The Acanthaceae (a dicotyledon) is a large family with about 220 genera and about 3000 species (Heywood *et al.*, 2007). The species of this family have been reported to contain terpenoids (iridoids, diterepenoids and triterpenoids), flavonoids, lignans, alkaloids, naphthoquinones and others.

Carbohydrates

Hokputsa *et al*. (2004) extracted bioactive neutral and acidic polysaccharides from the stems of *Acanthus ebracteatus*. The neutral polysaccharide was rich in galactose, 3-*O*-methylgalactose and arabinose, whereas the acidic polysaccharide consisted of galacturonic acid along with rhamnose, arabinose and galactose as minor components indicating a pectin-type polysaccharide with rhamnogalacturonan type backbone; 3-*O*-methylgalactose is also present in the acidic fraction. Both neutral and acidic fractions showed potent effects on the complement system (using pectic polysaccharide from *Plantago major* as a positive control). The traditional way of using this plant as a medical remedy appears to have a scientific basis. Two pheophytins, were isolated from the aerial parts of *Anisacanthus brasiliensis* (Dias *et al.*, 2007).

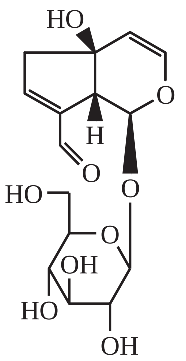
The water-soluble polysaccharide obtained from the seeds of *Hygrophila spinosa*, consisted mainly of D-xylose with minor quantities of D-glucose and traces of L-arabinose and D-mannose (Haq *et al*., 1985).

Lipids

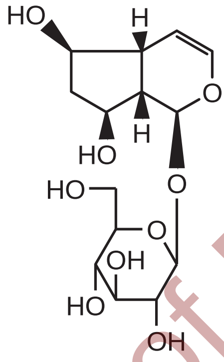
The major fatty acid of *Asteracantha longifolia* seed oil is linoleic ($C_{18:2}$) (Mannan *et al*., 1986). The fatty acids of the fixed oil from the seeds of *Hygrophila spinosa* consist of myristic ($C_{14:0}$), palmitic ($C_{16:0}$), stearic ($C_{18:0}$), oleic ($C_{18:1}$) and linoleic ($C_{18:2}$) acids (Godbole *et al*., 1941; Tiwari *et al*., 1967; Haq and Nabi, 1978; Mazumder and Sengupta, 1978). Furthermore, 2-hexylcyclopropane methyl caprylate (0.63%) and 2-octylcyclopropane methyl caprylate (3.42%) were also found in this species. Unsaturated fatty acids accounted for 51.30% of total acids in *Dicliptera chinensis*, including 26.86% oleic acid ($C_{18:1}$) and 21.70 % *trans*-linoleic acid (Gao *et al*., 2005). A mixture of nine cerebrosides and a monoacylmono-galactosylglycerol were separated from the leaves of *Clinacanthus nutans*. The structures of the cerebrosides were characterized as 1-*O*-β-D-glucosides of phytosphingosines, which comprised a long-chain base (2*S*,3*S*,4*S*,8*Z*)-2-amino-8(*Z*)-octadecene-1,3,4-triol with nine 2-hydroxy fatty acids of varying chain lengths (C_{16}, C_{18}, C_{20-26}) linked to the amino group. The glycosylglyceride was characterized as (2S)-1-*O*-linolenyl-3-*O*-β-D-galactopyranosylglycerol (Tuntiwachwuttikul *et al*., 2004). A cerebroside, dicliptercerebroside (1-*O*- β-D-glucopyanosyl-2N-{(2'*R*)-2'-hydroxy-(9*Z*)-palmitoleoyl}-2*S*,3*S*,4*R*-C_{20}-phytosphingosine, asperglaucide and amido alcohol were isolated from *Dicliptera chinensis* (Gao *et al*., 2007).

Terpenoids

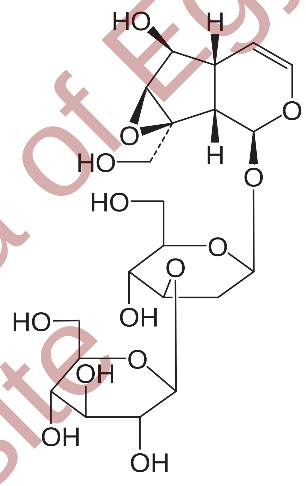
Fischer *et al.* (1988) stated that 14 of the 40 species of Acanthaceae *sensu lato* contain iridoid glycosides. About 20 iridoids have been reported from the family. Seven were unique for the family namely 6-*O*-acetylschanzhiside methyl ester, 6-*O*-acetylbarlerin, 8(*S*)-7,8-dihydroaucubin, eranthemoside, hygrophiloside, 6-*epi*-stilbericoside, and thunbergioside. The following iridoids have been identified from the family *e.g.* hygrophiloside (**1**) from *Hygrophila difformis* (Jensen and Nelsen, 1985), eranthemoside from *Eranthemum pulchellum* (Jensen *et al*., 1987), asystasiosides A-E, catalpol, gardoside methyl ester, 8-epiloganin and mussaenoside from *Asystasia bella* (*Mackaya bella*) (Demuth *et al*., 1989), ajugol (**2**) from *Asystasia gangetica* (L.) T. Anderson (Kanchanapoom and Ruchirawat,2007), 3'-*O*-β-D-glucopyranosyl-catalpol (**3**) from *Asystasia intrusa* (Kanchanapoom *et al.*, 2004a), procumbide from *Andrographis paniculata* (Abeysekera *et al.*, 1990), 6-*O*-*trans*-cinnamoyl E harpagoside from *Goldfussia yunnanensis* (Yu *et al.*, 2007) and 6-deoxyharpagoside (curvifloruside E) and 6-apiharpagoside (curvifloruside F) from *Phlogacanthus curviflorus* (Lai *et al.*, 2009).



1 Hygrophiloside



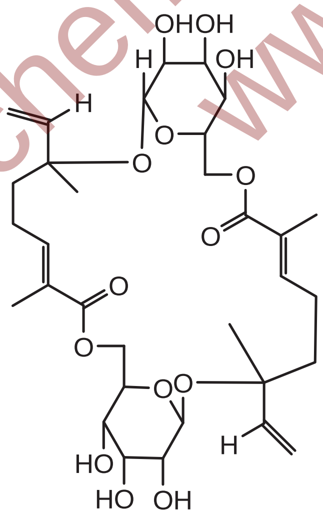
2 Ajugol



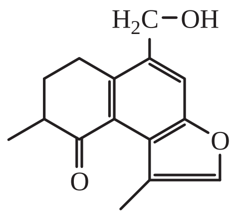
3 3' *O*-β-D-Glucopyranosyl-catalopl

The dimeric monoterpenoid glycoside, dicliripariside A (**4**) was isolated from *Dicliptera riparia* Nees (Luo *et al.*, 2002). Vomifoliol (a terpenoid alcohol) was obtained from the leaves of *Graptophyllum pictum* (L.) Griff. (Nonato *et al.*, 1996).

Cadinane and norcadinane sesquiterpenes, *viz.* goldfussin A (**5**), goldfussin B and goldfussinol, were isolated from *Goldfussia psilostachys* (Luo *et al.*, 2005).



4 Dicliripariside A

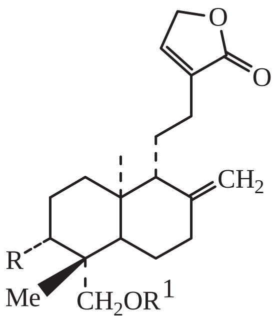


5 Goldfussin A

Several diterpenoids (abietane, labadane, *ent*-labdane, fusicane, diterpene dimers and diterpene ketones) and their glycosides have been isolated from species of different genera of the family Acanthaceae (Table 1). Betulin, lupeol and other triterpenoids have been isolated from several species of the family (Table 2).

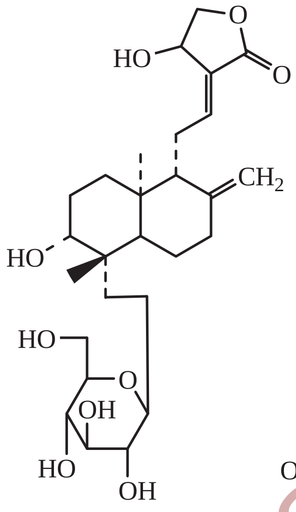
Table 1 – Diterpenoids of some species of the family Acanthaceae

Species	Plant Part	Diterpenoids	References
1-*Andrographis lineata*		17,19,20-Trihydroxy-5β,8αH,9βH,10α-labda-13-en-16,15 olactone.	Hari *et al*. (2003)
2- *Andrographis paniculata*	Ap,L, R	Andrographolide, deoxyandrographolide, 14-deoxy-11-oxo-andrographolide, 14-deoxy-11,12-didehydroandrographolide, neoandrographolide, 14-deoxyandrographolide 19-β-D-glucoside, 3,4-dideoxyandrographolide (**6**), deoxyandrographiside (**7**), andrographiside (**8**), 14-deoxyandrographiside, andrograpanin (**9**), andropanoside, 14-deoxy-12-methoxyandrographolide, 14-*epi*-andrographolide, isoandrographanolide, 14-deoxy-11- hydroxyandrographanolide, 6'–acetylneoandrogra phanolide, bisandrograpolides (dimers), *ent*-14-β-hydroxy-8(**7**), 12- labadien-16,15-olide-3β,19-oxide, andropanolide, 19-norandrographolides A-C, 7(*R*)-hydroxy-14- deoxyandrographolide 7*S*-hydroxy-14- deoxyandro-grapholide 12*S*, 13*S*-hydroxyandrographolide, 12*R*,13*R*-hydroxyandrographolide, andrographicacid, andrographanidin A, ninadrographolide, (**10**), 3-*O*-glucosyl-14-deoxyandrographiside 3-*O*-glucosyl-14-deoxy-11, 12-didehydroandrographiside, andrographolactone (**11**), 14-deoxy-15-isopropylidine-11,12-didehydroandrographolide, and 12-*epi*-14 deoxy-12-methoxyandrographanolide.	Gorter (1911); Chan *et al*. (1968); Chen and Liang (1982); Hu and Zhao (1981); Hu *et al*. (1982); Meng (1982); Fujita *et al*. (1984); Abeysekera *et al*. (1990); Matsuda *et al*. (1994); Jantan and Waterman (1994); Nguyen *et al*. (1997); Rao *et al*., (2004); Pramanick *et al*. (2006); Zhang *et al*. (2006a); Nguyen and Le (2007); Chen *et al*. (2006b, 2008); Reddy *et al*. (2003 a,b); Li *et al*. (2007a); Zhou *et al*. (2008); Wang *et al*. (2009)
3- *Andrographis wightiolide*		Wightional (**12**) and wightiolide (**13**)	Joshi *et al*. (1996)
4- *Goldfussia yunnanesis*	Ap	18-Hydroxyhelioscopinolide A, 18-oxoheloioscopinolide A	Yu *et al*. (2007)
5- *Hypoestes forskalei*		Deoxyhypoestenone (**14**), dehydrohypoestenone (**15**), hypoestene (**16**) and hypoestenone	Muhammed *et al*. (1997,1998)

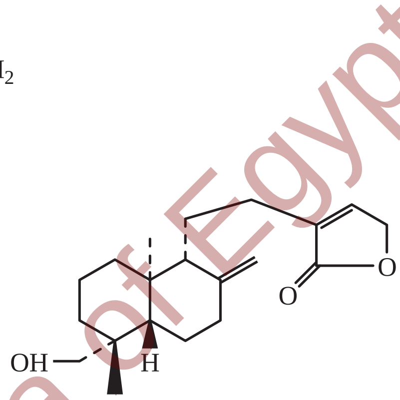


6 3,4-Dideoxyandrographolide
(R=R[1]=H)

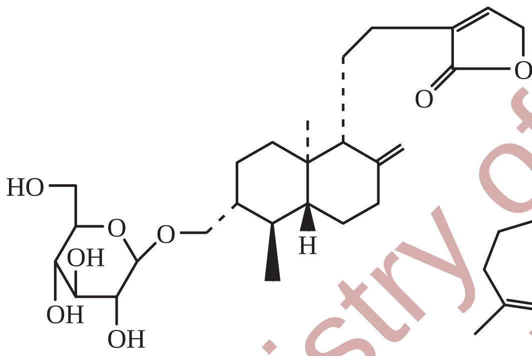
7 Deoxyandrographiside
R=OH, R=β-glucopyranosyl



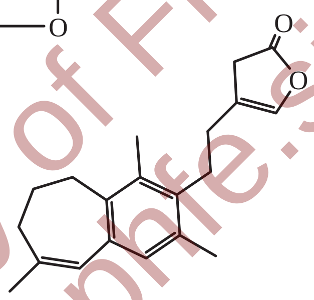
8 Andrographiside



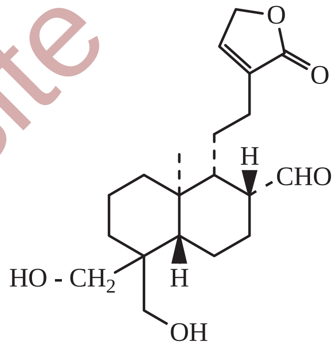
9 Andrograpanin



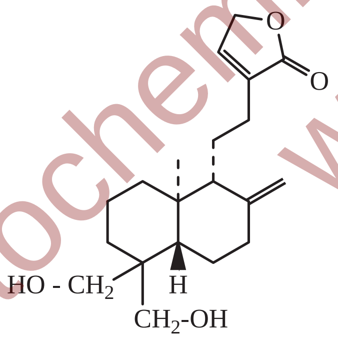
10 Ninadrographolide



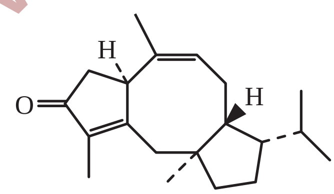
11 Andrographolactone



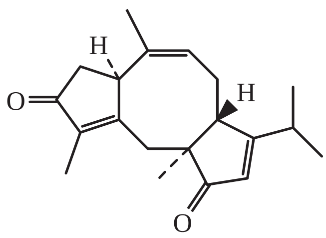
12 Wightional



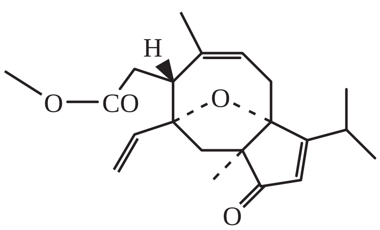
13 Wightiolide



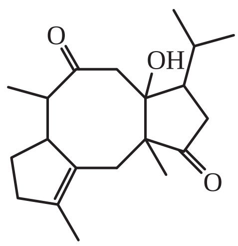
14 Deoxyhypoestenone



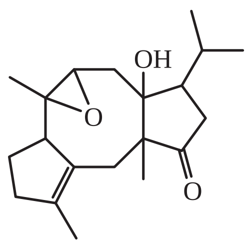
15 Dehydrohypoestenone



16 Hypoestene



17 Roseadione

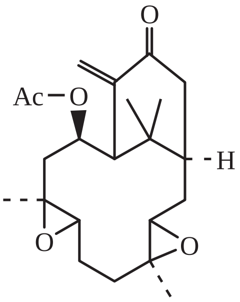


18 Roseatoxide

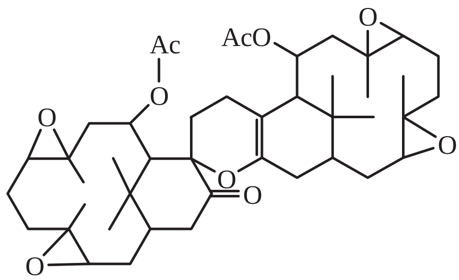
Table 1 – Diterpenoids of some species of the family Acanthaceae (cont.)

Species	Plant Part	Diterpenoids	References
6- *Hypoestes purpurea*	Ap	Hypopurin A, hypopurin B, hypopurin C, and hypopurin D	Shen *et al*. (2004)
7- *Hypoestes rosea*		Roseadione (**17**), roseatoxide (**18**), hypoestoxide (**19**), dihypoestoxide (**20**) and roseanolone (**21**)	Okogun *et al*. (1982); Adesomoju *et al*. (1983a,b); Adesomoju and Okogun (1984)
8- *Hypoestes serpens*	Ap,L	Serpendione (**22**), fusicoserpenol A (**23**), dolabeserpenoic acid A (**24**), 7β-hydroxyisopimara-8,15-dien-14-one,14α-hydroxyisopimara-7,15-dien-1-one,1β,14α-dihydroxy-isopimara-7,15-diene, 7β-hydroxyisopimara-8(14), 15-dien-1-one and 7β-aceitoxyisopimara 8(14), 15-dien-1-one.	Andriamihaja *et al*. (2001); Rasoamiaranjanahary *et al*. (2003a, b)
9- *Hypoestes verticillaris*		Verticillarone (**25**) and 13-hydroxy-7-oxo-labda-8,14-diene	Al-Rehaily *et al*. (2002a)
10-*Phlogacanthus curviflorus*	R	Curviflorusides A-D	Lai *et al*. (2009)
11-*Phlogacanthus guttatus*		Guttoside (**26**)	Yadav *et al*. (1999)
12-*Phlogacanthus thyrsiflorus*	L	Phlogantholoide A (**27**) and phloganthoside (**28**)	Barua *et al*. (1985, 1987)
13-*Phlogacanthus tubiflorus*		Phlogacanthin	Yadav *et al*. (1998)

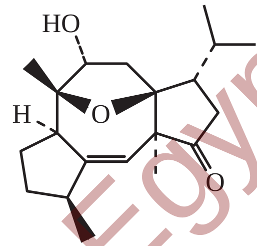
Ap: aerial parts, L: leaves, R: roots



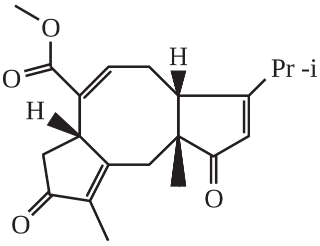
19 Hypoestoxide



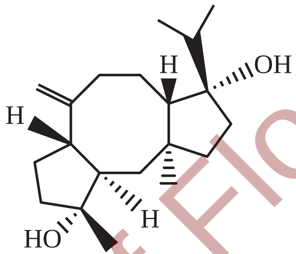
20 Dihypoestoxide



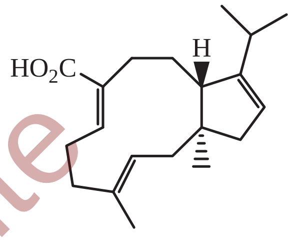
21 Roseanolone



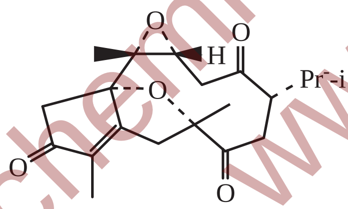
22 Serpendione



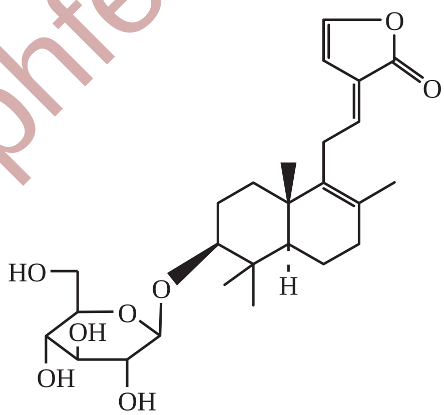
23 Fusicoserpenol A



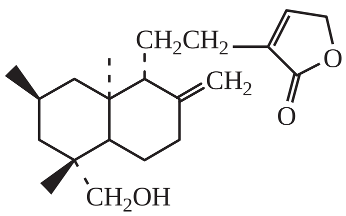
24 Dolabeserpenoic acid A



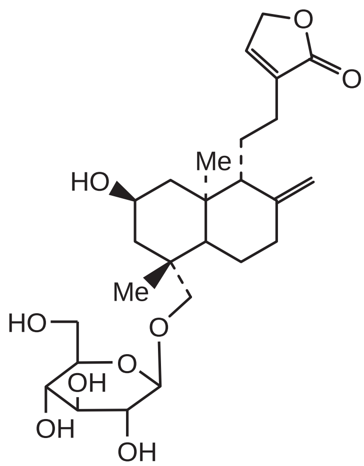
25 Verticillarone



26 Guttoside

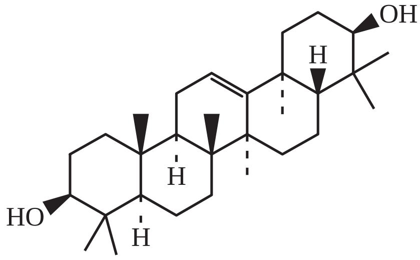


27 Phlogantholide A

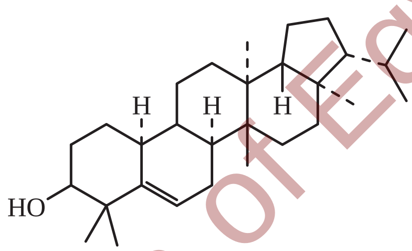


28 Phloganthoside

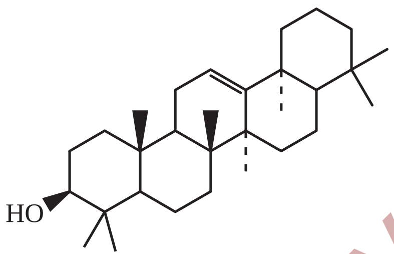
A triterpenoid saponin was isolated from *Acanthus ilicifolius* (Minocha and Tiwari, 1981). An antimicrobial triterpenoid saponin (3β-O-[α-L-rhamnopyranosyl (1→4)O-β-D-glucopyranosyl]16α-hydroxyolean-12-en-(13)-28(oic acid) was identified from the leaves of *Lepidagathis hyalina* Nees (Yadava, 2001).



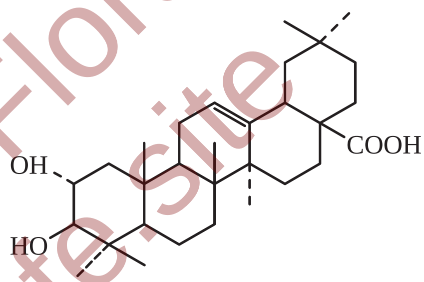
29 Acanthusol



30 Simiarenol



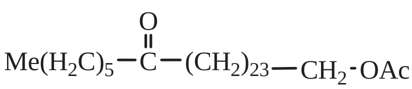
31 Monechmol



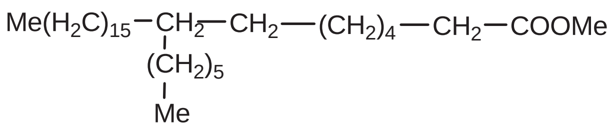
32 Maslinic acid

Sterols, Alcohols and Hydrocarbons

3-Methylnonacosane and 23-ethylcholesta-11(en),23(24)-dien-3β-ol have been identified from the aerial parts of *Asteracantha longifolia* (Misra *et al*., 2000). β-Sitosterol and its *O*-β-D-glucoside, stigmasterol and spinasterol were identified from several species. 3β-Hydroxy-5-stigmasta-9(11),22(23)-diene was isolated from *Andrographis paniculata* (Gupta *et al*., 1996a). Daucosterol (β-sitosterol β-D-glucoside) was isolated from *Dicliptera ripario* (Luo *et* al., 2002), *Hypoestes triflora* (Jiang *et al*., 2001) and *Rostellularia procumbens* (L.) Nees (Zhang *et al*., 2006b). Tritriacontane and hentriacontanol were isolated from *Adhatoda vasica* (Huq *et al*., 1967) and *Hemigraphis hirta* T. Anderson (Mukherjee *et al*., 1991) respectively. Two aliphatic hydroxyketones *viz.* 37-hydroxyhexatetracont-1-en-15-one and 37-hdroxyhentatetracontan-19-one (Singh *et al*., 1991) and an aliphatic alcohol (29-methyltriacontan-1-ol) (Singh *et al*., 1992) were isolated from the aerial parts of *Adhatoda vasica* Nees. Misra *et al.* (2001) reported the isolation of two aliphatic esters *viz*. 25-oxohentriacontanyl acetate (**33**) and methyl 8-*n*-hexyltetracosanoate (**34**) from *Asteracantha longifolia*. Two aliphatic alcohol glycosides *viz*. ilicifolioside A (**35**) and asystoside (**36**) were isolated from *Acanthus ilicifolius* (Wu *et al*., 2003b) and *Asystasia intrusa* (Kanchanapoom *et al*., 2004a) respectively. Three aliphatic alcohol glycosides (e.g. ebracteatoside, (**37**) were isolated from *Acanthus ebracteatus* (Kanchanapoom *et al*., 2001c).



33 25-Oxohentriacontamyl acetate



34 Methyl-8 *n*-hexyltetracosanoate

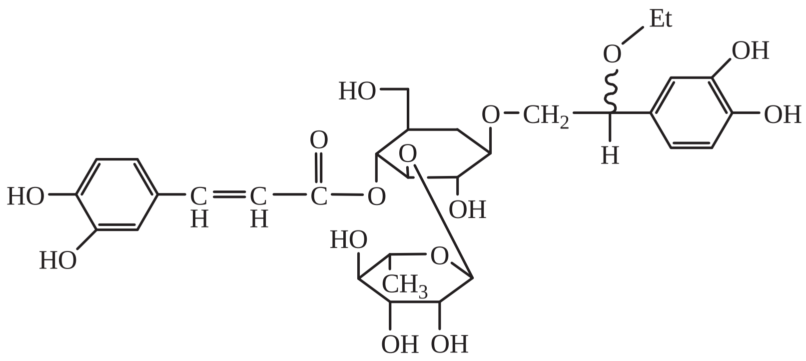
Table 2 – Triterpenes of some species of the family Acanthaceae

Species	Plant Part	Triterpenes	References
1- *Acanthus arboreus*		Lupeol	Amer *et al.* (2004)
2- *Acanthus ilicifolius*		Lupeol, oleanolic acid	Minocha and Tiwari (1980)
3- *Acanthus montanus*		Acanthusol (**29**), urs-12-ene-3α-L-rhamnopyranosyl (28→1)-β-D-glucopyranosyl ester, urs-12-en-28-oic acid-3-*O*-β-D-glucopyranosyl (1→2)-β-D-glucopyranoside and 3β,24-dihydroxyolean-12-en-28-oic acid.	Anam (1997a,b)
4- *Adhatoda vasica* (Malabar nut)	Ap	α-Amyrin, 3 α-hydroxy-oleane-5-ene, epitaraxerol and 3 α-hydroxy-D-friedoolean-6-ene	Rangaswami and Seshadri (1971); Atta-ur- Rahman *et al.* (1997); Sultana *et al.* (2005)
5- *Asteracantha longifolia*		Betulin, lupeol and 3β-acetoxy-urs-18 ene	Gupta *et al.* (1983a); Misra *et al.* (2000, 2001); Ali and Tripathi (2007)
6- *Brillantaisia palisatii*		α-Amyrin, β-amyrin, lupeol and 3-epiursolic acid	Berrond *et al.* (2003)
7- *Cardanthera uligonosa*		Lupeol	Govindachari and Nagarajan (1957)
8- *Clinacanthus nutans*		Betulin and lupeol	Lin *et al.* (1983)
9- *Dicliptera roxburghiana*		β-Amyrin and botulin	Bahuguna and Jangwan (1986).
10- *Gendarussa ventricosa*		Simiarenol (**30**)	Zhang *et al.* (2004)
11- *Lepidagathis cristata*	Wp	Cycloartenol	Ravikanth *et al.* (2001)
12- *Monechma debile*		Monechmol (**31**) and monechmol-3-*O*-glucoside	Ayoub and Babiker (1984)

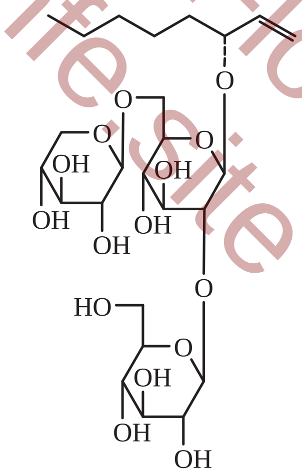
Table 2 – Triterpenes of some species of the family Acanthaceae (cont.)

Species	Plant Part	Triterpenes	References
13- *Rostellularia procumbens*	Wp	α-Amyrin, cycloeucalenol, friedelin, epifriedelin, lupenyl acetate, euscephalic acid, ursolic acid, 7α-hydroxyursolic acid and tomentic acid	Zhang *et al.* (2006b,2007)
14- *Strobilanthes callosus*		Taraxerol	Singh *et al.* (2002b)
15- *Strobilanthes cusia*		Betulin, lupeol and lupeonone	Li *et al.* (1993)
16- *Strobilanthes formosanus*		Betulin and lupeol	Kao *et al.* (2004)
17- *Strobilanthes ixiocephala*	R	19 α-*H*-Lupeol	Agarwal and Rangari (2001)
18- *Tomandersia laurifolia*	T	Maslinic acid (**32**), epimaslinic acid, taraxyl palmitate, thomandertriol and 2α,3α-dihydroxyurs-12-en-28-oic acid	Ngadjui *et al.* (1994,1995)

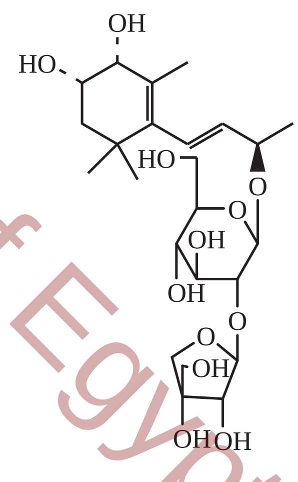
Ap: aerial parts, R: roots, T: twigs, Wp: whole plant



35 Ilicifolioside



36 Asystoside



37 Ebracteatoside

Essential Oils

The major volatile components of the leaves and flowers of *Adhatoda vasica* Nees, cultivated in Egypt, were identified as 3-methyl-4-heptanone and decane respectively (El-Sawi *et al*., 1999). Almost 40 components were identified from the essential oil of immature fruit of *Brillantaisia lamium*, representing more than 90% of the oil. The main constituents were isobornyl acetate (66.9%), caryophyllene oxide (5%), β-caryophyllene (4.5%) and isoborneol (2.4%) (Ayedoun *et al*., 1997). Ni *et al*. (2003) reported that the essential oil of *Calycanthus chinensis* is rich in sesquiterpenes and sesquiterpene oxides. It also contains monoterpenes and oxides, nitrogen-containing substances, alcohols, aldehydes, ketones, esters, hydrocarbons, etc.

Both 1-(3,4,5,6-tetrahydro-2-pyridyl)-1-propanone (41.2%) and 1-(1,4,5,6-tetrahydro-2-pyridyl)-1-propanone (37.5%) constitute the main part of the volatile compounds of *Semnostachys menglaensis* Tsui. Minor components are 1-(3,4,5,6-tetrahydro-2-pyridyl)-1-ethanone (4.8%), 1-(2-piperidyl)-1-propanone (5.2%), 1-octen-3-ol (3.2%), 1-octen-3-one (1.9%) and 3-octanol and 1-(2-pyridyl)-1-propanone in trace amounts (Naef *et al*., 2005).

Weyerstahl *et al*. (1987) identified 23 compounds from the essential oil of *Strobilanthes auriculatus*, from which isoborneol, its isobutyrate and 8-(isobtyryloxy) isobornyl isobutyrate are the main components (altogether 82%). Beside some sesquiterpene alcohols, all the interesting constituents of this species derive from isoborneol by further hydroxylation in various positions and subsequent esterification with isobutyric acid (Weyerstahl *et al*., 1988).

According to Weyerstahl *et al*. (1992), the essential oil obtained from preflowering plants of *Strobilanthes callosus* Nees was found to possess compositional differences to an oil from post-flowering plants. The oil from post-flowering plants contained *trans*-sabinene hydrate (3%), *cis*-sabinene hydrate (9%), terpinen-4-ol (19%), α-terpineol (5%) and methyl chavicol (24%). On the other hand, the oil from preflowering plants contained *trans*-sabinene hydrate (3%), *cis*-sabinene hydrate (14%), terpinen-4-ol (23%) and α-terpineol (5%), whereas methyl chavicol was not detected. The oil obtained from fresh flowering tops of *Strobilanthus ixiocephala* Benth., of 1st and 2nd consecutive year was found to possess compositional differences in the percentage of chemical constituents. A sesquiterpene alcohol, ixiocephal (23.4%) and T-cadinenol (17.6%) were identified. Among the other constituents β-caryophyllene (6.6%) and α-fenchyl acetate (2.2%) were also detected. The second year's oil also contained ixiocephal (3.9%) and T-cadinol (23%) along with α-caryophyllene (16%) and α-fenchyl acetate (24.7%) which differed drastically as compared to first year's oil (Agarwal and Rangari, 2005).

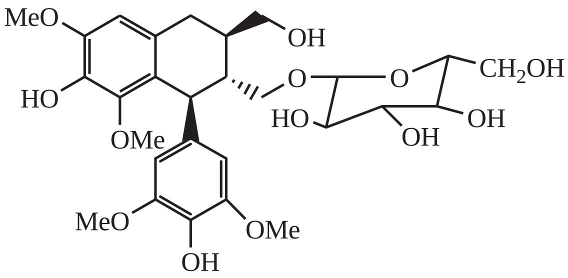
Flavonoids

Several flavonoids (including acylated ones) have been identified in species of the family Acanthaceae. Fifty-eight taxa belonging to three subfamilies of Acanthaceae have been screened for leaf flavonoids, phenolic acids and aucubins (Daniel and Sabnis, 1987). The patterns of distribution of leaf phenolics among the taxa investigated suggest that: (i) there are 3 well-defined taxonomic groups; (ii) the treatment of Thunbergiaceae as distinct from Acanthaceae (*sensu stricto*) is justified; (iii) Nelsonioideae appears to be an intermediate link between Thunbergiaceae and Acanthaceae, and its inclusion within Acanthaceae is justified and (iv) Thunbergiaceae is relatively more primitive than Acanthaceae. Of the 58 taxa screened, 47 contained flavones, flavonols, glycoflavones and proanthocyanidins. Thirty five species contained flavones as *O*-glycosides. Apigenin, luteolin and/or their mono-, bi- or trimethyl derivatives were the common flavones in most of the taxa investigated. Glycoflavones were isolated from 15 species. Vitexin and isovitexin were the most common glycoflavones. 4'-Methoxy vitexin was confined to *Bremekampia neilgherryensis*, *Haplanthus verticillaris* and *Ecbolium linnaeanum*. 6-Methoxy vitexin was restricted to *Justicia procumbens* var. *simplex*. In at least 6 species, flavone-*O*-glycosides and glycoflavones were found together. In *Adhatoda zeylanica*, glycoflavones were found in association with flavonols and they were the sole flavonoids in 8 taxa. The subfamilies Nelsonioideae and Thunbergioideae were rich in glycoflavones but poor in flavones. 6-Oxygenated flavones were entirely absent from these subfamilies, but were confined to the subfamily Acanthoideae. Flavonols, kaempferol, quercetin, myricetin and their monomethoxy derivatives were found in 4 species of the tribe Odontonemeae and Justicieae. In no plant flavones and flavonols did occur together. Proanthocyanins were rare and restricted to the three taxa; in *Hygrophila auriulata* and *Acanthus ilicifolius* they were found alongwith flavones and in *Elytraria crenata* with glycoflavones (Daniel and Sabnis, 1987). Hilsenbeck and Mabry (1990) reported that seven species of *Siphonoglossa* section *Siphonoglossa* formed only apigenin-based *C*-glycosylflavones that are methylated either at the 7 and 4'-positions, only the 7-position, or are not methylated at all. Fourteen *C*-glucosyl derivatives of apigenin including the 6-*C*-glucosyl types of 6-*C*-glucosylapigenin, 7,4'-dimethyl ether (embigenin), embinin, isovitexin, swertisin and some 2''-*O*-glucosyl derivatives of these two latter compounds were obtained from these species. The 8-*C*-glucosyl (*i.e.* isoembigenin, vitexin) and *C*-8, 8-di-*C*-glucosyl (*i.e.* vicenin 2) types occur less frequently in the investigated species. Examples of the flavonoids isolated from the family are shown in Table 3.

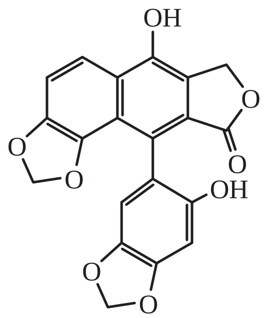
2'-Hydroxy-4-glucosylchalcone and 2'-hydroxy-2,3,4'-trimethoxychalcone were identified from the flowers of *Adhatoda vasica* (Bhartiya and Gupta, 1982) and whole plant of *Andrographis macrobotrys* (Reddy *et al*., 2005) respectively. 2'-Hydroxy-2,4,6'-trimethoxychalcone was isolated from *Andrographis lineata* (Hari *et al*., 2003). Also, androechin (chalcone glucoside) and 2',4',6',2,3,4-hexamethylchalcone were isolated from *Andrographis echioides* (Jayaprakasam *et al*., 2001) and *Andrographis neesiana* (Reddy *et al*., 2003d) respectively.

Lignans, Quinones and Xanthones

Lignans are typical chemical constituents of the family Acanthaceae, especially those of the arylnaphthalene and arylnaphthalide types (Day *et al*., 2000; Liu *et al*., 2008). Several lignan glycosides (arylnaphthalene, diphyllin, furofuranoid, cyclolignans and others) have been isolated from different genera of the family. Examples of these lignans are shown in Table 4.



38 (+)Lyoniresinol 3α -*O*-β-glucopyranoside
39 (-)Lyoniresinol 3α -*O*-β-glucopyranoside



40 2'-Hydroxyjostirumalin

Table 3 – Flavonoids of some species of the family Acanthaceae

Species	Plant Part	Flavonoids	References
1- *Acanthus arboreus*		Apigenin, apigenin 7-*O*-β-D-(6''-*trans*-*p*-coumaroyl)-glucoside and apigenin 7-*O*-β-D-(6''-*trans*-*p*-coumaroyl)-3''-*O*-acetylgluco-pyranoside	Amer *et al.* (2004).
2- *Acanthus ilicifolius*		Quercetin, quercetin 3-*O*-glucoside, vitexin and acacetin 7-*O*-α-L-rhamnopyranosyl-(1″→6″)-*O*-β-glucopyranoside	Minocha and Tiwari (1980); Wu *et al.* (2003c)
	L	Apigenin 7-*O*-glucuronide and methyl apigenin-7-*O*-β-gluco-pyranouronate	Nair and Pauchaname (1987)
3- *Acanthus integrifolius*	L	Apigenin 7-*O*-glucoside	Phan and Phan (2004)
4- *Acanthus mollis*	L	Luteolin 7-*O*-glucoside	Loukis and Philianos (1980b)
	L,S	Apigenin 7-*O*-glucoside Hispidulin and 5, 4'-dihydroxy-7,8-dimethoxyflavone	Ismail and El-Tantawy (1999) Reynaud *et al.* (1988)
5- *Acanthus spinosus*	L	Apigenin 7-galactoside and luteolin 7-glucoside	Loukis and Philianos (1980a)
6- *Acanthus volubilis*	Ap	Schaftoside and hispidulin-7-*O*-rutinoside	Kanchanapoom *et al.* (2006)
7- *Adhatoda vasica* (Malabar nut)	F	Kaempferol, kaempferol-3-glucoside, kaempferol-3-sophoroside, and quercetin	Rangaswami and Seshadri (1971)
	L,F	Apigenin, vitexin, isovitexin, 2''-*O*-xylosylvitexin and rhamnosylvitexin	El-Sawi *et al.* (1999)
8- *Andrographis affinis*	Wp	7-*O*-Methyldihydrowogonin,7-*O*-methylwogonin, skullcapflavone I, skullcapflavone I 2' –methyl ether, (2*S*)-5,7,2',3',4' –penta-methoxyflavanone, 5-hydroxy-7,8,2',5' tetramethoxyflavone and echioidinin-2'-*O*-β-D-(6''-*O*-acetyl) glucopyranoside	Reddy *et al.* (2003a)
9- *Andrographis alata*	Wp	Echioidinin, echioidinin 5-glucoside,5,2',6'-trihydroxy-7-methoxyflavone 2'-*O*-β-D-glucopyranoside and 5 acylated 5,7,2',6'-oxygenated flavone glycosides	Damu *et al.* (1998a,b); Das *et al.* (2006)

Table 3 – Flavonoids of some species of the family Acanthaceae (cont.)

Species	Plant Part	Flavonoids	References
10- *Andrographis echioides*	Wp	Echioidinin 5-*O*- glucoside., dihydroechioidinin, echioidinin, echioidin, skullcapflavone I 2'-*O*-methyl ether and skullcapflavone I 2'-*O*-glucoside	Jayaprakasam *et al.* (1999, 2001)
11- *Andrographis elongata*	Wp	7-*O*-Methylwogonin, skullcapflavone I, skullcapflavone I 2'-*O*-glucopyranoside, 5,2',6-trihydroxy-7-methoxyflavone and skullcapflavone I 2'-*O*-β-D- (4''-*E*-cinnamoyl) glucopyranoside	Jayakrishna *et al* (2001)
12- *Andrographis lineata*	Wp	5,7,2',3',4'-Pentamethoxyflavone, dihydroskullcapflavone I, 5-hydroxy-7,8,2',3',4'-pentamethoxyflavone, 5,2'-dihydroxy-7-methoxyflavanone, 5,2'- dihydroxy-7,8- dimethoxyflavone, and 5,2′-dihydroxy-7- methoxyflavone- 2'-*O*-β-D-glucopyranoside	Hari *et al.* (2003)
13- *Andrographis macrobotrys*	Wp	5,7,8,2'-Tetramethoxyflavanone, 5-hydroxy-7- methoxyflavone, 5,2',6'-trihydroxy-7-methoxyflavone and 5,7,2',6'-tetrahydroxy-flavone	Reddy *et al.* (2005)
14- *Andrographis nallamalayana*	Wp	Skullcapflavone I 2''-*O*-β-D- (6'' –*E*-cinnamoyl) glucopyranoside, 5,2'-dihydroxy-7-methoxyflavone and 5,2',6'-trihydroxy-7-methoxyflavone-2'-*O*-β-D- glucopyranoside	Reddy *et al.* (2007)
15- *Andrographis neesiana*	Wp	Echioidinin 5-*O*-glucoside and 5-hydroxy-7,2',5'-trimethoxy-flavone	Reddy *et al.* (2003d)
16- *Andrographis paniculata*	L	Oroxylin A and wogonin	Zhu and Liu (1984)
	R	Andrographidins A-F, panicolin , 5-hydroxy-7,8,2',3'-tetra-methoxyflavone, and 2',5-dihydroxy-7,8-dimethoxyflavone-2-*O*-β-D-glucoside	Qudrat-i-Khan *et al.* (1964); Govindachari *et al.* (1969); Kuroyangi *et al.* (1987); Gupta *et al.* (1996a)

Table 3 – Flavonoids of some species of the family Acanthaceae (cont.)

Species	Plant Part	Flavonoids	References
	Wp	Apigenin-7-*O*-β-D-glucoside, 5,4'-dihydroxy-7-methoxy-flavone-6-yl-β-D-pyranoglucoside, 5,4'-dihydroxy-7-methoxy-flavone-8-yl-β-D-pyranoglucoside, apigenin-4',7-dimethylether, mono-*O*- methylwightin, 5-hydroxy-2',7,8-trimethoxyflavone, 2',5',-dihydroxy 7-methoxyflavone, apigenin 4',7-dimethyl ether, 5-hydroxy-7,8-dimethoxy (2*R*)-flavanone-5-*O*-β-D-glucopyranoside, 5-hydroxy-7,8,2',5'-tetramethoxy-flavone-5-*O*-β-glucopyranoside, and 5-hydroxy-7,2',6'-trimethoxyflavone	Bianco *et al.* (1983); Gupta *et al.* (1983b); Zhong *et al.* (2001); Reddy *et al.* (2003 b); Rao *et al.* (2004); Li *et al.* (2007a); Ren *et al.* (2007)
17- *Andrographis rothii*	Wp	Echioidin, skullcapflavone I, 5,7,2',5'-tetramethoxyflavanone and 5-hydroxy-7,2'- dimethoxyflavone	Reddy *et al.* (2003c)
18- *Andrographis Serpyllifolia*	Wp	Andrographidin C, skullcapflavone I 2'-*O*-β-D-(3''-*E*-cinnamoyl) glucopyranoside, skullcapflavone I 2'-*O*-β-D-(2''*E*-cinnamoyl) glucopyranoside, and skullcapflavone I 2'-*O*-β-D-glucopyranoside	Damu *et al.* (1999)
19- *Andrographis viscosula*	Wp	Echioidinin, echioidin, echioidin 5-*O*-glucoside, 5,2',6'-trihydroxy -7- methoxyflavone, 5, 7,2',4',6'-pentamethoxy-flavone, 5,7,2'-trimethoxyflavone, 5,2',6'- trihydroxy-7-methoxyflavone-2'-*O*-glucoside, (2*R*)-5-hydroxy,7',2',3'-trimethoxyflavanone, 7,2',5'- trimethoxyflavone and 5,7,2',3'-tetramathoxyflavone	Rao *et al.* (2002, 2003)
20- *Ansicanthus virgularis*	Wp	Acacetin, acacetin 7-glucoside, apigenin, apigenin 4'-glucoside, chrysoeriol, luteolin, luteolin 7-rutinoside, vicenin 2, orientin, 6, 8-dihydroxyapigenin-6-*O*-α-L-rhamnopyranoside,8-*O*-β-D-galactopyranoside, and 8,3'-dimethoxyluteolin -6-*O*-α-L-rhamnopyranoside	Michael *et al.* (2007)

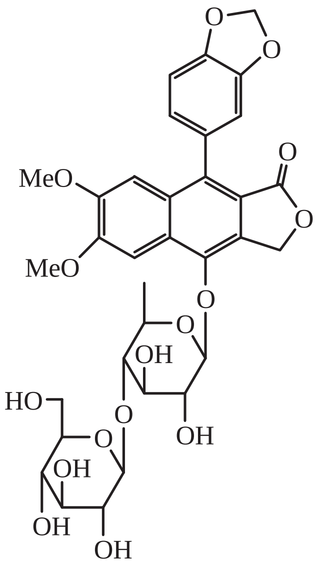
Table 3 – Flavonoids of some species of the family Acanthaceae (cont.)

Species	Plant Part	Flavonoids	References
21- *Aphelandra aurantiaca*	L,S	Chrysin, eucalyptin, gnaphalin and nevadensin	Bratoeff and Perez-Amador (1994)
22- *Asteracantha longifolia*	F	Apigenin 7-*O*-glucuronide and apigenin 7-*O*-glucoside	Balraj and Nagarajan (1982)
23- *Asystasia gangetica*	Ff	Luteolin-7-*O*-neohesperidoside	Sethuraman and Vigneswari (1998)
	Ap	Apigenin 7-*O*-β-glucopyronoside, apigenin 7-*O*-neohesperidoside and apigenin 7-*O*-glucopyranosyl (1→6) β-D-glucopyranoside	Kanchanapoom and Ruchirawat (2007)
24- *Brillantaisia palisatii*	Ap	Lespedin (a rare dirhamnosyl flavonol)	Berrond *et al.* (2003)
25- *Clinacanthus nutans*	L,S	Vitexin, isovitexin, shaftoside, isomollupentin, orientin-7-*O*-β-glucoside and isoorientin	Teshima *et al.* (1997)
26- *Dicliptera riparia*	Wp	Dicliripariside B and dicliripariside C	Luo *et al.* (2002)
27- *Dicliptera roxburghiana*		Apigenin, apigenin 7-*O*-glucoside, kaempferol and luteolin 7-*O*-glucoside	Bahuguna *et al.* (1987)
28- *Jungia paniculata*		Kaempferol-3-*O*-β-D-(6''-galloyl) glucopyranoside and 3,5,7,8,4'-pentahydroxyflavone-3-*O*-β-glucofuranoside	D'Agostino *et al.* (1995)
29- *Lepidagath cristata*		6-Hydroxyluteolin-7-*O*-apioside	Ranganathan *et al.* (1980)
30- *Pseuderanthemum latifolium*		7,4'-Dihydroxyflavone, 5,4'-dihydroxy-7-methoxyflavone and 5,6-dihydroxy-3',4',7,8-tetramethoxyflavone	Zhu *et al.* (2006)
31- *Rhinacanthus nasuta*	F	Rutin	Subramanian and Nagarajan (1981)
32- *Rostellularia procumbens*	Wp	Apigenin, apigenin-*O*-glucoside, apigenin-7-*O*-neohesperidin, luteolin, luteolin-7-*O*-glucoside, quercetin and quercetin-7-*O*-rhamnoside	Zhang *et al.* (2006b)

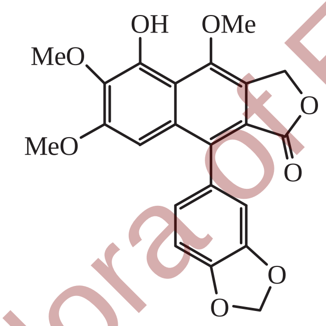
Table 3 – Flavonoids of some species of the family Acanthaceae (cont.)

Species	Plant Part	Flavonoids	References
33- *Rungia repens*	F	Apigenin-7- glucoside, chrysoeriol-7-glucoside, chrysoeriol-4'-glucoside, chrysoeriol-7,4'-diglucoside, kaempferol-3-*O*-rahmnopyranosyl (1→3) β-D-glucopyranoside and luteolin 7-*O*-glucoside	Subramanian and Nair. (1966); Seshadri and Vydeeswaran (1972)
34- *Sclerochiton vogelii*		Luteolin-7-*O*-(α-L-rhamnopyranosyl-(1→6)-[β-D-gluco-pyranosyl-(1→2)-β-D-glucopyranosyl, luteolin-7-*O*-β-D-apiofuranosyl(1→2)-β-D-xylopyranosyl and luteolin-7-*O*-α-L-rhamnosyl-(1→6) β-D-glucopyranoside	Lamidi *et al.* (2006)
35- *Siphonoglossa sessilis*		Embinin, embinoidin (2'-*O*-glucosyl-6-*C*-glucosylapigenin-7,4'-dimethylether), isoembigenin (8-*C*- glucosylapigenin-7,4'-dimethyl ether) and vicenin 2	Hilsenbeck and Mabry (1983)
36- *Strobilanthes formosanus*		3'-Hydroxy-5,7-dimethoxyflavone 4'-*O*-β D-apiofuranoside, 5,7-dimethoxyflavone 4'-*O*-[β-D-apiofuranosyl (1→5)-β-D-glucopyranoside] and 4'-hydroxy- 5,7-dimethoxyflavone	Kao *et al.* (2004)
37- *Strobilanthes japonica*		Strobilanthin (5,7-dimethoxy-4-hydroxyflavone-4'-*O*-apioside) and 5,7-dimethoxy-4-hydroxyflavone)	Huang *et al.* (1987)

Ap: aerial parts, F: flowers, Ff: fresh flowers, L: leaves, R: roots, S: stems, Wp: whole plant.

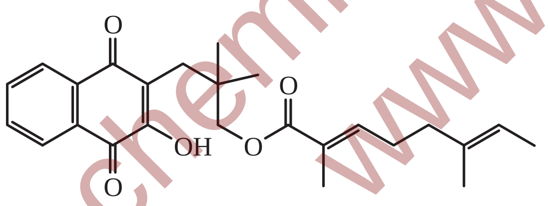


41 Mananthoside C

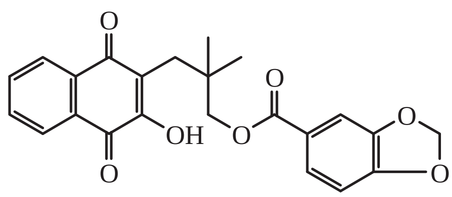


42 5-hydroxyjusticidin A

A quinol, 4-acetoxy-3,5-dimethoxy-*p*-quinol (Wu *et* al., 1995), two naphthoquinones, rhinacanthin C (**43**) and rhinacanthin D (**44**) (Sendl *et al*., 1996) and naphthoquinone esters *viz*. rhinacanthins A-Q and others have been identified from the roots of *Rhinacanthus nasutus* (Wu *et al*., 1988, 1998a,b). An antifungal naphthopyran (3,4-dihydro-3,3-dimethyl-2*H*-naphtho[2,3-*b*]pyran-5,10-dione) was also isolated from the same species (Kodama *et al*., 1993). 2,5-Dimethoxy-*p*-benzoquinone and 2,6-dimethoxy-1,4-benzoquinone were identified from *Diclipteria riparia* (Luo *et al*., 2002) and *Strobilanthes formosanus* (Kao *et al*., 2004) respectively.

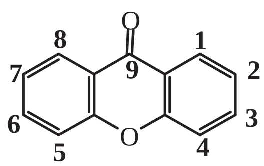


43 Rhinacanthin C



44 Rhinacanthin D

Four xanthones *viz*. 1,8-dihdroxy-3,7-dimethoxy-xanthone (**45**), 4,8-dihydroxy-2,7-dimethoxy-xanthone (**46**), 1,2-dihydoxy-6,8-dimethoxy-xanthone (**47**) and 3,7,8-trimethoxy-1-hydoxy-xanthone (**48**) were isolated from the roots of *Andrographis paniculata* (Dua *et al*., 2004).



Xanthone

45 1,8-Dihydroxy-3,7-dimethoxy-xanthone
46 4,8-Dihydroxy-2,7-dimethoxy-xanthone
47 1,2-Dihydroxy-6,8-dimethoxy-xanthone
48 3,7,8-Trimthoxy-1-hydroxy-xanthone

Table 4 – Lignans of some species of the family Acanthaceae

Species	Plant Part	Lignans	References
1- *Acanthus ilicifolius*	Ap	Acanfolioside, lyoniresinol, (+) lyoniresinol 3α-*O*-β-glucopyranoside (**38**), (-) lyoniresinol 3α-*O*-β-glucopyronside (**39**), alangilignoside C, 5, 5′-dimethoxylariciresinol 4-*O*-β-glucopyranoside, syringaresinol-*O*-β-glucoside, dihydroxymethyl- bis (3,5-dimethoxy- 4-hydroxyphenyl) tetrahydrofuran-9 (or 9')-*O*-β-glucopyranoside, lyoniresinol 3α-*O*-α-D-galactopyranosyl (1→6) β-D-glucopyranoside and lyoniresinol 2α-*O*-α-D-galactopyranosyl-3α-*O*-β-D-glucopyranoside	Kanchanapoom *et al*. (2001a); Wu *et al.* (2004); Liu and Lin (2008)
2- *Acanthus mollis*		Glycosides of 2'-hydroxyjustirumalin (**40**)	Rezanka *et al*. (2009)
3- *Anisacanthus virgularis*		(+)-Epipinoresinol-4''-β-D-glucoside and phyllyrin (+)-epipinoresinolmethyl ether-4''-β-D-glucoside	El-Domiaty *et al*. (2002)
4- *Crossandra nilotica*	R	Crossandrin containing glycosyl, arabinosyl, galactosyl and/or apiosyl residues	Thirupathaiah *et al.* (2008)
5- *Mananthes pateniflora*	Wp	Mananthosides, C (**41**), D-F, and 5-hydroxyjusticidin A (**42**)	Chen *et al.* (2002); Tian *et al.* (2006, 2008)
6- *Monechma debile*	Ap	Lariciresinol 4'-monomethyl ether and a dimethyl ether of lariciresinol	Ayoub (1987); Maat *et al.* (1985)
		Lariciresinol dimethyl ether	Ayoub and Kingston (1984)
7- *Phaylopsis falcisepala*		Eudesmin and sesamin	Adesomoju and Okogun (1985)
8- *Rostellularia procumbens*	Wp	Clinaphthalide A, justicidin A, justicidin C, justin and rostellulin A	Zhang *et al.* (2007)
9- *Strobilanthes cusia*	R	A lignan glycoside	Tanaka *et al.* (2004)

Ap: aerial parts, R: roots, Wp: whole plant.

Phenolics and Alcoholic Glycosides

Linaroside and verbascoside were isolated from *Acanthus longifolius* (Glizin *et al*., 1980) and *Acanthus mollis* L. (Ismail and El-Tantawy, 1999) respectively. The following phenolic glycosides have been isolated from the leaves of nuo-mi-xang-cao, a Chinese acanthaceous herb: nuomioside A (3,4-dihydroxy-phenylethyl alcohol-(3'-*O*-)β-D-apiosyl-4'-*O*-caffeoyl)-β-D-glucopyranoside), *iso*-nuomioside A (3,4-dihydroxyphenylethyl alcohol-(3'-*O*-)-β-D-apiosyl-6'-*O*-caffeoyl)-β-D-glucopyranoside), acetoside, isoacetoside and crassifolioside (Kasai *et al.*, 1991).

Three megastigmane glucosides were isaolated from *Acanthus ilicifolius* (Wu *et al.*, 2003c). From the latter China mangrove plant 5,11-epoxymegastigmane glucoside and (6*S*,9*S*)-roseoside were isolated (Huo *et al*., 2008). Two (*Z*)-4-coumaric acid glycosides, (*Z*)-4-coumaric acid 4-*O*-β-D-glucopyranoside and (*Z*)-4-coumaric acid-4-*O*-β-D-apiofuranosyl-(1''→2')-*O*-β-D-glucopyranoside were isolated from the aerial parts of *Acanthus ilicifolius* (Wu *et al*., 2003a). Ilicifolioside A (a phenylethanoid glycoside) was also identified from *Acanthus ilicifolius* (Wu *et al*., 2003b).

Caffeic acid rhamnoglucoside was isolated from *Acanthus spinosus* L. (Loukis and Philianos, 1980a). Analysis of the aerial parts of *Acanthus volubilis* Wall. revealed various compounds including verbascoside, isoverbascoside and phenylethyl-*O*-β-D-glucopyranosyl -(1→2)- β-D-glucopyranoside (Kanchanapoom *et al*., 2006).

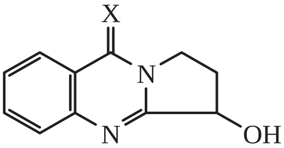
Benzyl β-D-glucoside, zizybeoside I, roseoside and scutellarioside II were isolated from the aerial parts of *Asystasia intrusa* (Kanchanapoom *et al*., 2004). A megastigmane glycoside (ebracteatoside A) was isolated from *Acanthus ebracteatus* (Kaschanapoom *et al*., 2001c). Asyaganoside (5,11-epoxymegastigmane glucoside), salidroside, benzyl-β-D-glucopyranoside and roseoside were isolated from *Asystasia gangetica* (L.) T. Anderson (Kanchanapoom and Ruchirawat, 2007).

Lugrandoside and poliumoside were identified from the whole plant of *Dicliptera riparia* Nees (Luo *et al*., 2002). Verbascoside (a caffeic glycoside ester) was isolated from the leaves of *Strobilanthus crispus* (L.) BL (Soediro *et al*., 1983) and cell suspension cultures of *Hygrophila erecta* (Henry *et al*., 1987). The roots of *Strobilanthes callosus* contain verbascoside and crassifolioside (Agarwal and Rangari, 2001).

The distribution of phenolic acids in 58 taxa belonging to 3 subfamilies of Acanthaceae has been studied by Daniel and Sabnis (1987). Of the 19 phenolic acids identified from the extracts, 14 were benzoic acids and the rest were cinnamic acids. Vanillic and syringic acids were present in more than 60% of the taxa studied. *p*-Hydroxybenzoic acid was recorded in about 50% of the taxa. This compound was not observed in any of the Nelsonioideae and Thunbergioideae, whereas vanillic acid and any of the cinnamic acids were also not found in the latter subfamily. Genistic and protocatechuic acids were found in all the members of Thunbergioideae studied**.** The identified phenolic acids were: salicylic, *p*-hydroxybenzoic, *o*-pyrocatechuic, genistic, protocatechuic, α-resorcylic, 2-hydroxy-4-methoxybenzoic, 2-hydroxy-5-methoxybenzoic, vanillic, syringic, 3-hydroxy-4-methoxybenzoic, 3-hydroxy-5-methoxybenzoic, phloretic, melilotic, *p*-coumaric, *o*-coumaric, caffeic, ferulic and sinapic acids (Daniel and Sabnis, 1987). Cyclic hydroxycinnamic acids have been identified in six Acanthaceae species: *Acanthus mollis*, *Acanthus spinosus*, *Aphelandra aurantiaca*, *Aphelandra squarrosa*, *Crossandra infundibuliformis* and *Crossandra pungens* (Pratt *et al*., 1995). Vanillic acid was also identified in *Acanthus arboreus* (Amer *et al*., 2004) and *Dicliptera riparia* Nees (Luo *et al*., 2002).

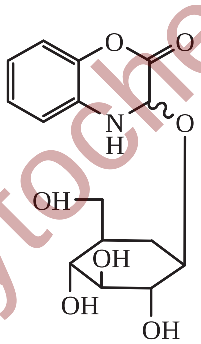
Alkaloids

The different parts of *Adhatoda vasica* Nees have been reported to contain bronchodilator quinozoline alkaloids e.g. vasicine (**49**) and vasicinone (**50**).

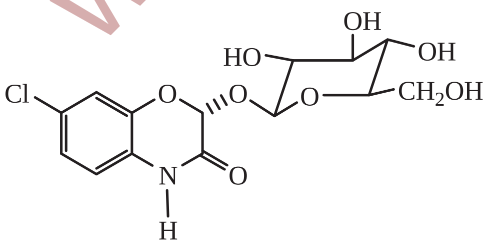


49 Vasicine X = 2H
50 Vasicinone X = O

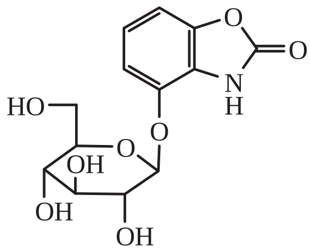
Alkaloids of different classes (simple carboline, *nor*-harmal, pyrrolidine, pyrrolo[2.1-*b*]quinazoline, benzoxazolinones, isoquinoline and macrocyclic spermine alkaloids) have been isolated from several species of the family Acanthaceae (Table 5). An immunosuppressive tryptophan-derived alkaloid (cristatin A) was isolated from *Lepidagathis cristata* (Ravikanth *et al.*, 2001). The seasonal variations and the distribution patterns of vasicine in different parts of *Adhatoda vasica* growing in Sri Lanka were studied. The highest amount of vasicine was found in the inflorescences and in the months of July-September in most parts of the plant (Arambewela *et al.*, 1988). On the other hand, Sharma *et al.* (1990) reported that leaves of *Adhatoda vasica* collected in March-April showed a higher percentage of minor alkaloids (vascinol, vasicinone, deoxyvasicinone and deoxyvasicine), whereas those collected in June-September had higher content of vasicine. The biosynthesis of peganine (vasicine) was studied in young *Adhatoda vasica* plants given various precursors via the roots and a scheme of the biosynthetic pathway of peganine was presented (Johne and Groeger, 1968; Johne *et al.*, 1968). Aphelandrine, a spermine alkaloid was reported to be synthesized from the root cells of *Aphelandra tetragona* (Vahl) Nees from labeled putrescine, spermidine and cinnamic acid. Whether spermine and the (*p*-hydroxycinnamoyl) spermidine are precursors of aphelandrine is uncertain, since the latter is hydrolysed to a large extent before incorporation and the former is metabolized to purescine and spermidine. Methionine is the source of cinnamopropyl unit of spermidine and spermine (Papazoglu *et al.*, 1991).



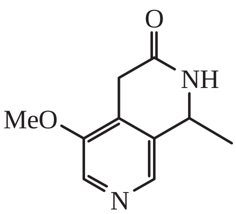
51 Acanthaminoside



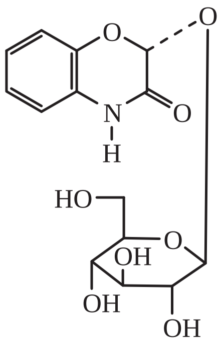
52 Benzoxazinoid glucoside



53 Benzoxazolinone glucoside



55 Acanthicifoline



54 Blepharin

Table 5 - Alkaloids of some species of the family Acanthaceae

Species	Plant Part	Alkaloids	References
1- *Acanthus arboreus*		6-Hydroxy-benzoxazolinone, 4 hydroxyacanthamine and acanthaminoside (**51**)	Amer *et al.* (2004)
2- *Acanthus ebracteatus*	AP	7- Chloro-(2*R*)-2-*O*-β-D-glucopyranosyl- 4- hydroxyl-2*H*-1,4-benzoxazin-3-(4*H*)-one (**52**) and four others	Kanchanapoom *et al.* (2001c)
3- *Acanthus ilicifolius*	AP	2-Benzoxazolinone, 5,5'-bis-benzooxazoline-2,2'- dione, 5 benzoxazinoid glycosides (7-chloro-(2*R*)-2-*O*-β-D-glucopyranosyl-2*H*-1,4-benzoxazin-3 (4*H*)-one; 2-*O*-β-D-glucopyranosyl- 5-hydroxy-2*H*-1,4- benzoxazin- 3(4*H*)- one and 4-*O*-β-D- glucopyranosyl-benzoxazolin- 2(3*H*)- one (**53**)	Murty *et al.* (1984); Kokpol *et al.* (1986 a,b); D'Souza *et al.* (1997); Kanchanapoom *et al.* (2001d); Huo *et al.* (2005 a)
	P	Blepharin (**54**) and (2*R*) -2β-D-glucopyranosyloxy- 4-hydroxy-1,4-benzoxazin-3- one	Wahidulla and Bhattacharjee (2001)
		Trigonelline	Minocha and Tiwari (1980)
	R	2- Hydroxy-2*H*-1,4-benzoxazin-3 (4*H*)-one and 2,4-dihydroxy- 2*H*-1,4 benzoxazin- 3(4*H*)-one	Huo *et al.* (2005 b)
		Acanthicifoline (**55**), 1*H*-indole 3-carboxylic acid, 1*H*-indole 3-carboxyaldehyde and 1*H*-indole 3-acetic acid	Tiwari *et al.* (1980); Liu and Lin (2008)
4- *Acanthus mollis*	S	Benzoxazolinone, 2,4-dihydroxy-1,4- benzoxazin-3-one and its glucoside	Wolf *et al.* (1985)
5- *Acanthus volubilis*		2-*O*-β-D-glucopyranosyl-2*H*-1,4-benzoxazin-3(4*H*)-one and (2*R*)-2-*O*-β-D-glucopyranosyl-5-hydroxy-2*H*,1,4-benzoxazin-3(4*H*) one	Kanchanapoom *et al.* (2006)
6- *Adhatoda vasica*	L	Anisotine, 3-hydroxyanisotine, vasicine, vasicinone, 1,2,3,9-tetrahydro-5-methoxypyrrolo [2, 1-*b*] quinazoline-3-o1(**56**), vasnetine (**57**) vasicolinone, vasicoline and isoquinoline-1-phenyl-2- methyl-6,7-dimethoxy-,2,3,4-tetrahydroisoquinoline, peganine, 6-hydroxypeganine, 1,2,3,9-tetrahydropyrrolo-(2,1-b)-quinazolin-9-one-	Amin and Mehta (1959); Kuffner *et al.* (1960); Mehta (1960); Mehta *at al.* (1963); Chowdhoury and Bhattacharyya (1985); Späth and Kesztler-Gandini (1960); Poi

Table 5 - Alkaloids of some species of the family Acanthaceae (cont.)

Species	Plant Part	Alkaloids	References
		3*R*-hydroxy-3(2′-dimethylaminophenyl) (desmethoxy-aniflorine) and 7-methoxy-3*R*-hydroxy-1,2,3,9-tetra-hydropyrrolo[2,1-b]-quinazolin -9-one(7-methoxyvasicinone)	and Thapa (1985); Adityachaudhury (1988); Joshi *at al*. (1994); Thappa *et al*. (1996); Hashem and Elsawi (1998)
	If	Vasicine (**49**) and vasicinone (**50**)	Choudhury and Chakrabarti (1977), Choudhoury (1979)
		Adhavasinone (**58**), vasicol (**59**), vasicine, vasicinone and deoxyvasmetime	Dhar *et al*. (1981), Jain and Srivastava (1986), Chowdhury and Bhattacharyya (1987)
	R	Vasicinolone (**60**), nor-harmal 9-acetamido-3,4 dihydropyrido [3,4-*b*] indole (**61**). and vasicinol (**62**)	Bhatnagar *et al*. (1965); Jain and Sharma (1982); Jain *et al*. (1980)
7- *Anisotes trisulcus*	Ap	Anisotine, peganine, vasicinone and trisulcusine (**63**)	Al-Azizi (1997), Al-Rehaily *et al*. (2002b)
8- *Aphelandra chemissoniana*	A	N^5,N^{10}- Di-*p*-coumaroylspermidine and N^1,N^5,N^{10}-tri-*p*-coumaroylspermidine	Werner *et al*. (1995)
9- *Aphelandra fuscopuncutata*	R	(+)-Aphelandrine (**64**), (+)-N^6-hydroxyaphelandrine (**65**), (+)-N^6-acetoxyaphelandrine (**66**), 2,4-dihydroxy-1,4-benzoxazin- 3 (4*H*)-one, 2,4-dihydroxy-7-methoxy-1,4-benzoxazin- (4*H*)-one, 2-hydroxy-1,4-benzoxazin-3(2*H*)-one, 2-hydroxy-7-methoxy-1,4-benzoxazin-3 (2*H*)-one and their corresponding glucosides	Youhnovski *et al*. (1999); Baumeler *et al*. (2000)
10- *Aphelandra squarrosa*	R	2,4-Dihydroxy-1,4-benzoxazin-3(4*H*)-one, 2,4-dihydroxy-7-methoxy-1,4-benzoxazin- (4*H*)- one, 2- hydroxy-1,4-benzoxazin- 3(2*H*)-one, 2-hydroxy-7-methoxy-1,4-benzoxazin-3(2*H*)-one and their corresponding glucosides	Baumeler *et al*. (2000)

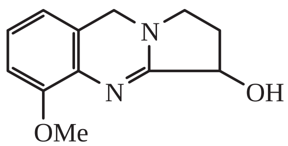
Table 5 - Alkaloids of some species of the family Acanthaceae (cont.)

Species	Plant Part	Alkaloids	References
11- *Aphelandra tetragona*	R	Aphelandrine	Hedberg *et al.* (1996)
	A	N^5,N^{10}- Di-*p*-coumaroylspermidine and N^1,N^5,N^{10}-tri-*p*-coumaroylspermidine	Werner *et al.* (1995)
	R	18-*O*-Methylchaenorpine, *iso*-18-*O*-Methylchaenorpine (**67**)	Tawil *et al.* (1989)
12- *Aphelandra* (8 species)	R	Aphelandrine	Bosshardt *et al.* (1978)
13- *Baphicacanthus cusia*	L	Tryptanthrin (**68**) and qingdainone (**69**)	Zou and Huang (1985)
	R	2-*O*-β-D-glucopyranosyl-2*H*-1,4-benzoxazin-3(4*H*)-one and (2*R*)-2-*O*-β-D-glucopyranosyl-4-hydroxy-2*H*-1,4- benzoxazin-3(4*H*)-one	Xie *et al.* (2005)
14- *Calycanthes floridus*	L	Folicanthine	Eiter and Svierak (1952)
15- *Calycanthus occidentalis*	Ap	Calycanthidine (**70**) and harmine.	Saxton *et al.* (1962); Lutomski *et al*. (1967)
16- *Encephalospharea lasiandra*	R	Aphelandrine and *O*-methylorantine	Bosshardt *et al.* (1978)
17- *Eranthemum nervosum*	L	3-Methoxyvascinone	Ismail (2001)
18- *Hypoestes verticillaris*		Hypoestestatin 1 (**71**) and hypoestestatin 2 (**72**)	Pettit *et al.* (1984)
19- *Lepidagathis cristata*	Wp	Cristatin A (**73**)	Ravikanth *et al.* (2001)
20- *Rungia grandis*		Macrorine and isomacrorine	Adesomoju (1982)
21- *Ruspolia hypercrateriformis*	R	Hypercratine (**74**), norruspoline, norruspolinone and ruspolinone	Neukomm *et al.* (1983)
22- *Strobilanthes cusia*	Wp	4(3*H*)-quinazolinone, 2,4(1*H*, 3*H*)-quinazdinedione and tryptanthrin	Honda and Tabata (1979), Li *et al.* (1993)

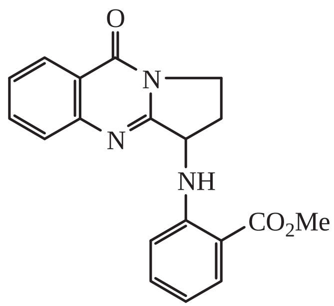
Table 5 - Alkaloids of some species of the family Acanthaceae (cont.)

Species	Plant Part	Alkaloids	References
23- *Macrorungia longistrobus*		Three tetrahydroquinolyimidazole alkaloids	Arndt *et al*. (1969)
24- *Stenandrium dulce*		1,4- Benzoxazin-3-ones and 2-benzoxazolinone	Bravo *et al*. (2004)
25- *Thomandersia laurifolia*	L	Thomandersine and isothomandersine	Ngadjui *et al*. (1995)

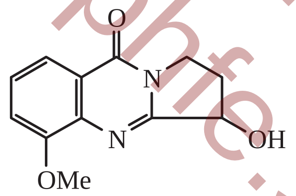
A: anthers, Ap: aerial parts, If: inflorescences, L: leaves, P: pods, R: roots, S: seeds, Wp: whole plant



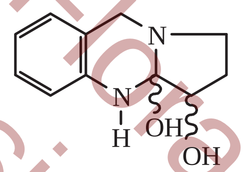
56 1,2,3,9-Tetrahydro-5-methoxy-pyrrolo[2,1-*b*]quinazoline-3-ol



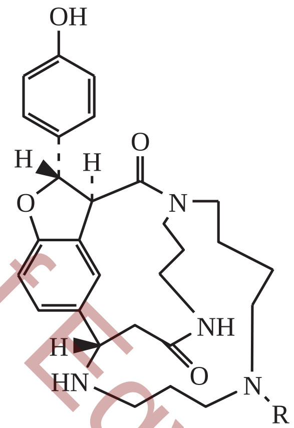
57 Vasnetine



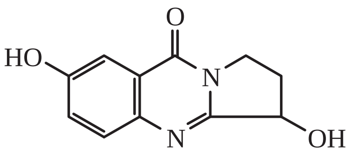
58 Adhavasinone



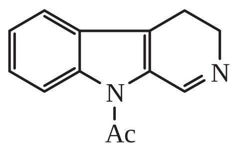
59 Vasicol



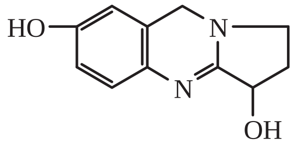
64 (+)Aphelandrine R= H
65 (+)-N^6-Hydroxyaphelandrine R= OH
66 (+)-N^6-Acetoxyaphelandrine R= OAc



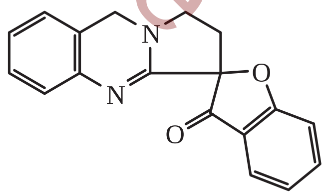
60 Vasicinolone



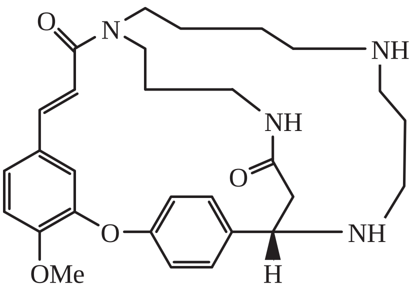
61 nor-Harmal 9-acetamido-3,4-dihydropyrido(3,4-*b*)indole



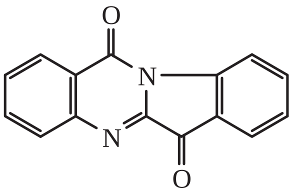
62 Vasicinol



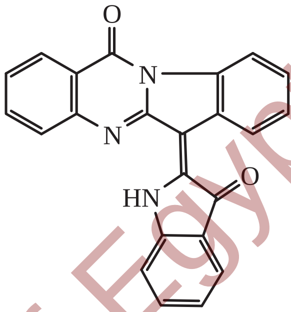
63 Trisulcusine



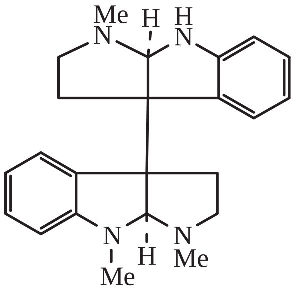
67 ***iso*-18-*O*-methylchaenorpine**



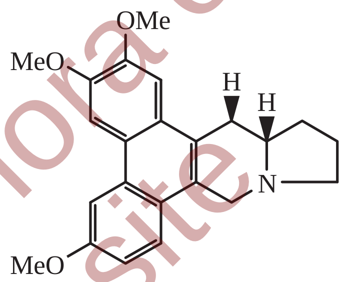
68 Tryptanthrin



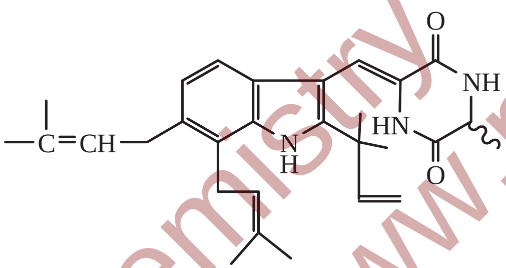
69 Qingdainone



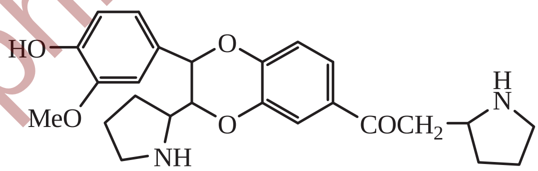
70 Calycanthidine



71 Hypoestestatin 1, R=H
72 Hypoestestatin 2, R=OH



73 Cristatin A



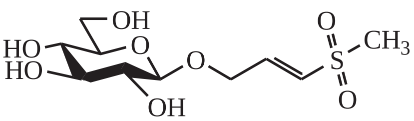
74 Hypercratine

Other Constituents

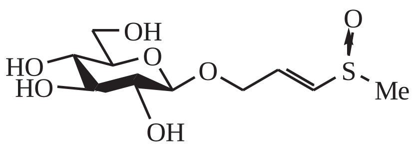
Coumarin and scopoletin were isolated from *Monechma ciliatum* seeds (Ayoub *et al*., 1983) and *Aphelandra aurantiaca* Scheider (Bratoeff and Perez-Amador, 1994) respectively.

Teshima *et al*. (1998) identified the following five sulphur-containing glucosides from *Clinacanthus nutans* (Burm. f.) Lindau: clinacoside A (**75**), clinacoside B (**76**), cycloclinacoside A1 (**77**), cycloclinacoside A2 (**78**) and cycloclinacoside C (**79**). Two sulphur containing compounds, *trans*-3-methylsulfonyl-2-propenol and *trans*-3-methylsulfinyl-2-propenol were isolated from the leaves of *Clinacanthus siamensis* (Tuntiwachwuttikul *et al*., 2003).

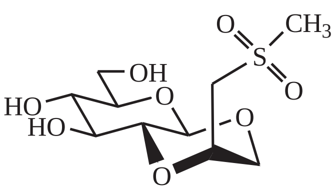
The total tannin content in the different organs of *Calycanthus chinensis* was determined by Li *et al*. (2007b). The content in the leaves was highest, and that of the root took the second place, while that in the annual twigs, biennial twigs or stems are very low. The average of the total tannins in the leaves is 1.69%.



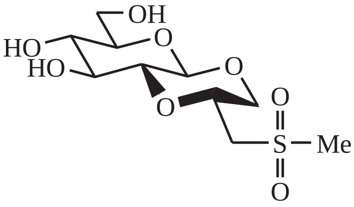
75 Clinacoside A



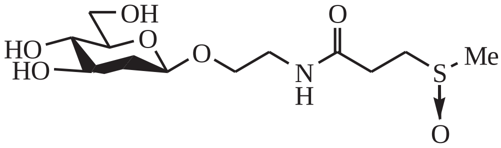
76 Clinacoside B



77 Cycloclinacoside A1



78 Cycloclinacoside A2



79 Cycloclinacoside C

Folk Medicine, Pharmacological and Biological Activities

Many species of the family Acanthaceae possess several medicinal properties and are used in treatment of various diseases. The leaves of *Acanthus ilicifolius* L. are used in ethnomedical practices in India to treat rheumatism, snake bite, paralysis and asthma. Analgesic, anti-inflammatory, antioxidant and hepatoprotective effects of this species has been also reported (Babu *et al*., 2001b; Peng and Long, 2006). The plant is also used as a purgative, and anti-inflammatory, and the leaves dispersed with pepper (*Piper nigrum* L.) as tonic pills for longevity (Kanchanapoom *et al*., 2001a). *Acanthus montanus* (Nees) T. Anderson is used in African traditional medicine for the treatment of urogenital infections, urethal pain, endometritis, urinary diseases, cystitis, leucorrhoea, aches, and pains (Okoli *et al*., 2008). The experimental evaluation of the effectiveness of the root in the treatment of furuncles showed that it may largely derive from mobilization of leukocytes to the site of infection and activation of phagocytic activity as well as suppression of exacerbated immune responses by its constituents (Okoli *et al*., 2008).

Adhatoda engleriana C. B. Cl. is used as a purgative in Tanganyika and Kenya. The Chagga use the plant to counter the bewitching of food and chew the fresh leaves as a purgative. A decoction of the leaf is given by the Bondi in childbirth to relieve pain. The root is a Shambala tuberculosis remedy (Watt and Breyer-Brandwijk, 1962). *Adhatoda vasica* Nees is an old remedy and is used in Indian traditional medicine for thousands of years**.** Its leaves are used in cough and asthma, bronchitis, tuberculosus, inflammation, allergy and as a uterotonic (Chopra *et al*., 1982; Bhattacharyya *et al*., 2005). It is also recommended in leprosy and phthisis (Aramberwela *et al*., 1988). The leaves showed significant hepatoprotective effect at doses of 50-100 mg/kg, p.o., on liver damage induced by D-galactosamine in rats (Bhattacharyya *et al*., 2005). Vasicine (an alkaloid isolated from the plant) is reported to possess slight hypotensive, appreciable bronchodilator and marked stimulant activities (Arambewela *et al*., 1988). Peganine, isolated from the plant had a cholegogic action (Rabinovich *et al*., 1966). Gao *et al*. (2008) studied the inhibitory effect of the methanolic extract from the leaves of *Adhatoda vasica*. The obtained results suggest a use of the extract as an antidiabetic and showed a possibility that vasicine and vasicinol could be a useful treatment for metabolic disorders. The alkaloids of *Adhatoda vasica* possess anti-inflammatory activity (Chakraborty and Brantner, 2001). The insecticidal activity of the plant was also reported (Srivastava and Awasthi, 1958; Srivastava *et al*., 1965). The results of the study of Shrivastava *et al*. (2006) suggest that the plant has an immense potential as an anti-ulcer agent of great therapeutic relevance.

The investigation of Sangameswaran *et al*. (2008) established pharmacological evidence to support the folklore claim that *Andrographis lineata* is used traditionally as a hepatoprotective agent. *Andrographis paniculata* has been widely used as a traditional medicine in China and Southeast Asia (Kuroyangi *et al*., 1987). The plant is a popular medicinal herb for treating infection, inflammation, cold, fever and diarrhea in China and Taiwan. It has been also used in traditional medicine of India for the treatment of hepatitis. The diterpenoid andrographolide was found to be slightly more active than silymarin, a known hepatoprotective drug (Saraswat *et al*., 1995). The plant has different interesting biological properties (Geethangili *et al*., 2008) such as antihepatic (Choudhury *et al*., 1987), antifertiliy (Akbarsha *et al*., 1990), hepatoprotective (Handa and Sharma, 1990), antithrombic (Zhao and Fang, 1991), immunostimulant (Puri *et al*., 1993), antihepatotoxic (Kapil *et al*., 1993), antiplatelet aggregation (Zhang *et al*., 1994; Burgos *et al*., 2005), cardiovascular (Zhang and Tan, 1997), antihyperglycemic, antioxidant (Zhang and Tan, 2000; Husen *et al*., 2004), anti-inflammatory (Madav *et al*., 1996; Shen *et al*., 2002; Ji *et al*., 2005), antimalarial (Dua *et al*., 2004), antiodema and analgesic activities (Lin *et al*., 2009). The aerial parts of the plant have been used traditionally as medicine to treat cancer (Kirtikar and Basu, 1975). Furthermore, the anticancer and cytotoxic activities of *Andrographis paniculata* diterpenoid constituents were also reported (Kumar *et al*., 2004, Tan *et al*., 2005; Li *et al*., 2007a; Sheeja and Kuttan, 2007; Geethangili *et al*., 2008). According to Geethangili *et al*. (2008), the flavonoids and some diterpenoids isolated from the plant may play a role in the prevention and/or management of cancer. Xanthones, from the roots of *Andrographis paniculata* exhibited promising anti-protozoal activity (Dua *et al*., 2009). The antimalarial activity of these xanthones has been also reported (Dua *et al*., 2004). The plant also possesses choleretic (Shukla *et al*., 1992), antibacterial (Singha *et al*., 2003) and antileishmaniasis (Sinha *et al*., 2003) activities. The ameliorating effects of *Andrographis paniculata* extract against cyclophosphamide-induced toxicity in mice (Sheeja and Kuttan, 2006), as well as the antiangiogenic activity of the plant extract (Sheeja *et al*., 2007) have been also reported.

Asteracantha longifolia Nees is used as a food stuff by the Pedi. In Hindu medicine it is considered cooling, diuretic, stimulating and especially efficacious in dropsy and in cases of stone or gravel in the kidney. The plant is thought to have antidysentric properties and has been used as a remedy for hepatic derangement. In India, the seeds has been used as aphrodisiac and the root and the leaf against dropsy (Watt and Breyer-Brandwijk, 1962). The essential oils of the aerial parts and roots of *Asteracantha longifolia* exhibited antibacterial acivity. The alkaloid-HCl solution of the plant is bronchodilator, diuretic and lowers the blood pressure after vagotomy or atropinization in dog and rabbit (Parashar and Singh, 1965). *Asteracantha longifolia* Nees is used as a diuretic and for the treatment of jaundice, dropsy, rheumatism, anascara and diseases of the urogenital tract (Misra *et al*., 2001). *Asystasia gangetica* T. Anderson is a galactagogue. The leaf is Swahili antidote for snake-bite. In Central Africa, the plant is applied as an antipruritic. In Philippines the leaf and flower are eaten as pot-herbs and may also be used as an intestinal astringent. In West Africa the plant is used to lighten the pains of childbirth. In India, the juice of the plant is administered for swellings and rheumatism and as a vermifuge (Watt and Breyer-Brandwijk, 1962).

Brillantaisia nitens Lindau is widely used in African traditional medicine to treat skin infections and pain like toothache. The decoction of the plant has been administered orally to treat arterial hypertension in Cameroon. The vasorelaxant effects of *Brillantaisia nutans*, on isolated rat vascular smooth muscle was reported by Dimo *et al*. (2007). *Clinacanthus nutans* is an important herbal medicine in Thailand and China, being used as an anti-hepatitis and anti-herpes agent (Teshima *et al*., 1998). The burnt and powdered root of *Crabbea hirsuta* Harv. is rubbed by the Pedi over the body of a hydrocephalic child. An infusion of the plant is said to be emetic. *Crabbea nana* Nees. is used by Xhosa as an anthrax remedy, and the leaf as a toothache remedy (Watt and Breyer-Brandwijk, 1962).

Dicliptera laxata C.B.Cl. is a remedy for general debility. The extract of *Dicliptera roxburghiana* Nees showed central nervous system depressant and skeletal muscle relaxant activities (Thapliyal *et al*., 1990). The Chagga use the leaf and the root of *Disperma kilmandscharicum* C.B.Cl. together with goat blood and an extract of goat meat, as an aphrodisiac (Watt and Breyer-Brandwijk, 1962).

The diuretic activity of *Hygrophila auriculata* has been also reported (Swamy *et al*., 2007). *Hygrophila stricta* is known as a malaria plant and is used for malaria, fever, rheumatic pains, wounds and headache (Khan and Omoloso, 2002). According to ethnobotanical investigations, a decoction of *Hypoestes serpens* (Vahl) R. Br. leaves is used in traditional Malagasy medicine for the treatment of high blood pressure (Rasoamiaranjanahary *et al*., 2003a). The diterpene fusicoccane, isolated from the plant had a relaxant activity on isolated rat aorta (Andriamihaja *et al*., 2001). A decoction of *Hypoestes verticillaris* R. Br. is used by the Swahili as a remedy for chest diseases (Watt and Breyer-Brandwijk, 1962). Hypoestatins 1 and 2 (phenanthroinolizidine alkaloids) isolated from *Hypoestes verticillaris*, were found to markedly inhibit growth of the murine P-388 cell line ($ED_{50} = 10^{-5}$μg/mL) (Pettit *et al*., 1984). The triterpenoid saponin, isolated from *Lepidagathis hyalina* Nees showed antimicrobial activity against various plant pathogenic bacteria and fungi (Yadava, 2001). The leaves of *Monechma ciliatum* have potent oxytocic effect (Uguru and Evans, 2000). The experimental findings by Kini *et al*. (2008) supported the use of *Odontonema striatum* by traditional physicians, in Burkino Faso, for the treatment of arterial hypertension in human disease. Rhinacanthins C and D (naphthoquinones), isolated from *Rhinacanthus nasutus*, exhibit inhibitory activity against cytomegalovirus (CMV), with EC_{50} values of 0.22 and 0.02 μg/mL, respectively against human CMV (Sendl *et al*., 1996). In Tanganyika the crushed root of *Streptosiphon hirsutus* Mildbr. is used as an application to wounds. A decoction of the root of *Strobilanthopsis linifolia* Milne-Redhead is used for gonorrhoea (Watt and Breyer-Brandwijk, 1962). Singh *et al*. (2002b) reported that the triterpenoids from *Strobilanthes callosus* Nees possess anti-inflammatory and antimicrobial activities, which confirm the use of this plant in folk medicine (Watt and Breyer-Brandwijk, 1962). The roots of *Strobilanthes cusia* Bremek has been commonly used in traditional Chinese medicine to treat influenza, epidemic cerebrospinal meningitis, encephalitis B, viral pneumonia, numps and severe acute respiratory syndrome (Tanaka *et al*., 2004). Indirubin, isolated from *Strobilanthes cusia* inhibited the growth of leukemia cells, and 4(3*H*)-quinazolinone had hypotensive activity (Li *et al*., 1993). The essential oil from *Strobilanthes crispus* had higher antioxidant activity compared to α-tocopherol (Rahmat *et al*., 2006).

The leaf of *Thunbergia atriplicifolia* E. Mey. ex Nees is much used by the Zulu and the Natal Indian in making a hair-wash. The leaf of *Thunbergia capensis* Retz. is one of the Xhosa applications to scrofulous swellings. *Thunbergia glaberrrima* Lindau is an African remedy for scrofula (Watt and Breyer-Brandwijk, 1962). The extracts of the different parts of *Thunbergia laurifolia* Lindl. are reported to have detoxification, anti-inflammatory and antipyretic properties (Oonsivilai *et al*., 2007). The experimental results obtained by the latter authors support the traditional medicinal use of the plant for detoxification.

The family is represented in Egypt by 6 genera and 6 species (Boulos, 2002).

1.1. ***BARLERIA*** *L.*

Iridoids, anthraquinones, phenylethanoid glycosides and flavonoids were identified from few *Barleria* species.

Iridoids

Several iridoids have been isolated from *Barleria* species. The following are examples of these iridoids:

1- *Barleria cristata* L.: Acetylbarlerin and (**80**) shanzhiside methyl ester (**81**) (El-Emary *et al*. 1990).