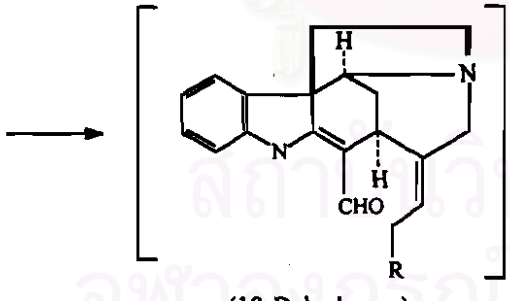


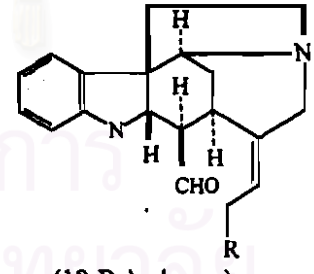
79 *4,21 Dehydrogeissoschizine*

Diploceline
Strychnorubigine
Mavacurine
Nor-macusine B
Alstonine
+1 Tryptam: Usambarance bases

80 *Dehydro-preakuammicine*

Condylocarpine

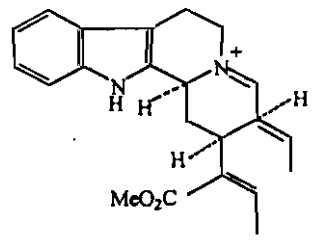




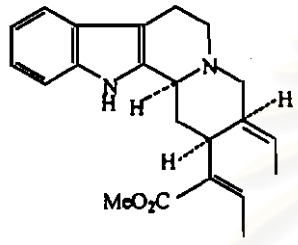
(18-Dehydroxy-)
81 *Nor-C-fluorocurarine*
R = H or OH
C-Fluorocurarine
2,16-Dehydrodiaboline

(18-Dehydroxy-)
82 *Wieland-Gumlich aldehyde*
R = H or OH
Dimeric bases
(18-Dehydroxy-)
Isoretuline/Retuline
Spermostrychnine
Tsilanine
Diaboline
Strychnine

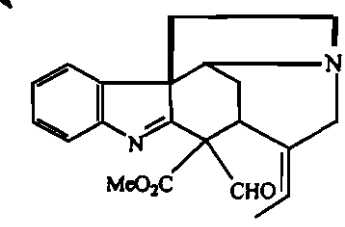
Scheme 2.6 Presumed central biosynthetic pathway indole alkaloid in *Strychnos*



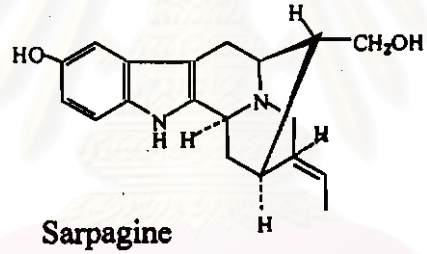
79 4.21- dehydrogeissoschizine



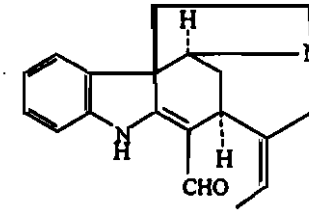
1 Geissoschizine



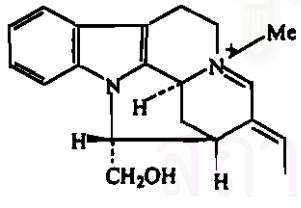
80 Dehydro-preakuammicine



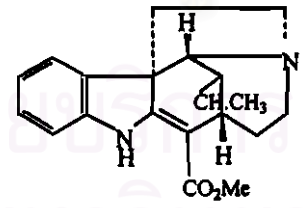
83 Sarpagine
(Corynanthean type)



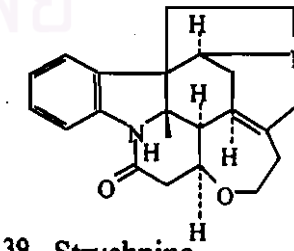
81 Nor-C-fluorocurarine



8 Mavacurine
(Corynanthean type)

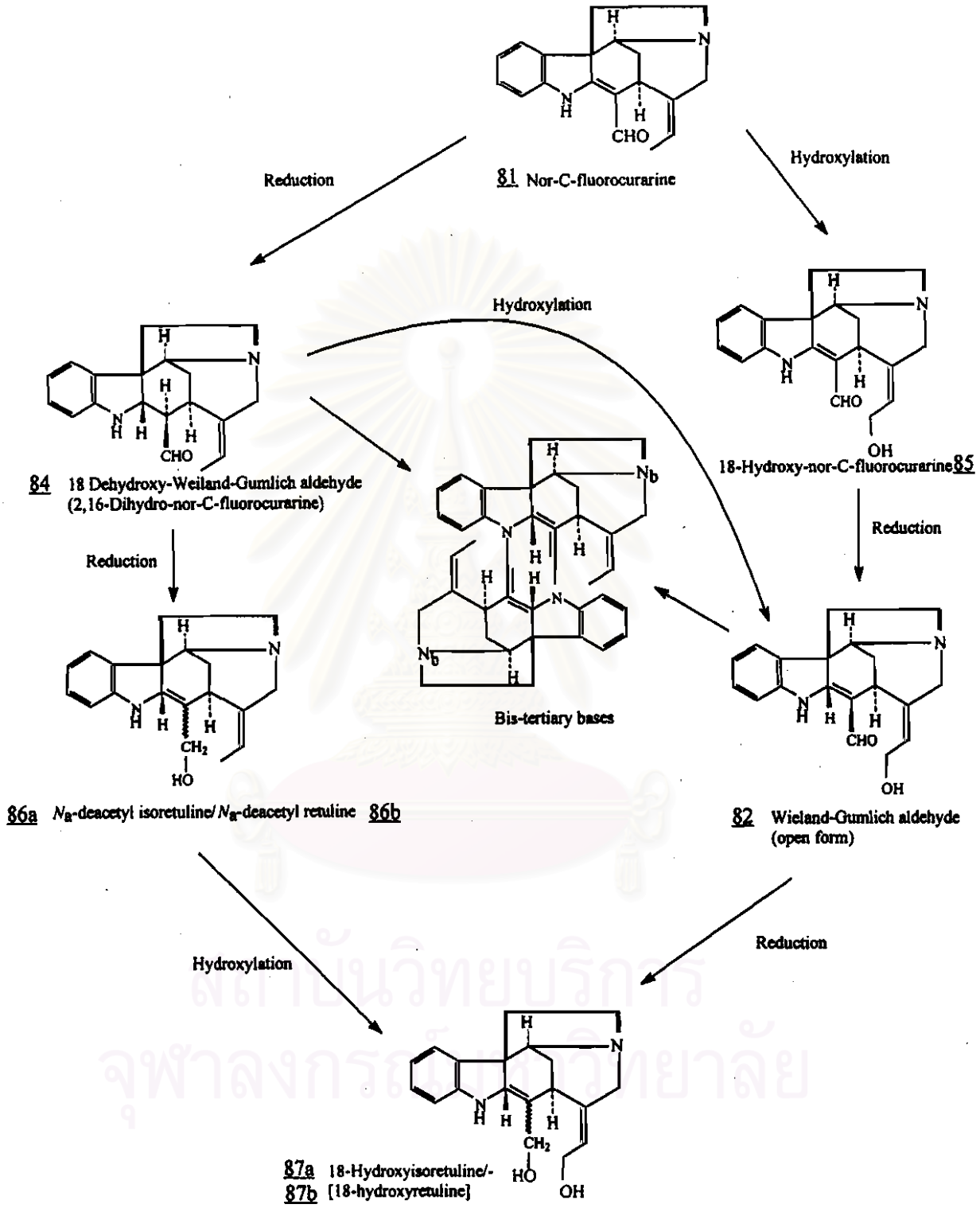


47 Condylocarpine
(Aspidospermatan type)

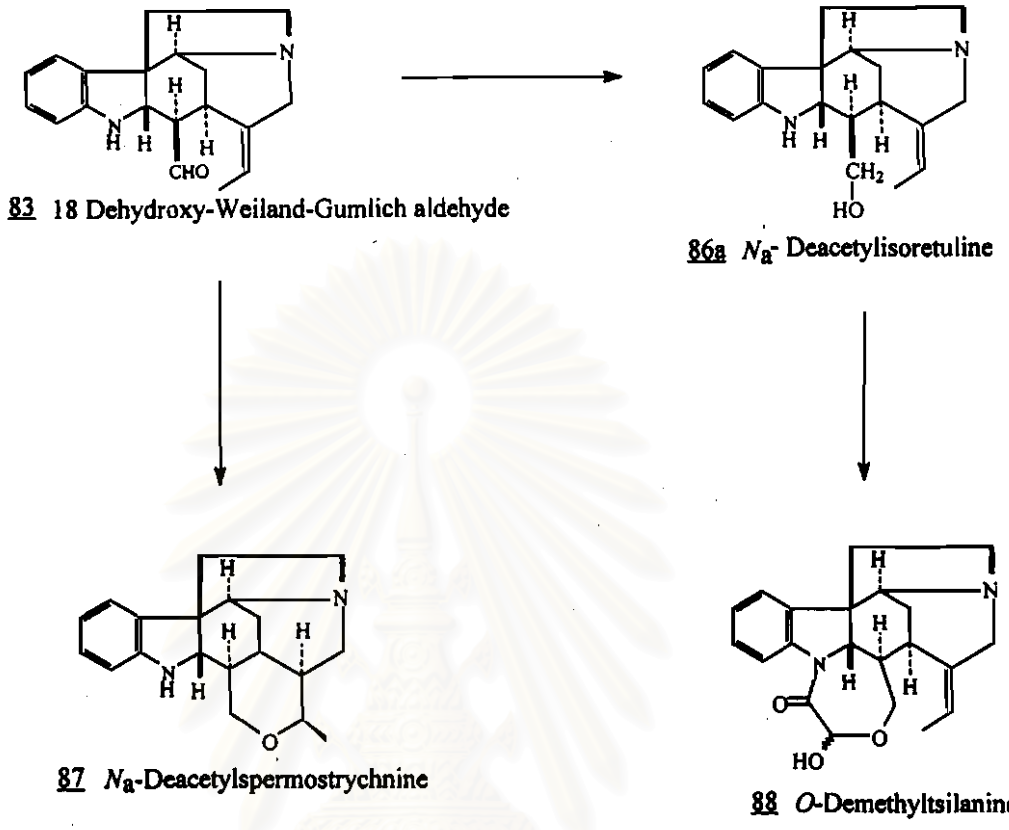


39 Strychnine
(Strychnan-type)

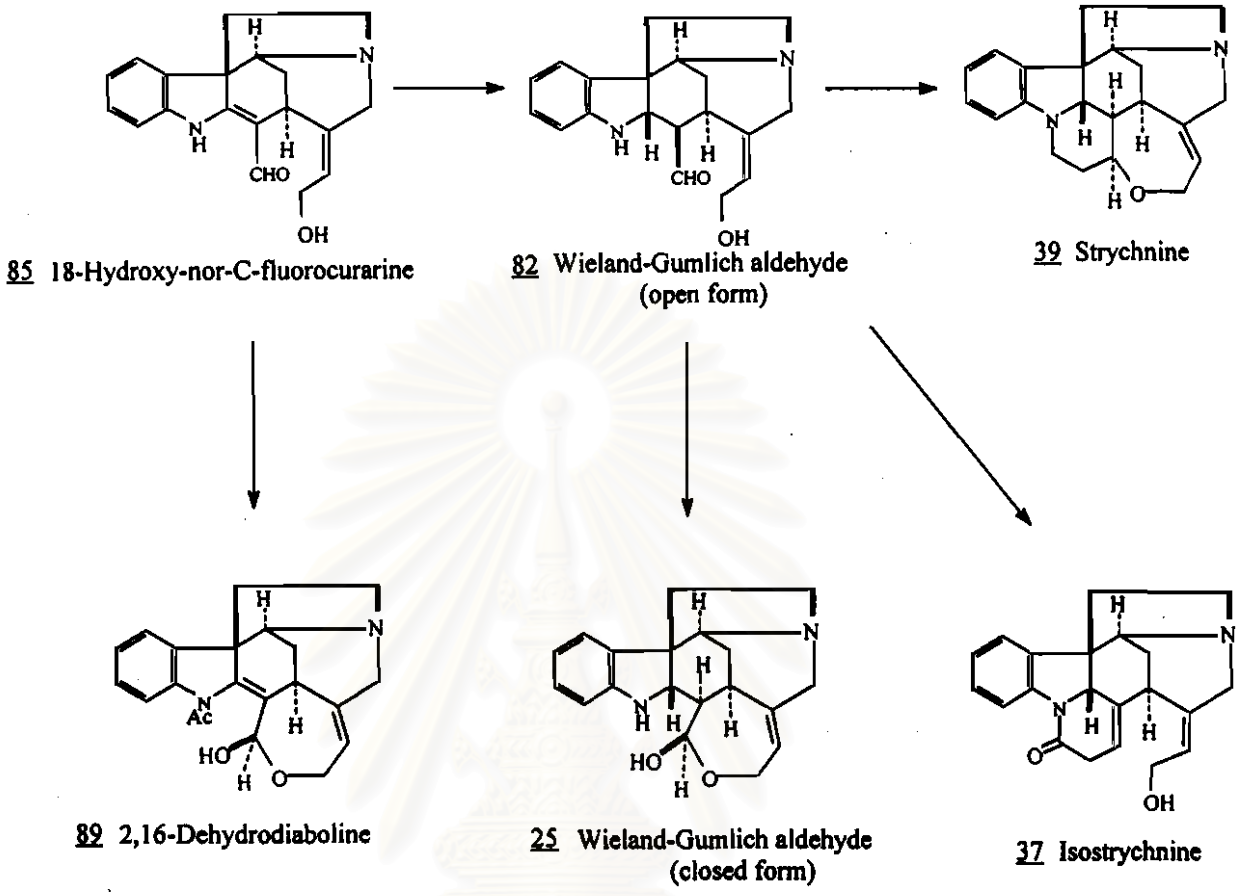
Scheme 2.7 4,21-Dehydrogeissoschizine as the key intermediate in *Strychnos* alkaloid biosynthesis



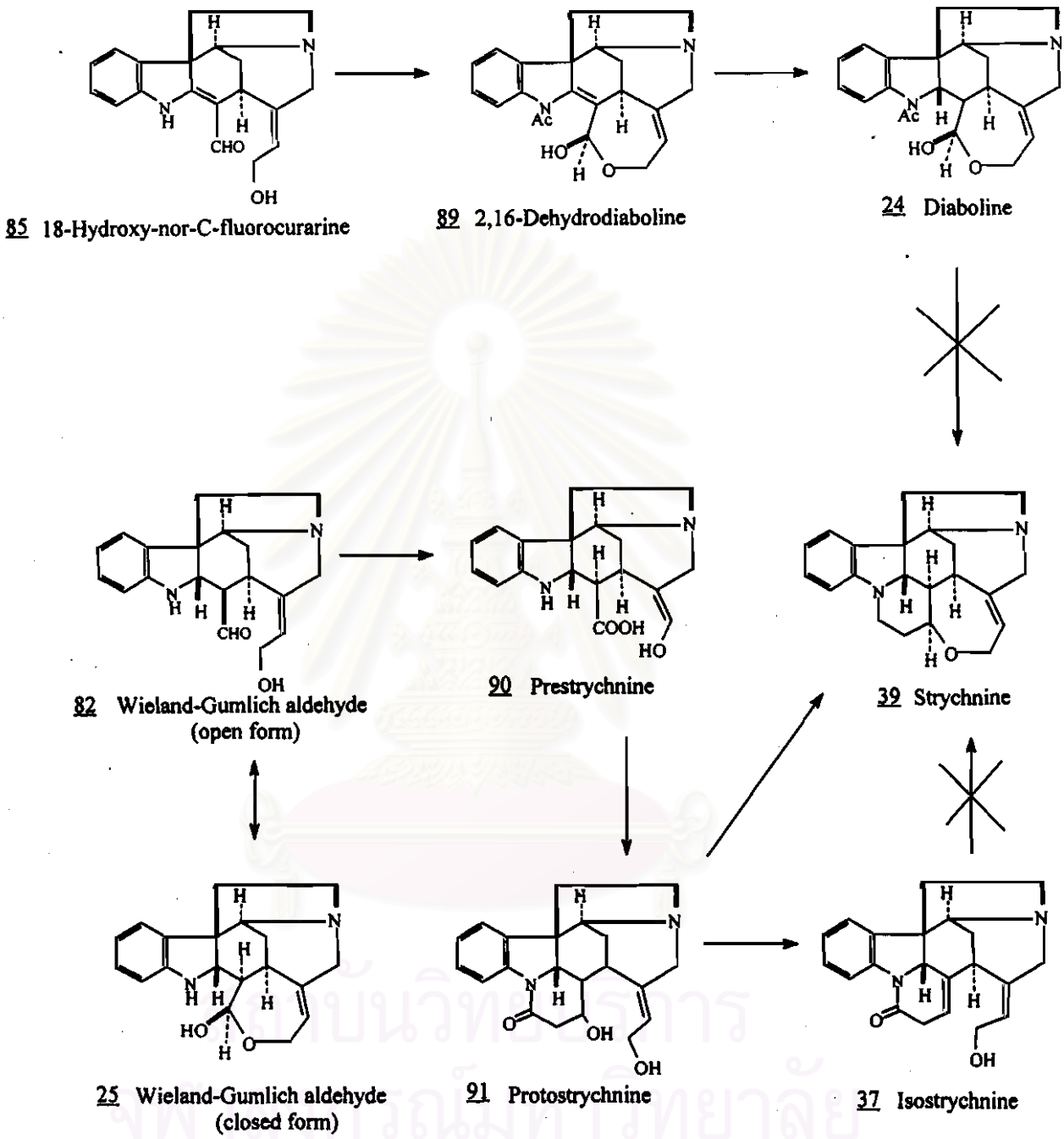
Scheme 2.8 Biogenetic route to retuline group alkaloids



Scheme 2.9 Biogenetic route to alkaloids of the spermostrychnine and tsilanine groups



Scheme 2.10 Biogenetic route to alkaloids of the isostrychnine and strychnine groups



Scheme 2.11 Final stage in the biogenesis of strychnine

3. Pharmacological Acitivity of *Strychnos* alkaloids

The two most well-known activities of Strychnos alkaloids are the muscle-relaxant and convulsant properties. The alkaloids possessing strong muscle-relaxant activity are quarternary dimeric alkaloids which include members of toxiferine, curarine and calebassine groups. The structure-activity relationship of these alkaloids has been studied and the results obtained were summarized in the review paper of Ohiri, Verpoorte and Svendsen [86]. Other alkaloids such as decussine, 11-methoxy-macusine A and malindine have also been described of their pronounced muscle-relaxant activity [88,168,169].

Convulsant effect is well-known as the property of strychnine group alkaloids. Strychnine and 12-hydroxystrychnine of the normal series are the most potent members of the group. The pseudo series are slightly less active than strychnine while the *N*-methyl-*sec* pseudo series are much less active. The structure-related diaboline and spermostrychnine group alkaloids possess weak convulsant activity. The alkaloid alagerine and its derivatives were also reported as the potent convulsive agents, however less active than strychnine. The discussion on structure activity relationships of strychnine and its congeners is available in the same paper as that of quaternary dimeric alkaloids [86].

Besides the two activities mentioned above, a number of pharmacological activities of *Strychnos* species have also been found. Such activities are antimicrobial activity, antitumour and cytotoxic activities, hypotensive activity, sedative activity, etc. The studies on structure-activity relationships of some types of alkaloids with certain activity have been carried out such as those of usambarensis group alkaloids with antimicrobial activity and cytotoxic activity [170,171].

The list of *Strychnos* alkaloids with their pharmacological activities is presented in Table 2.4 .

Table 2.4 Pharmacological activity of *Strychnos* alkaloids

Strychnos alkaloids	Pharmacological Activity	Reference
Monomeric indole alkaloids		
Corynanthean type		
Diploceline	antimicrobial activity	53
Alstonine	cytotoxic activity	86
	hypotensive activity	86
Serpentine	cytotoxic activity	86
	hypotensive activity	86
11-Methoxymacusine A	skeletal muscle-relaxant activity	168
Macusine B	hypotensive activity	172
	clonic convulsant *in vivo*	172
	serotonin inhibitor	172
Normacusine B	hypotensive activity	86
	sedative activity	86
C-Mavacurine	skeletal muscle-relaxant activity	86
C-Florocurine	skeletal muscle-relaxant activity	86
Akagerine	cytotoxic activity	171
	convulsive activity	81
17-*O*-methyakagerine	convulsive activity	81
10-Hydroxy-17-*O*-methyakagerine	convulsive activity	80
10-Hydroxy-21-*O*-methylkribine	convulsive activity	80
10-Hydroxy-*epi*-21-*O*-methylkribine	convulsive activity	80
Vincosan type		
Dolichantoside	cytotoxic acitivity	171
Isodolichantoside	cytotoxic acitivity	171
Decussine	skeletal muscle relaxant activity	88
3,14-Dihydrodecussine	skeletal muscle relaxant activity	62
Vallesiachotaman type		
Methylantirhine	cytotoxic activity	171
Strychnan type		
Fluorocurarine	skeletal muscle relaxant activity	86
Retuline	anti-inflammatory activity	178
Isoretuline	anti-inflammatory activity	178
Diaboline	cytotoxic acitivity	173
	hypotensive activity	174
Diaboline derivatives	convulsive activity	86
Henningsoline	cytotoxic acitivity	173
O-Methyl-N_a-acetylstrychnosplendine	skeletal muscle relaxant activity	124
Holstiine	cytotoxic activity	173
Strychnine	convulsant activity	86
12-Hydroxystrychnine	convulsant activity	86
Strychnine-*N*-oxide	convulsant activity	86

(continued)

Strychnos alkaloids	Pharmacological Activity	Reference
19,20-dihydrostrychnine	convulsant activity	86
Brucine	convulsant activity	86
β-Colubrine	convulsant activity	86
Pseudostrychnine	convulsant activity	86
Icajine	convulsant activity	86
Vomicine	convulsant activity	86
Aspidospermatan type		
(+)-Tubotaiwine	convulsant activity	86
Miscellaneous type		
Ellipticine	antimicrobial activity	175
	cytotoxic activity	86
9-Methoxyellipticine	cytotoxic activity	86
Dimeric indole alkaloids		
Quasi-dimeric alkaloids		
Usambarensine	cytotoxic activity	171
	antibacterial activity	170
N_b-Methylusambarensine	cytotoxic activity	171
Usambarine	cytotoxic activity	171
10-Hydrousambarine	cytotoxic activity	171
11- Hydrousambarine	cytotoxic activity	171
N_b-Methyl-10-hydroxyusambarine	cytotoxic activity	171
N_b-Methyl-11- hydroxyusambarine	cytotoxic activity	171
Strychnopentamine	cytotoxic activity	171
Tchibangensine	cytotoxic activity	171
	antiamoebic activity	170
4',17-Dihydro-17α- tchibangensine	antibacterial activity	170
4',17-Dihydro-17β- tchibangensine	antibacterial activity	170
4',17-Dihydro-17α-*epi*- tchibangensine	antibacterial activity	170
4',17-Dihydro-17β-*epi*- tchibangensine	antibacterial activity	170
10'-Hydroxy-4',17-Dihydro-17α- tchibangensine	antibacterial activity	170
11- Hydroxy-4',17-Dihydro-17β- tchibangensine	antibacterial activity	170
10,10'-Dimethoxy-4',17-Dihydro-17β-tchibangensine	antibacterial activity	170
10,10'-dihydroxy- N_b-Methyl-tetrahydrousambarensine	antimicrobial activity	170
10,10'-Dimethoxy- N_b-Methyl-tetrahydrousambarensine	antimicrobial activity	170
10-Hydroxy-10'-methoxy- N_b-Methyl-tetrahydrousambarensine	antimicrobial activity	170
Strychnophylline	cytotoxic acitivity	171
Strychnofoline	cytotoxic acitivity	171

(continued)

Strychnos alkaloids	Pharmacological Activity	Reference
Strychnan-Corynanthean type		
Longicaudatine	reserpine-like activity	86
Strychnan-Strychnan type		
Bisnordihydrotoxiferine	skeletal muscle relaxant activity	86
	cytotoxic activity	176
	antimicrobial activity	176
	sedative activity	86
Bisnordihydrotoxiferine-di-*N*-oxide	antimicrobial activity	177
Bisnor-*C*-alkaloid H	antimicrobial activity	177
Caracurine V	skeletal muscle relaxant activity	158
	antimicrobial activity	177
Caracurine V-*N*-oxide	skeletal muscle relaxant activity	158
Caracurine V-di-*N*-oxide	skeletal muscle relaxant activity	158
	antimicrobial activity	177
Toxiferine	skeletal muscle relaxant activity	86
C-Dihydrotoxiferine	skeletal muscle relaxant activity	86
C-Alkaloid H	skeletal muscle relaxant activity	86
C-Curarine	skeletal muscle relaxant activity	86
C-alkaloid E	skeletal muscle relaxant activity	86
C -Alkaloid G	skeletal muscle relaxant activity	86
C-Calebassine	skeletal muscle relaxant activity	86
C -Alkaloid A	skeletal muscle relaxant activity	86
C -Alkaloid F	skeletal muscle relaxant activity	86
Afrocurarine	skeletal muscle relaxant activity	86

Lignans and Iridoids of the *Strychnos*

1. Lignans

Lignans are regarded as a member of plant phenols whose structure is characterised by the assembly of two phenylpropanoid unit, the two cinnamic acid residues and their biogenetic equivalents. A great diversity in the structure of these compounds is due to the chemical combination of the two characteristic units as well as the degree of oxidation and types of substituents in the molecule. This class of natural products with more than 200 representatives has a widespread distribution throughout the plant kingdom. Chemical reviews of lignan structure and the review of their distribution in plants are available in the literature [179,180]. It is evident that the lignans are continued to be constantly encountered and knowledge of their variety as well as their range of occurrence is continually expanding.

A great variety of the biological actions of lignans is impressive. The well known representatives in this view are membes of the podophyllotoxin group. Some biological activities of lignans together with the examples of compounds responsible for the activities are summarized as follows [179,180].

Antitumor activity : podophyllotoxin derivatives (α-peltatin, β-peltatin, epipodophyllotoxin), nordihydroguaiaretic acid, burseran

Antiviral activity : podophyllotoxin derivatives

Antimitotic activity : podophyllotoxin derivatives

Antimicrobial activity : nor-isoguaiacin, (-)dihydroguaiaretic acid

Cathartic activity : podophyllotoxin derivatives, 2 -hydroxyarctiin

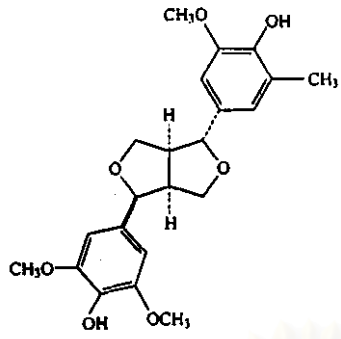
Allergenicity : plicatic acid

Piseicidal activity : justicidin A and B, diphyllin

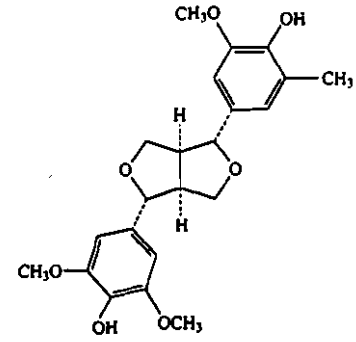
The information obtained from phytochemical studies of *Strychnos* species has suggested the rare occurrence of lignans in the genus. However, it is not clear whether this reflects natural situation or a bias in selection by phytochemists as it is generally known that most of phytochemical investigations of *Strychnos* species have been aimed at indole alkaloids. Only three lignans have been reported to be isolated from the *Strychnos*, and only two *Strychnos* species have been found as sources of lignans. The information of lignans of the *Strychnos* are summarized in Table 2.5. It is notable that the two species containing lignans are members of the same section, Lanigerae.

Table 2.5 Lignans of *Strychnos* species

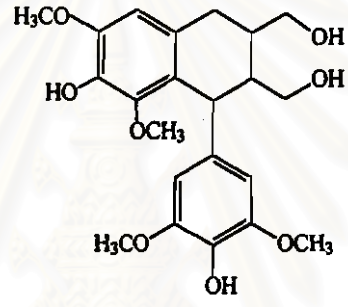
Lignan	*Strychnos* species	Plant part	Reference
Lirioresinol A (92)	*S. dinklagei*	stem bark	142
Lirioresinol A (93)	*S. dinklagei*	stem bark	142
Lyoniresinol (94)	*S. thorelii*	stem	8



92 Lirioresinol A



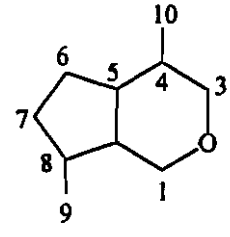
93 Lirioresinol B



94 Lyoniresinol

2. Iridoids

Iridoids , also referred as pseudoindicans, represent a group of monoterpenoids with the cyclopentan-(C)-pyran skeleton (95). These compounds are found in a large nember of plant families belonging to the order Tubiflorae. Most of them occur as glycosides; some are found in free forms and some as dimeric compounds. Those in which the pyran ring is open, called secoiridoids, are also included in the iridoid group. Certain representatives of iridoids are indicated to be biogenetic precursors of terpenoid indole alkaloids [162].



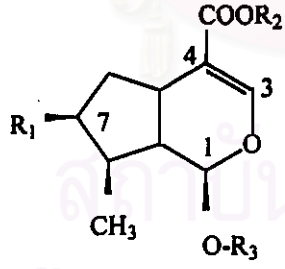
95 Cyclopentane-(C)-pyran skeleton

Several reviews of iridoids are available such as the reviews of the chemical structures together with the physical and spectroscopic data of the compound [181-183],the reviews which dealt with the isolation and structure elucidation [184,18,5], and the review of their properties and biosynthesis [186].

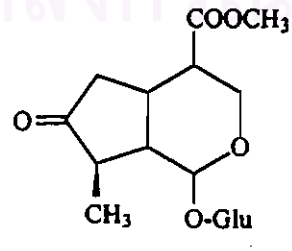
Iridoids found in *Strychnos* species are shown in Table 2.6.

Table 2.6 Iridoids of *Strychnos* species

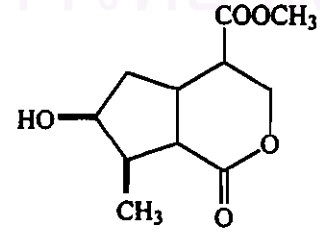
Iridoid	*Strychnos* species	Plant part	Reference
Loganin (96)	*S. lucida*	wood	187
	S. nux-vomica	fruit	136
Loganetin (97)	*S. lucida*	wood	187
Deoxyloganin (98)	*S. nux-vomica*	fruit	136
Loganic acid (99)	*S. lucida*	wood	187
7-Ketologanin (100)	*S. nux-vomica*	fruit	136
	S. roborans	fruit	188
3,4-Dihydro-1-oxo-loganin aglycone (101)	*S. dinklagei*	leaf	189
Ligustrinoside (102)	*S. lucida*	wood	187
Secologanin (103)	*S. nux-vomica*	fruit	136
Kingiside aglucone (101)	*S. spinosa*	fruit	190



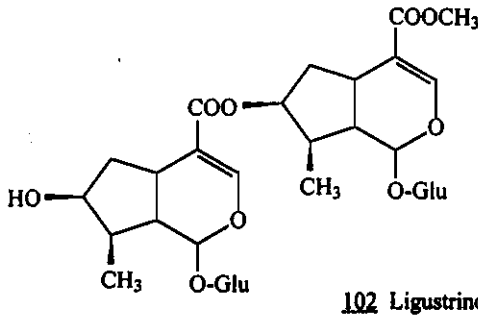
		R_1	R_2	R_3
96	Loganin	OH	Me	Glu
97	Loganetin	OH	Me	H
98	Deoxyloganin	H	Me	Glu
99	Loganic acid	OH	H	Glu



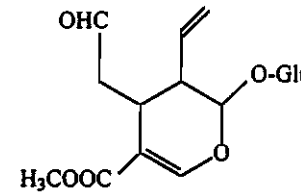
100 7-Ketologanin



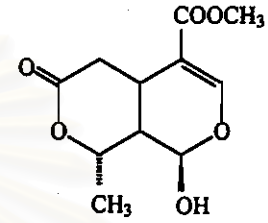
101 3,4-Dihydro-1-oxologanin aglycone



102 Ligustrinoside



103 Secologanin



104 Kingiside aglucone