The family Amaryllidaceae is a monocotyledon which comprises about 65 genera and 750 species (Boulos, 2005), some are cultivated and are mainly ornamental, while others are wild. A considerable number of the plants of this family are reputed for their potential toxicity, which is due to their alkaloidal content (Fahmy *et al*., 1960a).

Carbohydrates

Leaf saccharides of *Ungernia sewerozwii* consisted mainly of galactose, glucose, mannose, arabinose and rhamnose, and those of bulbs of glucose, mannose and sucrose; bulbs contained also oligosaccharides formed from glucose and galactose (Sabirova *et al*., 1977). Bulbs of *Galanthus elwesii*, *Leucojum aestivum* and *Leucojum vernum* contained a mixture of 1-kestose (1^F-β-D-fructofuranosyl-sucrose) and neokestose (6^G-β-D-fructofuranosyl-sucrose) (Hammer, 1968). The tetrasaccharides of *Leucojum aestivum* and *Leucojum vernum* correspond to products formed by transfructosylation to position 1 of a terminal fructofuranosyl group of each of the two saccharides (1-kestose and neokestose) found in these plants (Hammer, 1970). The results obtained by Uchiyama *et al*. (1985) suggested the presence of the following fructo-oligosaccharides in the bulbs of *Lycoris radiata* Herb.: 1-kestose(*O*-β-D-fructofuranosyl-(2→1)-*O*-β-D-fructofuranosyl-α-D-glucopyranoside), nystose (*O*-β-D-fructofuranosyl-[(2→1)-*O*-β-D-fructofuranosyl]$_2$ α-D-glucopyranoside), pentaose (*O*-β-D-fructofuranosyl-[(2→1)-*O*-β-D-fructofuranosyl]$_3$ α-D-glucopyranoside, and hexaose (*O*-β-D-fructofuranosyl-[(2→1)-*O*-β-fructofuranosyl]$_4$ α-D-glucopyranoside. Neokestose-based oligofructans were found in spring tissues of perennial *Lycoris radiata* Herb., in addition to 1-kestose-based-oligomers (Nagamatsu *et al*., 1990). 1-*n*-Butyl-β-D-fructopyranoside and di-D-fructose anhydride have been isolated from *Liriope spicata* var. *prolifera* (Zhu *et al*.,1991) and *Lycoris radiata* (Li *et al*., 1997). Two fructans with molecular weights 3.20 and 4.29 kDa were obtained from the tuberous roots of *Liriope spicata* var. *prolifera*. Both fructans have a backbone structure of β-(1→2)-fructosyl residues that branches at *O*-6 with fructosyl residues and terminates with a glucosyl residue and a fructosyl residue (Chen *et al*., 2009).

Two glucans A and B similar to amylopectin and glycogen were isolated from fresh rhizomes of *Crinum latifolium*. Glucan A was composed of 12 glucose units, while glucan B was composed of approximately 110 glucose residues mainly composed of α-1→4 linked D-glucopyranose moieties with branches linked at position 6. Among the carbohydrates of higher plants, glucan A, the main water-soluble neutral oligosaccharide in *Crinum latifolium*, is a unique dodecasaccharide containing acetyl groups (Tomoda *et al*., 1985a; Tram *et al*., 2002). Glucofructans were isolated from the bulbs of *Galanthus platyphyllus* (Barbakadze *et al*., 2007) and *Ungernia vvedenskyi* (Malikova *et al*., 1983a). The bulbs of 7 *Ungernia* species contained 8.1-11.7% water-soluble polysaccharides. Hydrolysis of the polysaccharides yielded mainly mannose, with a small amount of glucose and traces of galactose (Rakhimov *et al*., 1977). Water-soluble mannan-type polysaccharides were isolated and characterized from *Ungernia farganica* and *Ungernia sewerzowii* and named ungeromannan F and ungeromannan S. Ungeromannan F had a molecular weight of 93,000 while that of ungeromannan S was 61,000 and the predominant linkages were β- 1→4 bonds (Polyakova *et al*., 1979). Mannan fractions were isolated from other *Ungernia* species. Bulbs of *Ungernia vvedenskyi* S. Khamidkh contained 11% water-soluble polysaccharides, which upon fractionation yielded a neutral homogenous component named ungeromannan V (UN-

V) (Malinkova *et al*., 1980). The mannan (UN-V) had a regular structure of the carbohydrate chain consisting of linearly consecutive β-1→4 bound D-mannopyranose groups (Malinkova *et al*., 1981a). A similar polysaccharide was isolated from the bulbs of *Ungernia tadshikorum* consisting of glucose / mannose / arabinose ratio 3.4:61:6.1, named ungeromannan T (because of its prevailing mannose content). It is a linear polymer containing β-1→4-D-mannopyranose group (Malinkova *et al*., 1981b). The bulbs of *Ungernia trisphaera* contained ethanol-soluble substances, 18.0; water-soluble polysaccharides, 8.2; pectic substances, 7.0; and hemicelluloses A and B, 2.6 and 4.5%. The neutral fraction of the water-soluble polysaccharides yielded a partly acetylated polysaccharide high in mannose and containing traces of glucose, named ungeromannan-Tr (90 kDa). It is also based on a linear carbohydrate chain consisting of β-1→4 bound D-mannopyranose moieties (Malikova and Rakhimov, 1986). The isolation of a similar linear mannan from the bulbs of *Ungernia oligostroma* was also reported (Rakhimov and Nikonovich, 1989). A biologically active mannan fraction was isolated from *Ungernia ferganica* (Rakhimov *et al*., 1996). Mannan yield from bulbs of *Ungernia vvedeuskyi* peaked at n 15.2% and 17.2% during rapid foliage development in March and then during fruiting in October (Khamidkhodzhaev and Rakhimov, 1989). A gum similar to tragacanth has been isolated from the bulbs of rain lily (*Cooperia pedunculata*), containg mannose as a component monosaccharide (Guess *et al*., 1960). The polysaccharides of *Ungernia ferganica* bulbs contained glucomannan and pectin. The water-insoluble polysaccharide fraction yielded on hydrolysis galactose, mannose, galacturonic acid and traces of glucose. The leaf pectin contained galacturonic acid and glucose (Malikova *et al*., 1976). The leaves of *Ungernia tadshicorum* contained 7% pectin substances and partial hydrolysis afforded galacturonan (Malikova, 1994). The carbohydrate complex of *Ungernia vvedenskyi* contained water-soluble polysaccharides (native acetylated mannan), pectic substances, glucan, glucomannan and starch (Malikova *et al*., 1983b). Iwata *et al*. (1954-1955) reported that the bulb of *Lycoris radiata* contained about 20% crude starch.

The carbohydrates of *Ungernia severtzovii*, *Ungernia tadshikorum* and *Ungernia victoris* have been studied (Abdullaev and Khazanovich, 1969). Scales of the bulbs showed the greatest content of mucilage, saccharides (the maximum was observed when the leaves turned yellow), and pectins. The maximum accumulation of pentosans was observed during the growth of the leaves, and the maximum content of pectins when the leaves were completely developed. Pectic substances prevailed in leaves and reserve polysaccharides, especially acetylated mannans and starch in the bulbs of *Ungernia sewerzowii* (Sabirova *et al*., 1977).

A mucous polysaccharide, named lycoris-R-glucomannan was isolated from the bulbs of *Lycoris radiata*. It was composed of D-mannose and D-glucose in the molar ratio of 12:1. *O*-Acetyl groups were identified in the glucomannan and their content amounted to 15.5%. They were located at positions 2,6 of some of the D-mannose units (Tomoda and Shimizu, 1982). An acetyl-rich mucilage, named lycoris-S-glucomannan was also isolated from the bulbs of *Lycoris squamigera*. It was mainly composed of D-mannose and D-glucose in the molar ratio of 7:2. *O*-Acetyl groups were identified in the glucomannan and their content amounted to 16.7%. They were located at positions 2,6 of about half of the D-mannose units (Tomoda *et al*., 1983). The polysaccharides extracted from 5 *Lycoris* species (*Lycoris anhuiensis*, *Lycoris aurea*, *Lycoris chinensis*, *Lycoris radiata* and *Lycoris sprengeri*) were mostly acidic. The polysaccharides content varied from 5.12 - 8.06% in *Lycoris chinensis* and *Lycoris aurea* respectively (Wu *et al*., 2005). The bulbs of *Hippeastrum hybridum* yielded a mucous polysaccharide, named hippeastrum-H-glucomannan which was composed of D-mannose and D-glucose in the molar ratio of 5:2. Its *O*-acetyl groups amounted to 13.2% and were also located at positions 2,6 of some of the D-mannose units (Tomoda *et al*., 1985b).

Arabinose, xylose, fructose, galactose and galacturonic acid occurred in mucilages of both *Crinum americanum* L. and *Crinum augustum* Rox. (Abd El-Hafiz and Mesbah, 1984). Arabinose, galactose, glucose and galacturonic acid are the sugar components of the mucilage of *Hippeastrum vittatum* L. Her., cultivated in Egypt (Mesbah *et al.*, 1985).

Lectins

Bulbs from 3 species of the Amaryllidaceae (*Narcissus pseudonarcissus*, *Leucojum aestivum* and *Leucojum vernum*) contain mannose-specific lectins. The lectins are dimeric proteins composed of subunits of 13 kDa, which are held together by disulphide bridges. These lectins were serologically identical to a previously reported lectin from *Galanthus nivalis* bulbs, but had a different molecular structure. They all had a high specific agglutination activity with trypsin-treated rabbit erythrocytes, whereas human red blood cells were not agglutinated (Van Damme *et al*., 1988). Also, the isolation of lectins from bulbs of *Crinum latifolium* and *Sternbergia lutea* has been reported. The lectin from *Crinum latifolium* agglutinated red blood cells from rabbit and guinea pig, was not glycosylated, labile above 60^{o}C and did not require divalent ions for its activity (Kaur *et al*., 2006b). The lectin from *Sternbergia lutea* is a dimeric protein (20 kDa) composed of two identical subunits of 10 kDa which are linked by noncovalent interactions. It is an α-D-mannose-specific lectin (Saito *et al*., 1997). The isolation of agglutinin from *Lycoris radiata* was reported by Chang *et al*. (2005).

Lipids

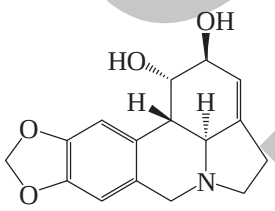
Lauric, myristic, palmitic, stearic, oleic and linoleic acids were present in all parts (bulb, leaf, root) of *Crinum americanum* and *Crinum augustum*; palmitic and linoleic acids were the major ones. Arachidic acid was present in *Crinum augustum* bulbs and roots only, whereas capreic acid was present in leaves, bulbs and roots of *Crinum americanum* (Abd El-Hafiz and Mesbah, 1984). Linoleic, oleic and palmitic acids were the most predominant fatty acids in the leaves and bulbs of *Crinum bulbispermum* (Ali and Abdel-Hafiz, 1983). Methyl palmitate, palmitic acid and stearic acid were identified in bulbs of *Crinum augustum* (Abd El-Hafiz, 1991). The fatty acids of *Hippeastrum vittatum* were identified as capric, isolauric, lauric, myristic, isopalmitic, palmitic, stearic, oleic and linoleic (Mesbah *et al*., 1985). The following five glucosphinogolipids were isolated from the fresh bulbs of *Hippeastrum vittatum*: (2*S*,3*R*,4*E*,6*Z*)-2-[(2*R*-2-hydroxyhexadecanoyl)amido]-4,8-octadecadiene-1,3-diol 1-*O*-β-D-glucopyranoside, (2*S*,3*R*,4*E*,8*E*)-2-[(2*R*-2-hydroxyhexadecanoyl) amido]-4,8-octadecadiene-1,3-diol 1-*O*-β-D-glucopyranoside, (2*S*,3*R*,4*E*,8*Z*)-2-[(2*R*-2-hydroxyoctadecanoyl)-amido-4,8-octadecadiene-1,3-diol 1-*O*-β-D-glucopyranoside, (2*S*,3*R*,4*E*,8*E*)-2-[(2*R*-2-hydroxyoctadecanoyl)amido-4,8-octadecadiene-1,3-diol 1-*O*-β-D-glucopyranoside and (2*S*,3*R*,4*E*,8*Z*)-2-[(2*R*-2-hydroxyeicosadecanoyl)amido-4,8-octadecadiene-1,3-diol 1-*O*-β-D-glucopyranoside (Wang *et al*., 2005a). Three glycerol-lipid glycosides were also isolated from the fresh bulbs of *Hippeastrum vittatum* and elucidated as 1-linenoyl-3-*O*-β-D-glucopyranosyl-*sn*-glycerol, 1-linoleoyl-3-*O*-β-D-galactopyranosyl-*sn*-glycerol and 1-oleoyl-3-*O*-β-D-galacto-pyranosyl-*sn*-glycerol. Two ceramides, candidamide A with phyto-sphinogolipid structure and candidamide B with tertiary amide structure were identified from *Zephyranthes candida* (Wu *et al*., 2009).

Long chain aliphatic alkanes were found in the unsaponifiable fraction of the petroleum ether extract from leaves and bulbs of *Crinum bulbispermum* and from bulbs of *Crinum augustum* (Tram *et al*., 2002). Triacontanol and five hydroxyketones were found in the bulbs of *Crinum augustum*. The hydroxyketones were identified as 5-hydroxydotriacontan-9-one,

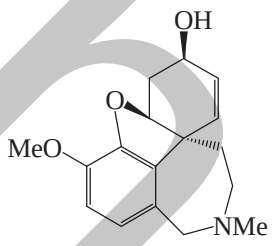
23-hydroxyhentriacontan-29-one (Abd El-Hafiz, 1990), 5-hydroxyheacosan-9-one, 5-hydroxyoctacosan-9-one and 5-hydroxytriacontan-9-one (Abd El-Hafiz, 1991).

Alkaloids

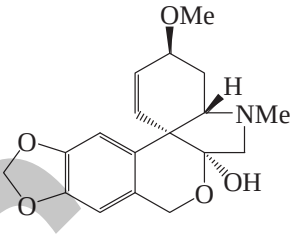
The Amaryllidaceae alkaloids, represent a group of isoquinoline alkaloids, which are produced almost solely by members of the Amaryllidaceae family. According to their structures, the Amaryllidaceae alkaloids are classified into eight skeleton types (Bastida *et al*., 2006), for which the representative alkaloids are : lycorine (**1**), galanthamine (**2**), tazettine (**3**), narciclasine (**4**), montanine (**5**), lycorenine (**6**), haemanthamine (**7**) and crinine (**8**). Ghosal's model has been used for numbering each skeleton (Ghosal *et al*., 1985d). Later, Unver (2007) and Jin (2009) have proposed subgroups for some skeleton types, according to the structures of new alkaloids isolated from *Galanthus* species (Cedrón *et al*., 2010). The alkaloids of the family have attracted considerable amount of interest due to some important pharmacological activities they were shown to possess (Unever, 2007). Lycorine (**1**), also named narcissine and galanthidine were isolated from several genera the family Amaryllidaceae. The alkaloids of several species of the genus *Crinum*, which comprises approximately 160 species, have been investigated and reviewed (Ghosal *et al*., 1985d; Tram *et al*., 2002a; Refaat *et al*., 2012a-c).



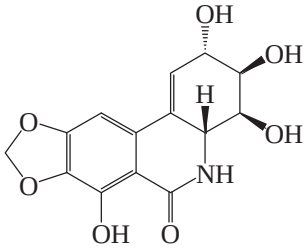
1 Lycorine



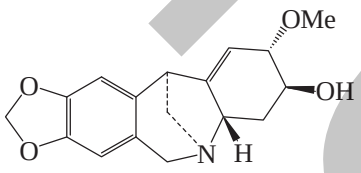
2 Galanthamine



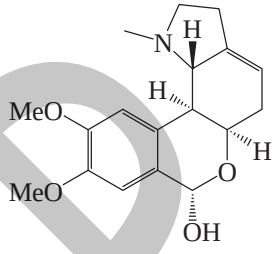
3 Tazettine



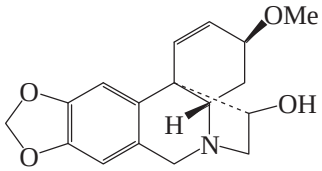
4 Narciclasine



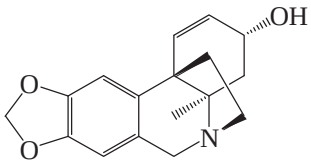
5 Montanine



6 Lycorenine



7 Haemanthamine



8 Crinine

The following types of alkaloids have been isolated from *Crinum* species (Tram *et al*., 2002a):

1- Crinane type (5,10b-ethanophenanthridines): The main source being bulbs. Structural

variations in ring C predominates (double bond, oxiran ring, substituents). Examples of this types are delagoenine (**9**), delagoensine (**10**), macowine (**11**) and 3-oxocrinine (**12**).

2- Lycorine (propylphenanthridine) type: The alkaloids which belong to this type were isolated from bulbs and fruits. Examples of this type are lycorine (**1**), lycoriside (**13**), kirkine (**14**), hippacine (**15**) and criasbetaine (**16**).

3- Tazettine type: e.g. tazettine (**3**), and *N*-demethyl-8α-ethoxyprecriwelline (**17**).

4- Phenanthridine type: e.g. trisphaeridine (**18**) and 3-hydroxy-8,9-methylenedioxy phenanthridine (**19**).

5- Lycorenine type: e.g. homolycorine (**20**), and 5α-hydroxyhomolycorine (**21**).

6- Galanthamine type: e.g. galanthamine (**2**), cripowelline A (**22**) and cripowelline B (**23**).

7- Ryllistine type: e.g. craugsodine (**24**) and isocraugsodine (**25**).

8- Cherylline type: e.g. cherylline (**26**) and latifine (**27**).

Also, the presence of the following types of alkaloids have been reported from the family Amaryllidaceae:

1- Isocarbostril alkaloids: e.g. pancratistanine (**28**) from *Haemanthus kalbreyeri* (Ghosal *et al*.,1989a).

2- Phenanthridone alkaloids: (e.g. kalboretorine (**29**) from *Haemanthus kalbreyeri* (Ghosal *et al* 1985c).

3- Pyrrolophenanthridone alkaloids: e.g. pratorimine (**30**) and pratosine (**31**) from *Crinum latifolium* (Ghosal *et al*, 1983b).

4- Phosphatidylpyrrolophenthridine alkaloids: e.g. *O*-glucerophosphoyllycorine (**32**) from *Zephyranthes flava* (Ghosal *et al*., 1987).

5- Pentacyclic dinitrogenous alkaloids: e.g. gracilamine (**33**) from *Galanthus gracilis* (Unver and Kaya, 2005).

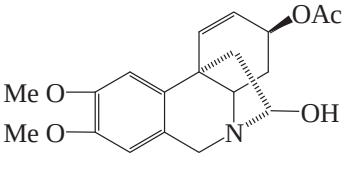
6- Massane-type alkaloids: e.g. nobilistines A (**34**) and B (**35**) from *Clivia nobilis* (Evidente *et al*., 1999).

7- Indole alkaloids: e.g. galanthindole from *Galanthus plicatus* ssp. *byzantinus* (Unver *et al*., 2003).

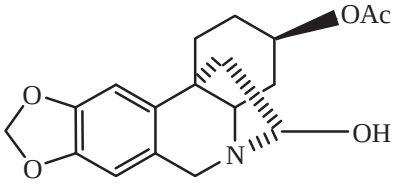
8- Augustamine type alkaloids from: e.g. augustamine from *Crinum latifolium* (Tram *et al*., 2002b) and noraugustamine from *Crinum kirkii* (Machocho *et al*., 2004).

9- Carboline type alkaloids: e.g. vittacarboline (**36**) from *Hippeastrum vittatum* (Youssef, 2001).

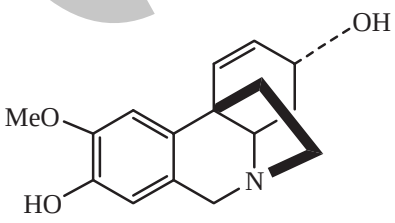
10- Phenylalkylamine alkaloids: e.g. hordenine from *Galanthus plicatus* ssp. *byzantinus* (Unver *et al.*, 2003).



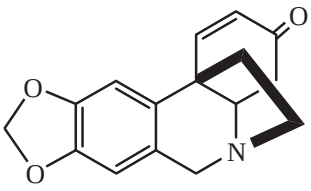
9 Delagoenine



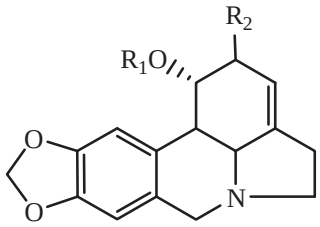
10 Delagoensine



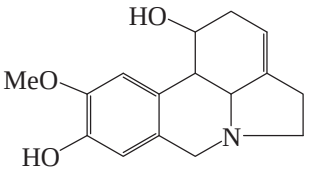
11 Macowine



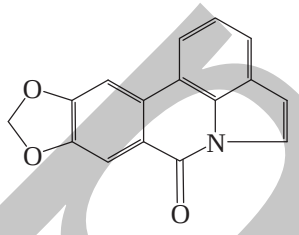
12 3- Oxocrinine



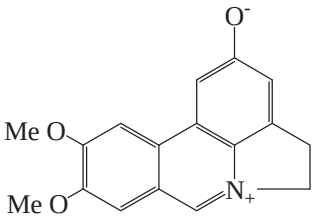
13 Lycoriside R_1= β -D-GL (6 - palmitoyl) R_2 =β -OH



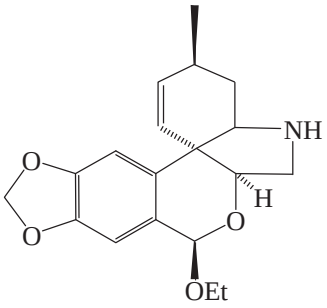
14 Kirkine



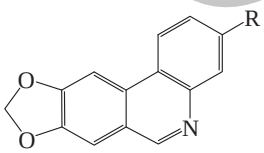
15 Hippacine



16 Criasbetaine

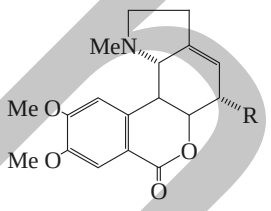


17



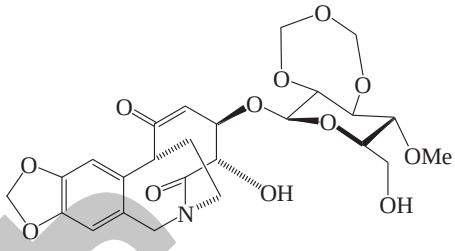
18 Trisphaeridine R = H

19 R = OH

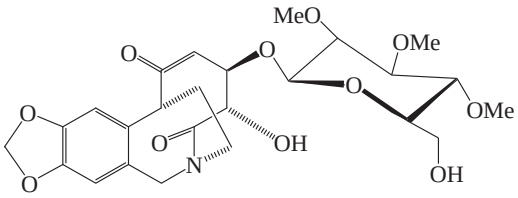


20 Homolycorine R=H

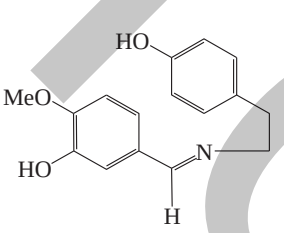
21 5 α-Hydroxyhomolycorine R = OH



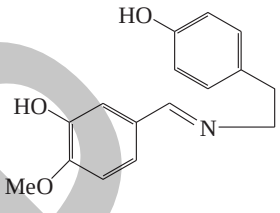
22 Cripowelline A



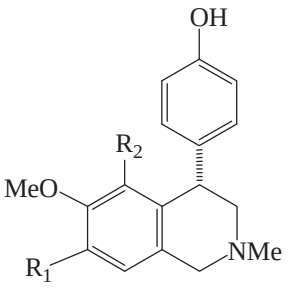
23 Cripowelline B



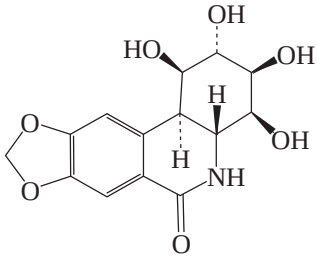
24 Craugsodine



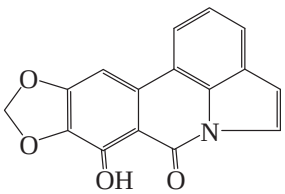
25 Isocraugsodine



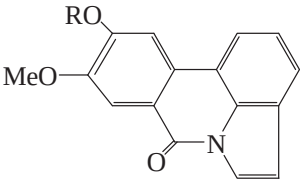
		R_1	R_2
26	**Cherylline**	OH,	H
27	**Latifine**	H,	OH



28 Pancratistanine

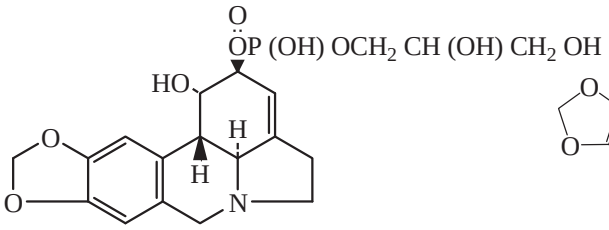


29 Kalboretorine

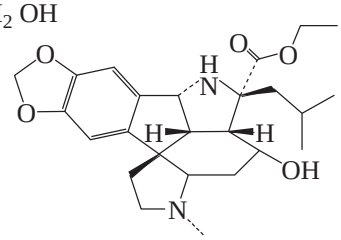


30 Pratorimine R = H

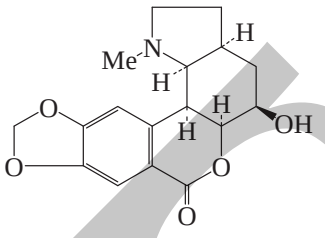
31 Pratosine R = Me



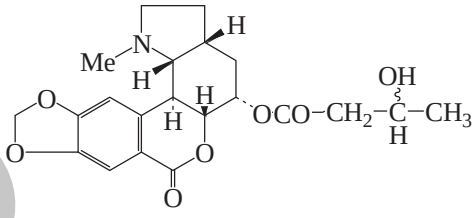
32 *O*-glucerophosphoyllycorine



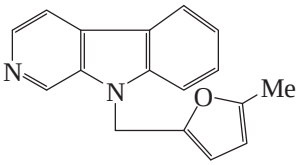
33 Gracilamine



34 Nobilstine A



35 Nobilstine B



36 Vittacarboline

In addition, the isolation of a hydrolycorinium chloride from *Brunswigia radulosa* (Crouch *et al*., 2002) was reported as the second ever isolation of this compound from a plant.

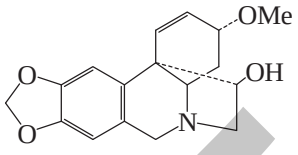
There are several reviews on the alkaloids of the family Amaryllidaceae, including their presence in plants, structure elucidation, stereochemistry, synthesis, biosynthesis and biological activities (e.g. Fahmy *et al*., 1960a; Wildman, 1968; Jeffs, 1973; Grundon *et al*., 1981a,b; Grundon, 1987; Ruan, 1988; Sener *et al*., 1992,1998a; Lewis, 1992-2002; Polt, 1996; Campbell *et al*., 1998; Evidente 2000; Jin *et al*., 2002; Jin, 2005, 2009). The review of Bastida *et al*. (2011) provides coverage of the biosynthesis, NMR spectroscopy and biological activity of the alkaloids up to the end of 2010. Examples of the alkaloids identified from species of the family Amaryllidaceae are shown in Table 1. Moreover, the isolation of alkaloids from several other species have been reported. Examples of these species are:

1- *Amaryllis belladonna* (Boit and Ehmke, 1956b).
2- *Amaryllis parkeri* (Doepke, 1963b).
3- *Ammocharis tinneana* (Machocho *et al*., 1999).
4- *Boophane flava* (Bastida *et al*., 1995a).
5- *Brunsdoma tubergenii* (a hybrid of *Brunswigia josephinae* and *Amaryllis belladonna*) (Boit and Doepke, 1960a).
6- *Brunswigia orientalis* (Viladomat *et al*., 1996).
7- *Brunswigia rosea* (Lam.) Hanibal (syn. *Amaryllis belladonna*) (Mason *et al*., 1955).
8- *Buphane fischeri* Baker (Fahmy *et al*., 1960a).
9- *Childanthus fragrans* (Boit, 1956).
10- *Clivia iniata* Regl. (Doepke and Roshan, 1981).
11- *Cooperia drummondi* Herb. (Fahmy *et al*., 1960a).
12- *Cooperia pedunclata* (Fahmy *et al*., 1960a).
13- *Crinum asiaticum* L. var. *japonicum* Baker (Kutani and Matsumoto, 1944; Kobayashi *et al*., 1976b; Ochi *et al*., 1976; Min *et al*., 2001).
14- *Crinum erubescens* Ait. (Boit and Doepke, 1960b; Wildman and Bailey, 1968; Tram *et al*., 2002a).
15- *Crinum firmifolium* var. *hygrophilum* (Razafimbelo *et al*., 1996; Tram *et al*., 2002a).

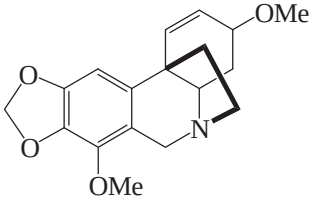
16- *Crinum giganteum* Andr (Gorter, 1920; Murav'eva and Popova, 1986; Tran, 1997; Kintsurashvili and Vachnadze, 2007).
17- *Crinum glaucum* Chevalier (Millington *et al*., 1972; Houghton *et al*., 2004).
18- *Crinum jagus* (Thompson) Dandy (Adesanya *et al*., 1992; Tram *et al*., 2002a; Houghton *et al*., 2004).
19- *Crinum krasnovii* (Kintsurashilvi and Vachnadze, 2007).
20- *Crinum kunthianum* Roem. (Ramires *et al*., 2001).
21- *Crinum lawrentii* Durant & De Wild (Tram *et al*., 2002a).
22- *Crinum lugardiae* (Elgorashy and Van Staden, 2001).
23- *Crinum macowanii* Baker (Nair *et al*., 2000; Elgorashi *et al*., 2001a; Elgorashi and Van Staden, 2001).
24- *Crinum moorei* (Boit, 1954b; Tran, 1997; Elgorashi *et al*., 2001b, 2002; Tram *et al*., 2002a).
25- *Crinum moorei* Hook. f. var. *schmidti* (El-Moghazi, 2001).
26- *Crinum natans* Baker (Onyiriuka and Jackson, 1978; Tram *et al*., 2002a).
27- *Crinum oliganthum* Urban (Doepke *et al*., 1983; Trimino *et al*., 1997; Tram *et al*., 2002a).
28- *Crinum ornatum* L. f. ex Aiton (Onyiriuka and Jackson, 1978; Tram *et al*., 2002a).
29- *Crinum pretense* (Rangaswami and Samamurthy, 1961; Ghosal *et al*., 1981).
30- *Crinum scabrum* Herb. (Fahmy *et al*., 1960a; Tram *et al*., 2002a).
31- *Crinum stuhlamanii* Baker (Tram *et al*., 2002a).
32- *Crinum woronowii* (Kintsurashvili and Vachnadze, 2007).
33- *Crinum yemense* Defl. (Tram *et al*., 2002a; Abdel-Halim *et al*., 2004).
34- *Crytanthus pallidus* (Fahmy *et al*., 1960a).
35- *Eucharis grandiflora* Planch. (Gorter, 1920; Fahmy *et al*., 1960a).
36- *Eucharis subdentata* (Gorbunova *et al*., 1978).
37- *Eurycles amboinensis* (Fahmy *et al*., 1960a).
38- *Eurycles sylvestris* Salisb. (Gorter,1920; Fahmy *et al*., 1960a).
39- *Galanthus gracilis* subsp. *byzantinus* (Linden *et al*., 1998).
40- *Galanthus ikariae* L. (Orhan and Sener, 2003).
41- *Galanthus nivalis* var. *gracilis* (Ivanova, 1958; Bubeva-Ivanova and Ivanov, 1961; Bubeva-Ivanova and Pavlova, 1965; Valkova, 1961; Cherkasov, 1977).
42- *Galanthus nivalis* L. ssp. *cilicicus* (Cherkasov *et al*., 1984; Kaya *et al*., 2004).
43- *Galanthus woronovi* (Pruskurnina and Yakovleva, 1952,1956; Proskurnina, 1953; Yakovleva, 1963; Tsitsishvili *et al*., 1971; Cherkasov, 1977).
44- *Haemanthus albomaculatus* (Briggs *et al*., 1956).
45- *Haemanthus deformis* (Crouch *et al*., 2005b).
46- *Haemanthus katherinae* (Noqueiras *et al*., 1971).
47- *Haemanthus multiflorus* (Boit and *et al*., 1958; Abdallah *et al*., 1989).
48- *Haemanthus natalensis* (Warren and Wright, 1958; Goosen *et al*., 1960).
49- *Hippeastrum bicolor* (R. et P.) Baker (Sepulveda *et al*., 1982).
50- *Hippeastrum punicum* Lam. (Quirion *et al*., 1991; Santana *et al*., 2008).
51- *Hippeastrum rutilum* (Rao and Devi, 1964,1965a).
52- *Hippeastrum solandriflorum* Herb. (Bastida *et al*., 1996).
53- *Hymenocallis amanacaes* (Fales and Wildman, 1958).
54- *Hymenolcallis arenicola* (Doepke *et al*., 1979).
55- *Hymenocallis expansa* (Antoun *et al*., 1993; Pettit *et al*., 1995b).
56- *Hymenocallis harisiana* (Boit and Doepke, 1960b).
57- *Hymenocallis littoralis* Salisb. (Gorter, 1920; Wildman and Kaufman, 1954; Lin *et al*.,

1995; Pettit *et al*., 1993,1995a).
58- *Hymenocallis occidentalis* (Wildman and Kaufman, 1954).
59- *Hymenocallis pedalis* (Pettit *et al*., 1995b).
60- *Hymenocallis speciosa* Salisb. (Pettit *et al*., 1995b; Nguyen *et al*., 2003).
61- *Hymenocallis sonoranensis* (Pettit *et al*., 1995b).
62- *Hymenocallis variegated* (Pettit *et al*., 1995b).
63- *Lapiedra martinezii* (Suau *et al*., 1990a).
64- *Leucojum vernum* (Boit and Stender, 1954b; Tomko *et al*., 1961; Kohlmuenzer and Cyunel, 1970; Kalashinkov, 1974; Cherkasov, 1977; Forgo and Hohmann, 2005).
65- *Lycoris aurea* (Boit and Ehmke, 1957a; Yamaguchi *et al*., 1962; Yang *et al*., 2005a).
66- *Lycoris sanguina* (Boit and Ehmke, 1957a; Yamaguchi *et al*., 1962; Takagi and Yamaki, 1974; Kobayashi *et al*., 1991; Abdallah, 1995).
67- *Lycoris sanguina* Maxim var. *kiushiana* Makino (Kobayashi *et al*., 1976a).
68- *Lycoris squamigera* (Hung and Ma, 1964; Kitajima *et al*., 2009).
69- *Nerine bowdentii* (Boit and Ehmke, 1956b).
70- *Nerine falcata* (Wildman and Kaufman, 1955).
71- *Nerine filifolia* (Nair *et al*., 2005).
72- *Nerine flexuosa* (Fales and Wildman, 1961; Boit and Ehmke, 1957a).
73- *Nerine krigei* (Garbutt *et al*., 1962).
74- *Nerine laticoma* (Wildman and Kaufman, 1955).
75- *Nerine masonarum* (Boit and Doepke, 1958).
76- *Nerine undulata* (Boit, 1956).
77- *Sprekelia formosissima* L. (Boit and Ehmke, 1955).
78- *Sternbergia clusiani* (Abdalla *et al*., 1993; Al-Khalil *et al*., 1997).
79- *Sternbergia colchiciflora* (Kintsurashvili and Vachnadze, 2007).
80- *Sternbergia fischeriana* (Cherkasov, 1977).
81- *Sternbergia sicula* (Phokas, 1969; Pabuccuoglu *et al*., 1989; Richomme *et al*., 1989).
82- *Ungernia ferganica* (Yunusov and Abduazimov, 1957; Abdusamatov *et al*., 1975b; Khamidkhodzhaev, 1980).
83-*Ungernia minor* (Abduazimov and Yunusov, 1960; Normatov *et al*., 1961; Abdumalikova *et al*., 1966).
84-*Ungernia severtzovii* (Regel.) Fedtsch (Yunusov and Abduazimov, 1957; Smirnova *et al*., 1961).
85- *Ungernia sewerzowii* (Zakirov *et al*., 1966; Sadikov and Shakirov, 1972).
86- *Ungernia spiralis* (Kadyrov *et al*., 1976; Kadyrov and Abdusamatov, 1977).
87- *Ungernia tadshicorum* Vved (Yunusov and Abduazimov, 1957; Sadikov and Shakirov, 1978).
88- *Ungernia trisphaera* (Abduazimov and Yunusov, 1967).
89- *Ungernia victoris* (Yunusov and Abduazimov, 1957; Abduazimov and Yunusov, 1960; Volodina *et al*., 1975; Cherkasov, 1977; Khamidkhodzhaev and Abdusamatov, 1978; Khamidkhodzhaev, 1980; Babaskin, 1983; Sadykov and Khodzhimatov, 1988).
90- *Vallota speciosa* (Rao and Devi, 1970; Amico and Stefanizzi, 1978; Gorbunova *et al*., 1978).
91- *Zephyranthes andersoniana* (Cherkasov, 1977)
92- *Zephyranthes candida* Herb. (Boit and Ehmke, 1955; Shoji, 1964,1965; Pettit *et al*., 1990; Wu *et al*., 2009).
93- *Zephyranthes carinata* Herb. (Kobayashi *et al*., 1977; Kojima *et al*., 1998; Nagatsu *et al*., 2000).
94- *Zephyranthes citrina* (Herrera *et al*., 2001a; Spengler Salabarria *et al*., 2001).

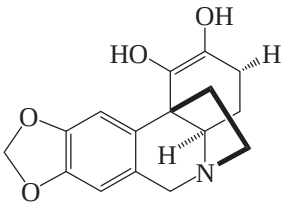
95- *Zephyranthes grandiflora* (Pettit *et al.*, 1984b).
96- *Zephyranthes robusta* (Rao and Krishna, 1969; Rao and Rao, 1979).
97- *Zephyranthes rosea* (Ghosal *et al*., 1985e).
98- *Zephyranthes sulphurea* (Rao, 1969; Rao and Rao, 1979).
99- *Zephyranthes texana* (Fahmy *et al*., 1960a).
100-*Zephyranthes tubispatha* Herb. (Doepke, 1963a; Spenglers and Trimino, 1989).



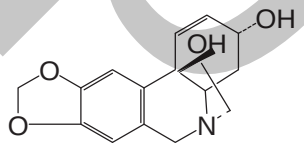
37 Crinamine



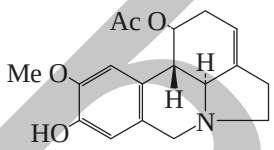
38 Buphanidrine



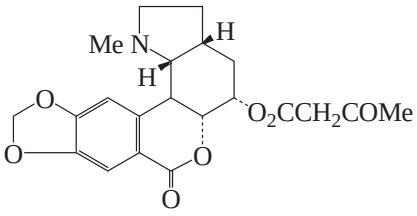
39 Ambelline



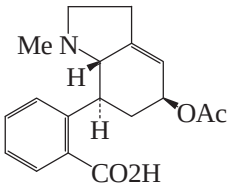
40 Hamayne



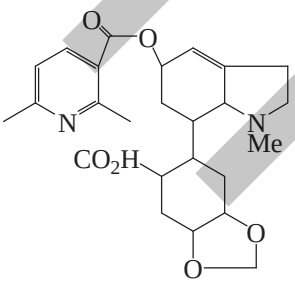
41 1-*O*-Acetylnorpluviine



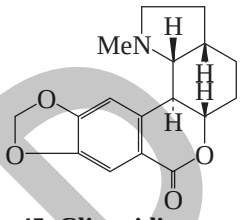
42 Clivacetine



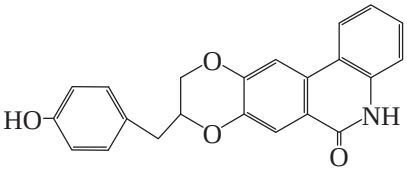
43 Clivojuline



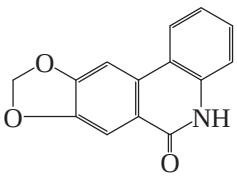
44 Cliviaaline



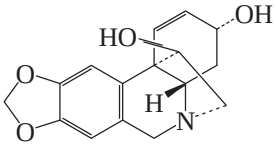
45 Clivonidine



46 Crinasiatine



47 Crinasiadine



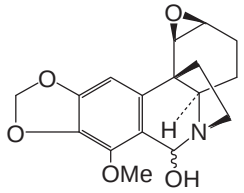
48 Bulbispermine

Table 1. Alkaloids of some species of the family Amaryllidaceae

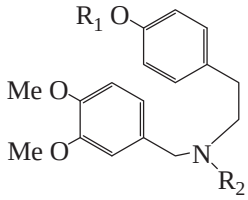
Species	Plant part	Alkaloids	References
1. *Amaryllis equestria*	B	Lycorine (**1**) and pseudolycorine	Rao and Rao (1969)
2. *Ammocharis coranica*	B	Lycorine (**1**), crinamine (**37**), caranine, acetylcaranine, 6-hydroxycrinamine, (+)-epicrinine, buphanisine, buphanidrine (**38**), ambelline (**39**), epibuphanisine, coranicine, l-*O*-acetyllycorine, hippadine, 6-hydroxypowelline and hamayne (**40**)	Mason *et al.* (1955); Hauth and Stauffacher (1962); Koorbanally *et al.* (2000)
3. *Brunsvigia gregaria*		Crinamidine, crinine, flexinine, haemanthidine, lycoramine, lycorine, 8,9-methylenedioxyphenanthridine, tazettine and undulatine	Queckenberg *et al.* (1995)
4. *Brunsvigia josephinae*	B	Ambelline, crinamine, hamayne, 3-*O*-acetylhamayne, josephinine, sternbergine, crinine, buphnisine, buphanidrine, undulatine, 11-*O*-acetylambelline, brunsbelline and hippadine	Viladomat *et al*. (1994, 1995)
5. *Brunswigia radulosa*	B	l-*O*-acetylnorpluviine (**41**), l-epideacetylbowdensine, crinamine, crinine, hamayne, lycorine, anhydrolycorin-7-one, sternbergine, anhydrolycorinium chloride and l-*O*-acetyllycorine	Campbell *et al*. (2000); Crouch *et al*. (2002)
6. *Buphane disticha*	B	Buphanamine, buphanitine, lycorine, distichanine, undulatine, distichine and hemathidine	Fahmy *et al*. (1960a); Hauth and Stauffacher (1961)
7. *Clivia caulescens*	H	Hippeastrine, haemanthamine, (11*S*)-11-hydroxyvittatine, lycorine and sterbergine	Crouch *et al*. (2003)
8. *Clivia gardenii*	H	Haemanthamine, haemanthidine (free base and quaternary salt) and tazettine (quaternary salt)	Crouch *et al*. (2003)
9. *Clivia miniata*	L	Hippeastrine Clivacetine (**42**), clivatine, clivonine, lycorine, clivojuline (**43**), cliviaaline (**44**), clivonidine (**45**). clivonine, cliviahaskine and lycorine	Abdusamatov *et al.* (1975a) Kobayashi *et al*. (1980); Doepke and Roshan (1981, 1982, 1983); Boit (1954b) Ali *et al.* (1983)

Table 1. Alkaloids of some species of the family Amaryllidaceae (cont.)

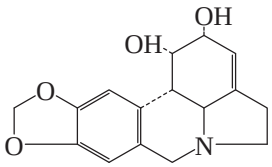
Species	Plant part	Alkaloids	References
10. *Clivia nobilis*		Nobilistine A (**34**), nobilistine B (**35**), clivamine and (+)-8-demethylmartidine	Jeffs (1988); Evidente *et al.* (1999, 2005)
11. *Crinum amabile*	B	Hippeastrine, tazettine, galanthamine, galanthine, narwedine, crinidine, amabiline, crinamabine, 4a-dehydroxycrinamabine, augustine, buphanisinelycorine, carmine, and flexinine	Murav´eva and Popova (1982); Likhitwitayawuid *et al*. (1993a); Pham *et al.* (1998); Tram *et al.* (2002a)
12. *Crinum americaunm*	R	Dihydrocrinidine	Tram *et al.* (2002a)
	B	Oxocrinine, crinine, flexinine, *O*-acetylcrinine (= krepowine), lycorine, hippadine, pratorinine, pratorimine, pratosine, ungerimine, trispheridine and a minor alkaloid	Ali *et al*. (1986); Trimino *et al.* (1987b); Tram *et al*. (2002a).
	L	Lycorine, tazettine, crinamine, buphamisine and crinidine	Trimino *et al.* (1987a)
13. *Crinum asiaticum*	Fb	Crinasiatine (**46**) and crinasiadine (**47**)	Ghosal *et al.* (1985a)
	Fr	Palmilycorine, lycoriside (**13**), isocraugsodine, and trisphaeridine	Ghosal *et al.* (1985b, 1988);Tram *et al.* (2002a)
		Hippadine, pratorimine, pratorinine, crinine, 1-*O*-acetyllycorine and lycorine	Phan *et al*. (2002)
	B	Crinisine, and ungermine (lycobetaine)	Tram *et al*. (2002a)
14. *Crinum augustum*	Fsf	Craugsodine (**24**)	Ghosal *et al*. (1986a)
	B	Hippadine, lycobetaine, pratorimine and pratorinine	Ali *et al*. (1988a); Ramadan, (1998); Tram *et al*. (2002a)
	F	Craisbetaine	Tram *et al*. (2002a)
15. *Criunm bulbispermum*	B	Bulbispermine (**48**), hippacine (**15**), bowdensine, deacetylbowdensine, crinamine, 3-*O*-acetyl hamayne, 6-hydroxycrinamine, 8α-ethoxyprecriwelline, *N*-desmethyl-8α-ethoxypretazettine, *N*-desmethyl-8β-ethoxypretazettine, 8-hydroxy-lycorin-7-one, 2-deoxylycorine, vittatine, 11-hydroxyvittatine and hippamine, hippacine, and krepowine (*O*-acetylcrinine)	Ali *et al.* (1984b); Elgorashi *et al.* (1999); Tram *et al.* (2002a); Ramadan *et al.* (2000); Aboul-Ela *et al*. (2004)



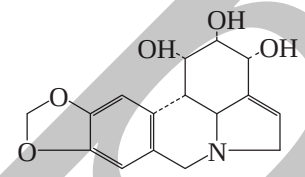
49 6- Hydroxycrinamidine



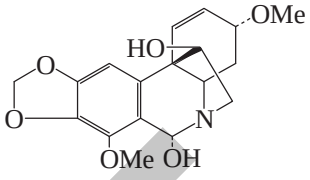
50 Latisoline R_1=β-*O*-glu, R_2=H



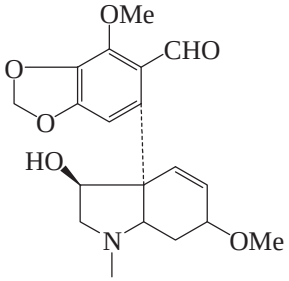
51 2- Epilycorine



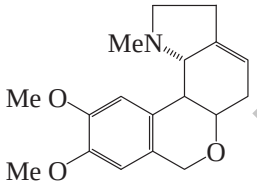
52 2- Epipancrassidine



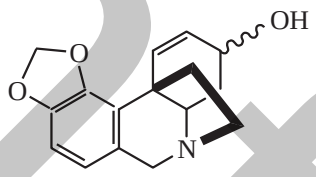
53 Crinafoline



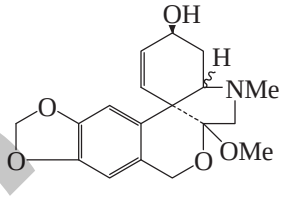
54 Crinafolidine



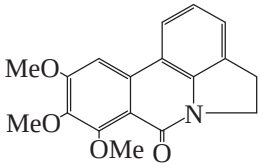
55 Nerusine (Deoxylycorenine)



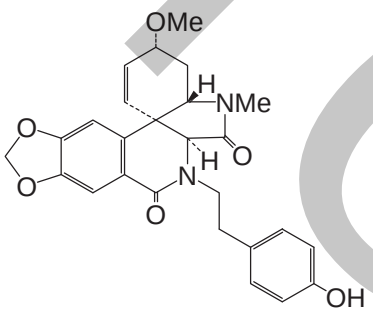
56 (+)Powellamine



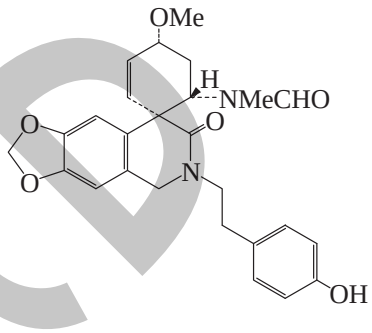
57 Zeylamine



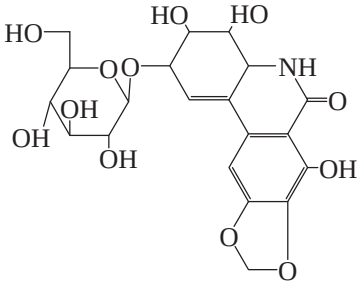
58 7- Methoxyoxoassoanine



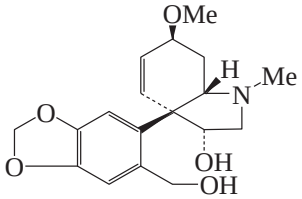
59 (+) - Plicamine



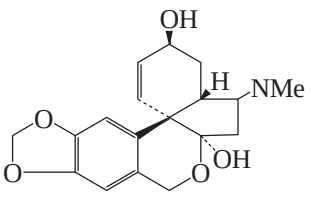
60 (-)- Secoplicamine



61 Kalbreclasine



62 Egonine



63 3-*O*-Demethyltazettine

Table 1. Alkaloids of some species of the family Amaryllidaceae (cont.)

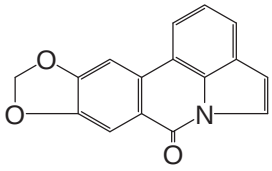
Species	Plant part	Alkaloids	References
16. *Crinum defixum*	B	Lycorine, 9-*O*-demethylhomolycorine, homolycorine, 5-hydroxyhomolycorine, 5α-hydroxyhomolycorine and lycorine	Rangaswami and Rao (1954); Fahmy *et al.* (1960a); Jeffs *et al.* (1985); Tram *et al.* (2002a)
17. *Crinum delagoense*	B	Delagoensine (**10**), delagoenine (**9**) and criwelline (3-epitazettine)	Nair *et al.* (1998)
18. *Crinum kirkii*	B	Kirkine (**14**), 8-*O*-demethylvasconine, noraugstamine, 4α, *N*-dedihydroaugustamine, 3-*O*-acetylsanguinine and 1,2-diacetyllycorine	Bastida *et al*. (1995b); Machoche *et al*. (2004)
19. *Crinum latifolium*	Rz	Lycorine and 3α-1,2 didehydro-crinan-3-ol	Rangaswami and Rao (1955); Nguyen *et al*. (1997); Ghosal *et al*. (1983b)
	B	6-Hydroxycrinamidine (**49**), 3-*O*-acetylhamayne, lycorine, acetyllycorine, cherylline (*S*), pratorimine (**30**), and pratosine (**31**)	Tan and Trinh (1997); Nguyen *et al.* (2002); Tram *et al.* (2002a).
	Fs	Latisoline (**50**), 2-epilycorine (**51**), and 2-epipancrassidine (**52**)	Ghosal *et al.* (1983b,1989b); Tram *et al*. (2002a)
	L	6-Hydrocrinmidine, and latifine	Vo *et al*. (1997); Tram *et al.* (2002a)
	B,L	Crinamidine, powelline, 3α-1,2-didehydrocrinan-3-ol and lycorine	Tran *et al.* (1999)
	R	3α,1-2-Dihydrocrinan-3-ol	Tram *et al.* (2002a)
		Crinafoline (**53**), crinafolidine (**54**), and latifine (**27**), 11-*O* acetylambelline and 11-*O*-acetyl-1,2-β-epoxyambelline	Kobayashi *et al.* (1984); Ghosal *et al.* (1986b); Tram *et al.* (2002a)
20. *Crinum macrantherum*		Macranthine, *O*-monoacetylmacranthine, *O*,*O*-diacetylmacranthine, macronine, lycorine, crinamine, criwelline, acetylcaranine, and epitazettine.	Hauth and Stauffacher (1964); Tram *et al*. (2002a)
		Nerusine (deoxylycorenine) (**55**)	Tram *et al*. (2002a)

Table 1. Alkaloids of some species of the family Amaryllidaceae (cont.)

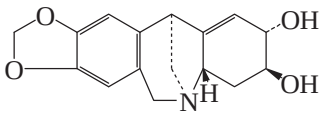
Species	Plant part	Alkaloids	References
21. *Crinum powellii*	B	Crinosine, crinidine, lycorine, powelline, cripowelline A, cripowelline B, criwelline (3-epitazettine), dihydrohaemanthidine, krepowine,(+)-powellamine (**56**), and (-) powellamine (cripaline)	Doepke and Fritsch (1965); Vetten *et al.* (1998) Tram *et al.* (2002a)
22. *Crinum zeylanicum*	Rz B	Zeylamine (**57**) 3-*O*-Acetylhamayne, 6-methoxycrinamine, crimidine, flexinine, and 6-hydroxypowelline	Doepke *et al.* (1986) Trmino *et al.* (1988); Tram *et al.* (2002a)
23. *Cyrtanthus breviflorus*		Haemanthamine, crinamine hydrochloride, lycorine and tazettine	Crouch *et al.* (2005a)
24. *Cyrtanthus elatus*	B	Haemanthamine, haemanthidine, galanthamine, zephyranthine, and 1,2-*O*-diacetylzephyranthine	Herrera *et al*. (2001b)
25. *Cyrtanthus falcatus*	B	Papayramine, epipapyramine, martidine, *O*-methylmartidine and tazettine.	Elgorashi and Van Staden (2003)
26. *Cyrtanthus obliquus*	B	Obliquine (a dinitrogenous alkaloid), 11α-hydroxygalanthamine, 3-epimacronine, narcissidine, tazettine and trisphaeridine	Brine *et al*. (2002)
27. *Eucharis amazonica*	BL	7-Methoxyoxoassoanine (**58**), 6-*O*-methylpretazettine, apohaemanthamine and others	Cabezas *et al*. (2003)
28. *Galanthus caucasicus* (Snowdrop)		Galanthamine, galanthine, lycorine, tazettine, homolycorine, galanthusine, galanthusidine and demethylhomolycorine	Tsakadze *et al.* (1969a,b, 1979); Yunusov *et al.* (1972)
29. *Galanthus elwesii*	Wp	5-Methoxy-9-*O*-demethylhomolycorine, galwesine, 9-*O*-demethylgalwesine, 16-hydroxygalwesine, 16-hydroxy-9-*O*-demethygalwesine, galasine, galanthamine, sanguinine, leucotamine, *O*-methylleucotamine, narwedine, N-demethylgalanthamine, 11-hydroxyvittatine, 9-*O*-demethylhomolycorine, lycorine, galanthine, hordenine, (*E*), *N*-feruloyltyramine, crinine and haemanthidine	Latvala *et al*. (1995); Sidjimova *et al.* (2003); Berkov *et al.* (2004, 2005)

Table 1. Alkaloids of some species of the family Amaryllidaceae (cont.)

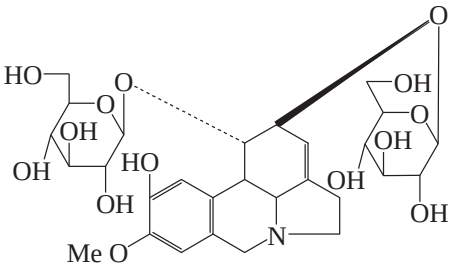
Species	Plant part	Alkaloids	References
30. *Galanthus gracilis*		Graciline, 11-acetoxygraciline, 3,4-dihydro-3-hydroxy-graciline, digracine, 3-*epi*-3,4-dihydro-3-hydroxygraciline, gracilamine (a pentacyclic dinitrogenous alkaloid), isotazettinol and 3-*O*-demethylmacronine	Noyan *et al*. (1998); Unver *et al*. (1999b, 2001); Unver and Kaya (2005)
31. *Galanthus nivalis*	S B,R	Galanthamine, nivalidine, hippeastrine, narwedine and lycorine Galanthamine, tazettine, nivalidine, norwedine and lycorine Galanthamine, lycorine and tazettine Lycorine, ungeramine, lycorine, tazettine, ismine, 11-*O*-(3′-hydroxybutanoyl) hamayne, 3,11-*O*-(3′,3″-dihydroxybutanoyl) hamayne, 3-*O*-(2″-butanoyl)-11-*O*-(3′-idhydroxybutanoyl) hamayne, 3,11,3′′-*O*-(3′,3″,3′′′-trihydroxybutanoyl) hamayne, and 2-*O*-(3′-acetoxybutanoyl)	Kalashinkov (1970) Boit (1954a); Kalashinkov (1970) Leifertova and Brazdova (1967) Berkov *et al.* (2007)
32. *Galanthus plicatus* ssp. *byzantinus*	Ap	Galanthindole plicamine (**59**), secoplicamine (**60**), 3-*O*-demethylmacronine, plicane, 3-*O*-(3-hydroxybutyryl) tazettinol, *N*-formylisamine, 11-hydroxyvittatine and hordenine	Unver *et al.* (1999a,b, 2001, 2003)
33. *Haemanthus albiflos*		Alpiflomanthine, omalnthine, albomaculine, homolycorine (**20**), *O*-methyllycornium salt, lycorenine and tazettine	Fahmy *et al.* (1960a); Baudouin *et al.* (1994); Crouch *et al*. (2005b)
34. *Haemanthus kalbreyeri*	B R	7-Deoxypancratistatine, pancratiside and pancratistatine Kalbretorine (**29**), kalbreclasine (**61**), lycorine, haemanthamine, hemanthidine, hippadine, narciclassine and pratorimine	Ghosal *et al.* (1989a) Ghosal *et al*. (1985c)
35. *Haemanthus pauculifolius*		Homolycorine, paucamine salt and the quaternary salts of homolycorine, montanine and menthadine	Crouch *et al.* (2005b)
36. *Hippeastrum ananuca*	B	Hemanthamine, lycorine, homolycorine, martidine, hippeastidine and epihomolycorine	Pacheco *et al.* (1978, 1982)



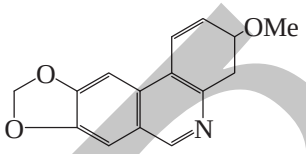
64 Hippadine



65 Pancracine



66



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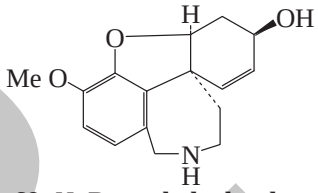
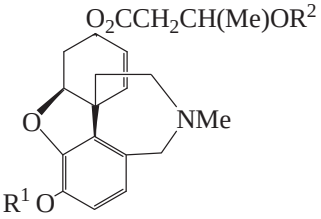
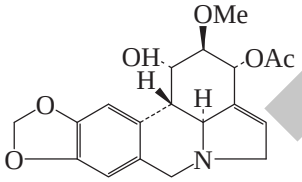


68 *N*- Demethylgalanthamine

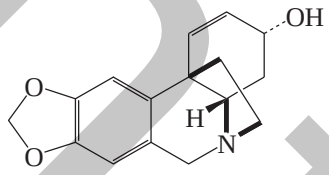


69 Leucotamine $R^1= R^2=H$

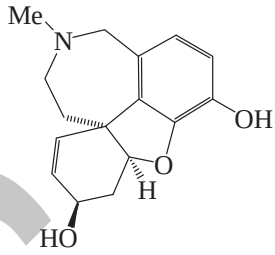
70 *O*- Methylleucotamine $R^1=Me, R^2=H$



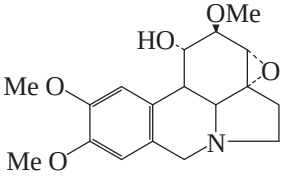
71 3-*O*-Acetylungiminorine



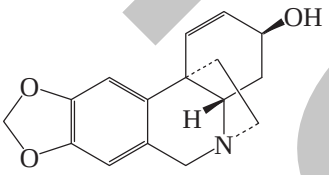
72 Elwesine



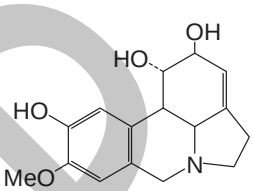
73 Sanguinine



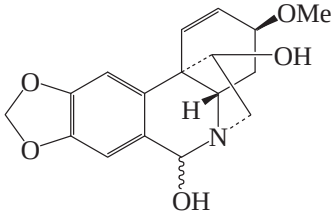
74 Incartine



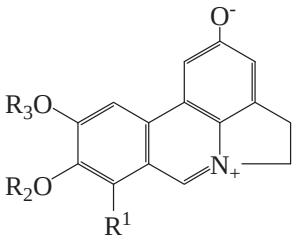
75 Vittatine



76 Pseudolycorine



77 Haemanthidine



78 Zefbetaine $R_1=R_2=H,R_3=Me$

79 Zeflabetaine $R_1= OMe, R_2, R_3= -CH_2 -$

Table 1. Alkaloids of some species of the family Amaryllidaceae (cont.)

Species	Plant part	Alkaloids	References
37. *Hippeastrum equestre*	Ag	Lycorine, galanthine, galanthamine, hippeastrine, haemanthidine and tazettine	Murav'eva and Alam (1982)
	B	Lycorine, *N*-methylnarcissidine, 8,9-methylenedioxyphenanthridine, lycorine, tazettine, hippeastrine, phamine, 11-hydroxyvittatine, pretazettine, 9-*O*-demethylhomolycorine, epimacronine, egonine (**62**), and 3-*O*-demethyltazettine (**63**)	Ganguly *et al.* (1967); Doepke *et al.* (1995a,b); Pham *et al.* (1997, 1999)
	B,R	Lycorine, galanthine, hippeastrine and tazettine	Alam and Murav′eva (1982)
38. *Hippeatrum glaucescens*	B	Lycorine, tazettine and pretazettine	Hofmann *et al.* (2003)
39. *Hippeastrum johnsonii*	B	Lycorine, tazettine and pseudolycorine	Rao *et al.* (1971)
40. *Hippeastrum vittatum*		Homolycorine, lycorine, hippeastrine, tazettine, vittatine, hippacine (**15**), hippadine (**64**), hippagine, hippafine and pancracine (**65**)	Boit *et al*. (1954,1956); El Moghazi *et al*. (1975a); Ali *et al.* (1981b, 1984a)
	F	Vittacarboline (**36**), ismine and *O*-methylismine	Youssef (2001)
41. *Hymenocallis caymanensis*		Lycorine, tazettine and a glucoalkaloid (**66**)	Wildman and Kaufman (1954); Doepke *et al.* (1990)
	L	4-Hydroxyanhydrolycorine	Trimino *et al.* (1989)
	Sd	Macronine, tazettine, criwelline and pretazettine	Trimino *et al.* (1996)
42. *Hymenocallis x festalis*	B	3-Methoxy-8,9-methylenedioxy-3,4-dihydroxyphenanthridine (**67**)	Hohman *et al.* (2002)
43. *Hymenocallis rotata*	B	Demethylmartidine, *N*-demethyllycoramine, vittatine, isamine, 3-epimacronine, pretatazettine, tazettine, lycorine, galanthamine, *N*-demethylgalanthamine (**68**), haemanthamine and others	Kihara *et al.* (1987)
44. *Hymenocallis tubiflora*		Lycorine, pseudolycorine and pretazettine	Seaforth *et al*. (1998)

Table 1. Alkaloids of some species of the family Amaryllidaceae (cont.)

Species	Plant part	Alkaloids	References
45. *Leucojum aestivum*	L,Ag	Lycorine, lycorenine, leucotamine (**69**), *O*-methylleucotamine (**70**), 3-*O*-acetylungiminorine (**71**), galanthamine, narwedine, *N*-(14-methylallyl)norgalanthamine, *N*-allylnorgalanthamine and epinorgalanthamine	Bubeva-Ivanova and Ivanov (1962); Gheorghiu and Ionescu-Matiu (1962); Kobayashi *et al.* (1982, 1985); Kintsurashvili *et al.* (2000); Berkov *et al.* (2008)
46. *Leucojum aestivum* subsp. *pulchellum*		Lycorine, galanthamine, elwesine (**72**), and sanguinine (**73**)	Capo and Saa (1989)
47. *Leucojum autumnale*		Lycorine, narcissidine, 3-*O*-acetylnarcissidine and 3-*O*-acetylnarcissidine *N*-oxide	Kihara *et al.* (1995)
48. *Lycoris guangxiensis*	B	Lycorine, narwedine, lycoramine, crinine, pseudolycorine, galanthamine, norgalanthamine and *N*-allylnorgalanthamine	Li *et al.* (1987)
49. *Lycoris incarnata*	F	Incartine (**74**), galanthamine, galanthine, galanthamine *N*-oxide, ungiminorine, ungiminorine *N*-oxide, lycorine, sanguinine and *O*-demethylycoramine.	Kihara *et al.* (1994)
		Galanthamine and hemanthidine	Biot and Ehmke (1957b)
50. *Lycoris radiata*	F	Hippeastrine, hippeastrine *N*-oxide, galanthamine *N*-oxide, lycoramine *N*-oxide, galanthamine, lycoramine, *O*-methyllycorenine *N*-oxide, *O*-methyllycorenine, homolycorine *N*-oxide, homolycorine, *O*-demethyllycoramine, vittatine (**75**), tazettine, lycorine, haemanthidine and *O*-demethylhomolycorine	Kihara *et al.* (1991)
	B	Lycorine, sekisanine, lycoremine, lycoramines A and B, and pretazettine	Uyeo and Koboyashi (1953); Fahmy *et al.* (1960a); Kobayashi *et al.* (1976a); Wang *et al.* (2009)

Table 1. Alkaloids of some species of the family Amaryllidaceae (cont)

Species	Plant part	Alkaloids	References
		Lycorine, sekisanoline, homolycorine, lycorenine, sekisanine, tazettine, pluviine, norpluviine, vittatine, demethylhomolycorine, haemanthamine, *O*-methyllycorenine, pseudolycorine (**76**), and galanthamine	Boit *et al.* (1957a); Fahmy *et al.* (1960a); Uyeo *et al.* (1966); Numata *et al.* (1983)
51. *Sternbergia lutea*	B	Galanthamine, lycorine, haemanthidine (**77**), galanthine, hippeastrine, tazettine, hippamine, sternbergine, lutessine, deacetyllutessine and 11-hydroxyvittatine	Foka (1971); Evidente *et al.* (1984a,b); Evidente (1986a,b)
	L	Lycorine	Abduazimov and Yunusov (1965); Amico *et al.* (1980)
52. *Ungernia trisphaera*	L	Lycorine, trisphaerine, ungernidine, hippeastrine, tazettine, pancratine and hordenine	Khamidkhodzhaev (1963); Allayarov and Abduazimov (1970)
53. *Ungernia vvednskyi*	Ap	Lycorine, tazettine, ungminorine, ungminoridine, hippeastrine, galanthamine, narwedine, pancratine and hordenine	Kadyron and Khamidkhodzhaev (1979)
	F	Lycorine, tazettine and ungminorine	Kadyron and Khamidkhodzhaev (1979)
54. *Valotta purpurea*		Haemanthidine, hemanthamine, galanthamine and vallotidine.	Boit (1956)
55. Zephyranthes flava	F	Alkaloidal phospholipids: *O*-glycerophoryllycorine, phosphatidyllycorines, phosphatidylpseudolycorines and phoshatidyllycorinium methocation.	Ghosal *et al.* (1987)
	Sd	2-Oxyphenanthridium alkaloids: zefbetaine (**78**), zeflabetaine (**79**) and others	Ghosal *et al.* (1986c)

Ag: above ground parts; Ap: aerial parts; B: bulb; F: flower; Fb: flowering bulb; Fr: fruit; Fs: flower stem; Fsf: flower stem fluid; H: herb; L: leaves; R: root; Rz: rhizome; S: shoots; Sd: seeds; Wp: whole plant.

Terpenoids and Sterols

The triterpene alcohols, cycloart-24-en-ol, cyclolaudenol and 31-norcyclolaudenol were isolated from *Crinum asiaticum* var. *japonicum* (Takagi and Yamaki, 1977). 24-Methylenecycloartenol and cycloeucalenol were identified in bulbs of *Crinum augustum* (Ramadan, 1998). The bulbs of *Ammocharis coranica* contained 24-methylenecycloartan-3β-ol, cycloeucalenol, cycloeucalenone and 24-methylenepollinastanone (Koorbanally *et al*., 2000). Five lupanone triterpenoids were isolated from the bulbs of *Cyrtanthus breviflorus* (Crouch *et al*., 2005a): lupeol, lupenone, glochidone, 3β,27-dihydroxylup-20(29)-ene and betulin aldehyde. Olean-12-one and ursan-12-ene were isolated from *Stenomesson variegatum* (R. et P.) Macbr. (Ruggeri *et al*., 1991).

The typical plant steroids, stigmasterol from bulbs of *Crinum asiaticum* var. *japonicum* (Takagi and Yamaki, 1977) and from leaves and bulbs of *Crinum bulbispermum* (Ali and Abdel-Hafiz, 1983), sitosterol from *Crinum moorei* (Kamel, 1996); as well as β-sitosterol-β-glucoside from bulbs of *Crinum augustum* (Abd El-Hafiz, 1990) were isolated. Dihydro-α-sitosterol was identified from bulbs and leaves of *Crinum bulbispermum* (Ali and Abdel-Hafiz, 1983). Stigmasta-4-en-3β-ol was isolated from *Stenomesson variegatum* (Ruggeri *et al*., 1991).

Volatile Constituents

The brown part of the leaves of *Proiphys amboinensis* contains a mixture of methyl eugenol, 5-allyl-1,2,3-trimethoxybenzene, 3,4,5-trimethoxyacetophenone, aliphatic hydrocarbons and long chain acids (Chuah *et al*., 1997). The analysis of the head-space volatiles of *Gethyllis afra* and *Gethyllis ciliaris* fruits has been studied by Kamatou *et al*. (2008). Twenty-nine compounds were characterized in the fruit of *Gethyllis ciliaris* representing 96.5 % of the total composition. Major compounds include pentacosane, ethyl octanoate, ethyl isovalerate, ethyl hexanoate and ethyl benzoate. Fourty-three compounds were identified in the fruit of *Gethyllis afra* representing 87.9 % of the total composition with α-pinene, β-pinene, butyl *n*-butyrate, isoamyl acetate and 2-methyl butyl butyrate as main constituents.

Saponins

Steroidal saponins were isolated from the leaves of several *Agave* and *Furcraea* (Agavaceae or Amaryllidaceae). Tigogenin and hecogenin are the major sapogenins identified from the hydrolysate of the different *Agave* species. Among the other identified steroid sapogenins are gitogenin, yuccagenin, rocogenin and chlorogenin (Rizk and Al-Nowaihi, 1989). Several spirostanol glycosides have been identified from plants of both genera (e.g. Rizk and Al-Nowaihi, 1989; Itabashi *et al*., 2000; Simmons-Boyce *et al*., 2004; Pereira da Silva *et al*., 2006). Bisdesmosidic furostanol saponins were also identified from both genera (e.g. Da Silva and Parente, 2006, 2007). Neotigogenin, tigogenin and other steroids were identified in *Furcroya adina* (Fukusaki and Leon, C., 1979).

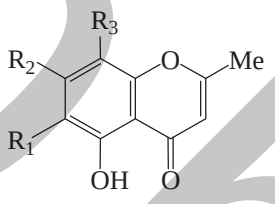
Flavonoids, Chromones and Other Phenolics

Laracine *et al*. (1985) investigated the flavonoids (flavonols, *C*-glycoflavones, and proanthocyanidins) in 14 species of Agavaceae, and in the related families of Amaryllidaceae (7 species) and Liliaceae (7 species). Proanthocyanidins were found only in the Agavaceae. Quercetin, kaempferol, and isorhamnetin were major flavonoids in all families. *C*-glycoflavones were reported absent in the Amaryllidaceae (Laracine *et al*., 1985). On the

other hand, Pacheo *et al*. (1981) identified two proanthocyanidins from *Hippeastrum ananuca* (Table 2). Examples of the flavonoids isolated from some species of the family Amaryllidaceae are shown in Table 2.

An anthocyanin, named lycoricyanin (which gave on partial hydrolysis chrysthanthemin) was isolated from flowers of *Lycoris radiata* (Hayashi, 1942). Later, Arisumi (1971) identified the following anthocyanins from *Lycoris* species: pelargonidin-3-glucoside, pelargonidin-3-xyloglucoside, cyanidin-3-glucoside and cyanidin-3-xyloglucoside, in addition to some anthocyanins which seemed to be triglycosides. The anthocyanins, cyanidin 3-*O*-(6''-*O*-α-rhamnopyranosyl-β-glucopyranoside) and pelargonidin 3-*O*-(6''-*O*-α-rhamnopyranosyl-β-glucopyranoside) were isolated from the ornamental flowers of *Hippeastrum* cultivars (Byamukama *et al*., 2006).

Three chromones *viz.* eugenin (**80**), noreugenin (5,7-dihydroxy-2-methyl chromone, **81**) and 5,7-dihydroxy-6-methoxy-2,8-dimethyl chromone (**82**) were isolated from the bulbs of *Crinum moorei* (Kamel, 1996).



	R_1	R_2	R_3
80	H	OMe	H
81	H	OH	H
82	OMe	OH	OMe

Amabiloside (3-hydroxy-4-*O*-β-D-glucopyranosybenzaldehyde) were isolated from the bulbs of *Crinum amabile* Donn. (Likhitwitayawuid *et al.*, 1993b). Other phenolic compounds have been identified from species of the family Amaryllidaceae e.g. 1-(2-hydroxy-4-hydroxymethyl)phenyl-6-*O*-caffeoyl-β-D-glucopyranoside from *Crinum asiaticum* L. (Sun *et al*., 2008); β-(3,4-dimethoxyphenyl)-α,β-ethandiol, *p*-hydroxybenzene acetic acid ethyl ester from bulbs of *Crinum bulbispermum* (Khalifa, 2001); dihydrodiconiferyl alcohol and *trans*-*N*-(4-hydroxyphenethyl) ferulamide from *Hippeastrum vittatum* (Wang *et al*., 2005b); and 2-(4-hydroxybenzyl) malic acid from *Lycoris radiata* (Koizumi *et al*., 1976).

Other Constituents

Tyramine was isolated from *Crinum* stems (probably *Crinum yuccaeflorum*) (Fowden, 1954; Tram *et al*., 2002a) and *Crinum firmifolium* var. *hygrophyllum* (Razafimbelo *et al*., 1996). A hydroxycinnamoyl polyamine derivative *N*,*N'*,*N''*-triferuloylspermidine (**83**) was identified from pollen of *Hippeastrum x hortorum*. This was claimed as the first report of triferuloylspermidine in nature (Youchnovski *et al*., 2001). Ethylene glycol 1',1''',2',2'' diribofuranoside was isolated from *Polianthes tuberosa* (Firdou *et al*., 1999).

Isoeugenitol (dihydroxydimethylbenzopyran-4-one), a cyclooxygenase-1 inhibitor, was isolated from the underground parts of *Gethyllis ciliaris* (Elgorashi *et al*., 2007).