PART - I

CHEMICAL INVESTIGATION OF LEUCAS ASPERA

CHAPTER - I

A BRIEF REVIEW ON PENTACYCLIC TRITERPENOID LACTONES

Nature is a store house of various chemicals, both inorganic and organic. Among the different classes of natural products reported to be present in the vegetable world, 'terpenes' is one[1]. Most of the naturally occurring terpene hydrocarbons have the general formula $(C_5H_8)_n$ and the value of 'n' is defined as the basis of classification. On this basis, the terpenes are classified as follows :

(a) Hemiterpene (Isoprene), C_5H_8
(b) Monoterpene, $C_{10}H_{16}$
(c) Sesquiterpene, $C_{15}H_{24}$
(d) Diterpene, $C_{20}H_{32}$
(e) Sesterterpene, $C_{25}H_{40}$
(f) Triterpene, $C_{30}H_{48}$
(g) Tetraterpene (Carotenoid), $C_{40}H_{64}$
(h) Polyterpene $(C_5H_8)_n$

Thus, the term triterpenoids refers to a group of natural products contaning thirty carbon atoms on six isoprene units. This definition, though generally applicable, is by no means rigid, since several substances which contain more or less than thirty carbon atoms and also those which do not strictly follow the isoprene rule have been isolated and characterized as triterpenoids. Aided by the availability of highly sophisticated physico-chemical techniques and the developments in biogenetic theories, isolation and identification of many complex triterpenoids have been achieved.

Many authors in the past have exhaustively reviewed the subject[2-9]. The present write-up will mainly deal with some aspect of triterpenoids emphasising on detailed survey of literature on pentacyclic triterpene lactones relevant to the present work of the author.

A large number of triterpenoids of biogenetic interest have been isolated from plants of different families and have been classified on the basis of carbocyclic rings occurring therein.

Type	Typical examples
a) Acyclic	Squalene[10-13]
b) Monocyclic	Pre-squalene[14]
c) Bicyclic	Lansic Acid[15]
d) Tricyclic	Malabarical[16]
e) Tetraclyclic[17-18]	
(i) Methyl steroid type	Dammaradienol[19]
(ii) Tetracyclosqualene type	Onocerin[20]
(iii) Shionone type	Shionone[21]
f) Pentacyclic	Astrantiagenin G[22]

Of the various types of triterpenoids, pentacyclic ones form the largest group which needs systematic classification. The first systematic classification of pentacyclic triterpenes was attempted by O.Jager[23] and then by D.E.White[24] who classified these compounds into six major groups e.g. Oleanane, Ursane, Lupane, Taraxastane, Taraxerane and Friedelane. Based on the different skeletal patterns, Halsal and Alpin[3] and Rastogi et al[7] classified all the known pentacyclic triterpenes into five major systems which were further subdivided into different groups depending on their stereochemical and structural variations as enumerated below :

1. Arborene, 7

2. Hopane system :

a) Compounds with unchanged hopane skeleton, 8

b) Compounds with iso-hopane (=21-epihopane) 9 skeleton

c) Compounds with rearranged hopane skeleton

(i) E: C-friedo (fernane, 10) derivative

(ii) E: A-friedo (filicane, 11) derivative

3. Lupane system :

a) Compounds with unchanged lupane skeleton

b) Compounds with rearranged lupane skeleton -

(i) Allobetullin, 12 derivative

(ii) Taraxastance, 4 derivative

(iii) Ceanothane, 13 derivative

4. Oleanane system :

a) Compounds with unchanged oleanane skeleton, 1

b) Compounds with rearranged oleanane skeleton

(i) D-friedo (Taraxerane, 5) derivative

(ii) D: C-friedo (multiflorane, 14) derivative

(iii) D: B-friedo (glutane, 15) derivative

(iv) D: A-friedo (friedelane, 6) derivative

5. Ursane system :

a) Compounds with unchanged ursane skeleton, 2

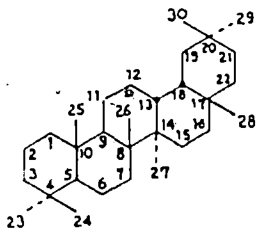
b) Compounds with rearranged ursane skeleton

(i) D: C-friedo (bauerene, 16) derivative

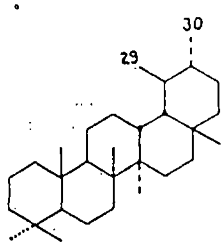
(ii) D: A-friedo (eupacane, 17) derivative

Due to the advancement in analytical aids, it has been possible to isolate and identify more complex type of triterpenoids. Some of these skeleton types and examples of some members are given in the sequel.

Carbon skeletons of pentacyclic triterpenoids (C_{30})



1
Oleanane



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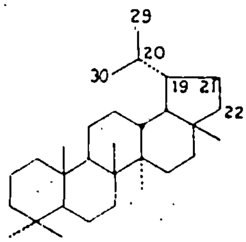
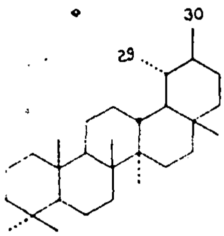
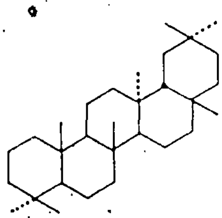
Ursane



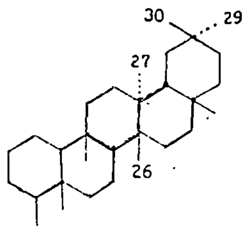
3
Lupane



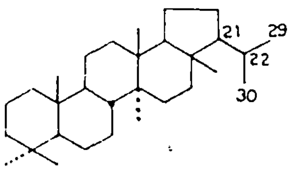
4
Taraxastane



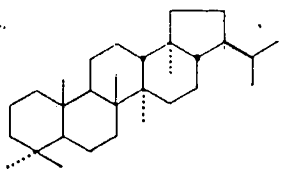
5
Taraxerane
= D-Friedooleanane



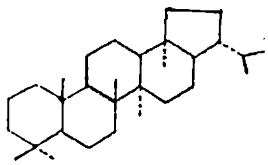
6
Friedelane
= D:A-Friedooleanane



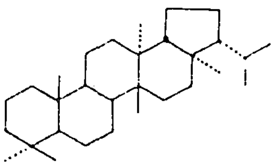
7
Arborane



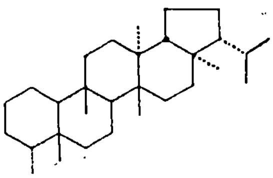
8
Hopane



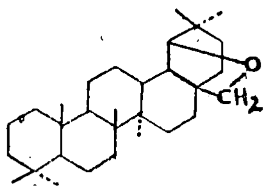
9
Isohopane



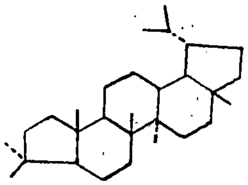
10
Fernane
= E:C-Friedohopane



11
Filicane
= E:A-Friedohopane

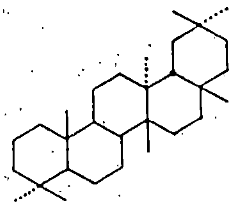


12
Allobetullin



13

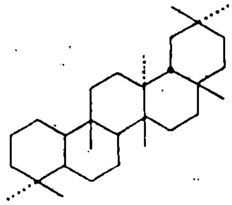
Ceanothane



14

Multiflorane

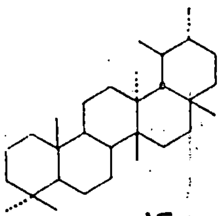
= D:C-Friedooleanane



15

Glutane

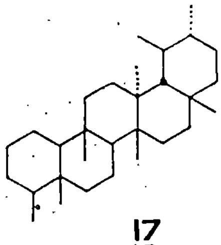
= D:B-Friedooleanane



16

Baurane

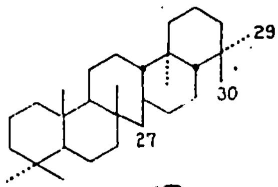
= D:C-Friedoursane



17

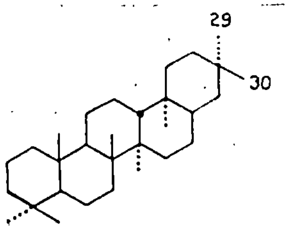
Eupaçane

= E:A-Friedoursane



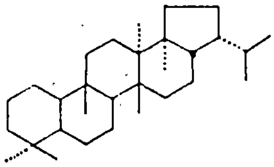
18

Serratane

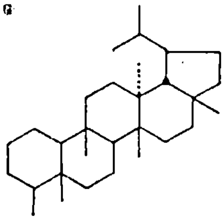


19

Stictane

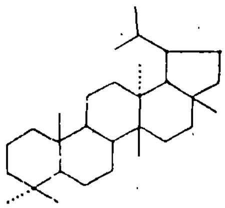


D:B-Friedohopane



D:A-Friedolupane

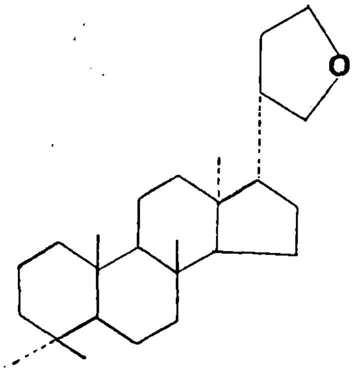
(18β,19α-H-form)



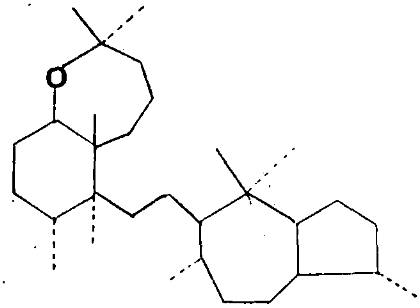
D:C-Friedolupane

(19α-H-form)

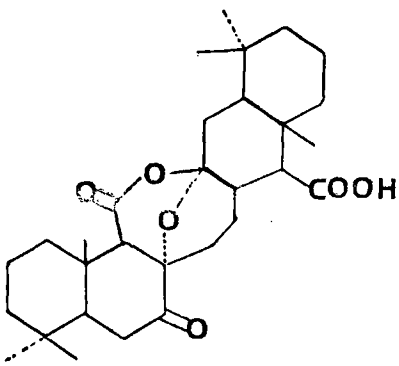
Examples of triterpene bearing unusual types of skeleton :



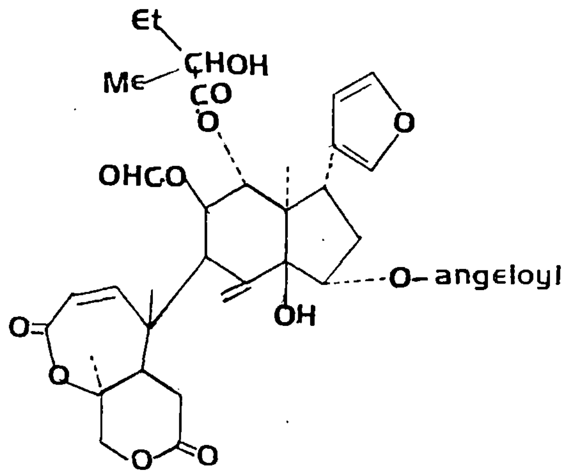
Meliacin (20)



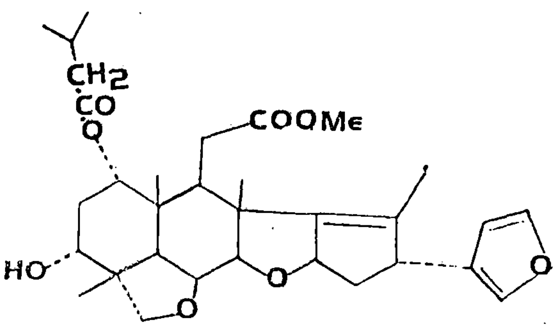
Sipholane (21)



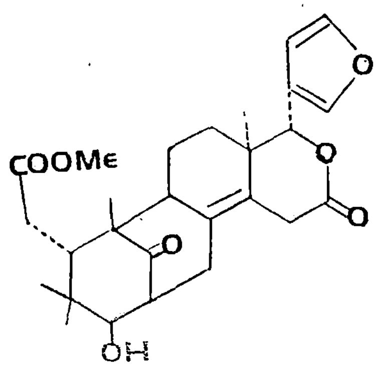
Officinalic acid (22)



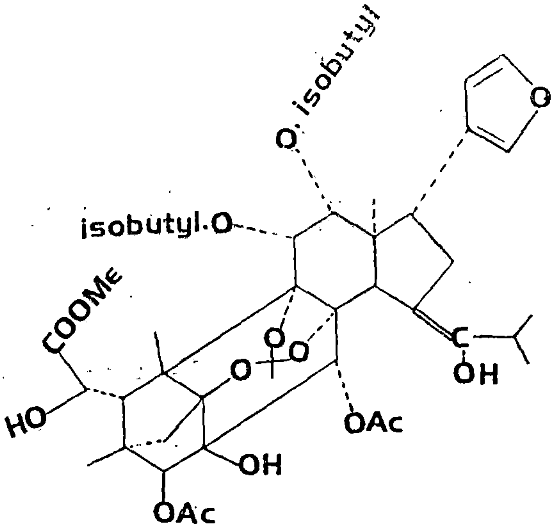
Hispidin B[25] (23)



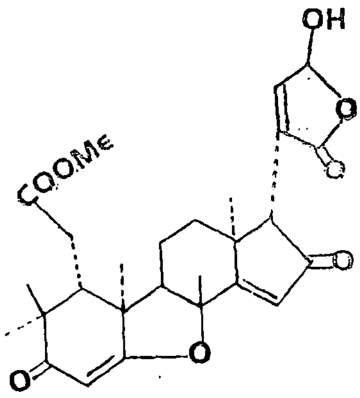
Salannol[26] (24)



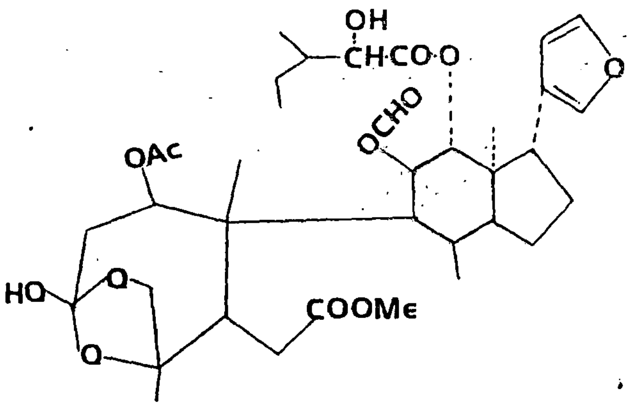
Proceranolide[27] (25)



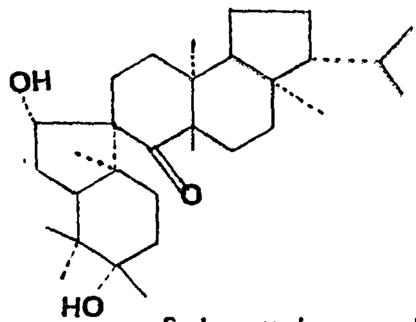
Chukrasin A[28] (26)



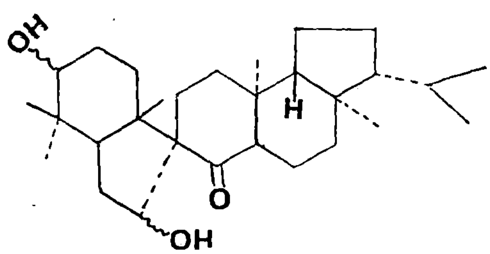
Tricoccin S8[29] (27)



Hispidin A[25] (28)



Spirosupinanonediol[30] (29)



Neospirosupinanonediol[30] (30)

A brief description is given here regarding the process of isolation and identification of triterpenes.

Triterpenoids occur in nature either in the free state or as saponin. The free triterpenoids are generally isolated in pure state by solvent extraction followed by column chromatography of the extract on alumina or silica gel. In the case of saponins, the triterpene moiety is isolated by acid or enzymatic hydrolysis. It is to be noted that at times acid hydrolysis method do bring in formation of artefacts and enzymatic hydrolysis is not always wholly successful. Some newer techniques have been reported over the years[31-33] for the purpose.

TLC and GLC[34] permit quick detection and identification of triterpenoids. Panaxadiol and panaxatriol on treatment with 100 fold of β-naphthyl chloride in pyridine at room temperature give the stable naphthoates which are analysed by TLC dual chromatoscanners[35]. A new GC method for the determination of ginseng sapogenins as their acetylated products using N-methyl unidazole as catalyst has been described[36].

Among the methods that are now more frequently employed, mention may be made of HPLC, Droplet Counter Current Chromatography. The advantage with HPLC method, unlike GC, it does not require derivatisation. Techniques have been described in the literature[37].

GC/MS is used for rapid detection and estimation of triterpenoids e.g. triterpenes from licorice root[38].

Elucidation of structure is only possible by deciphering all the information about the particular molecule derived from the application of IR, NMR, MS, ORD/CD, X-ray crystallography. The FT-IR technique was found very useful for structure elucidation of two non-triterpene ketones with the lanostane skeleton[39].

NMR spectroscopy, particularly ^{13}C NMR spectroscopy is now being frequently employed in triterpene structure elucidation. ^{13}C signals to specific carbons of various skeletons have been determined[40–49].

Internuclear double resonance (INDOR) and lanthanide induced shift studies are frequently reported for stereochemical assignments of triterpenoids[50–51]. Complete assignments of the carbon frequencies of 16 olean-18-en derivatives have been accomplished by means of SFORD and NORD experiments using shift reagent techniques[52].

2D-spectroscopy (2D-J NMR) has been used to assign all the peaks in the complex spectra as well as to derive the structure of triterpenoids[53–54]. Pradhan et al have recently employed the 2D-INADEQUATE NMR technique on unveiling the actual structure of odolactone and related triterpenoids[55].

Other important physical methods necessary for complete structure elucidation are Mass spectrometry[6], Molecular rotation measurement, ORD and CD[6], and X-ray crystallography, Barton and Jones[56] have used Molecular Rotation techniques to study structural and stereochemical problems. With the help of X-ray crystallography one can establish the stereochemistry of most complicated terpenoids e.g. epifriedelinol[57], officinalic acid[58], hecaregenin[59], sipholenol and dephalenone[60].

Distribution of Triterpenes in Nature

Tetracyclic lanostance type triterpene are common in fungi[6,9]. The pentacyclic triterpenes are found almost solely in the photosynthetic Eukaryotes. The pentacyclic 3-deoxy-hopenes, with one five membered ring occur mainly in ferns, lichems and some microorganism. In ferns one also finds other structurally related pentacyclic triterpene hydrocarbons (feronens, adiantenol fillicene) which like the 3-deoxy-hopanes are formed by direct cyclization of squalene. The isolation of C-3-oxygenated squalene-2,3-oxide derived oleanene-type triterpenes has been reported from two ferns of the genus Polypodium[61]. 3-oxo-hopenoids occur in a few families of Angiospermae, 3-deoxy-'extended' hopanes are characteristic of certain groups of micro organism.

In lichen, pentacyclic triterpenes are relatively common but their skeletons (stictane, hopane, fernane) are derived from direct cyclization of squalene.

Gymnosperm seem to lack pentacyclic triterpenes.

Squalene -2,3-oxide derived triterpenes with five six membered rings (oleanane, ursane and related types) mainly occur in Angiospermae[62-64].

In sediments like oil and (brown) coals, the presence of oleanane and ursane type triterpene point to the sedimentation of Angiosperm-derived waxy compounds[63]. They are present only in fossil sediments of terrestrial origin from the tertees and younger, which is in accordance with the fact that the Angiosperms have developed since then.

Biological Activity and Triterpenes Structure :

In the plant kingdom the triterpenes form a continuum ranging from very lipophilic compound on the one hand to very hydrophilic substance on the other hand. In addition to performing structural functions many triterpenes and their derivatives display a wide range of physiological and pharmacological activities. The latter are probably largely based on the same mechanisms as are the ecological activities. The compounds may affect membrane structural and may have cytotoxic (antimicrobial) properties[65].

Examples of biologically active triterpenes are given below :

Triterpene	Activity
1. β-amyrin	Stimulare vegetative growth[66] of the fungus
2. $\alpha+\beta$-amyrin actate	Anti inflammatory[67]
3. Lupeol acetate	Bacteriostatic[68]
4. Cycloartenol & 24-methylene cycloartenol	Hypocholesterolemic[69] activity
5. Mytenfolic acid	Anti leukaemic properties[70]
6. Maytenfoliol	Do
7. Moronic acid	Antimicrobial[71]
8. Xeorin	Antifeedant[72-74]
9. Melientriol	Do

Triterpene	Activity
10. Toonacilin	Antifeedant[72–74]
11. Lupeolactone	Hypolipidermic[75]
12. 25-hydroxy Vit-D	Bone calcium[76] mobilization in man
13. Fusidic acid	Antibacterial[77] and Antiviral
14. Seco-ring A der.of Eburicoic acid	Anti bacterial[78]
15. Calaminthadiol	Disinfectant properties[79]
16. Sondexianol	Anti bacterial[80]
17. Siaresinolic acid	Antiseptic[66] and Antioxidant
18. Curcubitacins	Antifeedant, cytotoxic[81], fungistatic
19. Meliacins	Insecticidal properties[82]
20. Ring A seco limonoids	Antifeedant, insecticidal[83] properties
21. Quassinoids	Antineoplastic, antiviral, anti-malarial, antiamaobic, antifeedant and insecticidal properties[84]
22. Saponins (triterpene)	Anti microbial, antiviral, mollu-scicidal, antifungal, cytoxic[35] activity
23. Gymnemic acids	Antiviral activity[85]
24. Bufadienolides	Cardiotonic[66]
25. Withanolides	Antimitotic, cancerostatic, anti-biotic, insect-repllent activity[66]
26. Fasciculols	Plant growth inhibitors, anti-microbial activity[86]
27. Lantadane A (22-angeloyl oxyoleanolic acid)	Toxic to sheep[87]

Some examples of triterpenes with various functional groups are given below :

(A) Naturally occurring seco-ring A triterpenoids :

	Source	Compound	Skeleton type	Group	Ref
1.	Nyctanthes arbotristis	Dammarenolic acid	Dammarolanostane	3,4-seco; $\Delta^{4(29),24}$ 20-OH; 3-CooH	88
2.	Do	Nyctanthic acid	Oleanane	3,4-seco; $\Delta^{4(23),12}$ 3-CooH	88
3.	Quercus robus	Roburic acid	Ursane	3,4-seco; $\Delta^{4(23),12}$ 3-CooH	89
4.	Canarium muelleri	Canneric acid	Lupene	3,4-seco; $\Delta^{4(23),20(30)}$ 3-COOH	90
5.	Lansium domesticum	Lansic acid	Onocerane	3,4; 21,22-diseco $\Delta^{7,4(23),14(27),22(29)}$	91
6.	Schizaendra Nijra	Nigranoic acid	Cyclolanostane	3,4-seco; 9,19 cyclo; $\Delta^{4(28),24}$; 3,26-$(COOH)_2$	92

	Source	Compound	Skeleton type	Group	Ref.
7.	Alnus serrulatoides	Alnuseric acid	Dammarane	3,4-seco; $\Delta^{4(28)}$; 20,24-epoxy; 3-COOH	93
8.	Entandrophragma angolense	Entrandolide	Euphane	A-seco; $\Delta^{7,24}$, 3-5 lactone	94
9.	Sapium sebiferum	Sebiferic acid	Isohopane	3-4-seco; $\Delta^{4(23),20(29)}$ 3-COOH	95
10.	Iris germanica	Iridogermanol	Ambrane	2,3-18-diseco $\Delta^{2(7),14,18,22}$; 3,10 21-$(OH)_3$, 1-CHO	96
11.	Musanga cacropoides	Musangic acid	Ursane	2,3-seco, 16,19-$(OH)_2$, 2,3,28-$(COOH)_3$	97

(B) Naturally occurring pentacyclic triterpene alcohols :

	Source	Compound	Skeleton type	Group	Ref
1.	*Parmelia leucotylize*	Leucotylin	Alopence	$6\alpha, 16\beta, 22$-OH	98
2.	*Lycopodium clavatum L.*	Lycoclavanol	Serratene	$3\alpha, 21\beta, 24$-OH Δ^{14}	99
3.	*Sticta coronata*	Substance VII	Stictane	$3\beta, 22\alpha$-OH	100
4.	*Calendula officinalis*	Ursadiol	Ursene	$3\beta, 21\alpha$-OH, Δ^{12}	101
5.	*Hydnocarpus octandra*	Octandrolol	Friedelane	3α-OH, 29-CH_2OH	102
6.	*Glochidion eriocarpum*	Glochidol	Lupene	3β-OH, $\Delta^{1,20(29)}$	103
7.	*Pseudocyphellaria berberina*	Durvilldiol	Stictane	3β, 22α-$(OH)_2$	104
8.	*Lycopodium wightianum*	Wightianol A	Serratene	$3\beta, 14\beta, 20\beta, 21\beta$, 24-$(OH)_5$	105

	Source	Compound	Skeleton type	Group	Ref
9.	*Bayeris brevifolis*	Triterpene	Lupane	$3\beta, 16\beta, 28-(OH)_3$; $\Delta^{20(29)}$	106
10.	*Tricosanthes kirilowii*	Karonnidiol	Friedo-oleanane	$3\beta 29-(OH)_2$	107
11.	*Crotolaria seltiens*	Crotolarol	Ursane	$3\beta, 15, 16, 18, 20-(OH)_5$	108

(C) Some examples of poly functional group bearing pentacyclic triterpene :

	Source	Compound	Skeleton type	Group	Ref
1.	*Picea sitchensis*	Compound-A	Serratene	$3\beta-OCH_3, 21\beta-OH$	109
2.	*Pachysandra terminalis*	Cerin	Friedelane	2α-OH, 3-oxo	110
3.	*Bursera arida*	Bemulin	Lupane	3α-OH, $\Delta 20(29)$, 28-COOH, 3→25-epoxy	111
4.	*Trachadenia zeylanica*	O-acetyl-trichadenal	Friedelane	3β-OAc, 26-CHO	112
5.	*Styrax officinalis*	21-Benzoyl barringtogenols	Oleanane	$3\beta, 16\alpha, 22\beta, 28-(OH)_4$; 14-Nor; 14α-OMe ; $21\beta-OCOC_6H_5$	113

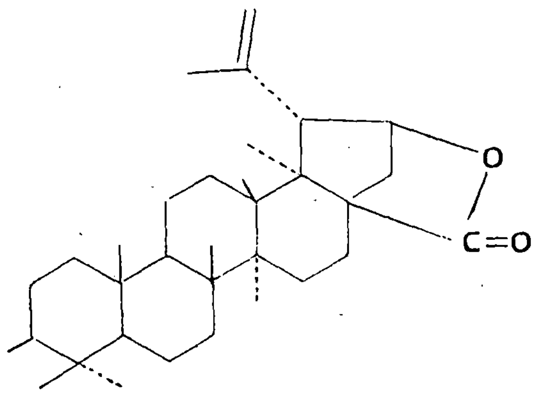
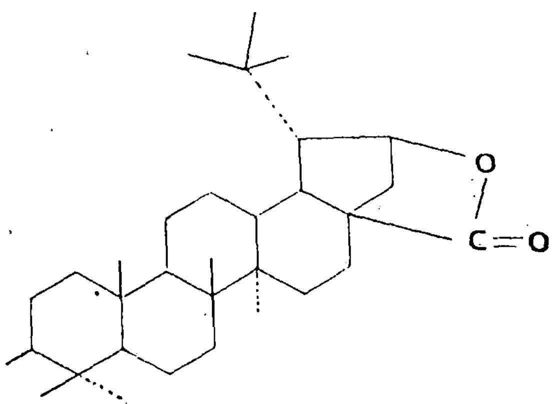
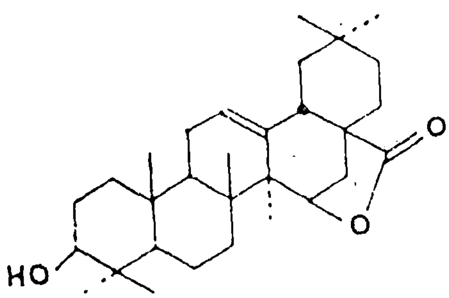
Source	Compound	Skeleton type	Group	Ref.
6. <u>Pseudo-cyphellaria</u> sp.	22-hydroxy sticten-3 one	Stictene	22α-OH, 3-oxo	114
7. <u>Nerium oleander</u>	Oleanderolic acid	Oleanene	3β-p-hydroxyphenoxy-11α-methoxy-12α-hydroxy-20-ursen 28-oic acid	115

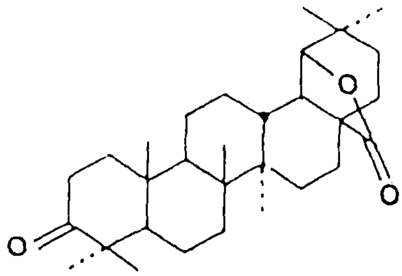
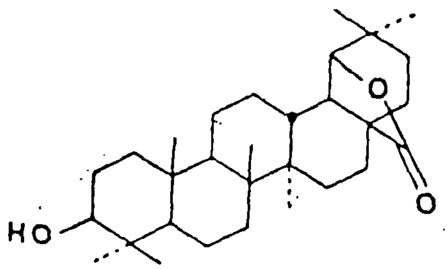
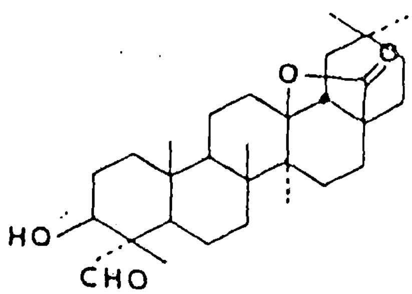
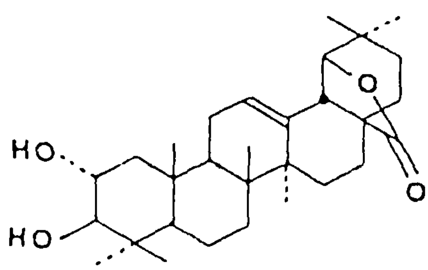
(D) (Nor) triterpenoid peroxide having pentacyclic polyfunctional group (only one compound reported so far) :

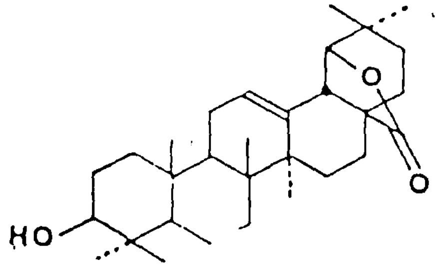
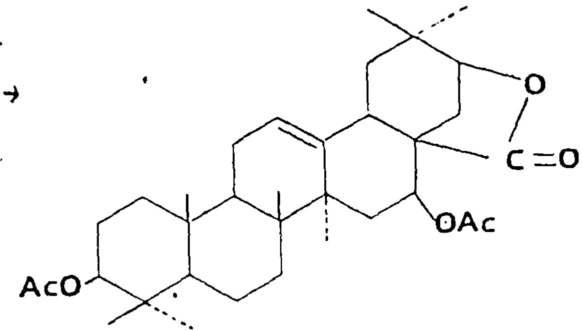
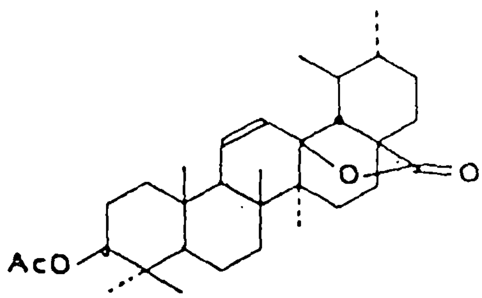
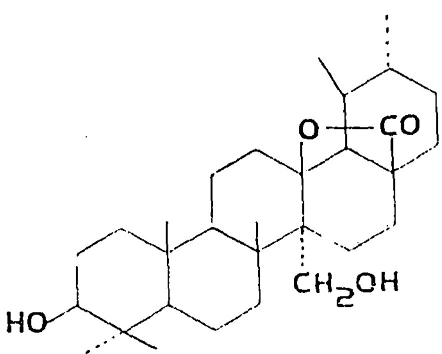
Source	Compound	Skeleton type	Group	Ref.
1. <u>Sapium baccatum</u>	Baccatin	Oleanene	2α,3β-(OH), $\Delta^{15(16)}$, 14-17 peroxide	116

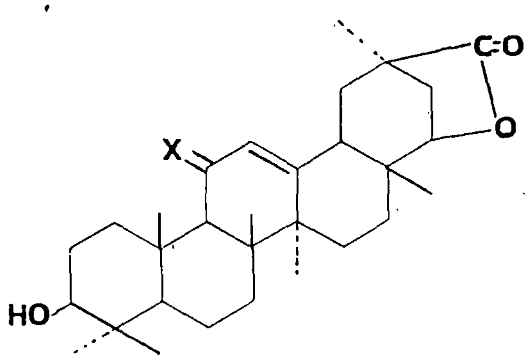
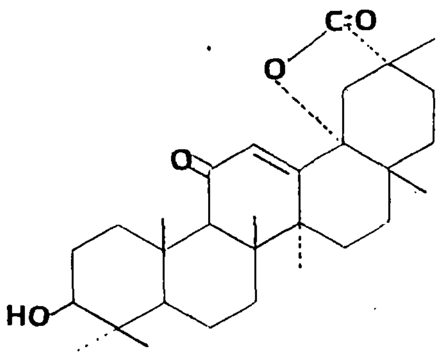
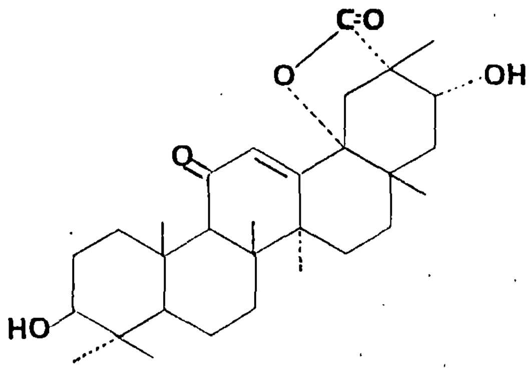
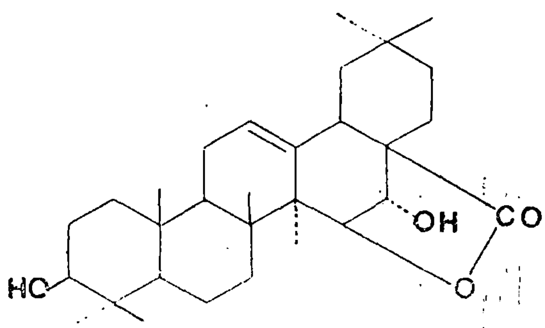
After providing a few examples of various types of triterpenes as mentioned above, an attempt is made here to record in detail the pentacyclic triterpene lactones so far isolated and identified which bears relevance to our present work.

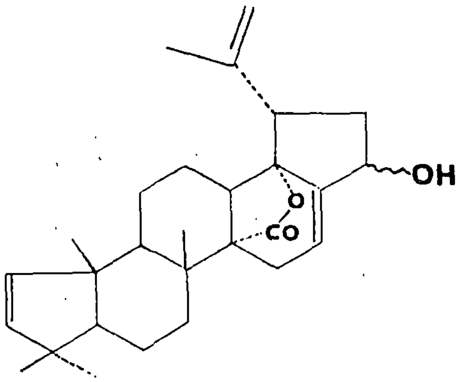
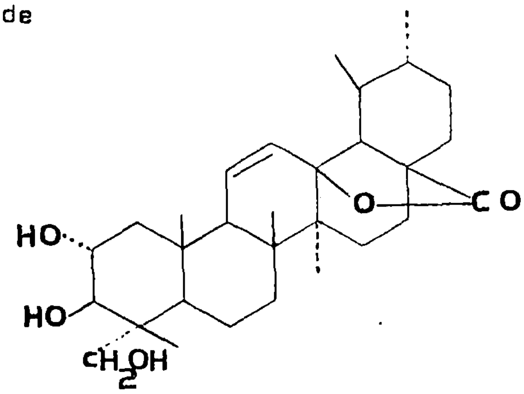
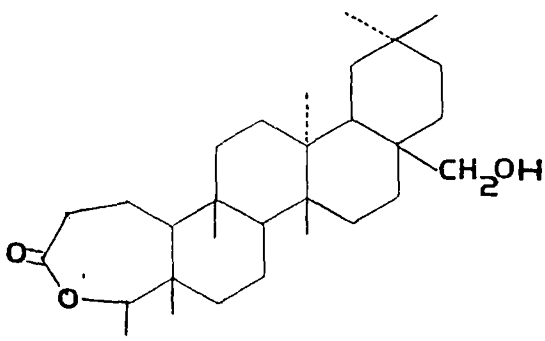
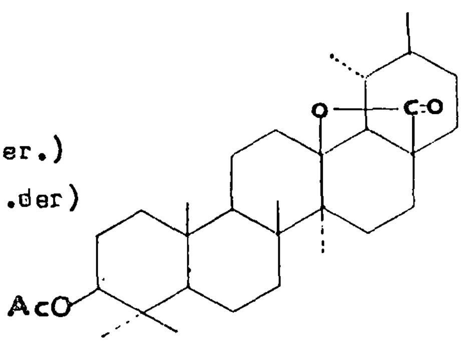
Naturally occurring pentacyclic triterpene lactones :

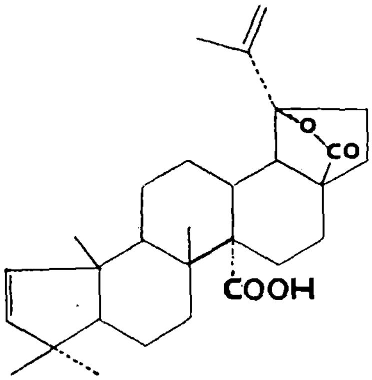
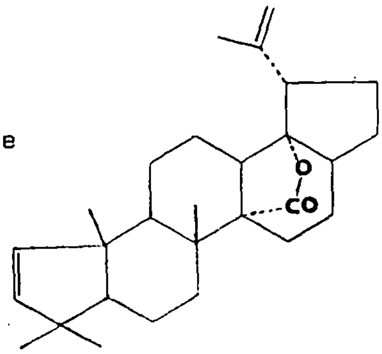
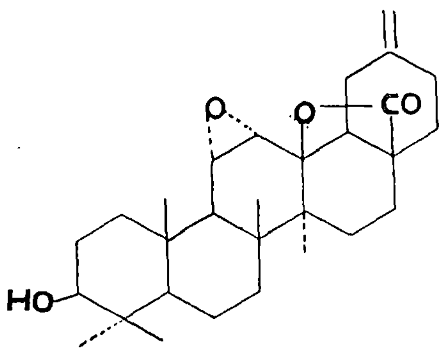
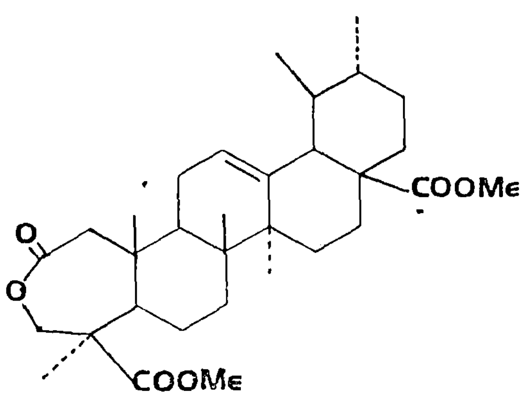
Sl. No.	Name and some physical datas	Structure	Source and Reference
1.	Thurberogenin $C_{30}H_{46}O_3$ mp 283.5^0 $[\alpha]_D$ +11^0		Cactus (Lemaireocerees thurbari) Djrasi,C. et al (1955) J.Am.Chem. Soc.77, 5330 Mark, M. et al (1967) J.Org.Chem. 32, 3150
2.	Stellatogenin $C_{30}H_{48}O_4$ mp 317-9^0 $[\alpha]_D$ +36^0		Cactus (L. thurbari) Djarassi,C. et al (1955) J.Am.Chem. Soc., 77, 5330 Mark,M. et al (1967) J.Org.Chem. 32, 3150
3.	Dumortierigenin $C_{30}H_{46}O_3$ mp 292-5^0 $[\alpha]_D$ -19^0		(Maxican cactus) Lemiareocereus dumortieri Djarassi,C. et al (1956) J.Am.Chem. Soc., 78, 5685

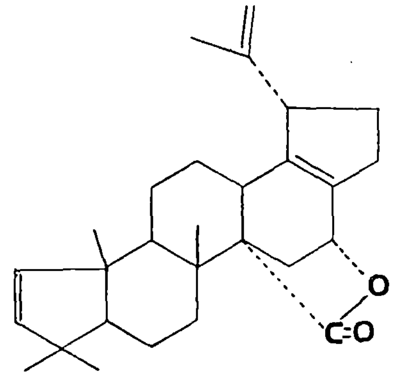
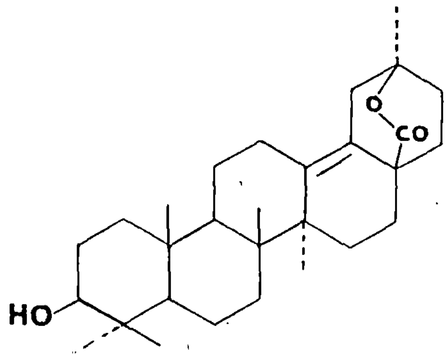
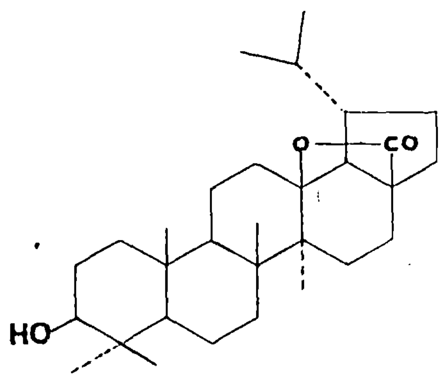
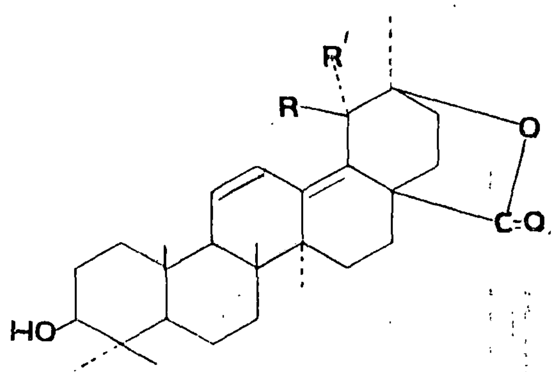
Sl. No.	Name and some Physical datas	Structure	Sourse and Reference
4.	Oxyallobetulone $C_{30}H_{46}O_3$ mp 331–2^0 $[\alpha]_D$ +84^0		Jerolim V. et al (1958) Chem.Ind. 1142. Ikan,R. et al (1960) J.Chem.Soc. 893
5.	Oxybetulin $C_{30}H_{48}O_3$ mp 345–6^0 $[\alpha]_D$ +47^0		Do
6.	Gypsogenin lactone $C_{30}H_{46}O_4$ mp 330–1^0 $[\alpha]_D$ +30^0		Khorlin,A.Ya et al (1962); Zhurn Obscei Khimii, 32 782
7.	Styphnodendron sapogenin'F' $C_{30}H_{46}O_4$ mp 265–1^0 $[\alpha]_D$ +5		Tursch,B. et al (1963); J.Org. Chem. 28, 2390

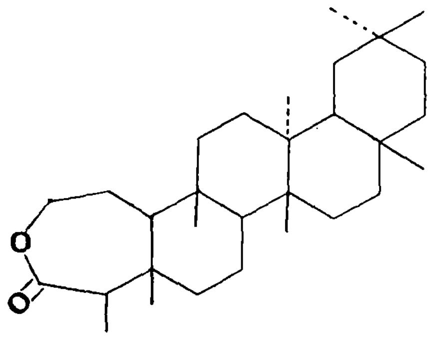
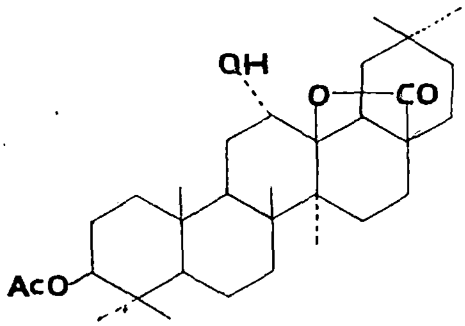
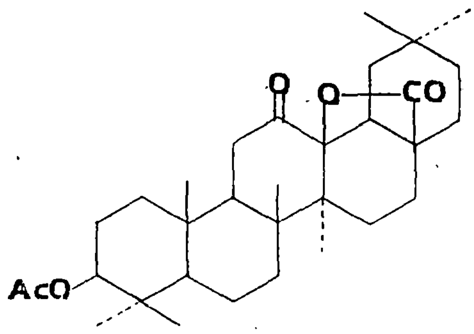
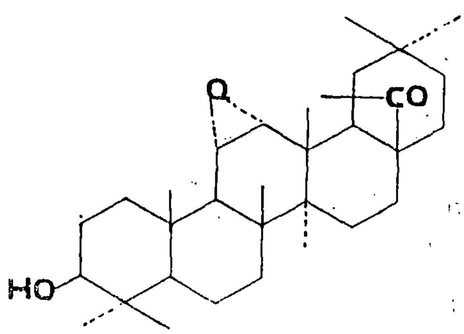
Sl. No.	Name and some Physical datas	Structure	Source and Reference
8.	Stryphodendron sapogenin'B' $C_{30}H_{46}O_3$ mp 240-3^o $[\alpha]_D$ -16^o		Tursch,B. et al (1963); J.Org. Chem. 28, 2390
9.	3,16-diacetoxy-12-en-Oleana-28→21-Olide mp 235-36^o		Acacia consinna pods, K.M.Shamsuddin Tetrahedron Letters(1964), 2055-8
10.	3βhydroxy-11-ursen 28→13 -olide $C_{32}H_{48}O_4$ mp 252^o $[\alpha]_D$ +46^o		Eucalyptus sp (leaves) D.H.S.Horn et al (1964), Aust.J. Chem. 17, 477
11.	Phillyrigenin $C_{30}H_{48}O_4$ mp 339-41 $[\alpha]_D$ +23^o		Pittosporium phillyroe A.L.Bekanth,ARH, Cola, J.C.Watkins, O.E.White. Aust. J.Chem.(1956),9 428

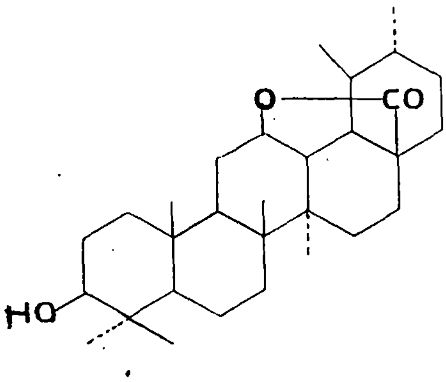
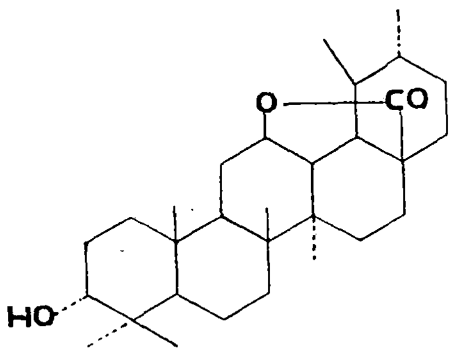
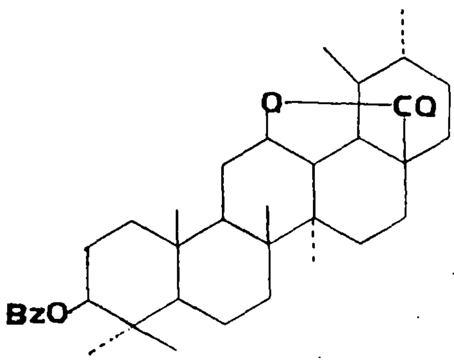
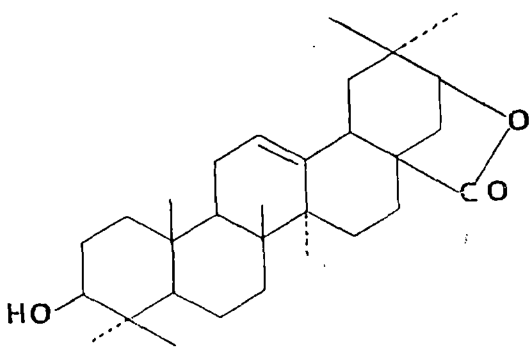
Sl. No.	Name and some physical data	Structure	Source and Referennce
12.(a)	Glabrolide, X= O mp 360-5^{o} $[\alpha]_D^{25}$ = 76.5 $C_{30}H_{44}O_4$		Glycyrihize glabra Gazz.Chim.Int. 96(6) 772-85
(b)	Deoxyglabro-lide X= H_2 mp 274-8^{o} $[\alpha]_D^{25}$ = 59.6 $C_{30}H_{46}O_3$		Do 96(6)843-51
(c)	Isoglabrolide mp 318-28^{o} $[\alpha]_D^{25}$ = 46 $C_{30}H_{44}O_4$		Russo G. et al (1968) Corsi Semin.Chim.11, 20
13.	21α-hydroxy iso glabrolide $C_{30}H_{44}O_5$ mp 304^{o}(d) $[\alpha]_D$ -11(Py)		Canonica et al (1967) Gazz. Chim.Ital. 97 1347
14.	Proceragenin A		Albizzia procera Sujata et al Tetrahedron Letters(1966) (46)5643-50

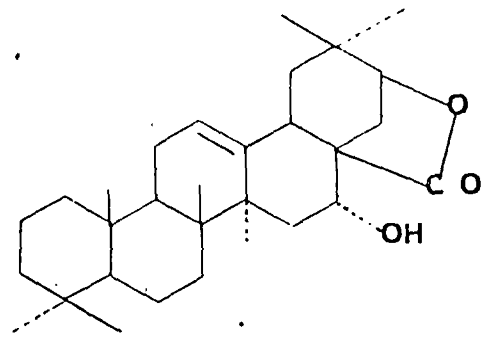
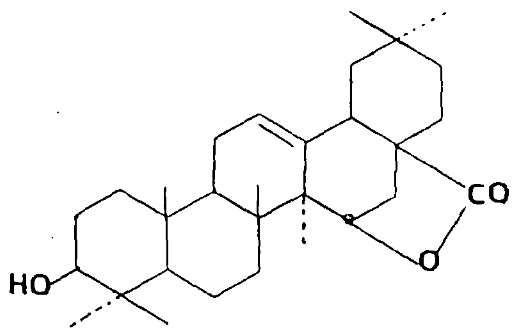
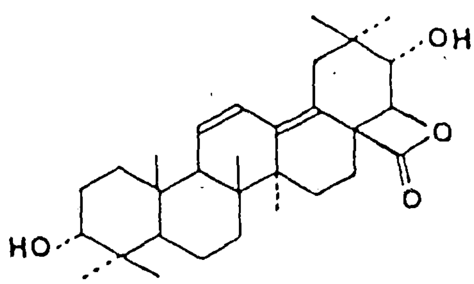
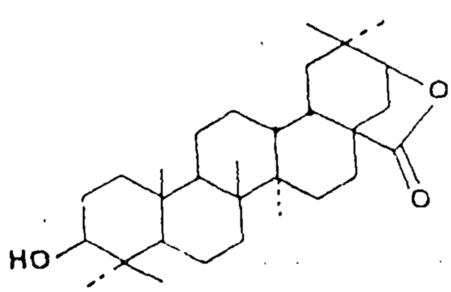
Sl. No.	Name and some physical data	Structure	Source and Reference
15.	Emmolactone		*Emmenosparmum alphitonioides* J.J.H.Simas (1967); Aust. J.Chem. 20(12) 2737-49
16.	Dryobalanolide $C_{30}H_{46}O_5$ mp 278-30° IR 1765		*Dryobalanops aromatica* L.Tokes(1968) Tetrahedron Letters (41) 4363-6
17.	Apetalactone $C_{30}H_{50}O_2$ mp 335° $[\alpha]_D$ +37.5°		*Calpphyllum apetalum* and *C.tomentosum* T.R.Govindachari et al(1968). J. Chem.Soc.C.(11) 1323-4
18.	Ursolactone $C_{30}H_{48}O_3$ mp 252°(ac.der.) $[\alpha]_D$ +12(ac.der)		*Helichaysum italicum* Orzalaso G. et al (1969) Bull. Chim.Farm. 108 540

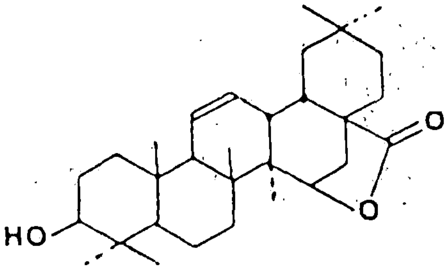
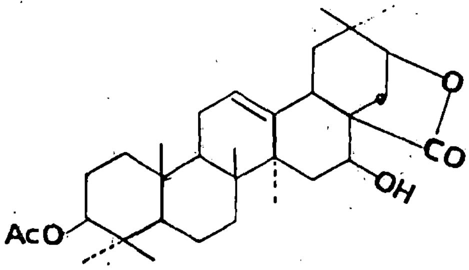
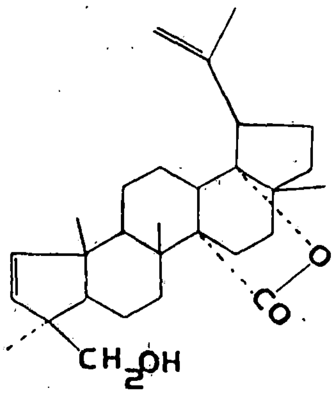
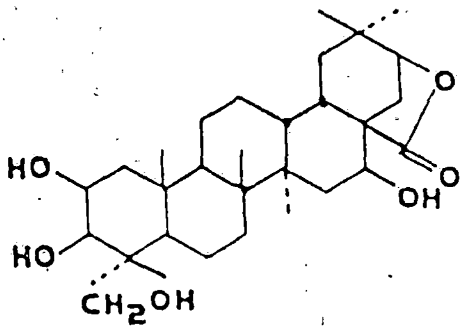
Sl. No.	Name and some physical data	Structure	Source and Reference
19.	Jingullic acid		Emmenospermum alphtoniodes J.J.H.Simes (1969), J.Chem. Soc.D.(11) 579-80
20.	Deoxyemmolactone		Allangium villosum K.Jewers(1970) J.Chem.Soc.D. 13,814
21.	Eupteleogenin $C_{29}H_{42}O_4$ mp 268-272° $[\alpha]_D^{22}$ +83°		Euptelea polyandra M.Goto et al (1970),Yakkugaku Zesshi, 90(6) 744-51
22.	Dammar Resin lactone $C_{32}H_{52}O_6$ mp 234-36° $[\alpha]_D$ +117°		Dammer resin S.Brewis(1971) J.Chem.Soc.C. (14) 2525-9

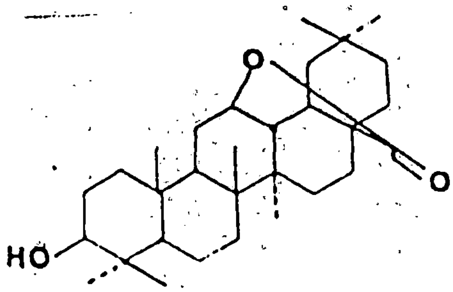
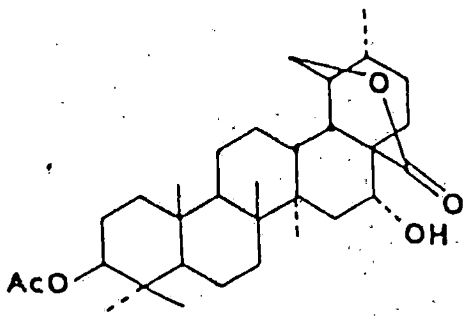
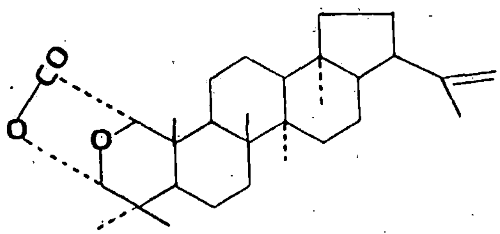
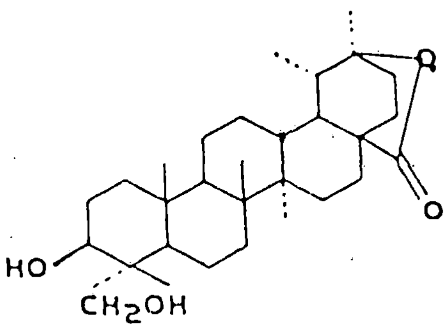
Sl. No.	Name and some physical data	Structure	Source and Reference
23.	Isodeoxyemmo-lactone		*Allangium villosum* and *Emmenospermum alphitoniodes* J.J.H.Simes (1971 J.Chem.Soc.D. 4, 195
24.	Larreagenin A		*Larrea divericata*. G.Habermehl (1974) Jastus Liebigs Ann. Chem.(2), 169-175
25.	3β-hydroxy-lupan 13 →28 - olide		*Dillenia indica*. Nilima Banerjee et al (1975), Phytochemistry 14, (5-6),1447-48
26.	Latifoloside A genin I R=OMe, R'=Me II R=OH, R'=Me III R=Me, R'=OH		*Ilex latifolia* (leaves) M.Ochi et al (1975) Bull.Chem.Soc. Jpn. 48(3),937-40

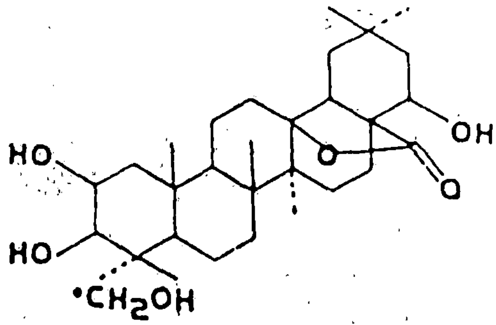
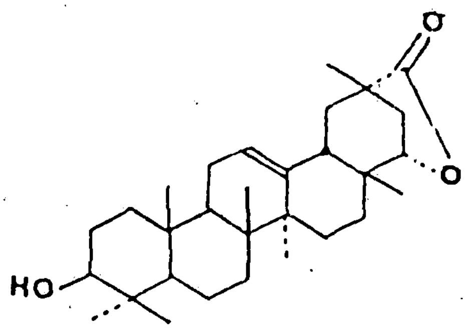
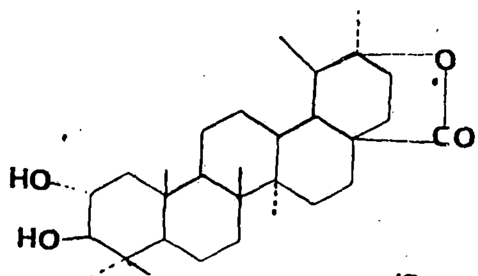
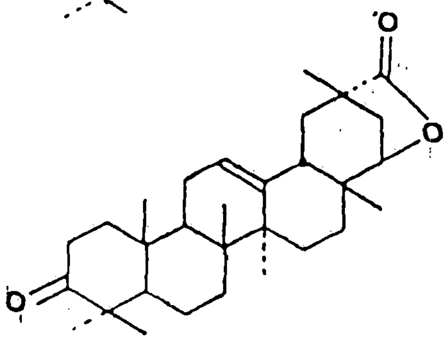
Sl. No.	Name and some physical data	Structure	Source and Reference
27.	Lithocarpic lectone $C_{30}H_{50}O_2$ mp 319-20^0 $[\alpha]_D$ +54		Lithocarpus irwinii. W.H. Hui et al(1975) J.C.S.Perkin I 617 - 19
28.	3β- Acetoxy - 12α-hydroxy - 28→13β-oleenolide $C_{32}H_{50}O_5$ mp 284-86 $[\alpha]_D$ +39.7		Rhodomyrtus tomentosa. W. H.Hui et al (1976), Phyto-chemistry, 15, 1741
29.	3β-ecetoxy -12-oxo-28→13 - oleananolide $C_{32}H_{48}O_5$ mp 287-9^0 $[\alpha]_D$+38^0		Rhodomyrtus tomentose. W. H.Hui et al (1976), Phyto-chemistry, 15, 1741
30.	11α, 12α-epoxy- 3β-hydroxy - 28→13β-oleanano-lide $C_{30}H_{48}O_4$ mp 329-31 $[\alpha]_D$ +45.3^0		Rhodomyrtus tomentosa. W.H.Hui et al (1977), Phyto-chemistry 15, 1741

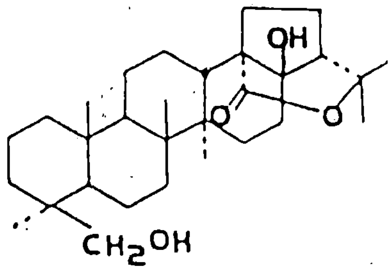
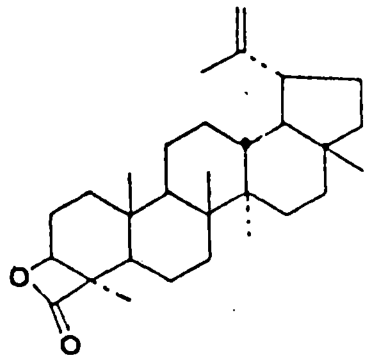
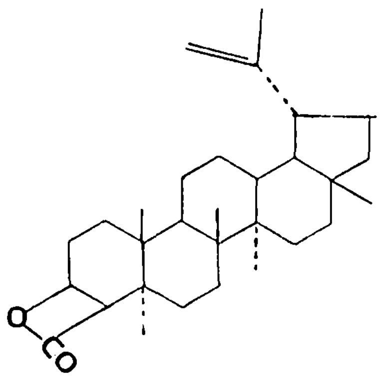
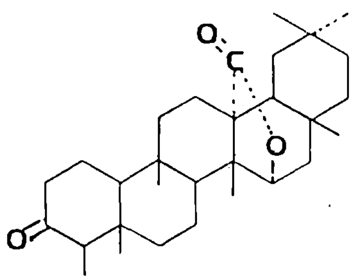
Sl. No.	Name and some physical data	Structure	Source and Reference
31.	3β-hydroxy - 13α-H-28→12β-ursanolide $C_{30}H_{48}O_3$ mp 385-86° $[\alpha]_D$ +17°		Mallotus repandus W.H.Hui et al (1977), Phytochemistry 16, 113
32.	3α- hydroxy - 13α- H -28→ 12β-Ursanolide $C_{30}H_{48}O_3$ mp 319-21° $[\alpha]_D$ +9°		Mallotus repandus W.H.Hui et al (1977), Phytochemistry 16, 113
33.	3β-benzoyl-13α-H-28→12β-ursanolide mp 340-2° $[\alpha]_D$ +32°		Mallotus repandus W.H.Hui et al (1977), Phytochemistry 16, 113
34.	Machaerinic acid lactone		Acacia concinna pods. A.S.R. Anjaneyala et al (1977), Indian J.Chem.Soc.B.15(1) 1-6

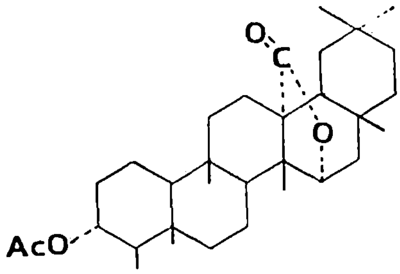
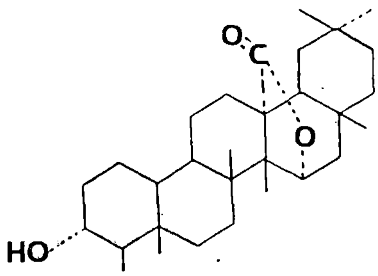
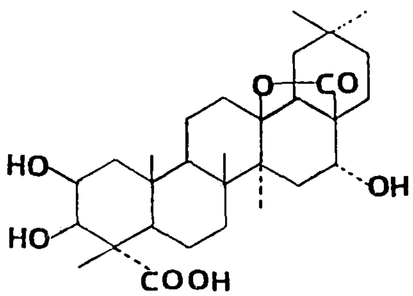
Sl. No.	Name and some physical data	Structure	Source and Reference
35.	Acacic acid lactone		*Acacia conicanna* pods. A.S.R. Anjeneyala et al (1977). *Indian J.Chem.Sec.B.* 15(1), 1-6
36.	Astrantagenin - G		*Astrantea major* S.Caccamese et al (1978). *Experientia*, 34(9) 1129-30
37.	3α,21α-dihydroxy-11,13(18)-Oleanan-28→22-olide $C_{30}H_{44}O_4$ mp 188-9°		Y.Ogihara et al (1978), *Chem. Comm.* 364
38.	Dihydromachaerinic acid lactone $C_{30}H_{48}O_3$		M.Tomoca et al (1978), *Farmatsiya* 28,31

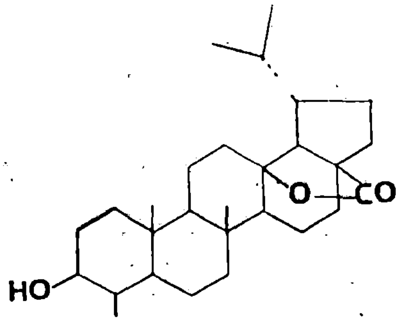
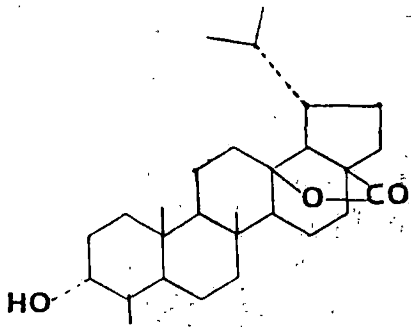
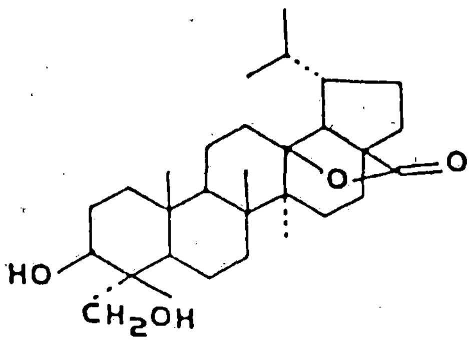
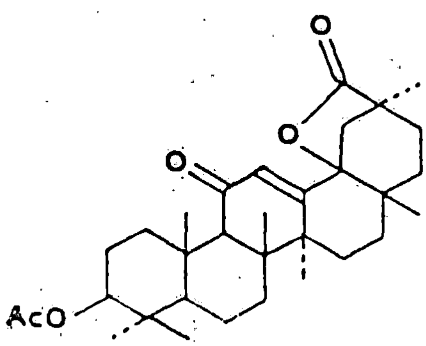
Sl. No.	Name and some physical date	Structure	Source and Reference
39.	3β-hydroxy-11-oleanan-28→15 -olide $C_{30}H_{46}O_3$	 	H.D.Woitke et al(1978) <u>Pharmazie</u>, 33, 541
40.	Acacic acid lactone 3β- acetate	 	<u>Acacia concinna</u>(pods) A.S.R.Anjeneyala et al (1979);<u>Phytochemistry</u> 18 (7) 1199-201
41.	18α, 24-dihydroxy -A(1) nor-lup-2, 20(29)-diens-27,28-dioic acid 28 methyl ester 27, 18α-lectone	 	<u>Emmemospermum pancherianum</u> (bark). G.V. Baddeley et al (1980); <u>Aust. J.Chem</u>. 33(9) 2071-86
42.	2β,23-Dihydroxy acacic acid lactone $C_{30}H_{48}O_6$ mp 189-92^0 $[\alpha]_D$ +16.2^0	 	<u>Gymnocladus dioica</u>(seed) R.M.Parkhurst et al (1980) <u>Phytochemistry</u> 19, 273

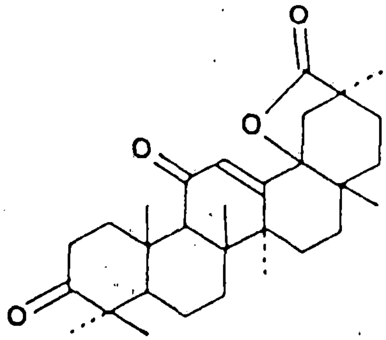
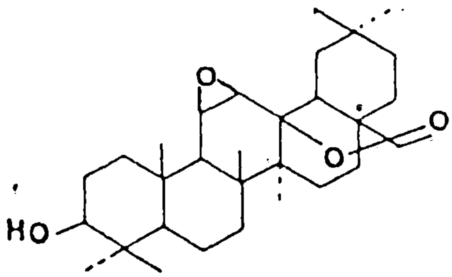
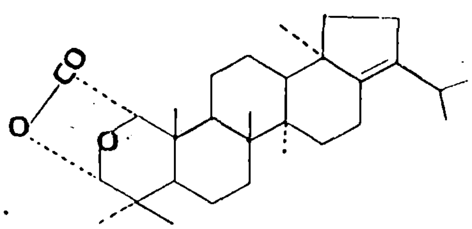
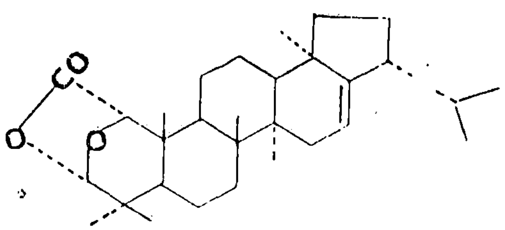
Sl. No.	Name and some physical data	Structure	Source and Reference
43.	Salviolide $C_{30}H_{48}O_3$		*Salvia mexicana* O.Collera et al (1980) *Rev. Latinoam.Quim.* 11(2) 60–2 M.Katai et al (1981), *Chem. Pharm.Bull.*29,261
44.	3β-acetoxy-16α-hydroxy-28→29-ursanolide $C_{32}H_{50}O_5$ mp 262–3		Do
45.	Thysanolactone		*Thysanospermum diffuxum champ.* ver. *longitubum ohwi*. A.Noris et al(1981), *Tetrahedron* 37(5), 983–5
46.	Nahagenin $C_{30}H_{48}O_4$ mp 290°		*Fagonia indica* Att-ur-Rahaman et al(1982), *Heterocycles*, 19 217

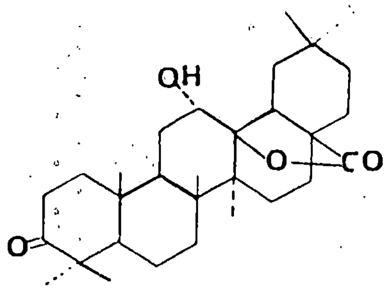
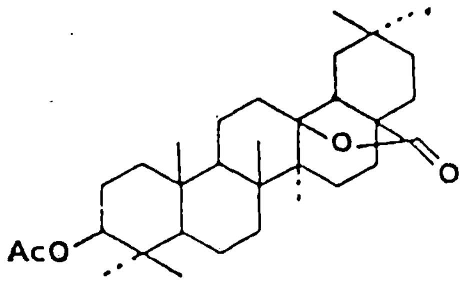
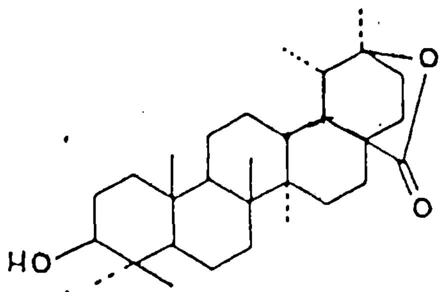
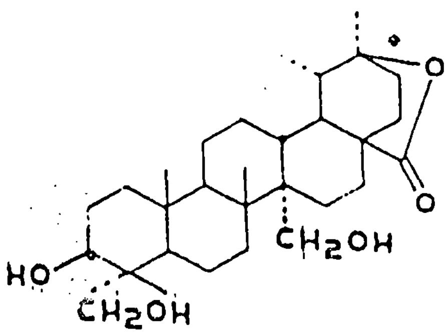
Sl. No.	Name and some physical date	Structure	Source and Reference
47.	Atroxigenic acid lactone $C_{30}H_{48}O_6$		Atroxime afzeliana. B. Badaely et al (1982). Bull.Soc. Chim.Belg. 91(4) 321-31
48.	Abruslactone A $C_{30}H_{46}O_3$ mp 329-30		Abrus precatorius (Roots & vines) M.H.Chang et al (1982). J.Chem. Soc.,Chem.Commun. (20), 1197-8
49.	Careyagenolide $C_{30}H_{48}O_4$ mp 299^{o}(d)		Careya arborea (leaves). S.B. Maheto et al (1982). Phyto-chemistry 21(8), 2069-73
50.	Wilforlide A $C_{30}H_{44}O_3$		Tripterygium wilfordii. G.Qui et al (1982) Haaxua Xuebao(40) 637

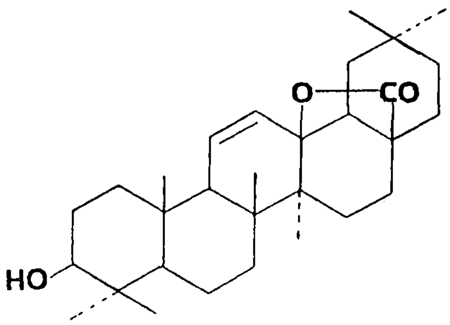
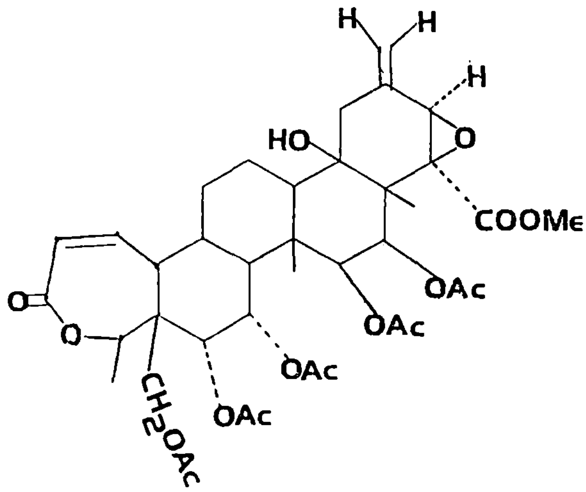
Sl. No.	Name and some physical data	Structure	Source and Reference
51.	17,24-Dihydroxy hopan-28,22-olide $C_{30}H_{48}O_4$ mp 258-65° [α]$_D$ 48.5° (Py)		*Diplazium subsinuatum* (Wall) Tagawa. N.Tanaka et al (1982). Chem.Pharm.Bull. 30, 3632
52.	Lupeolactone $C_{30}H_{46}O_2$ mp 186-91°		*Antidesma pentandrum* Merr. H Kikuchi et al (1983). Chem. Lett. 603
53.	24-nor-5 -methyl-lupeolactone		*Antidesma pentandrum.* (Chem. Abs.Nov.7,1983, Vol-99,Nov 19)
54.	Odolactone $C_{30}H_{46}O_3$ mp 304-5° [α]$_D$ -47.06°		*Gynocardia odorata*. B.P.Pradhan et al. Tet.Lett. (1984), Vol-25 No.6, 865-868 Indian J.Chem. 1990, Vol 29B, 797-799

Sl. No.	Name and some physical data	Structure	Source and Reference
55.	O-acetyl-odollactone $C_{32}H_{50}O_4$ mp 302-03 $[\alpha]_D$ -19^o		Gynocordia odorata. B.P. Pradhan et al Tetrahedron Letters(1984), Vol-25 No.8, 865-868; Indian.J. Chem. 1990,Vol 1298, 797-799
56.	Odollactone $C_{30}H_{48}O_3$ mp 303-4^o		Do
57.	Zanhic acid γ-lactone		Zanha golungensis and Genophyllum gigentum M.Z.Dimbi et al (1984), Bull.Soc. Chim.Belg. 93(4) 323-8

Sl. No.	Name and some physical data	Structure	Source and Reference
58.	Caltholide		Caltha palustris R.P.Rastogi et al(1984), Phytochemistry, 23(8),1699-702
59.	Epi-caltholide		Do
60.	Palustrolide $C_{30}H_{48}O_4$ mp 310^0(d)		Caltha palustris P.Bhandari et al (1984),Phytochemistry 23 2082
61.	Echilactone A $C_{32}H_{46}O_5$ mp 245^0		Echinopora lamallose (Marine coelanterate) R.Sandiya (1984) Chem.Commu. 1091

Sl. No.	Name and some physical data	Structure	Source and Reference
62.	Echilactone B $C_{30}H_{42}O_4$ mp 295		Echinapare lamellose (Marine coelenterete), R. Sandiya (1984) Chem.Commu., 1091
63.	3β-hydroxy-11,12-epoxy-28-13 -oleana-nolide		Lepechinia glomerata (aerial part) G.Delgado et al (1986), J.Chem. Res.Synop.(8), 286-7
64.	Swertia lactone C $C_{30}H_{46}O_3$ mp 308^o		Swertia petiolata K.L.Dhar et al (1987), Phytochemistry 26(12) 3363-64
65.	Swertia lactone D $C_{30}H_{46}O_3$ mp 304.5^o		Do

Sl. No.	Name and some physical data	Structure	Source and Reference
66.	12α-hydroxy-3-oxo-oleana-28→13 -olide		D.S.Errington (1987), Acta. crystallogr., Sect.D.Cryst. Structure.Commun. C(33)6, 1229-31
67.	3β-acetoxy-oleanan-28→13 -olide $C_{30}H_{48}O_3$ mp 282°		Salvia lanigera (leaves), Hassan M.G.Al-Hazimi et al (1987).Phytochemistry 26, 1091
68.	3β-hydroxy terexästen-28→20β-olide $C_{30}H_{48}O_3$ mp 294-7°		S.G.Errington et al (1988), Phytochemistry, 27, 543
69.	3β, 23,27-Trihydroxy teraxasten-28→20β-olide $C_{30}H_{48}O_5$ mp 330-2°		Do

Sl. No.	Name and some physical data	Structure	Source and Reference
70.	3β-hydroxy olean-11-en-28→13 -olide		*Hyptis albida* M.R.Pereda et al (1990), J.Nat. Prod., 53(1) 182-85
71.	6α, 7α, 15β, 16β, 24,-penta-acetoxy-22α-carbomethoxy-21β, 22β-epoxy - 18β-hydroxy - 27, 30- bis-nor- 3,4-seco friedela-1,20(29) dien-3,4R-olide		*Lophanthera lactescens* H.S.Abreu et al (1990), Phytochemistry, 29(7), 2257-61