Natural Product Reports

REVIEW

View Article Online
View Journal | View Issue

Check for updates

Cite this: *Nat. Prod. Rep.*, 2018, **35**, 1294

# Triterpenoids

Robert A. Hill * and Joseph D. Connolly

Covering 2014. Previous review: *Nat. Prod. Rep.*, 2017, **34**, 90–122

Received 29th March 2018

DOI: 10.1039/c8np00029h

rsc.li/npr

This review covers the isolation and structure determination of triterpenoids reported during 2014 including squalene derivatives, lanostanes, holostanes, cycloartanes, cucurbitanes, dammaranes, euphanes, tirucallanes, tetranortriterpenoids, quassinoids, lupanes, oleananes, friedelanes, ursanes, hopanes, serratanes, isomalabaricanes and saponins; 374 references are cited.





## 1. Introduction

The interest in the pharmacological activities of triterpenoids continues to be very important.[1] Several reviews have covered the anticancer effects of triterpenoids.[2–9] Other activities that have been highlighted include anti-HIV,[10–12] antiinflammatory,[13] antiviral[6] and against neurodegenerative disorders.[14] As many of the active compounds are saponins there has been an interest in their synthesis[15] and biosynthesis.[16] Reviews have also appeared covering triterpenoids found in *Astragalus* species,[17] *Gymnema sylvestre*,[18] *Panax* species,[19,20] *Sapindus* species[21] and *Siraitia grosvenorii*[22] and plants of the Schisandraceae.[23–25] Triterpenoid biosynthesis in plants[26] and the mechanisms of oxidosqualene cyclases[27] have also been covered.

## 2. The squalene group

Two interesting series of polyisoprenoid derivatives, terreolides A **1**–F **6** and saponaceolides H **7**–P **15**, have been reported from the previously unknown poisonous European mushroom *Tricholoma terreum*.[28] The known saponaceolide B **16** was also obtained. The structures of terreolides A **1** and D **4** and saponaceolide B **16** were confirmed by X-ray crystallographic analyses. A complex polyisoprenoid glycoside, from the fruit of *Lycium chinense*, has been assigned the putative structure **17**.[29]

*School of Chemistry, Glasgow University, Glasgow, UK G12 8QQ. E-mail: bob.hill@glasgow.ac.uk*

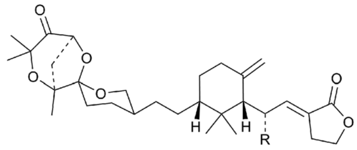
## 3. The lanostane group

The flow of *Ganoderma* lanostanes continues.[30] *Ganoderma boninense* is the source of ganoboninketals A **18**, B **19** and C **20**.[31] Fornicatins D **21**, E **22** and F **23** and ganodercochlearins A **24**, B **25** and C **26** are constituents of *Ganoderma cochlear*.[32] The structure of ganodercochlearin B **25** was confirmed by X-ray analysis of the corresponding diacetate. Cultures of *Ganoderma* sp. KM01 produced ganodermalactones B **27**, D **28** and E **29**.[33] The structure of ganodermalactone B **27** was confirmed by X-ray analysis and was shown to have the same structure as the previously reported colossolactone C, from *Ganoderma colossum*,[34] however the pmr and cmr spectra for rings A and B are not in agreement.

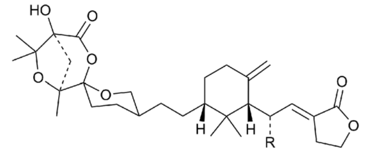
Other *Ganoderma* lanostanes include ganoderic acids $XL_1$ **30** and $XL_2$ **31**, 20-hydroxyganoderic acid $AM_1$ **32**, ganoderenic acid $AM_1$ **33** and ganoderesin C **34** from *Ganoderma theaecolum*,[35] methyl lucidenate B **35** (ref. 36) and the butyl esters **36** and **37** (ref. 37) from the fruiting bodies of *Ganoderma lucidum* and the norlanostane **38** from the fruiting bodies of *Ganoderma tropicum*.[38] The biological and pharmacological activities of ganoderic acid and lucidenic acid have been covered in a review.[39]

The mushroom *Inonotus obliquus* is a rich source of the 21,24-cyclolanostanes inonotusols A **39**–E **43**.[40] They are accompanied by inonotusols F **44** and G **45**. Inonotusols B **40**, D **42** and E **43** have unusual configurations at C17 and inonotusol F **44** has an unusual configuration at C20 and methylation at C24. Further C24-methylated metabolites of *Inonotus obliquus* include inotolactones A **46** and B **47**.[41] Hexatenuins A **48**, B **49**

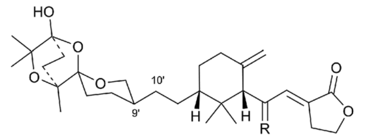
 



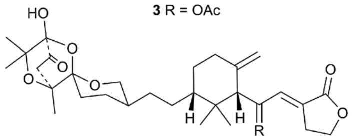
**1** R = OH
**2** R = H
**3** R = OAc



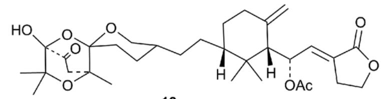
**4** R = H
**5** R = OH
**6** R = OAc



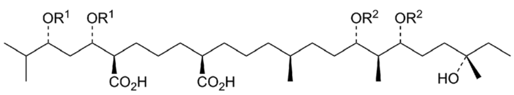
**7** R = αOH, H
**8** R = αOAc, H
**9** R = $H_2$; $\Delta^{9'}E$
**10** R = αOAc, H; $\Delta^{9'}E$
**14** R = O
**16** R = $H_2$



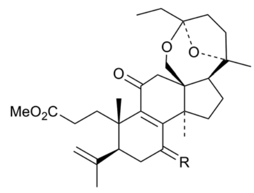
**11** R = αOH, H
**12** R = αOAc, H
**15** R = O



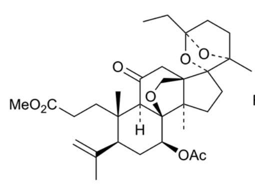
**13**



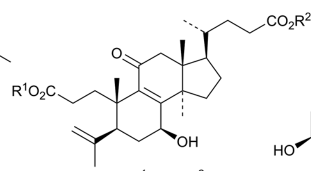
**17** $R^1$ = Glc*p*-(1->6)-Glc*p*-(1->6)-Glc*f*; $R^2$ = Glc*p*-(1->6)-Glc*p*-(1->6)-Glc*p*



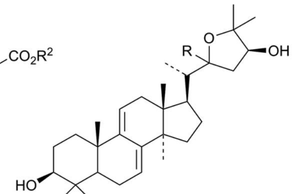
**18** R = βOAc, H
**19** R = O



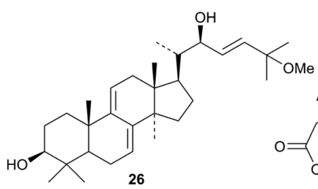
**20**



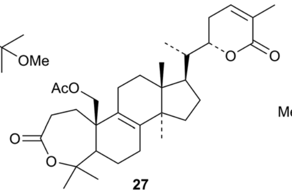
**21** $R^1$ =Me; $R^2$ = H
**22** $R^1$ =H; $R^2$ = Me
**23** $R^1$ = $R^2$ = Me



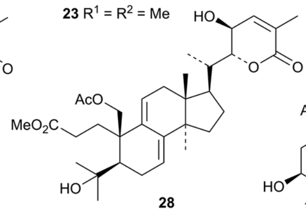
**24** R = βH
**25** R = αH



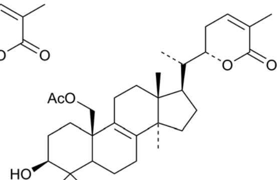
**26**



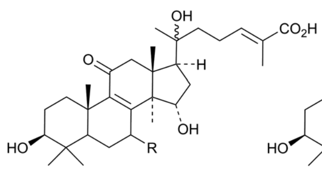
**27**



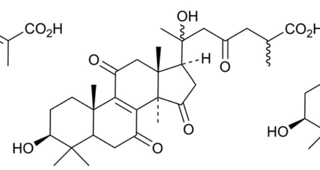
**28**



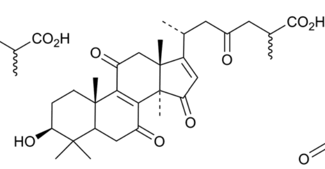
**29**



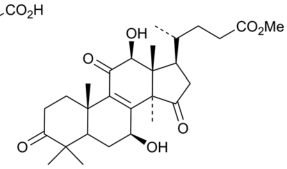
**30** R = βOH
**31** R = αOH



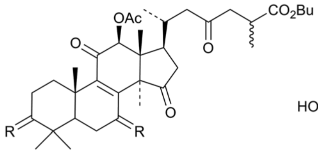
**32**



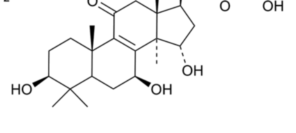
**33** $\Delta^{17(20)}$
**34**



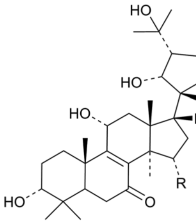
**35**



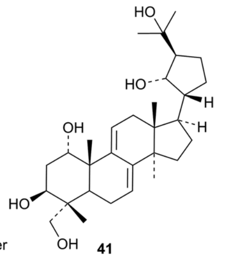
**36** R = βOH, H
**37** R = O



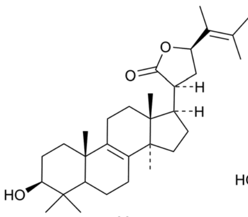
**38**



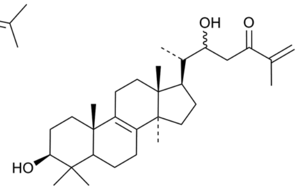
**39** R = OH; 17,24-diepimer
**40** R = OH
**43** R = H



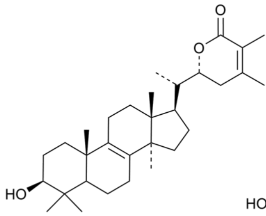
**41**
**42** 17,24-diepimer



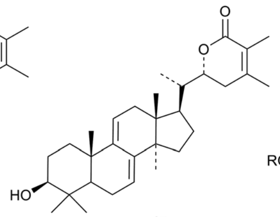
**44**



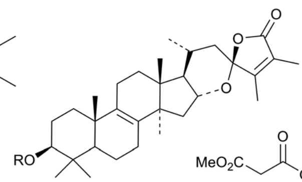
**45**



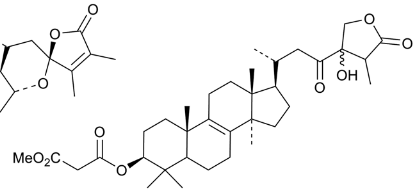
**46**



**47**



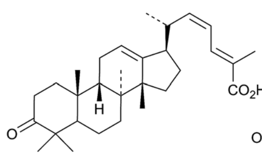
**48** R = malonyl
**49** R = H; 7,11-didehydro



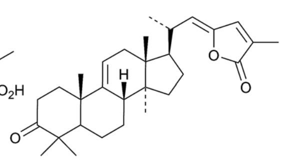
**50**

and C **50**, from the fruiting body of *Hexagonia tenuis*, also have an extra carbon at C-24.[42]

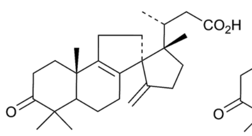
The protostane **51**, from the bark of *Garcinia ferrea*, is accompanied by the lanostanes garciferolides A **52** and B **53**.[43] Two rearranged lanostanes **54** and **55** have been isolated from *Abies nukiangensis* together with compounds **56–59**.[44] The structures of **54** and the known **60** were confirmed by X-ray analyses. 3-*O*-Methylabiesatrine A **61** is a rearranged lanostane from *Abies delavayi*.[45]



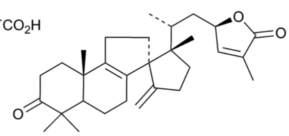
**51**



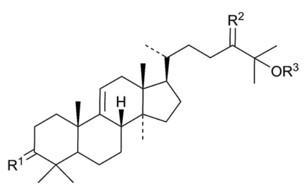
**52**
**53** 22*E*-isomer



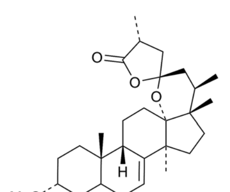
**54**



**55**



**56** $R^1$ = αOMe, H; $R^2$ = αOH, H; $R^3$ = H
**57** $R^1$ = αOH, H; $R^2$ = O; $R^3$ = H
**58** $R^1$ = βOAc, H; $R^2$ = αOH, H; $R^3$ = H
**59** $R^1$ = βOH, H; $R^2$ = αOH, H; $R^3$ = Et
**60** $R^1$ = O; $R^2$ = αOH, H; $R^2$ = H



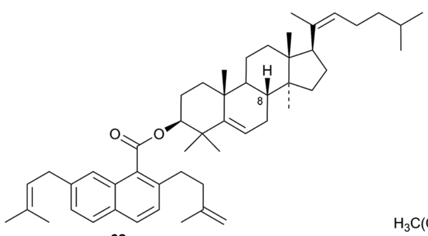
**61**

Two naphthalene esters, lanostenyl naphthoates A **62** and B **63** have been reported from the rhizomes of *Acorus calamus*.[46] The related compounds **64–66** are found in the bark of *Ficus religiosa*.[47] The mariesane derivative opaciniol B **67** and the lanostane opaciniol C **68** are constituents of *Garcinia opaca*.[48] Opaciniol B **67** is the same as garcihombronane K isolated from *Garcinia hombroniana* in 2013.[49] The rearranged lanostane **69** has been isolated from *Garcinia hombroniana*.[50]

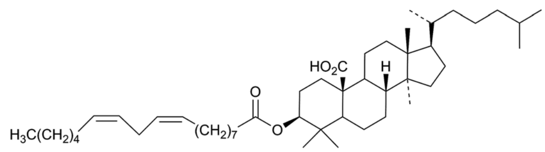
Other lanostanes include manglanostenoic acids A **70**–D **73** from *Mangifera indica* var. Fazli,[51] myrrhalanostenyl acetate **74**, myrrhalanostenol **75**, and myrrhalanostenoic acid **76** from the oleoresin of *Commiphora myrrha*,[52] 3β-hydroxylanosta-9(11),24-dien-21-oic acid **77** and its methyl ester **78** from *Protorhus longifolia*,[53,54] the norlanostane **79** from *Euphorbia bupleuroides*,[55] the ester **80** from the fruit of *Cuminum cyminum*,[56] kiusianin A **81** from *Tilia kiusiana*[57] and methyl ether **82** from *Cymbopogon citratus*.[58] Compounds **83** and **84**, from the branches and leaves of *Polyalthia obliquei*, were originally thought to be tirucallane derivatives but are now considered to be lanostanes.[59,60] Lanostane saponins with known genins have been isolated from *Cuminum cyminum*[56] and *Panax ginseng*.[61,62]

Investigations of several sea cucumbers have resulted in the identification of more holostane saponins, some with interesting pharmacological activities.[63,64] Cladolosides $A_1$–$A_6$, from Vietnamese *Cladolabes schmeltzii*, have the new genins **85–89**.[65] Coustesides A–J are new saponins from *Bohadschia cousteaui*.[66] Coustesides B and G have the new genin **90** and C and D the new genins **91** and **92**, respectively. All the others have known genins.

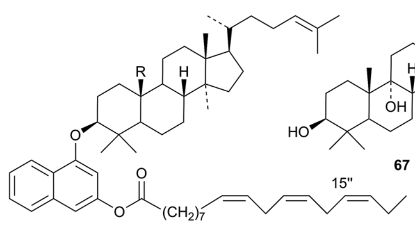
Variegatusides C–F have been isolated from *Stichopus variegates*.[67] Only variegatuside C has a new genin **93**. Holothurins D and E, with the new genin **94** and holothurinoside X, with the new genin **95**, are constituents of *Holothuria lessoni* together



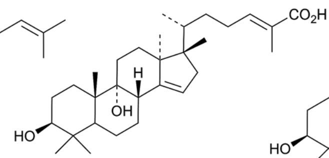
**62**
**63** 8,9-didehydro; 20*R*,22-dihydro



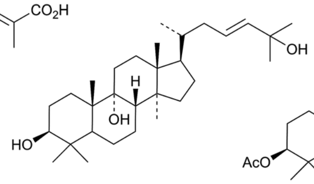
**64**



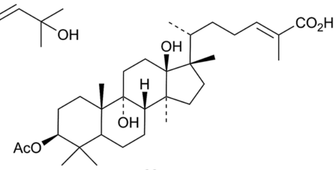
**65** R = $CH_3$; 15″,16″-dihydro
**66** R = $CO_2H$; 24,25-dihydro



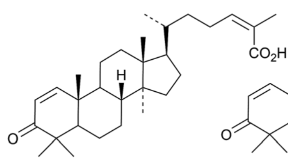
**67**



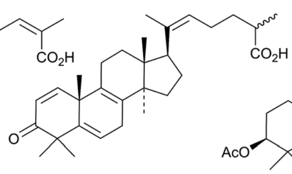
**68**



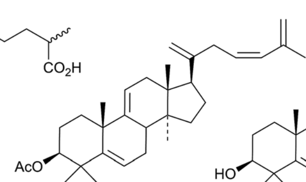
**69**



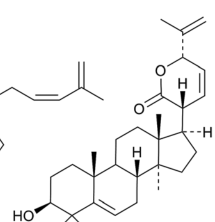
**70**
**73** 5,6-didehydro



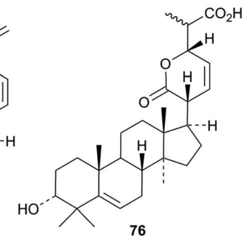
**71**
**72** 5α,6-dihydro; $\Delta^7$-isomer



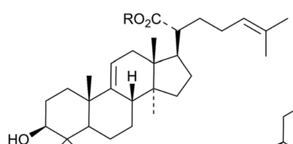
**74**



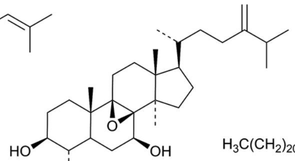
**75**



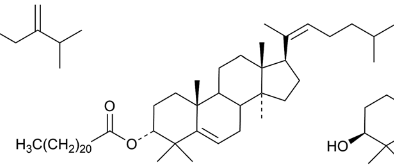
**76**



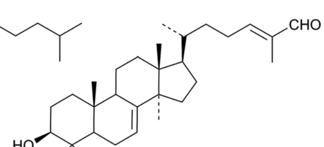
**77** R = H
**78** R = Me



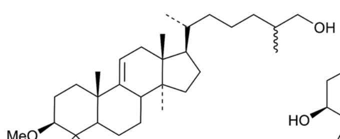
**79**



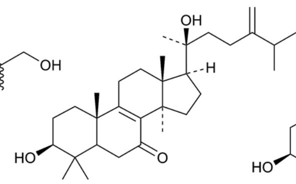
**80**



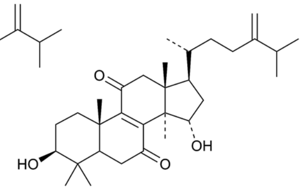
**81**



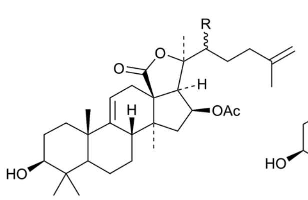
**82**



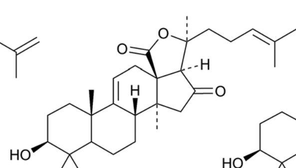
**83**



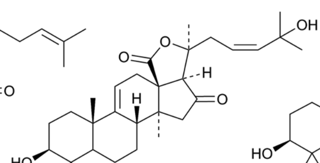
**84**



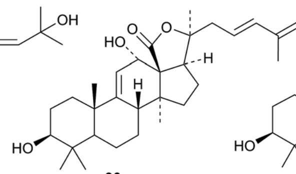
**85** R = OAc; 25,26-dihydro
**86** R = OAc
**87** R = H



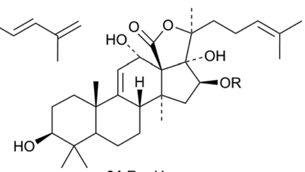
**88**



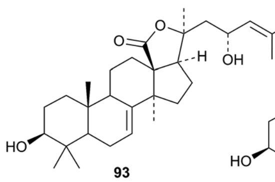
**89**

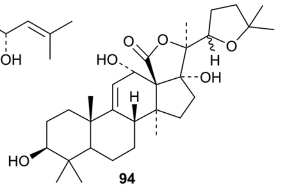


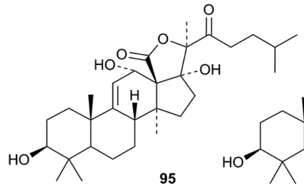
**90**

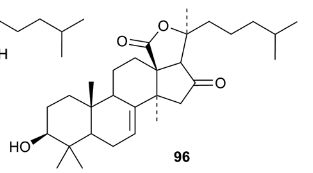


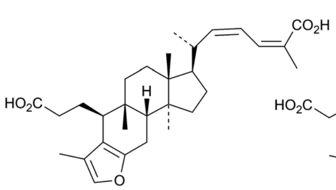
**91** R = H
**92** R = Ac

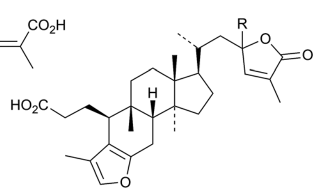

93

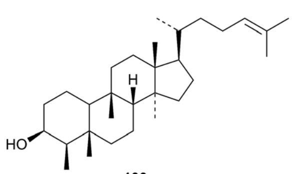

94


95


96


97


98 R = βH
99 R = αH


100

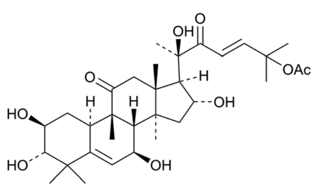
with holothurinosides Y and Z with known genins.[68] The new genin **96** has been reported for pseudocnoside A from *Pseudocnus dubiosus leoninus*.[69] Holostane saponins with known genins include cucumariosides $F_1$ and $F_2$ from *Eupentacta fraudatrix*,[70] kolgaosides A and B from *Kolga hyalina*,[71] stichloroside F from *Stichopus chloronotus*[72] and violaceusosides C, D, E and G from *Pseudocolochirus violaceus*.[73]

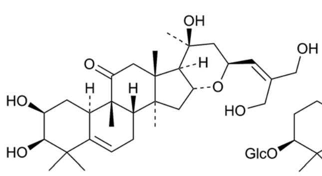
Cucurbitane triterpenoids of mushroom origin have been covered in a review.[74] Three interesting furanoid cucurbitane derivatives, roseic acid **97** and roseolactones A **98** and B **99**, have been isolated from *Russula aurora* and *Russula minutula*.[75] *Empetrun nigrum* var. *japonicum* is the source of the migrated cucurbitane nigrum-24-en-3β-ol **100**.[76]

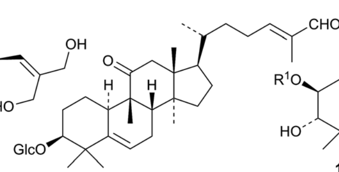
New cucurbitane derivatives isolated from *Hemsleya* species include **101** and **102** from *Hemsleya amabilis*[77] and hemslepenside A **103**, 16,25-di-*O*-acetylcucurbitacin F 2-*O*-β-D-glucopyranoside **104** and 16-*O*-acetylcucurbitacin F **105** from *Hemsleya penxianensis*.[78] New cucurbitanes are still being found in the various parts of *Momordica charantia*.[79] The fruit is the source of kuguacins T **106**–W **109** (ref. 80) and charantosides D **110**–G **113**.[81] The structure of kuguacin W **109** was confirmed by X-ray analysis.

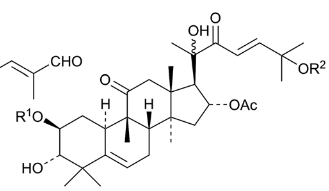
The leaves and stem yielded karavilagenin F **114**, karavilosides XII **115** and XIII **116** and momordicines VI **117**, VII **118** and VIII **119**.[82] A separate investigation of the leaves led to the isolation of compounds **120** and **121**.[83] Two new glycosides were reported from the seeds, one with the new genin **122**.[84]

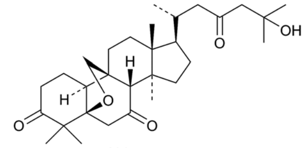
Kinoin D **123** is an octanorcucurbitane derivative from the roots of *Ibervillea sonorae*.[85] Minor cucurbitane glycosides from *Siraitia grosvenorii* include 11-deoxymogrosides V and VI and 11-deoxyisomogroside V, all with known genins.[86] 23,24-Dihydrocucurbitacin C **124** is a new compound from *Cucumus sativus*.[87] The unlikely stereochemistry of **125** has been proposed for a compound from the leaves and twigs of *Euonymus alatus*.[88]

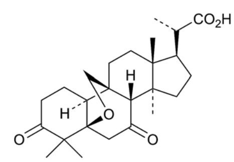

101

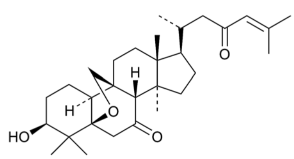

102

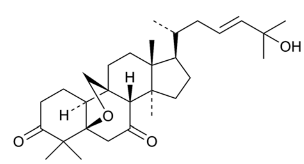

103

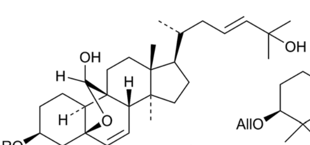

104 $R^1 = R^2 = H$
105 $R^1$ = β-*D*-Glc; $R^2$ = Ac

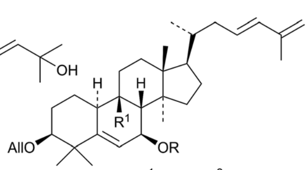

106

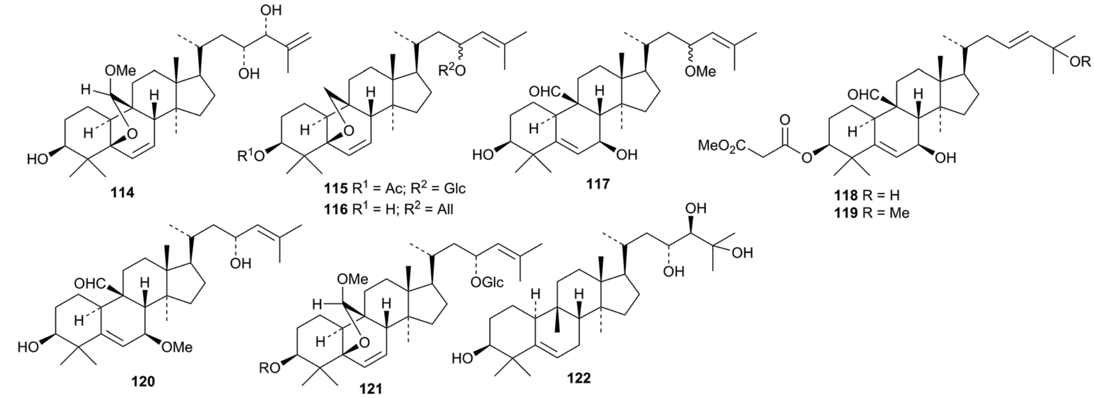

107


108

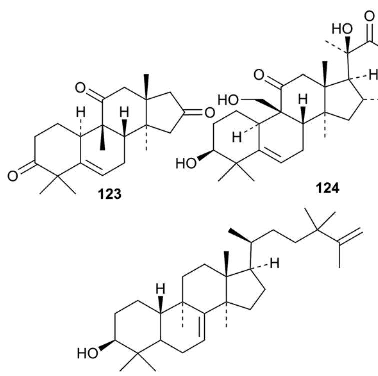

109


110 R = Glc
111 R = All


112 $R^1 = CH_3$; $R^2$ = Me
113 $R^1$ = CHO; $R^2$ = H



114; 115 $R^1$ = Ac; $R^2$ = Glc; 116 $R^1$ = H; $R^2$ = All; 117; 118 R = H; 119 R = Me; 120; 121; 122

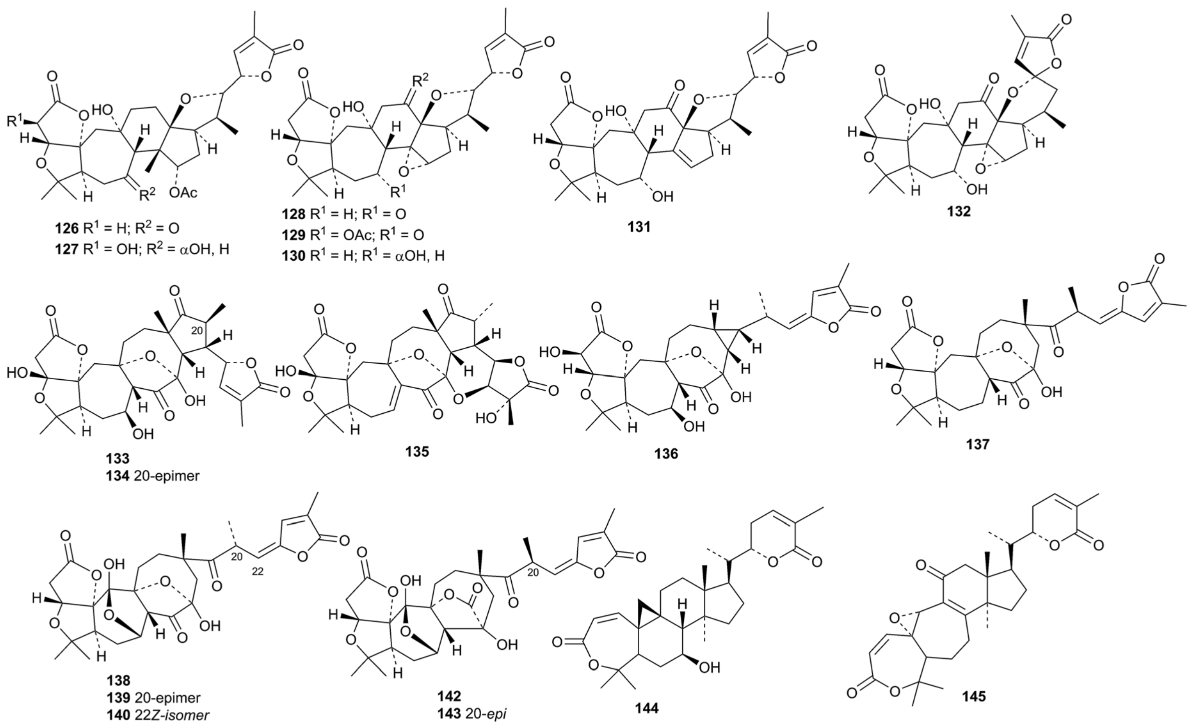


123; 124; 125

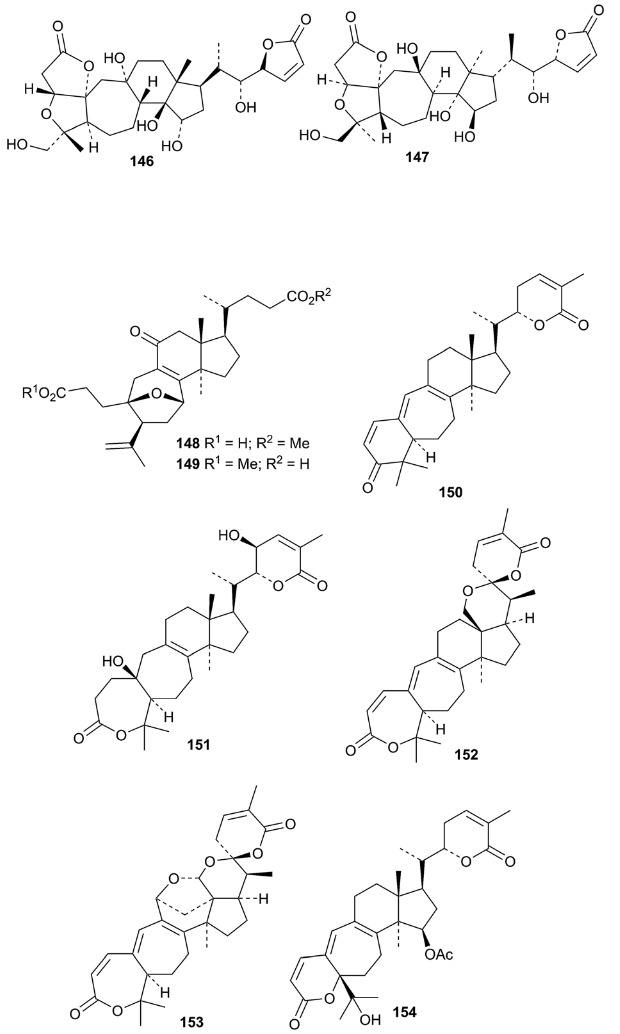
An impressive list of new compounds from *Schisandra chinensis* includes wuweizidilactones J **126**–P **132**, schindilactones I **133**, J **134** and K **135**, preschisanartanin N **136** and schisdilactone J **137**.[89] Lancifonins A **138**–F **143** are new compounds from *Schisandra lancifolia*.[90] *Schisandra sphenanthera* is the source of schisphendilactones A **144** and B **145**.[91] The structures of lancifonin A **138** and schisphendilactone A **144** were confirmed by X-ray analyses.

Other new compounds include heteroclitalactone N **146** from the stems of *Kadsura heteroclitus*[92] and micrandiactone H **147** from *Kadsura coccinea*.[93] The reported stereochemistry for micrandiactone H **147** is unusual and probably requires revision. The name of **147** should be changed to micrandilactone H in line with other compounds in the series.

Cochlates A **148** and B **149** are cleaved cycloartane derivatives from *Ganoderma cochlear*.[32] The structure of cochlate B **149** was confirmed by X-ray analysis. Cultures of *Ganoderma* sp. KM01 produce further cleaved derivatives ganodermalactones A **150**, C **151**, F **152** and G **153**.[33] The structures of ganodermalactones F **152** and G **153** were confirmed by X-ray analyses. The revised structure **154** has been assigned to colossolactone G, a further metabolite of these cultures.



126 $R^1$ = H; $R^2$ = O; 127 $R^1$ = OH; $R^2$ = αOH, H; 128 $R^1$ = H; $R^1$ = O; 129 $R^1$ = OAc; $R^1$ = O; 130 $R^1$ = H; $R^1$ = αOH, H; 131; 132; 133; 134 20-epimer; 135; 136; 137; 138; 139 20-epimer; 140 22*Z-isomer*; 141 22*Z*-isomer; 20-epimer; 142; 143 20-*epi*; 144; 145



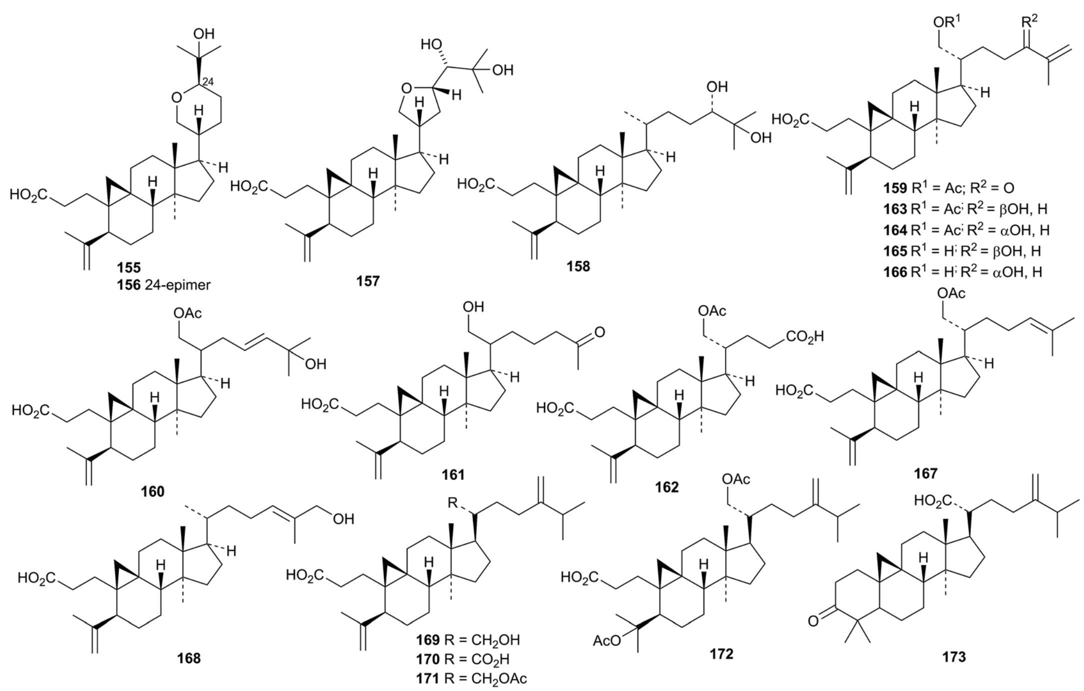

An impressive number of side-chain variations is to be found in the 3,4-secocycloartanes lithocarpic acids A **155**–N **168** from *Lithocarpus polystachyus*.[94] Lithocarpic acids O **169**–S **173** are further examples from the same source.[95] The structure of lithocarpic acid A **155** was confirmed by X-ray analysis.

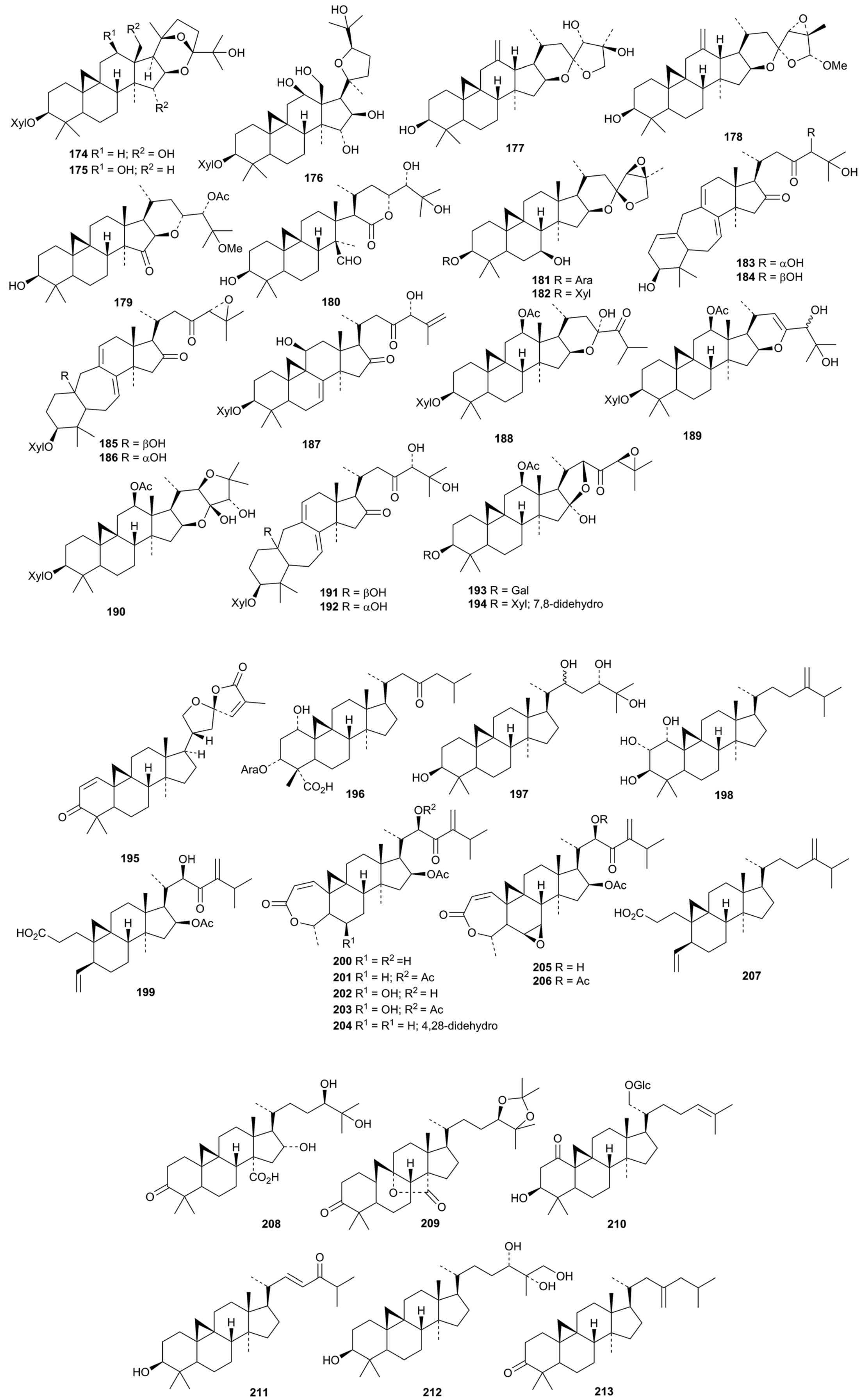
The three cycloartane xylosides **174–176**, from *Beesia calthaefolia*, all have new genins.[96] New compounds from *Cimicifuga* species include the rearranged cycloartanes yunnanterpene G **177** and 12,18-didehydro-26-methoxyacetol **178**, isodahurinol 24-acetate 25-methyl ether **179**, 15,16-secoshengmanol C **180** and the glycosides **181** and **182** from the aerial parts of *Cimicifuga yunnanensis*,[97] cimifoetidanols A **183**–H **190** and cimifoetidanosides A **191** and B **192** from the rhizomes of *Cimicifuga foetida*[98] and glycosides **193** and **194** from the roots of *Cimicifuga simplex*.[99] The structure of cimifoetidanol A **183** was confirmed by X-ray analysis.

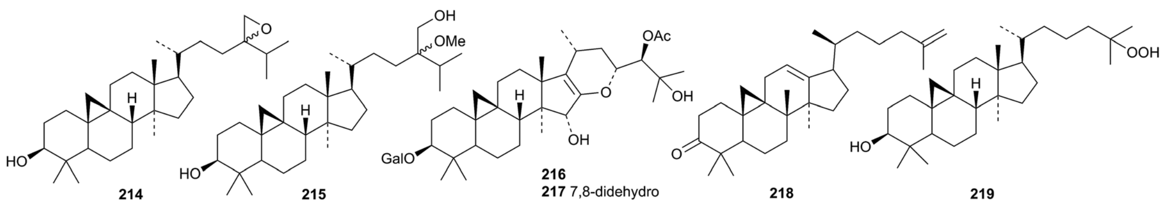
Two new cycloartanes **195** and **196** have been found in *Kleinhovia hospita*.[100] The arabinoside **196** has a new genin. Two new glycosides, one with the new genin **197**, have been reported from *Landoltia punctata*.[101] Neomacrotriol **198** and the 29-norcycloartanes neomacroin **199**, neomacrolactone **200** and related compounds **201–206** have been isolated from *Neoboutonia macrocalyx*.[102] The related 29-nor-derivative **207** has been found in *Cinnamosma fragrans*.[103]

Other new cycloartanes include caloncobic acid C **208** and caloncobalactone C **209** from the leaves of *Caloncoba glauca*,[104] the glucoside rhizostyloside **210**, with a new genin, from *Rhizophora stylosa*,[105] compound **211** from *Cassia italica*,[106] and the tetrol **212** from the leaves and twigs of *Walsura yunnanensis*.[107] The unusual 23-methylene structure **213** has been proposed for a constituent of *Piper thomsonii*.[108]

Compounds **214** and **215** have been isolated as mixtures of 24-epimers from *Euphorbia fischeriana*.[109] Two glycosides **216** and **217** from the roots of *Cimicifuga simplex* are described as




174 R1 = H; R2 = OH
175 R1 = OH; R2 = H
176
177
178
179
180
181 R = Ara
182 R = Xyl
183 R = αOH
184 R = βOH
185 R = βOH
186 R = αOH
187
188
189
190
191 R = βOH
192 R = αOH
193 R = Gal
194 R = Xyl; 7,8-didehydro
195
196
197
198
199
200 R1 = R2 =H
201 R1 = H; R2 = Ac
202 R1 = OH; R2 = H
203 R1 = OH; R2 = Ac
204 R1 = R1 = H; 4,28-didehydro
205 R = H
206 R = Ac
207
208
209
210
211
212
213




galactopyranosides but drawn as furanosides.[99] Cycloarta-12,25-dien-3β-ol has been claimed as a constituent of Cameroonian brown propolis but the structure drawn is actually the 9(19)-cyclodammarane **218**.[110] 25-Hydroperoxycycloartanol **219** is a constituent of *Euphorbia bupleuroides*.[55]

Cycloartane saponins with known genins include krugianoside A from *Astragalus plumosus* var. *krugianus*[111] and riparsaponin from *Homonoia riparia*[112] and saponins from *Beesia calthaefolia*,[113] *Cimicifuga foetida*[114] and *Euphorbia boissierana*.[115]

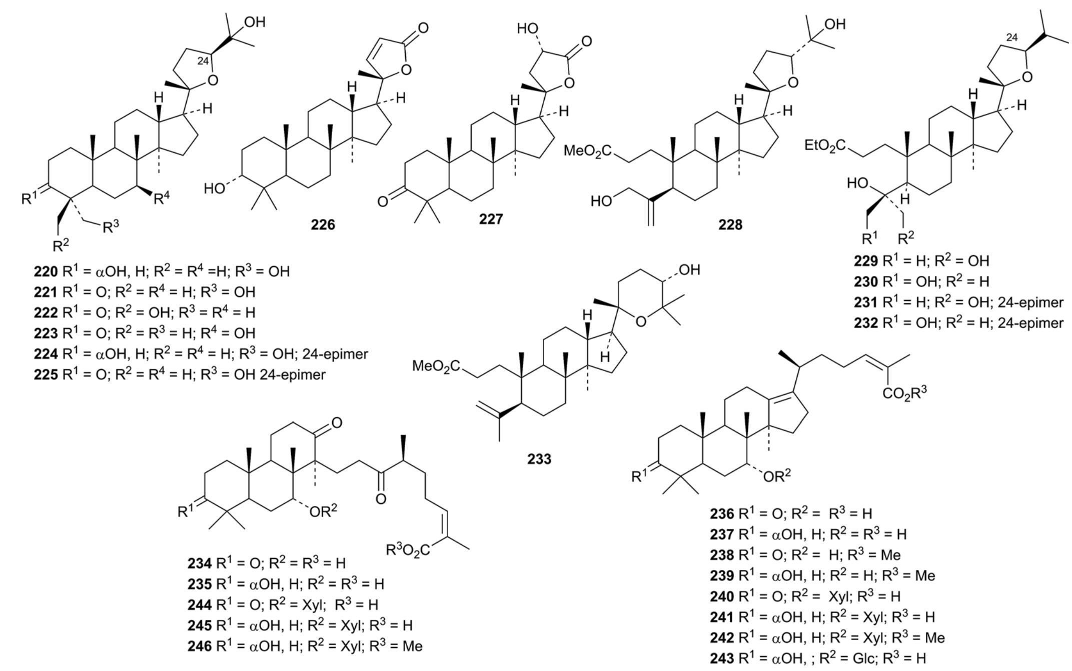
## 4. The dammarane group

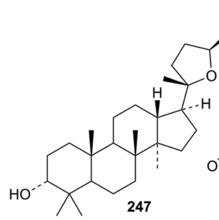
An interesting group of new dammaranes **220–233** has been reported from the stems of *Dysoxylum binecteriferum*.[116] Several 13,17-secodammaranes are among the 20-epi-derivatives dysotriflorins A **234**–M **246** from *Dysoxylum densiflorum*.[117] The structure of dysotriflorin I **242** was confirmed by X-ray analysis.

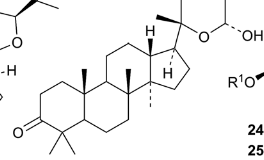
Dysomollisol **247** and dysomollisone **248** are constituents of the fruit of *Dysoxylum mollissimum*.[118] Dysomollisone **248** has been assigned an unusual rearranged side-chain. The octanor-derivative rosanol A **249** has been found in the roots of *Rosa rugosa*.[119] Horipenoids A **250**–H **257**, from *Homonoia riparia*, include several other octanor-derivatives.[120] The structure of horipenoid E **254** was confirmed by X-ray analysis. Thirteen new dammarane saponins have been isolated from *Gentianella azurea* including the glucosides **258–260** whose structures were confirmed by X-ray analyses.[121] Glucosides **258–260** have new genins. Further new genins **261–265** are found in the new dammarane saponins. The known gentirigenic acid and gentirigeoside A were also obtained from *Gentianella azurea* and their structures have been revised to **266** and **267**, respectively, on the basis of X-ray analyses. The genins of the known gentirigeosides B and E were also revised to **268** and **269**, respectively.

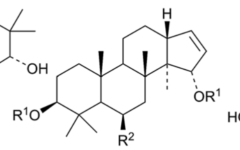
Phlomisumbrosides A and B are new glycosides from *Phlomis umbrosa* with the new genins **270** and **271**.[122] The 27-nordammarane **272** and the glucoside **273**, with a known genin, are further constituents of the leaves of *Panax ginseng*.[123] The three 3,12-diketones **274–276** were obtained from the same source.[124] The epoxydammaranetetrol **277** has been isolated from the stems and leaves of American ginseng and given the erroneous name 3α-ocotillol (ocotillol is an epoxydammaranediol).[125]

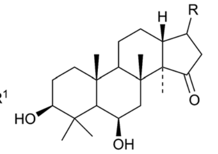
New compounds from *Gynostemma pentaphyllum* include two saponins with new genins **278** and **279**,[126] the saponins damulins C and D with the new genins **280** and **281** (ref. 127)

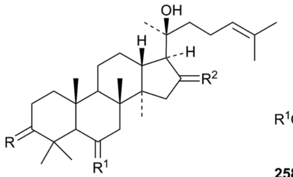


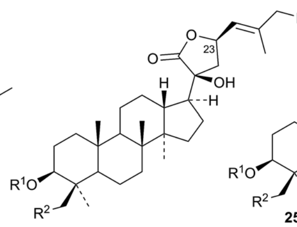

247

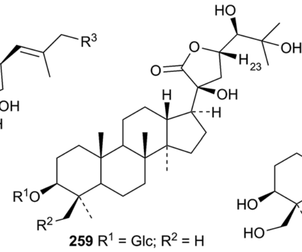

248

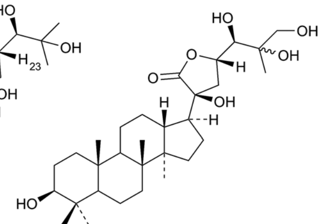

**249** $R^1 = R^2 = H$
**252** $R^1 = H$; $R^2 = OH$
**253** $R^1 = Ac$; $R^2 = OH$

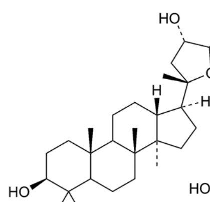

**250** R = αOH
**251** R = βOH

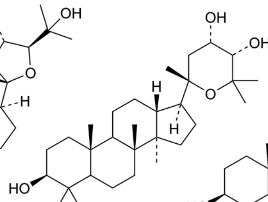

**254** $R^1 = R^3 =$ βOH, H; $R^2 =$ αOH, H
**255** $R^1 = O$; $R^2 =$ αOH, H; $R^2 =$ βOH, H
**256** $R^1 = R^3 =$ βOH, H; $R^2 = O$
**257** $R^1 =$ βOH, H; $R^2 =$ αOH, H; $R^3 = O$

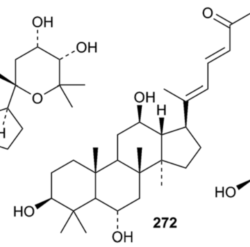

**258** $R^1 = Glc$; $R^2 = OH$; $R^3 = H$
**261** $R^1 = R^3 = H$; $R^2 = OH$; 23-epimer
**262** $R^1 = H$; $R^2 = R^3 = OH$
**263** $R^1 = R^2 = R^3 = H$
**264** $R^1 = R^2 = R^3 = H$; 23-epimer

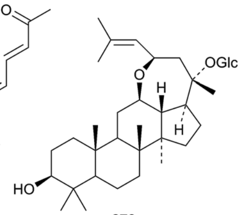

**259** $R^1 = Glc$; $R^2 = H$
**260** $R^1 = Glc$; $R^2 = OH$; 23-epimer
**265** $R^1 = H$; $R^2 = OH$
**266** $R^1 = R^2 = OH$
**267** $R^1 = Glc$; $R^2 = OH$
**269** $R^1 = R^2 = H$

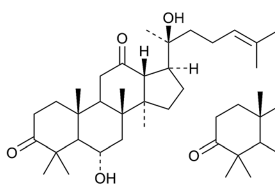

268

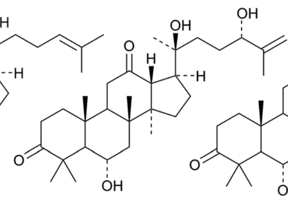

270

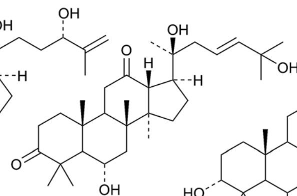

271

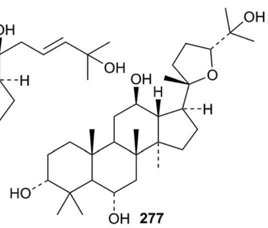

272

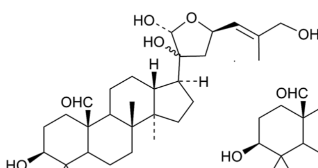

273

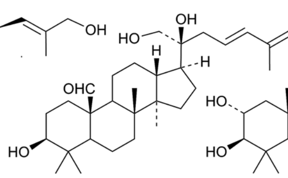

274

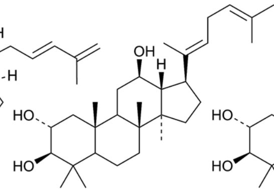

275

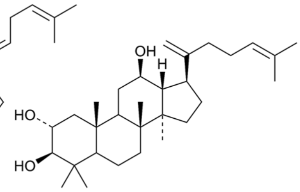

276

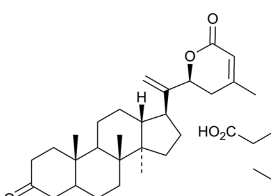

277

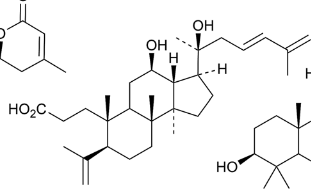

278

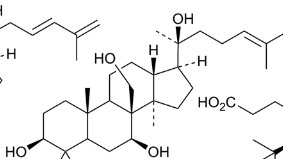

279

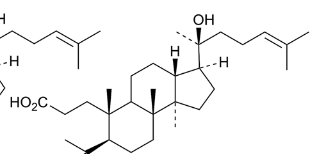

280

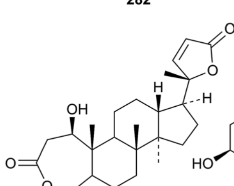

281

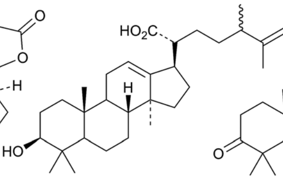

282

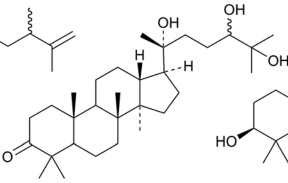

283

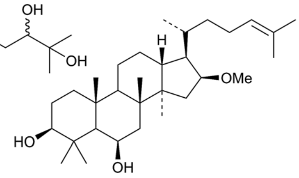

284


285


286

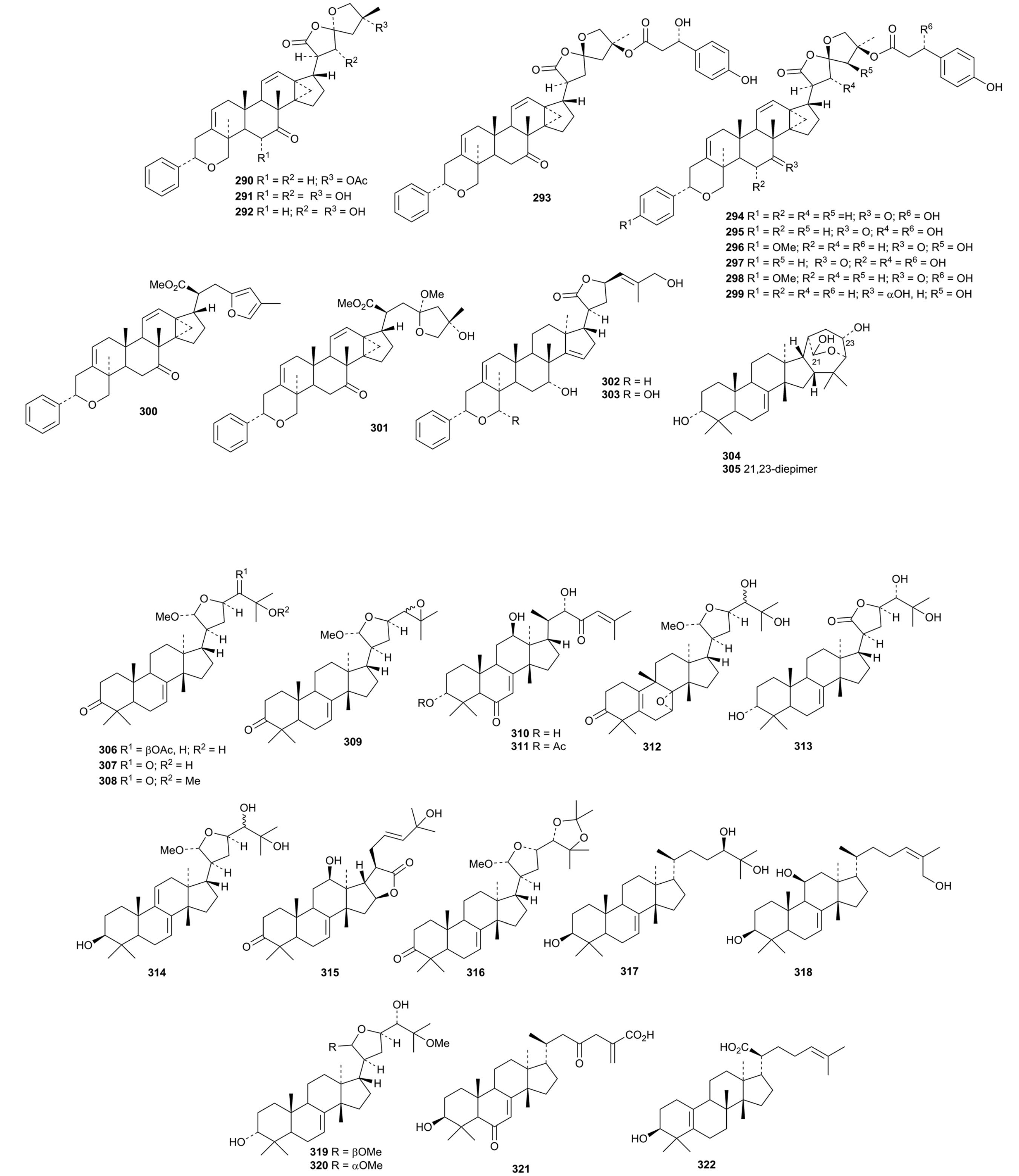

287


288

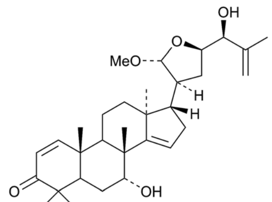

289

and the keto-lactone **282**.[128] Cyclocarioside K, from *Cyclocarya paliurus*,[129] and tubeimoside C, from *Bolbostemma paniculatum*,[130] also have new genins, **283** and **284**, respectively. Other new dammaranes include the ring A-cleaved derivative **285** from *Aglaia abbreviata*,[131] deacetybrachycarpon-22-ene **286** from *Cleome arabica*,[132] the 30-nor-24-methyl derivative floccosic acid **287** from *Nepeta floccosa*,[133] the keto-triol **288** from the root bark of *Ailanthus altissima*[134] and farmanol **289** from *Nepeta suavis*.[135]

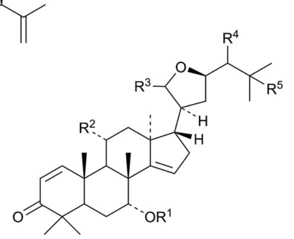
New dammarane saponins with known genins include cyclocarioside J from *Cyclocarya paliurus*,[136] jujubosides D and E (duplicate names) from *Ziziphus jujuba*,[137] notoginsenosides FZ,



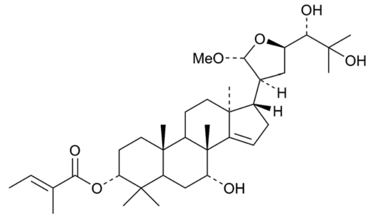

 



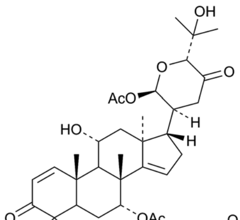

**323**



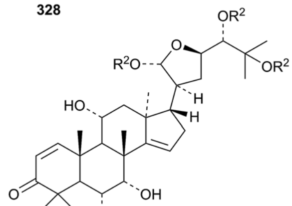

**324** R$^1$ = Ac; R$^2$ = H; R$^3$ = αOMe; R$^4$ = βOH; R$^5$ = OH
**325** R$^1$ = R$^2$ = H; R$^3$ = αOMe; R$^4$ = αOAc; R$^5$ = OH
**326** R$^1$ = R$^2$ = H; R$^3$ = αOMe; R$^4$ = βOH; R$^5$ = OMe
**327** R$^1$ = H; R$^2$ = OAc; R$^3$ = αOMe; R$^4$ = αOH; R$^5$ = OMe
**329** R$^1$ =Ac; R$^2$ = H; R$^3$ = βOMe; R$^4$ = αOH; R$^5$ = OH



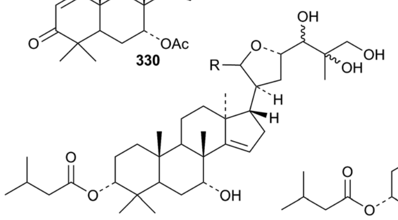

**328**



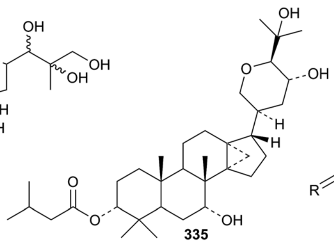

**330**



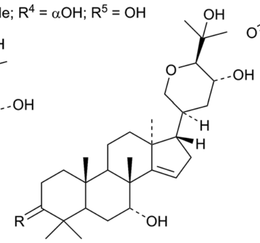

**331** R$^1$ = OH; R$^2$ = Ac
**332** R$^1$ = R$^2$ = H



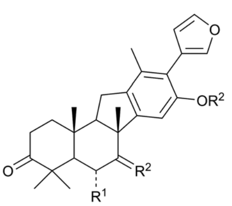

**333** R = βOMe
**334** R = αOMe



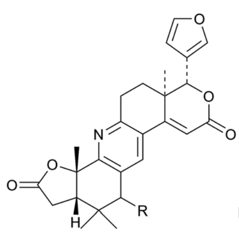

**335**



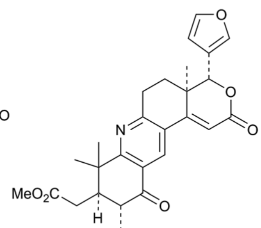

**336** R = O
**337** R = Otigloyl, H



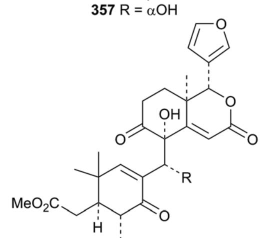

**338** R$^1$ = H; R$^2$ = αOH, H; R$^3$ = Me
**339** R$^1$ = H; R$^2$ = O; R$^3$ = Me
**340** R$^1$ = H; R$^2$ = αOAc, H; R$^3$ = Me
**341** R$^1$ = R$^3$ = H; R$^2$ = αOAc, H
**342** R$^1$ = OH; R$^2$ = αOAc, H; R$^3$ = Me
**343** R$^1$ = OH; R$^2$ = αOAc, H; R$^3$ = H
**344** R$^1$ = OH; R$^2$ = αOAc, H; R$^3$ = Me; 1,2-didehydro
**345** R$^1$ = OAc; R$^2$ = αOH, H; R$^3$ = Me; 1,2-didehydro
**346** R$^1$ = OH; R$^2$ = αOAc, H; R$^3$ = H; 1,2-didehydro



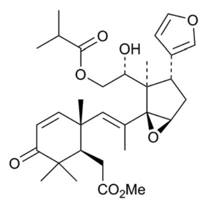

**354** R = βOMe
**357** R = αOH



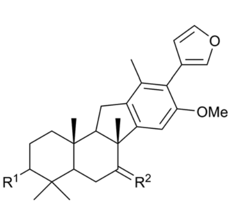

**355**



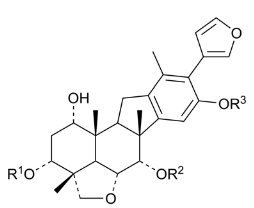

**356** R = H
**358** R = OAc




**359**




**347** R$^1$ = αOH; R$^2$ = αOH, H
**348** R$^1$ = βOH; R$^2$ = αOH, H
**349** R$^1$ = βOH; R$^2$ = O




**350** R$^1$ = 2-methylbutanoyl; R$^2$ = H; R$^3$ = Me
**351** R$^1$ = 2-methylbutanoyl; R$^2$ = R$^3$ = H
**352** R$^1$ = tigloyl; R$^2$ = H; R$^3$ = Me
**353** R$^1$ = tigloyl; R$^2$ = Val$^i$; R$^3$ = H

LX and LY from *Panax notoginseng*[138] and saponins from *Aralia elata*[139] and *Panax notoginseng*.[140] The pharmacological activities and production of saponins from *Centella asiatica* have been reviewed.

Fourteen new dichapetalin derivatives have been obtained from *Dichapetalum gelonioides* including 22-deoxydichapetalin P **290**, 25-deacetyldichapetalins M **291** and P **292**, dichapetalins T **293**, U **294**, V **295** and W **296**, 6α-hydroxydichapetalin V **297**, 22-deoxy-4″-methoxydichapetalin V **298**, 4″-demethoxy-7-dihydrodichapetalin W **299**, 7-dehydrodichapetalins E **300**, G **301** and Q **302** and 29α-hydroxy-21-dehydrodichapetalin Q **303**.[141] The structure of 22-deoxydichapetalin P **290** was confirmed by X-ray analysis. The unusual 16,25-cyclised tirucallane structures **304** and **305** have been proposed for asperols A and B from *Canarium asperum*.[142]

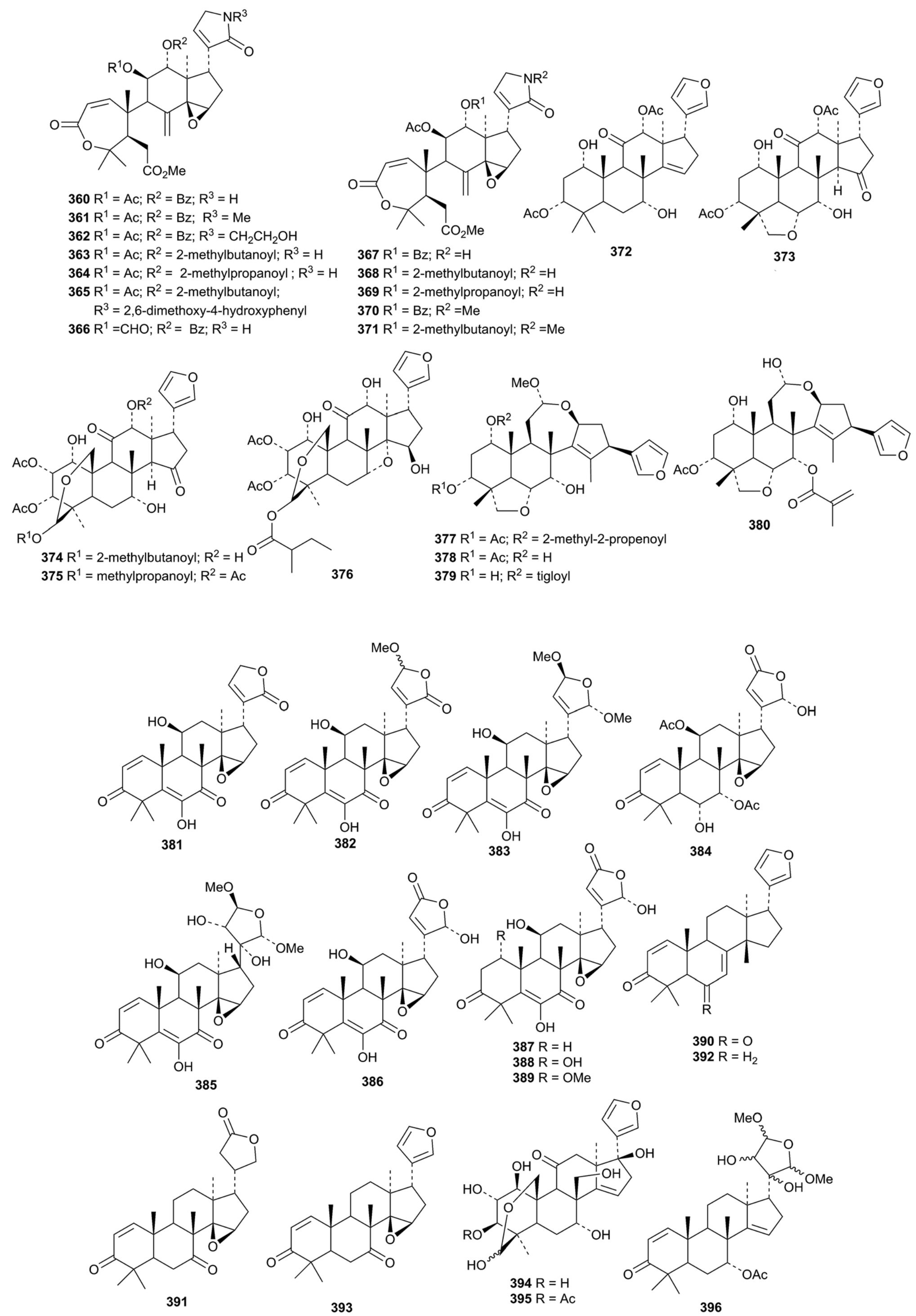
Other new tirucallane derivatives include the acetals **306**–**309** from *Dysoxylum binectariferum*,[143] trichostemonol **310** and the corresponding 3-acetate **311**, trichostemonate, from the stem bark of *Walsura trichostemon*,[144,145] indicalilacols A **312**–D **315** from the fruits of *Azadirachta indica*,[146] toosendansin D **316** from *Melia toosendan*,[147] compounds **317** and **318** from

*Celastrus stylosus*,[148] the 21-epimers paramignyols A **319** and B **320** from *Paramignya scandens*[149] and dysoxylumin A **321** (duplicate name) from *Dysoxylum densiflorum*.[150] The unusual structure **322** has been ascribed to a constituent of *Melia azedarach*.[151]

Xylogranatumines A **323**–G **328** are new apotirucallenes from the Chinese mangrove *Xylocarpus granatum*.[152] Other members of this class are represented by compounds **330–332** from the leaves of *Walsura trichostemon*,[153] dictamnins A **333** and B **334**, 21-epimers from the bark of *Dictamnus dasycarpus*,[154] cedrodorols A **335** and B **336** from *Cedrela odorata*[155] and compound **337** from *Melia azedarach*.[156]

### 4.1 Tetranortriterpenoids

There is a strong interest in the biological activities of limonoids.[157–160] Anticancer[161,162] and pesticidal[163] activities of limonoids have also been highlighted. The publication of new

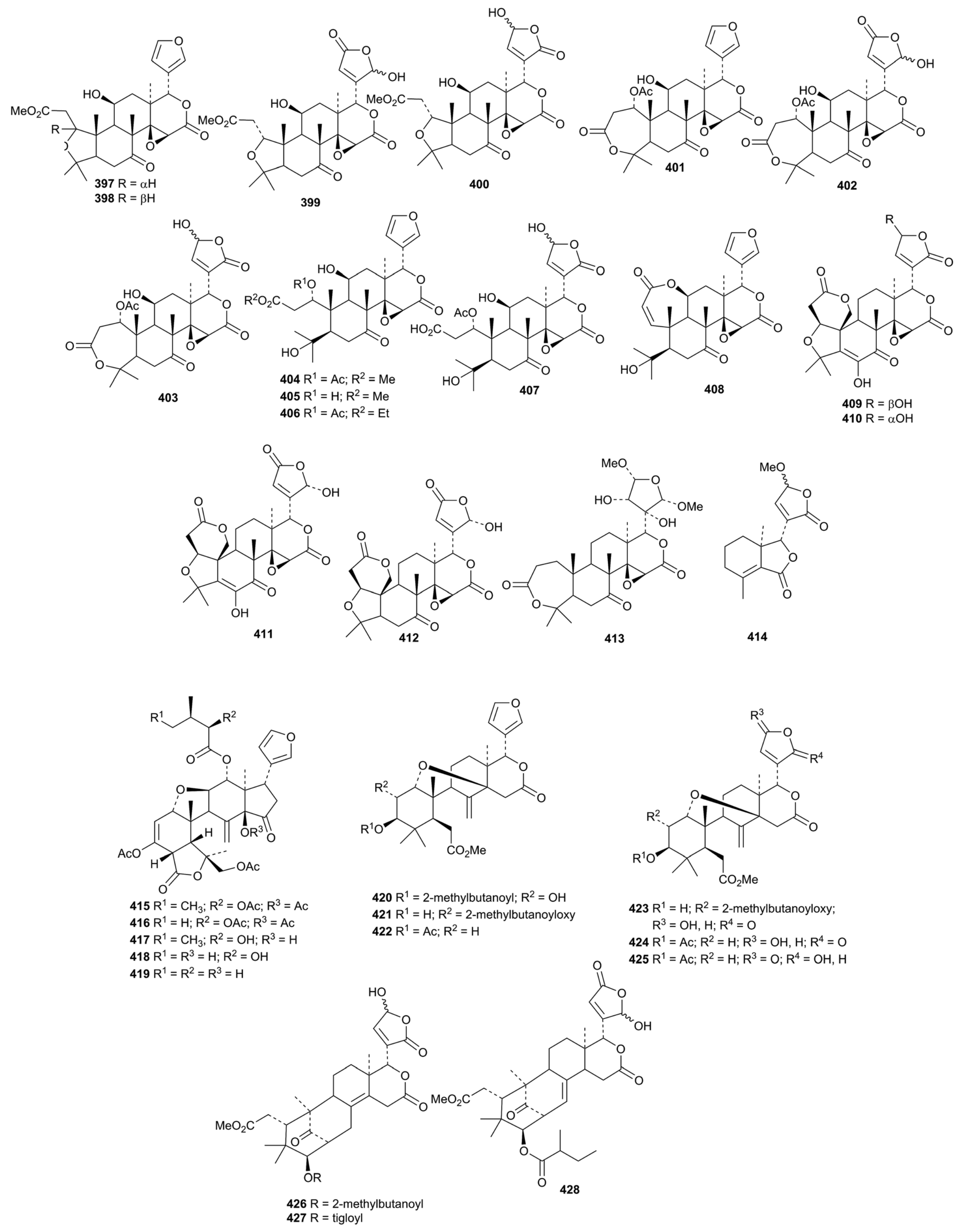


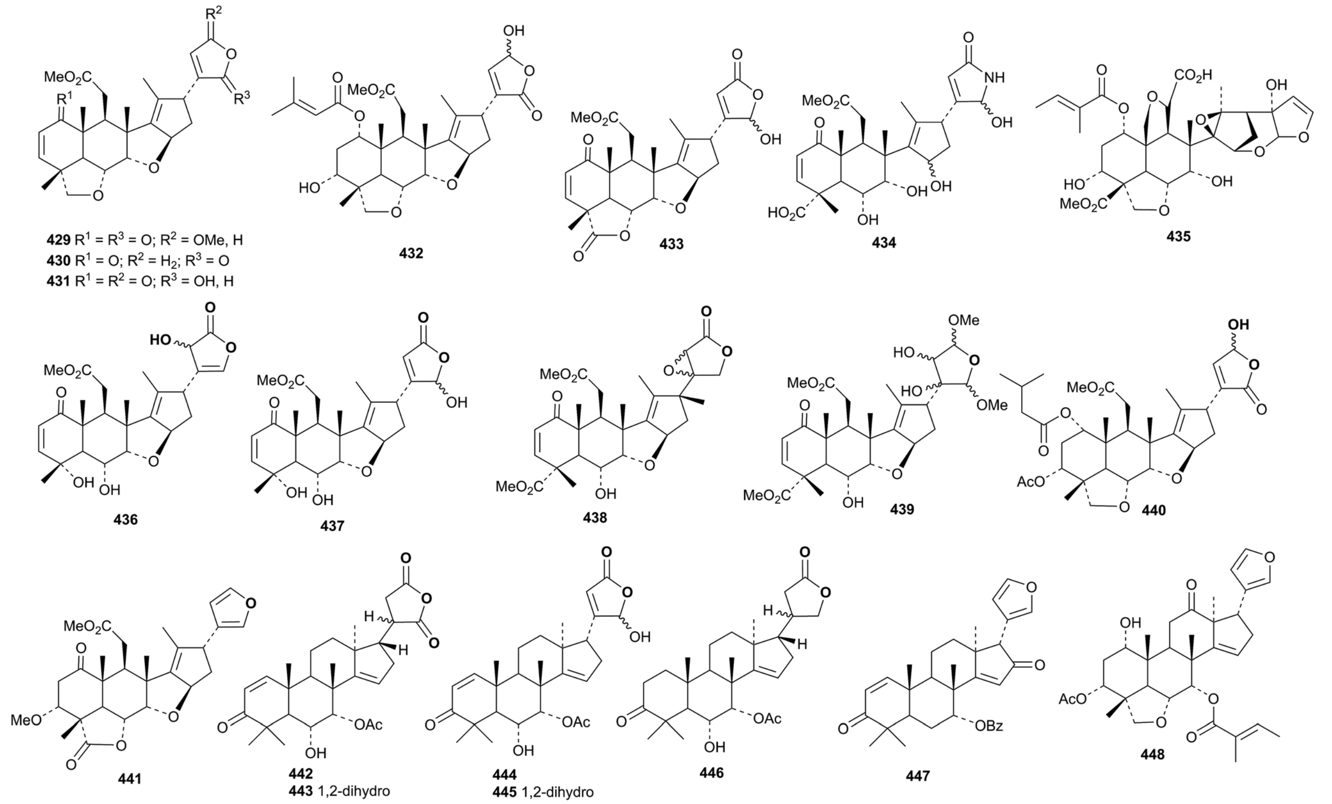
members of this class continues unabated. Walsucochinoids C **338**–R **353**, from *Walsura cochinchinensis*, form an interesting group of rearranged derivatives.[164] The structures of walsuchinoids C **338** and L **347** were confirmed by X-ray analyses.

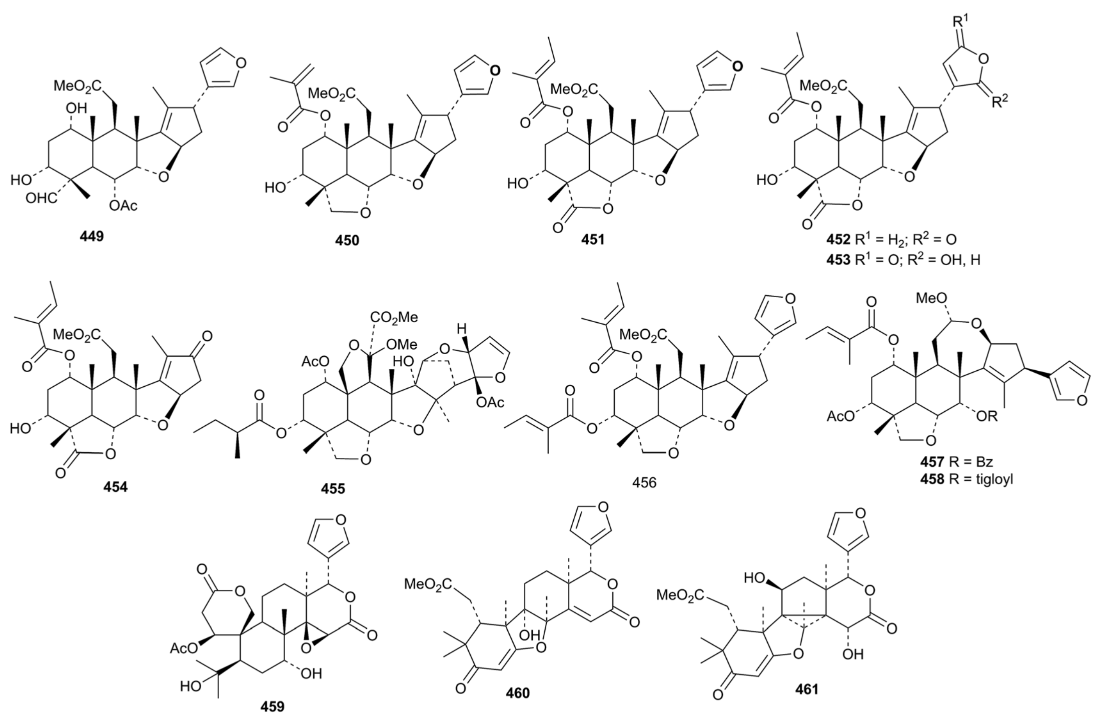
Xylogranatopyridines A **354**, B **355** and prexylogranatopyridine **356**, from the Chinese mangrove *Xylocarpus granatum*, are closely related to the known xylogranatin F **357** and hainangranatumin D **358**.[165] The unusual 9,11-seco-derivative toonasecone A **359** has been isolated from *Toona ciliata*.[166]

A series of amides, amooramides A **360**–L **371**, has been reported from the twigs and leaves of *Amoora tsangii*.[167] The highly oxygenated tetranortriterpenoids **372**–**376**, from the fruits of *Melia toosendan*, are accompanied by the ring-C cleaved derivatives **377**–**379**.[168] Compound **378** has also be isolated from *Melia azedarach* together with **380**.[169]



Nine new cedrelone derivatives, walsuranolide B **381**, 11β-hydroxy-23-*O*-methylwalsuranolide **382**, yunnanolides A **383** and B **384**, yunnanol A **385**, the isowalsuranolide derivatives **386–389**, have been isolated from the leaves and twigs of *Walsura yunnanensis*.[107] Dysoxylamins B **390**, C **391** (duplicate names) and compounds **392** and **393** are constituents of *Dysoxylum densiflorum*.[150] Other derivatives with intact skeletons include flexuosoids A **394** and B **395** from *Phyllanthus*



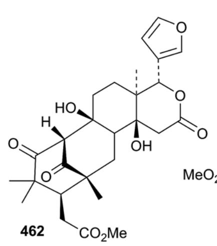



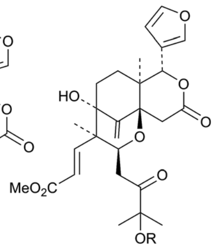
*flexuosus*[170] and compound **396** from the flowers of *Azadirachta indica* var. *siamensis*.[171]

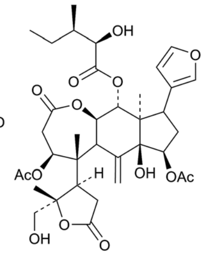
The A,D-seco derivatives clauemargines A **397**–L **408** have been isolated from the stems of *Clausena emarginata*.[172] The structure of clauemargine A **397** was confirmed by X-ray analysis. Other A,D-seco derivatives include euodirutaecins A **409** and B **410**, as an inseparable mixture, evodirutaenin A **411** and shihulimonin A1 **412** from the rhizomes of *Coptis chinensis* and *Euodia rutaecarpa*[173] and kihadanin C **413** from the root bark of *Dictamnus dasycarpus*.[174] 23-*O*-Methyldasylactone B **414** is a further constituent of *Dictamnus dasycarpus*.[174]

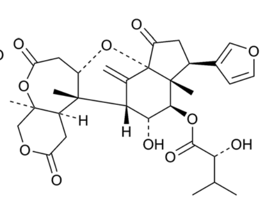
Ring B-cleaved derivatives are represented by aphagranols D **415**–H **419** from the fruits of *Aphanamixis grandifolia*[175] and the methyl angolensate derivatives cipaferens E **420**–J **425** from the seeds of *Cipadessa baccifera*.[176] The mexicanolide derivatives, cipaferens K **426**, L **427** and M **428**, were also isolated together with the known compounds cipadesin A and 2*R*-methylbutanoylproceranolide whose structures were confirmed by X-ray analyses.

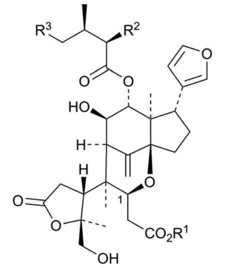
The seemingly endless investigations of the constituents of *Azadirachta indica* have, unsurprisingly, produced more unremarkable ring C-cleaved derivatives. These include the 28-

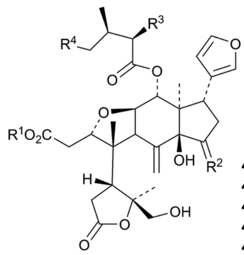

**462**

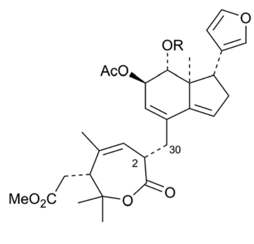

**463** R = Ac
**464** R = H

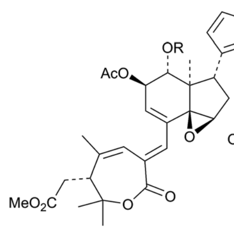

**465**

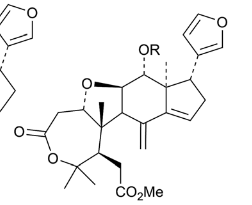

**466**

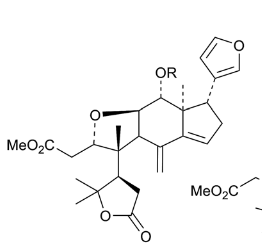

**467** $R^1$ = Me; $R^2$ = OH; $R^3$ = $CH_3$
**468** $R^1$ = Et; $R^2$ = OH; $R^3$ = $CH_3$
**469** $R^1$ = H; $R^2$ = OH; $R^3$ = $CH_3$; 1-epimer
**470** $R^1$ = Et; $R^2$ = OH; $R^3$ = $CH_3$; 1-epimer
**471** $R^1$ = H; $R^2$ = OH; $R^3$ = $CH_3$
**472** $R^1$ = Me; $R^2$ = OH; $R^3$ = $CH_3$
**473** $R^1$ = Et; $R^2$ = OH; $R^3$ = $CH_3$
**474** $R^1$ = $R^3$ = H; $R^2$ = OH; 1-epimer
**475** $R^1$ = Et; $R^2$ = OH; $R^3$ = H; 1-epimer
**476** $R^1$ = $R^3$ = H; $R^2$ = OH
**477** $R^1$ = Me; $R^2$ = OH; $R^3$ = H
**478** $R^1$ = Et; $R^2$ = OH; $R^3$ = H
**479** $R^1$ = $R^2$ = $R^3$ = H

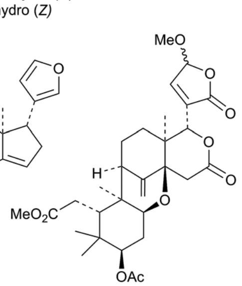

**480** $R^1$ = H; $R^2$ = O; $R^3$ = OH; $R^4$ = $CH_3$
**481** $R^1$ = Me; $R^2$ = O; $R^3$ = OH; $R^4$ = $CH_3$
**482** $R^1$ = Me; $R^2$ = βOAc, H; $R^3$ = OH; $R^4$ = $CH_3$
**483** $R^1$ = Et; $R^2$ = βOAc, H; $R^3$ = OH; $R^4$ = $CH_3$
**484** $R^1$ = Et; $R^2$ = βOH, H; $R^3$ = OH; $R^4$ = $CH_3$
**485** $R^1$ = $R^4$ = H; $R^2$ = O; $R^3$ = OH
**486** $R^1$ = Me; $R^2$ = O; $R^3$ = OH; $R^4$ = H
**487** $R^1$ = Et; $R^2$ = O; $R^3$ = OH; $R^4$ = H
**488** $R^1$ = $R^3$ = $R^4$ = H; $R^2$ = O
**489** $R^1$ = Me; $R^2$ = O;$R^3$ = $R^4$ = H

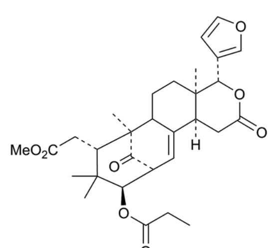

**490a** R = Ac
**490b** R = tigloyl
**491** R = 2-methylbutanoyl
**492** R = Ac; 2,30-didehydro (*E*)
**493** R = tigloyl; 2,30-didehydro (*E*)
**494** R = Ac; 2,30-didehydro (*Z*)


**495** R = Ac
**496** R = tigloyl


**497** R = tigloyl
**498** R = 2-methylbutanoyl
**499** R - Bz

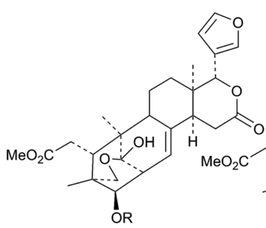

**500** R = tigloyl
**501** R = 2-methylbutanoyl
**502** R - Bz


**503**

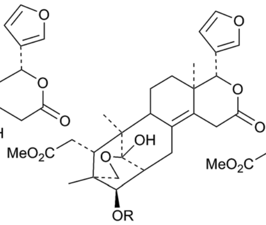

**504**

deoxynimbolide derivative **429**,[177] compounds **430–432**,[178] nimbolide B **433** and nimbic acid B **434** (ref. 179) and compounds **435–437** from *Azadirachta indica*[180] and compounds **438–441** from *Azadirachta indica* var. *siamensis*.[181] The uncleaved derivatives **442–446** (ref. 180) and **447** and **448** (ref. 181) were also obtained.

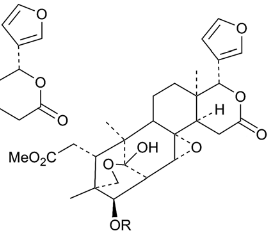
Three new ring C-cleaved derivatives **449–451**, along with a host of known compounds, have been reported from the fruits of *Melia azedarach*.[182] The leaves and bark are the source of the new derivatives **452–454** (ref. 183) while the meliacarpin derivative **455** was found in the leaves.[156] Toosendansins A **456**, B **457** and C **458** are constituents of *Melia toosendan*.[147]



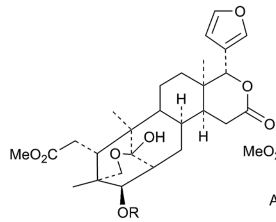
**505** R = tigloyl
**506** R = 2-methylbutanoyl



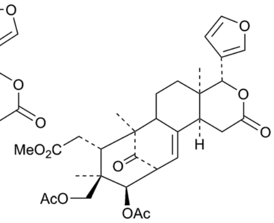
**507** R = Ac
**508** R = 2-methyl-2-propenoyl



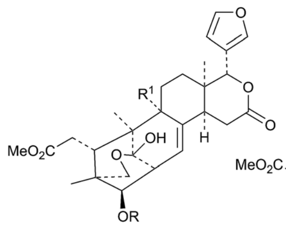
**509** R = Ac
**510** R = 2-methyl-2-propenoyl

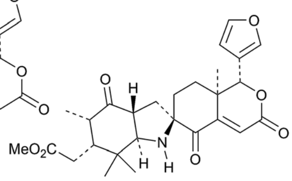


**511** R = tigloyl
**512** R = 2-methylpropanoyl
**513** R = Ac; 8,9,14,15-tetradehydro

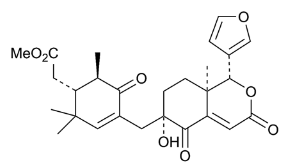


**514**

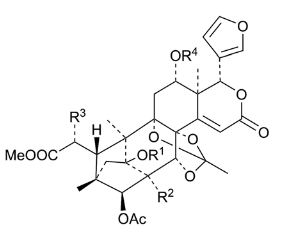




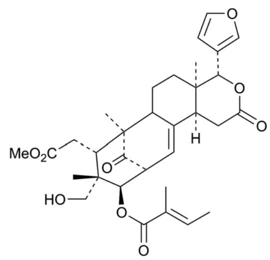
**518**



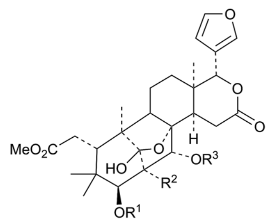
**520**



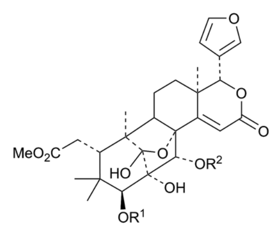
**521** R[1] = R[4] = H; R[2] = OH; R[3] = OAc
**522** R[1] = R[2] = R[3] =H; R[4] = Ac
**523** R[1] = R[4] = Ac; R[2] = R[3] =H
**524** R[1] = R[4] = Ac; R[2] = H; R[3] = OAc



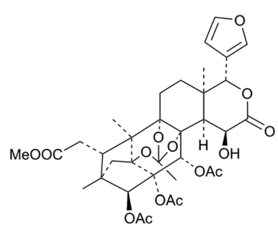
**525**



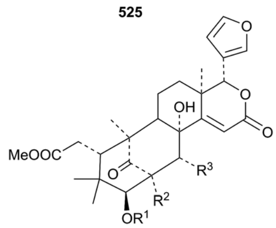
**526** R[1] = R[3] = 2-methylpropanoyl; R[2] = H
**527** R[1] = 2-methylpropanoyl; R[2] = H; R[3] = 2*S*-methylbutanoyl
**528** R[1] = R[3] = 2*S*-methylbutanoyl; R[2] = OH
**529** R[1] = Ac; R[2] = OH; R[3] = 2-methylpropanoyl
**532** R[1] = 2-methylpropanoyl; R[2] = OH; R[3] = 2*S*-methylbutanoyl



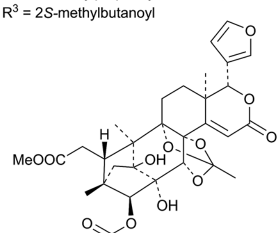
**530** R[1] = R[2] = 2*S*-methylbutanoyl
**536** R[1] = tigloyl; R[2] = 2*S*-methylbutanoyl
**537** R[1] = tigloyl; R[2] = 2-methylpropanoyl



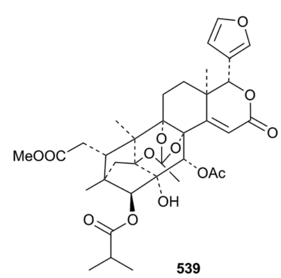
**531**



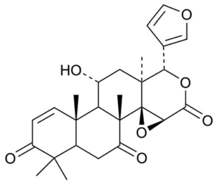
**533** R[1] = 2-methylbutanoyl; R[2] = OAc; R[3] = H
**534** R[1] = 2-methylbutanoyl; R[2] = OH; R[3] = OAc
**535** R[1] = 2-methylpropanoyl; R[2] = R[3] = H



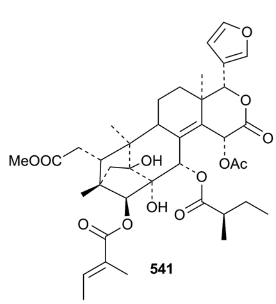
**538**



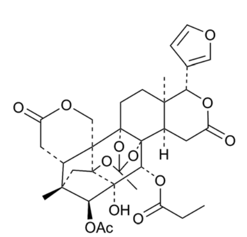
**539**



**540**



**541**



**542**

The ichangin derivative **459**, 9α-hydroxyhortolide A **460** and 11β-hydroxyhortolide C **461** were isolated from *Hortia orcadia*.[184]

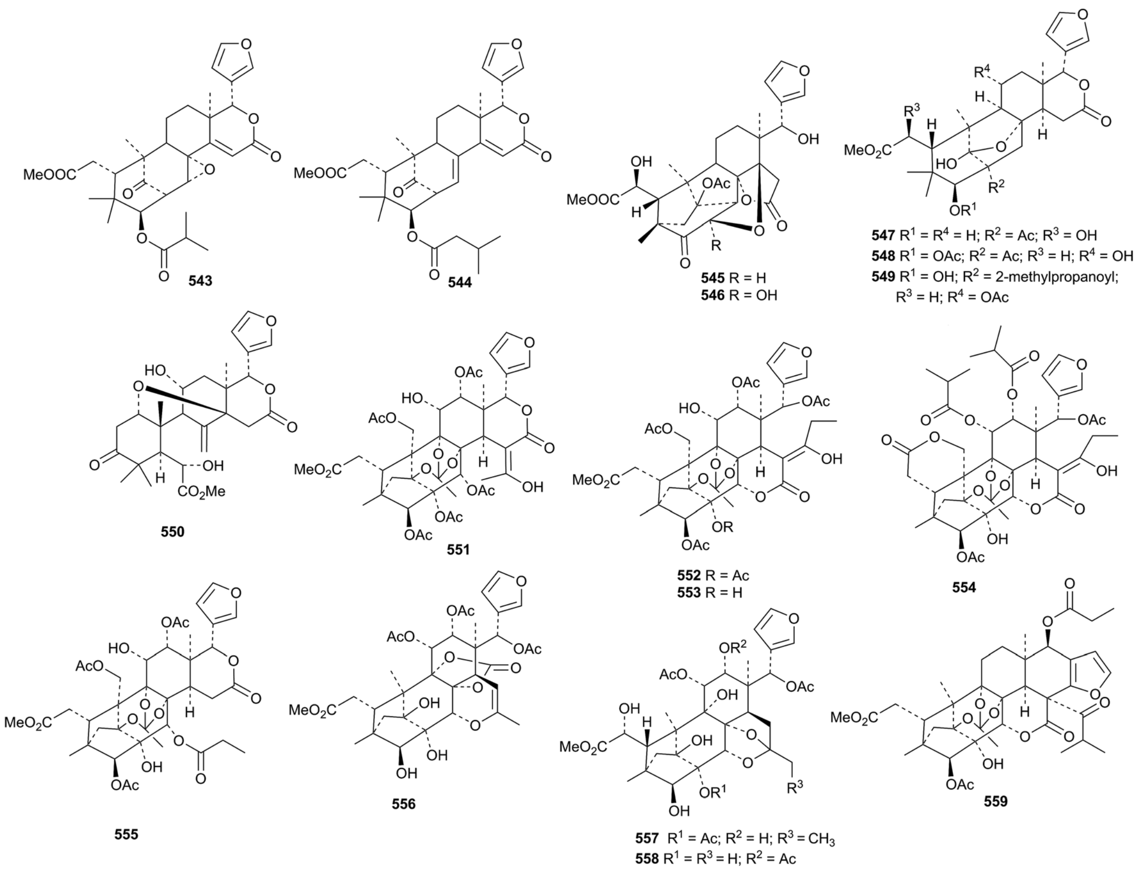
New skeletal variations of rearranged limonoids continue to appear. The structures of trichiconins A **462** and B **463**, from *Trichilia connaroides*, were confirmed by X-ray analyses.[185] They were accompanied by trichiconin C **464**. Zaphaprinins A **465**–Y **489** are modified prieurianin derivatives from the fruits of *Aphanamixis grandifolia*.[186] The structures of zaphaprinins B **466**, E **469** and P **480** were confirmed by X-ray analyses. Eight members of this group are ethyl esters and are presumably artefacts of the extraction process.

A similar group of compounds, aphanamixoids C **490a**–P **502**, has been reported from *Aphanamixis polystachya*.[187] Cineracipadesin G **503** (ref. 188) and the swietenine derivative **504** (ref. 189) are constituents of *Cipadessa cinerascens*.

**525**.[194] Xylorumphins E **526**–J **531** and 2-hydroxyxylorumphin F **532** are constituents of the seeds of *Xylocarpus rumphii*.[195] The structure of xylorumphin G **528** was confirmed by X-ray analysis.

Carapanolides C **533**–I **539** (ref. 196) and carapanolides J **540**, K **541** and L **542** (ref. 197) have been reported from the seeds of *Carapa guianensis*. The structure of carapanolide F **536** was confirmed by X-ray analysis.

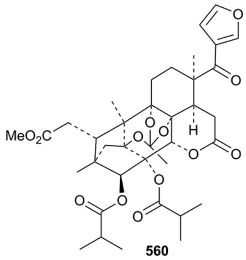
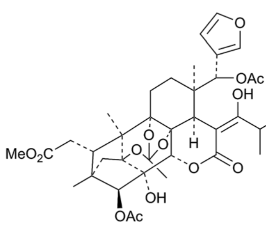
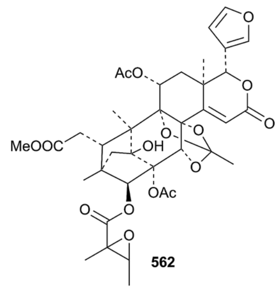
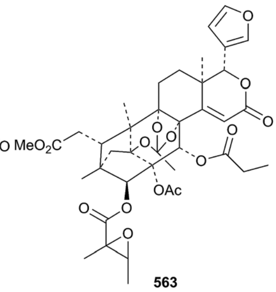
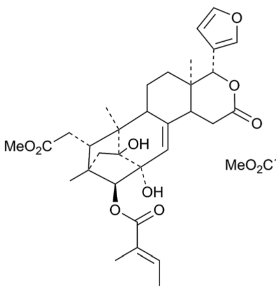
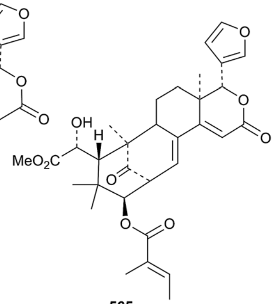
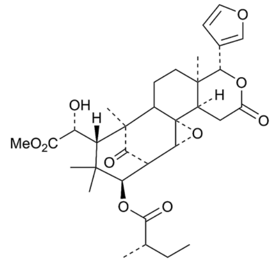
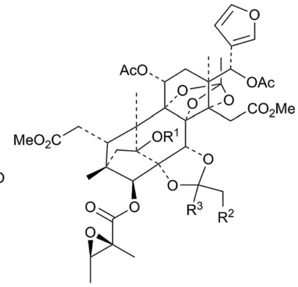
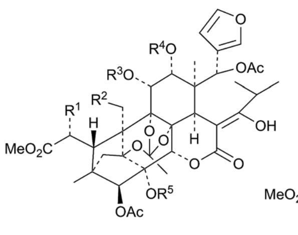
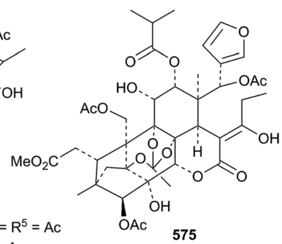
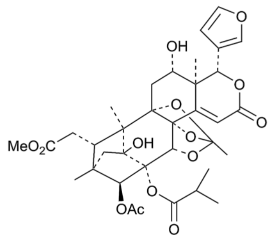
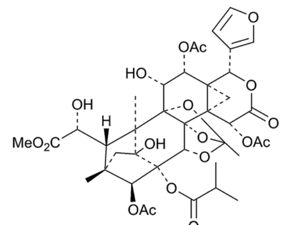
Further investigations of *Khaya ivorensis* have resulted in the isolation of 14,15-didehydroruageanin A **543** and 3-*O*-(3-methylbutanoyl)seneganolide A **544** (ref. 198) and ivorenoids A **545**–F **550**.[199] Velutinasins A **551**–H **558** are phragmalin derivatives from *Chukrasia tabularis* var. *velutina*.[200] Velutinalide C **559** is another new compound from this source.[201]




Compounds from an Indian *Xylocarpus granatum* include granatumins L **505**–U **514** (ref. 190) and granatumins V **515**–Y **518**.[191] The structures of granatumins L **505** and Y **518** were confirmed by X-ray analyses. Granatumins M **506** and V **515** have also been isolated from *Xylocarpus granatum* by another group and named xylomexicanins H and G, respectively.[192] They occur with xylomexicanins E **519** and F **520** that were drawn with the wrong absolute configuration in the reference.

Other constituents of *Xylocarpus granatum* include the phragmalin derivatives **521**–**524** (ref. 193) and xylocartin C

*Neobeguea mahafalensis* is the source of the phragmalin derivatives libiguin A **560** and libiguin B **561** (in equilibrium with its keto tautomer).[202] These compounds are reported to have aphrodisiac properties. 2-Acetylsoymidin B **562** and soymidins D **563** and E **564** are constituents of *Soymida febrifuga*.[203] Swielimonoids A **565**–F **570** are additional constituents of *Swietenia macrophylla* seeds.[204] Chukvelutilides I **571**–O **577** are further new phragmalin derivatives from the seeds of *Chukrasia tabularis*.[205] Synthetic studies have indicated that the biosynthesis of the 1,8,9-orthoester moiety in phragmalins involves intermediates with an ester at C-1.[206]

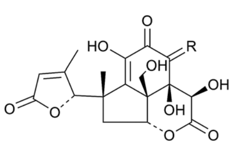
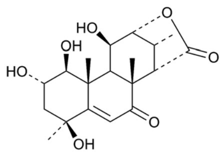
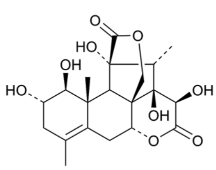
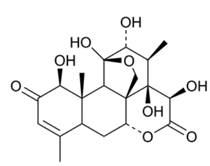
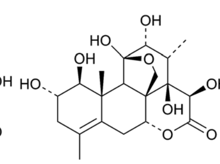
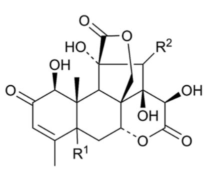
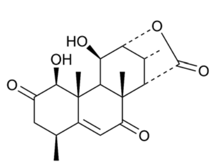
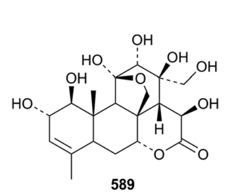

560

561

562

563

564

565

566

567 $R^1$ = Ac; $R^2$ = $CH_3$; $R^3$ = βOMe
568 $R^1$ = Ac; $R^2$ = $CH_3$; $R^3$ = αOMe
569 $R^1$ = H; $R^2$ = H; $R^3$ = αOMe
570 $R^1$ = Ac; $R^2$ = H; $R^3$ = αOMe

571 $R^1$ = $R^3$ = H; $R^2$ = OAc; $R^4$ = $R^5$ = Ac
572 $R^1$ = $R^2$ = $R^3$ = H; $R^4$ = $R^5$ = Ac
573 $R^1$ = OAc; $R^2$ = $R^4$ = H; $R^3$ = $R^5$ = Ac
574 $R^1$ = $R^3$ = $R^5$ = H; $R^2$ = OAc; $R^4$ = Ac

575

576

577

### 4.2 Quassinoids

Eurylactones E **578**, F **579** and G **580**, eurycomalides D **581**, and E **582** and 13α,18-dihydroeurycomanone **583** are new constituents of the roots of *Eurycoma longifolia*.[207] Other constituents of *Eurycoma longifolia* include $\Delta^4$-14-hydroxyglaucarbol **584**, 5-isoeurycomadilactone **585**, eurycomadilactone **586** and 13-epieurycomadilactone **587** (ref. 208) and eurycomalide C **588**.[209] The structures of $\Delta^4$-14-hydroxyglaucarabol **584** and 5-isoeurycomadilactone **585** were confirmed by X-ray analyses. Shinjulactone O **589** has been isolated from the root bark of *Ailanthus altissima*.[210]

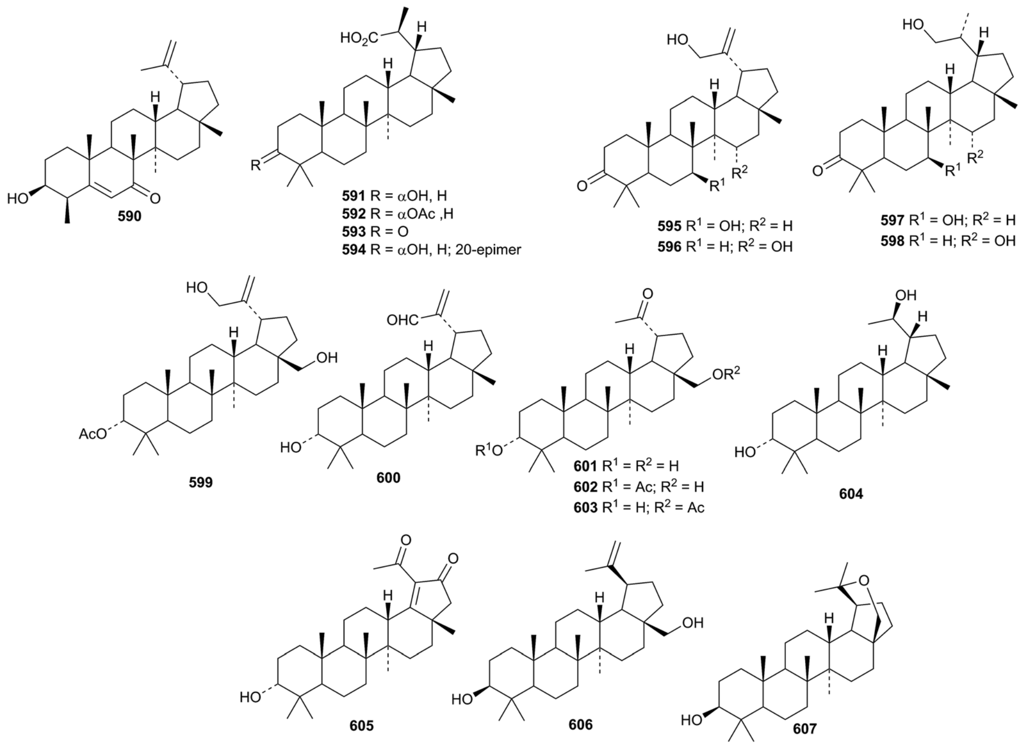
## 5. The lupane group

Betulinic acid has been reported to have a variety of pharmacological activities including antitumour activity.[211,212] The first

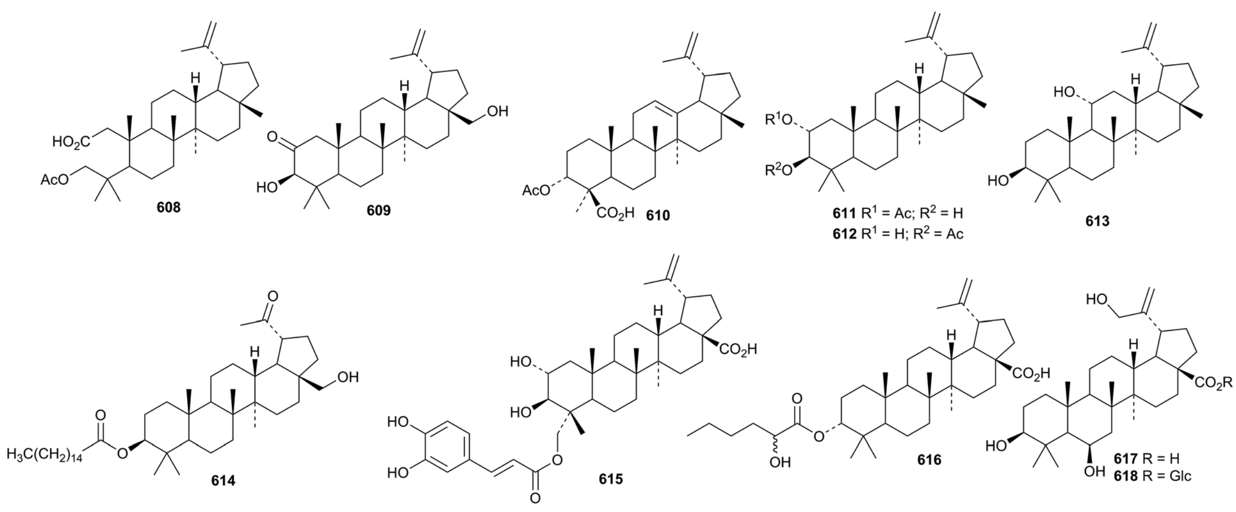

578 R = α$CH_3$, H
579 R = β$CH_3$, H
580 R = $CH_2$

581

582

583

584

585 $R^1$ = αH; $R^2$ = β$CH_3$
586 $R^1$ = βH; $R^2$ = β$CH_3$
587 $R^1$ = βH; $R^2$ = α$CH_3$

588

589

example of a 23-norlupane, 3-hydroxy-23-nor-5,20(29)-lupadien-7-one **590**, has been reported from *Lagerstroemia indica*.[213] *Euonymus carnosus* is a prolific source of lupane triterpenoids. Fifteen new compounds **591–605**, including the 30-nor-derivatives **601–605**, have been isolated.[214] The structure of **591** was confirmed by X-ray analysis. 19-Epibetulin **606** and 19-*epi*-20,28-epoxy-3-lupanol **607** have been reported from *Hibiscus syriacus*.[215]

20(29)-lupene-3β,11α-diol **613** together with its 3-palmitate and the 30-norlupane palmitate **614** from *Saussurea phyllocephala*,[219] sorbanolic acid **615** from *Sorbus lanata*[220] and the 2-hydroxyhexanoyl ester of 3-epibetulinic acid **616** from *Dillenia indica*.[221] 3β,6β,29-Trihydroxy-20(30)-lupen-28-oic acid **617** and its β-D-glucopyranosyl ester **618** are constituents of *Licania cruegeriana*.[222] Lupane saponins with known genins include schekwangsiensides F and G




Other simple lupane derivatives include salacinins A **608** and B **609** from *Salacia hainanensis*,[216] the acetates **610** from *Boswellia sacra*[217] and **611** and **612** from *Salvia viridis*,[218] from *Schefflera kwangsiensis*[223] and saponins from *Eryngium agavifolium*.[224]



# 6. The oleanane group

Oleanane triterpenoids and their saponins have a wide range of pharmacological activities.[225–227] Oleanolic acid[228–231] and maslinic acid[232] have been well studied, particularly for their anti-tumour effects.

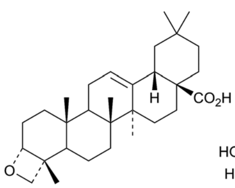
Cyclocaric acid A, from *Cyclocarya paliurus*, was claimed to have the structure **619** with an oxetane ring.[233] Synthesis of the oxetane **619** and re-examination of the original literature report indicates that cyclocaric acid A is identical with hederagenin **620**.[234] The 2,3-seco-derivative **621** has been found in *Ligularia przewalskii*,[235] and the 2,3-seco anhydride **622** is a constituent of *Microtropis fokiensis* where it is accompanied by the intact oleananes **623**, **624** and the 18-oleanene derivative **625**.[236] Further 18-oleanene derivatives include 2α,3β-dihydroxy-18-oleanen-28-oic acid **626** from *Lawsonia inermis*[237] and the corresponding 29-oic acid **627** from *Mentha suaveolens*.[238]

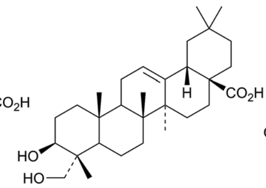
The 3,4-seco-derivatives camelliaoleans A **628** and B **629**, together with the 28-noroleanane derivatives **630** and **631**, have been isolated from *Camellia japonica*.[239] Liquidaformone **632** is another 28-noroleanane from fruits of *Liquidambar formosana*.[240] Asprellol C **633** is a 24-noroleanane from *Ilex asprella*,[241] whereas the noroleananes **634** and **635** have been found in *Akebia trifoliata*[242] and glyyunnansapogenin I **636** is from *Glycyrrhiza yunnanensis*.[243]

Two unusual 9(11)-oleanene derivatives **637** and **638**, lacking a ketone at C-12, have been isolated from *Boswellia ovalifiolata*.[244] Cannabifolin A **639**, from *Vitex negundo* var. *cannabifolia*, has unusual *cis*-fused C/D rings.[245] It is accompanied by cannabifolins E **640** and F **641**. Rusaic acid B **642**, from the roots of *Rosa rugosa*, has a contracted ring A.[119]

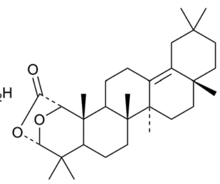
Other simple oleanane derivatives include 12-oleanene-1β,3β,11α,28-tetrol **643** and its 3-palmitate **644** from *Saussurea phyllocephala*,[219] uncarinic acids F **645**, G **646** and H **647** from *Uncaria rhynchophylla*,[246] schekwangsiensin **648** from *Schefflera kwangsiensis*,[223] glaucescic acid **649** from *Terminalia glaucescens*,[247] the 28,13-olide **650** from *Ekebergia capensis*,[248] 3α-hydroxy-12-oleanene-23,28,29-trioic acid **651** from *Acanthopanax gracilistylus*[249] and 12-oleanene-3β,7β,15α,28-tetrol **652** from *Salvia argentea* var. *aurasiaca*.[250]

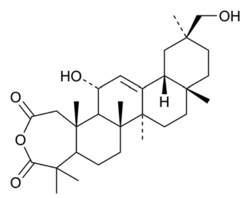
3β-Hydroxy-11,13(18)-oleanadiene-23,28-dioic acid **653**, previously identified as the genin of saponarioside J, has been isolated from *Anoectochilus elwesii*.[251] Yunganosides L, M, $N_1$, $N_2$, O and P are saponins from *Glycyrrhiza yunnanensis* with the new genins yunganogenins L **654**–P **658**.[243] Licorice-


**619**

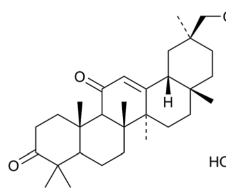


**620**

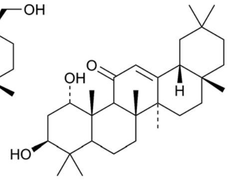

**621**



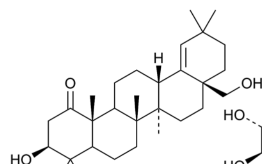
**622**



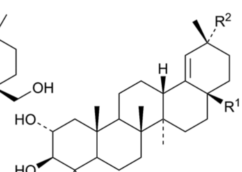
**623**



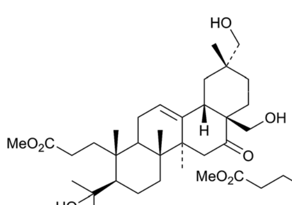
**624**



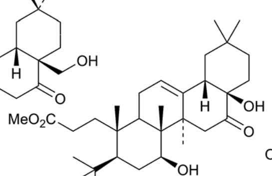
**625**



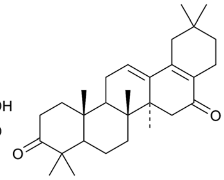
**626** $R^1 = CO_2H$; $R^2 = H$
**627** $R^1 = CH_3$; $R^2 = CO_2H$

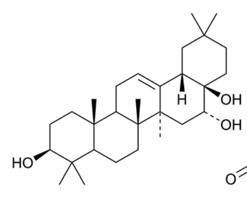


**628**

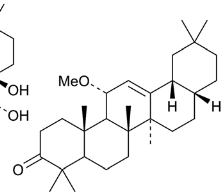


**629**

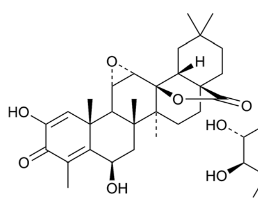

**630**



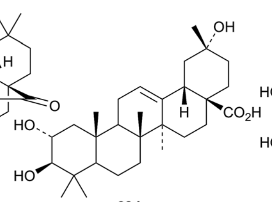
**631**



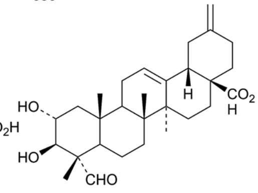
**632**



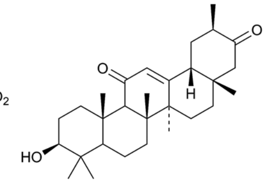
**633**



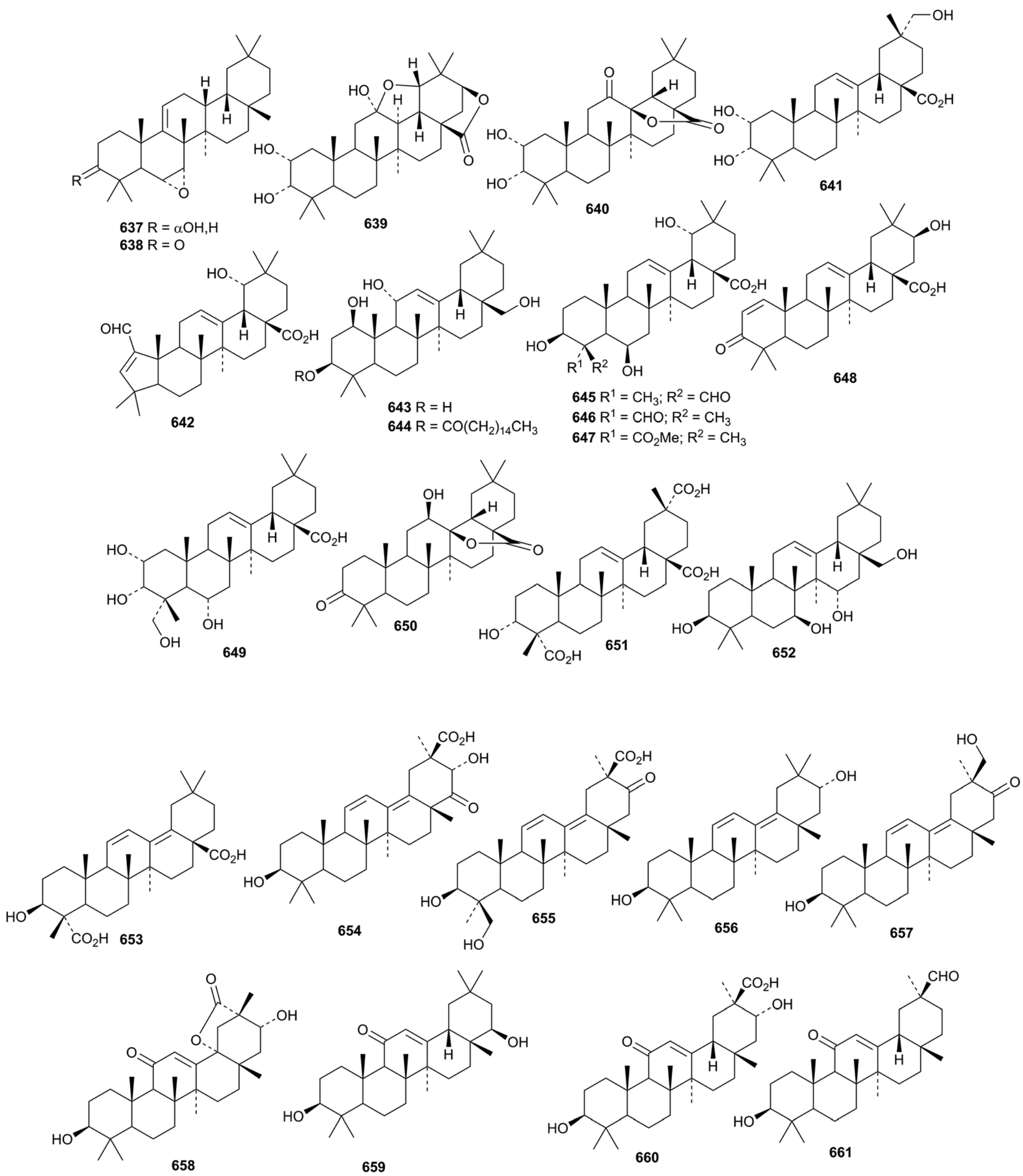
**634**



**635**



**636**




saponins M3 and N4, from *Glycyrrhiza glabra*, have the new genin **659**.[252] Licorice-saponin M3 is the same as uralsaponin T that has been isolated from *Glycyrrhiza uralensis* together with uralsaponins P–S and W that have the new genins **660** and **661**, respectively.[253]

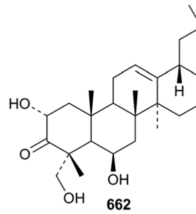
Other oleanane saponins with new genins include centellasaponins E and I, from *Centela asiatica*, with the genins **662** and **663**,[254] hippophosides A–D, from *Hippophae rhamnoides* ssp. *sinensis*, with the genins **664** and **665**,[255] oleiferasaponin $B_2$, from *Camellia oleifera*, with the genin **666**,[256] tubeimosides A and B, from *Bolbostemma paniculatum*, with the genins **667** and **668**,[130] saponins from *Akebia trifoliata* with the noroleanane genins **669** and **670**,[257] *Entada phaseoloides* with the genins **671–673**,[258] *Eclipata prostrata* with the genin 12-oleanene-3β,16β,29-triol **674** (ref. 259) and *Silphium asteriscus* also with the genin **674** together with eleven related genins **675–685**.[260]

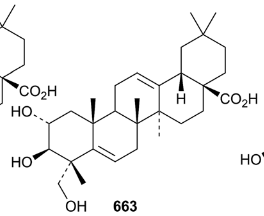
New oleanane saponins with known genins that have been assigned trivial names are listed in Table 1.

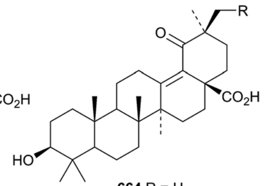
The sources of new oleanane saponins with known genins that have not been assigned trivial names are listed in Table 2.

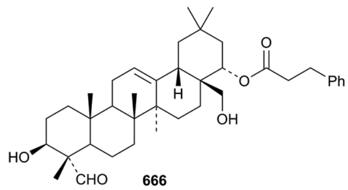
The unlikely acetone hemiacetal **686** has been reported as a constituent of *Isodon adenantha*.[315] 11,21-Dihydroxy-1-oleananone **687** and four esters **688–691** are claimed to be substituents of *Coriandrum sativum*.[316] Other new oleanane esters include the 3-palmitoyl ester of 3β,28-dihydroxy-12-oleanen-11-one (procerenone) from *Omphalocarpum procerum*,[317] and the oleoyl ester 12,18-oleanadien-3β-ol.[318] Leonurusoleanolides E **692**–J **697**, from *Leonurus japonicus*, are further esters of the 19(18→17)-*abeo*-28-noroleanane phlomistetraol B.[319]

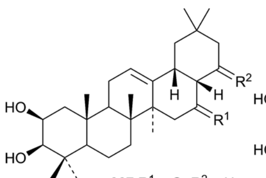
Malaytaxerate **698**, from *Sapium baccatum*, is a ring-E contracted nortaraxerane derivative.[320] *Davidia involucrata* is the

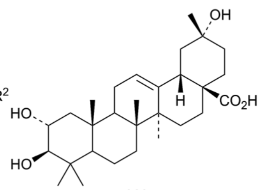

662

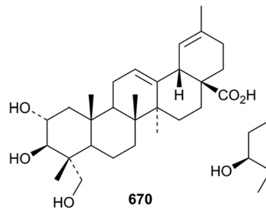

663

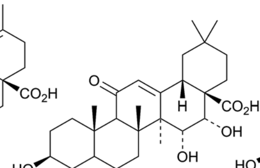

**664** R = H
**665** R = OH

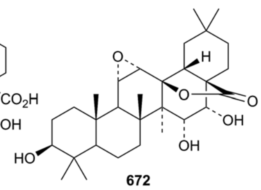

666

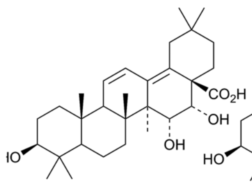

**667** $R^1$ = O; $R^2$ = $H_2$
**668** $R^1$ = $H_2$; $R^2$ = O

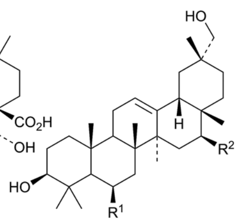

669

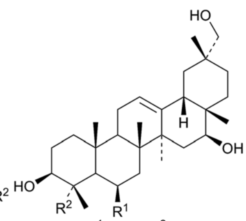

670

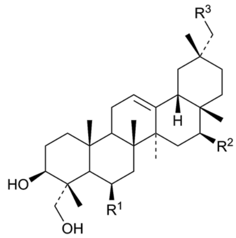

671


672

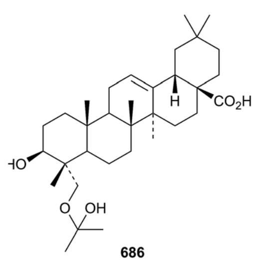

673

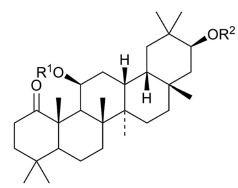

**674** $R^1$ = H; $R^2$ = OH
**675** $R^1$ = $R^2$ = OH
**676** $R^1$ = OH; $R^2$ = H

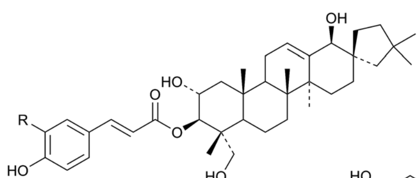

**677** $R^1$ = OH; $R^2$ = $CH_2OH$
**678** $R^1$ = OH; $R^2$ = CHO
**679** $R^1$ = OH; $R^2$ = $CO_2H$
**680** $R^1$ = H; $R^2$ = $CH_2OH$
**681** $R^1$ = H; $R^2$ = CHO
**682** $R^1$ = H; $R^2$ = $CO_2H$


**683** $R^1$ = $R^3$ = H; $R^2$ = OH
**684** $R^1$ = $R^3$ = OH; $R^2$ = H
**685** $R^1$ = $R^2$ = H; $R^3$ - OH

source of the ring-A contracted nortaraxeranes davinvolunols A **699** and B **700** and davinolunone A **701** together with the intact taraxeranes davinolunones B **702** and C **703**.[321] The structure of the 2,3-secotaraxerane pycanocarpine **704**, from *Pleiocarpa pycnantha*, was established by X-ray analysis.[322] A taraxerane saponin with a known genin has been isolated from the roots of *Clematis argentilucida*.[323] The structures of both the multiflorane derivative turranoic acid **705** and turraenine **706**, from a *Turraea* species, were also established by X-ray analysis.[324] Turraenine **706** is an unusual nitrogen-containing dimeric normultiflorane. Three multiflorane esters **707–709** have been isolated from seeds of *Cucurbita maxima*.[325] The glutinane derivative klodorol A **710**, from *Kleinia odora*, is 5α-hydroxydebdropanoxide.[326] The authors


686


**687** $R^1$ = $R^2$ = H
**688** $R^1$ = H; $R^2$ = Ac
**689** $R^1$ = H; $R^2$ = angeloyl
**690** $R^1$ = Ac; $R^2$ = angeloyl
**691** $R^1$ = $R^2$ = Bz


**692** R = OMe
**693** R = OMe; *Z-isomer*
**694** R = H
**695** R = H; Z-isomer
**696** R = OH

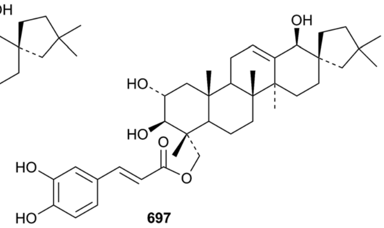

697

Table 1 Trivial names and sources of new oleanane saponins with known genins

| Trivial name | Plant species | Reference |
|---|---|---|
| Angulasaponins A–D | *Vigna angularis* | 261 |
| Aristatosides A–C | *Cephalaria aristata* | 262 |
| Bafouoside C | *Cussonia bancoensis* | 263 |
| Caspicaosides E–K | *Gliditsia caspica* | 264 |
| Celosins H–J (celosin I is a duplicate name) | *Celosia argentea* | 265 |
| Clematiunicinosides A–H | *Clematis uncinata* | 266 |
| Comastomasaponins A–H | *Comastoma pedunculatum* | 267 |
| Conyzasaponins R, S | *Conyza japonica* | 268 |
| Conyzasaponins T, U | *Conyza japonica* | 269 |
| Davisianosides A, B | *Cephalaria davisiana* | 270 |
| Flaccidosides V–VII | *Anemone flaccida* | 271 |
| Grindeliosides A–C | *Grindelia argentina* | 272 |
| Ilexasprellanosides D–F | *Ilex asprella* | 273 |
| Ilexpublesnin R | *Ilex pubescens* | 274 |
| Leptocarposide | *Ludwigia leptocarpa* | 275 |
| Licorice-saponin O4 | *Glycyrrhiza glabra* | 252 |
| Lobeliodosides A–D | *Lysimachia lobelioides* | 276 |
| Lonicerosides F–J | *Lonicera japonica* | 277 |
| Officinoterpenoside D | *Rosmarinus officinalis* | 278 |
| Oleiferosides A–H | *Camellia oleifera* | 279 |
| Oleiferoside $B_1$ | *Camellia oleifera* | 256 |
| Paradoxosides A–E | *Vitellaria paradoxa* | 280 |
| Pittangretosides N, O, P | *Pittosporum angustifolium* | 281 |
| Pittangretosides $A_1$, $B_1$, J, K, M, Q–Z | *Pittosporum angustifolium* | 282 |
| Potentillanoside F | *Potentilla anserina* | 283 |
| Salbiges A, B | *Salicornia herbacea* | 284 |
| Sarconepaside C | *Sarcopyramis nepalensis* | 285 |
| Schefflesides A–H | *Schefflera kwangsiensis* | 286 |
| Schefflesides I–L | *Schefflera kwangsiensis* | 287 |
| Sieboldiisaponin B | *Stachys sieboldii* | 288 |
| Simenoside A | *Gypsophila simonii* | 289 |
| Schekwangsiensides A–E | *Schefflera kwangsiensis* | 223 |
| Uralsaponins M, N, O, U, V, Y | *Glycyrrhiza uralensis* | 253 |
| Yemuosides $YM_{36}$, $YM_{37}$ | *Stauntonia chinensis* | 290 |
| Yunganoside $E_3$ | *Glycyrrhiza yunnanensis* | 243 |

draw klodorol A **710** with incorrect stereochemistry at C-13 and C-14.

The structures of the friedelane triterpenoids found in *Maytenus* species have been summarised.[327] Glaucalactone B **711** is a 29-norfriedelane 27,20-lactone from *Caloncoba glauca*[104] and hainanenone **712** is a 23-norfriedelane derivative from *Drypetes hainanensis*.[328] The 23,24-dinorfriedelane pristimerol **713**, from *Celastrus aculeatus*, has been given the same name as the reduction product of pristimerin.[329] Galphimines K **714** and L **715** are further 3,4-seco-derivatives from *Galphimia glauca*.[330] Other friedelane derivatives include salacinin C **716** from *Salacia hainanensis*,[216] the 3-ketones **717** and **718** from *Maytenus robusta*[331] and the esters **718** and **720** from *Drypetes hoanensis*.[332] The structure of **717** was confirmed by X-ray analysis. The known norfriedelane celastrol from *Triperygium wilfordii* has shown interesting antitumour activity.[333]

Table 2 Sources of new oleanane saponins with known genins not assigned trivial names

| Plant species | Reference |
|---|---|
| *Acacia auriculiformis* | 291 |
| *Anemone rivularis* var. *flore-minore* | 292 |
| *Callicarpa nudiflora* | 293 |
| *Centratherum anthelminticum* | 294 |
| *Clematis argentilucida* | 295 |
| *Croton lachnocarpus* | 296 |
| *Eclipta prostrata* | 259 and 297 |
| *Entada phaseoloides* | 258 |
| *Eryngium planum* | 298 |
| *Ganophyllum giganteum* | 299 |
| *Garcinia hanburyi* | 300 |
| *Gymnema sylvestre* | 301 |
| *Gypsophila arrostii* var. *nebulosi*, *Gypsophila bicolor* | 302 |
| *Manilkara hexandra* | 303 |
| *Melissa officinalis* | 304 |
| *Momordica charantia* | 305 |
| *Paonychia anatolica* ssp. *balansae* | 306 |
| *Patrinia scabra* | 307 |
| *Polycarpaea corymbosa* var. *eriantha* | 308 |
| *Polygala tenuifolia* | 309 |
| *Pycnanthemum flexuosum* | 310 |
| *Sapindus mukorossi* | 311 |
| *Silene rubicunda* | 312 |
| *Silphium asteriscus* | 260 |
| *Tremastelma palaestinum* | 313 |
| *Xanthoceras sorbifolia* | 314 |

# 7. The ursane group

The antitumour activity of ursolic acid has been highlighted.[334,335] The unusual 9,25-cyclo-12-ursen-3β-ol **721** has been reported from Cameroonian brown propolis.[110] The ring-A modified ursanes davinvolunic acids A **722**, B **723** and C **724** have been isolated from *Davidia involucrata*.[336] Davinvolunic acid C **724** contains an unusual methyl hemiacetal. The leaves of *Vitex negundo* var. *cannabifolia* are the source of cannabifolins A **725**, C **726** and D **727**.[245] The structure of cannabifolin A **725** was confirmed by X-ray analysis to have *cis*-fused rings C and D. Two ursane derivatives **728** and **729**, with the unusual 20α*H*-configuration, have been identified in *Ilex cornuta*.[337] Asprellols A **730** and B **731**, from *Ilex asprella*, are 24-norursane derivatives.[241] Urs-12-ene-2α,3β,19α-triol **732**, from *Terminalia arjuna*, has been named torment.[338]

Other simple ursane derivatives include cymosic acid **733** from *Rosa cymosa*,[339] elatumic acid **734** from *Omphalocarpum elatum*,[340] erandione **735** from *Ricinus communis*,[341] klodorone A **736** from *Kleinia odora*,[326] meyanthic acid **737** and urs-12-ene-2α,3α,19α,24,28-pentol **738** from *Meyna* (*Vangueria*) *spinosa*,[342] uncarinic acids H **739** and I **740** from *Uncaria rhynchophylla*,[246] 3α,6β,19α-trihydroxyurs-12-en-28-oic acid **741** from *Mitragyna diversifolia*,[343] 3β,20β-dihydroxyursan-28-oic acid **742** from *Malus domestica*,[344] 3α,11β-dihydroxyurs-12-en-28-oic acid **743** from *Gentiana veitchiorum*,[345] three compounds **744–746** from *Zizyphus jujuba*,[346] three compounds **747–749** from *Microtropis fokienensis*[236] and nine ursanes **750–758** from *Salvia argentea* var. *aurasiaca*.[250]

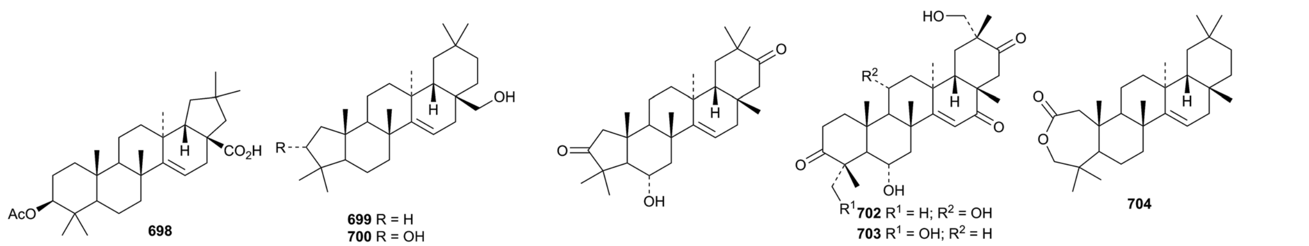
Centrellasaponin J, from *Cenrella asiatica*, has the new ursane genin **759**.[254] Further new ursane genins include **760** from *Callicarpa nudiflora*,[293] **761** from *Clematis argentilucida*,[323] **762** and **763** from *Panax ginseng*[61] and **764–766** from *Schefflera heptaphylla*.[347]

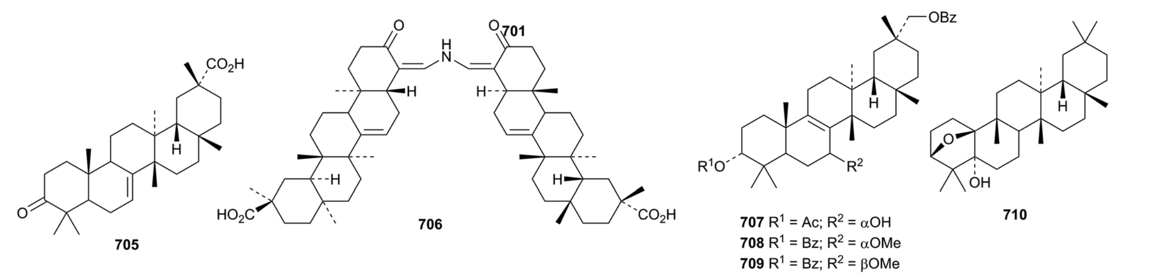
Named ursane saponins with known genins include fagonoside A from *Fagonia cretica*,[348] grandoside from *Syzygium grande*,[349] ilexsaponins G and H from *Ilex pubescens*,[350] ilexasprellanosides A–C from *Ilex asprella*,[273] ilexpublesnins N–Q (Q is the same as zygoeichwaloside H isolated in 2007(ref. 351)) from *Ilex pubescens*,[274] officinoterpenoside C from *Rosmarinus officinalis*,[278] potentillanosides A–E[283] and G[352] from *Potentilla anserina*, sieboldiisaponins A[353] and C[288] from *Stachys sieboldii*, and zygofaboside C from *Zygophyllum fabago*.[354] Unnamed saponins with known genins have been isolated from *Eucommia ulmoides*,[355] *Ilex cornuta*,[356,357] *Melissa officinalis*,[304] *Schefflera heptaphylla*[347] and *Vitex negundo*.[358]

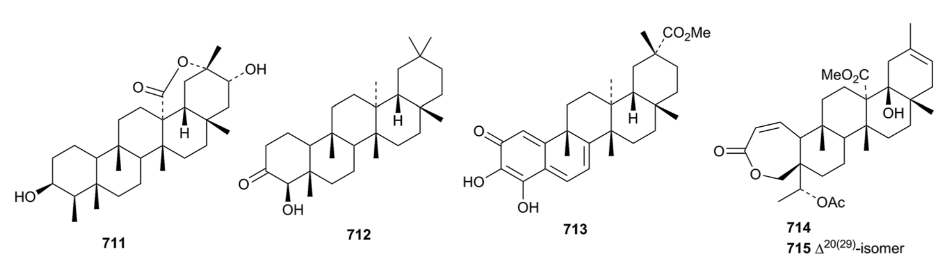
Further ursane esters include the acetate **767** from *Boswellia sacra*,[217] the acetate **768** from *Mentha suaveolens*,[238] ferulates **769** and **770** from *Ampelopsis japonica*.[359] and the palmitate **771** from *Inula cappa*.[360] Flaccidoside IV is a taraxastane saponin with a known genin from *Anemone flaccida*.[271] The unusual 3β-acetoxy-22,28-cyclobauer-7-ene **772** has been identified in *Ixeris chinensis*.[361]

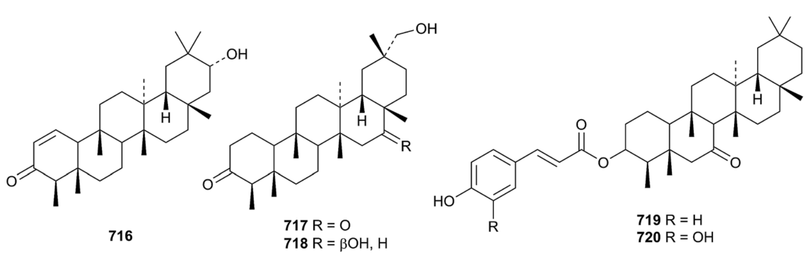
# 8. The hopane group

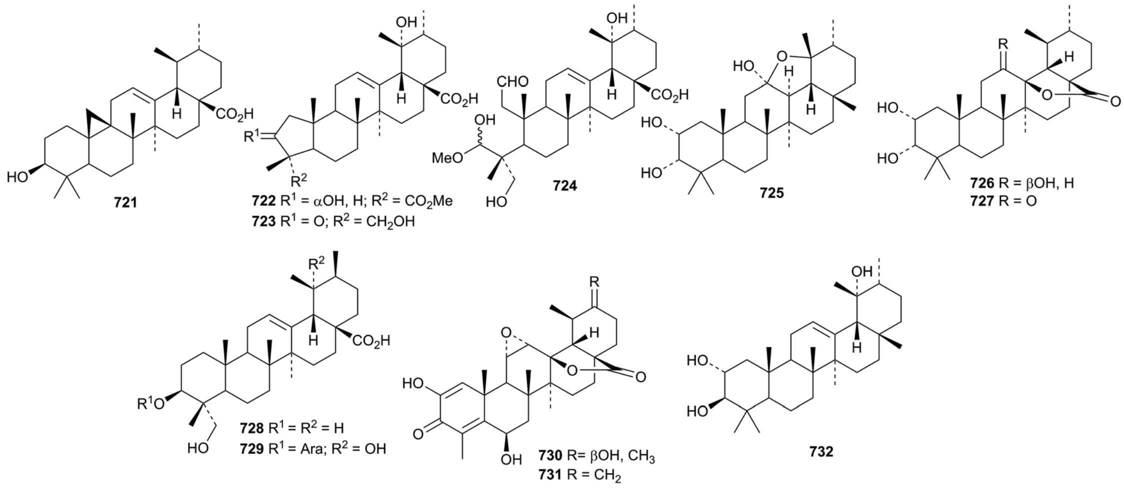
The 2,3-seco-21α*H*-hopane derivatives **773** and **774** have been isolated from *Megacodon stylophorus*.[362] The structure of **773** was confirmed by X-ray analysis. Ribosylhopane **775**, which has been postulated as a precursor of $C_{35}$ bacteriohopanepolyols in *Streptomyces coelicolor*, has now been found in blocked mutants.[363] Two fernane derivatives **776** and **777** have been reported from *Lonicera quinquelocularis* however the structures are drawn lacking C-28 in the reference.[364] A fernane saponin, from *Spergula fallax*, has the new genin **778**.[365]

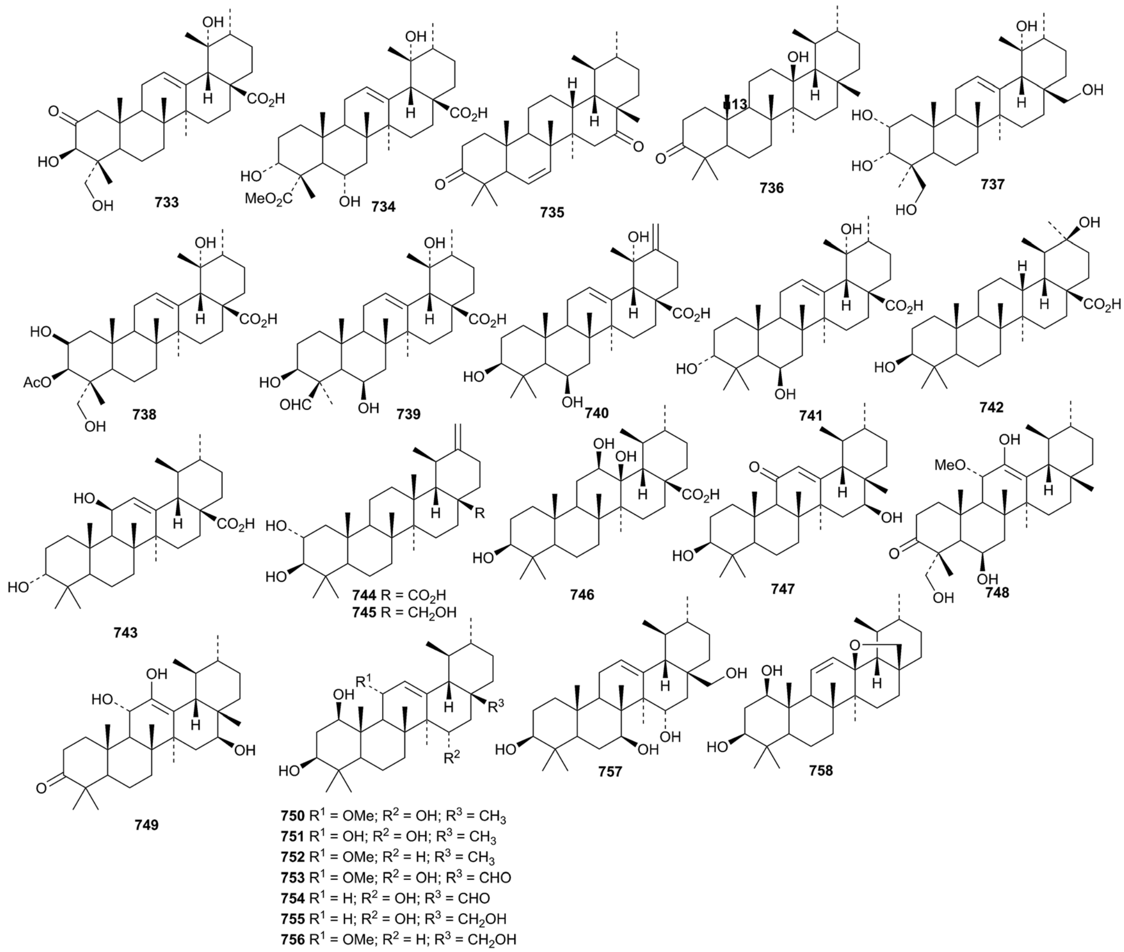


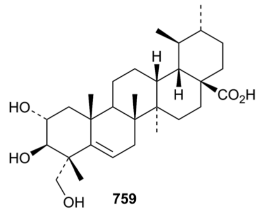



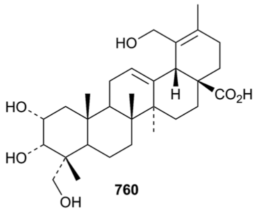


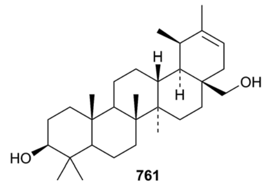



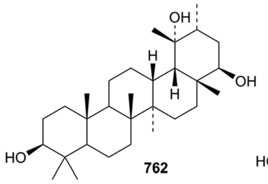

# 9. Miscellaneous compounds

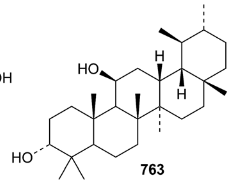
The unlikely structure **779** has been assigned to a triterpene rhamnoside from *Sesbania aculeata*.[366] Three gammacerane saponins, from *Spergula fallax*, have the new genin **780**.[365] *Lycopodium japonicum* is the source of the serratane derivatives lycojaponicuminols A **781**–F **786** (ref. 367) and the formate esters **787** and **788**.[368]

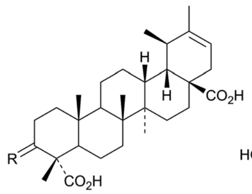

759

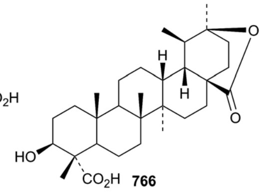

760

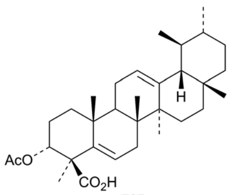

761

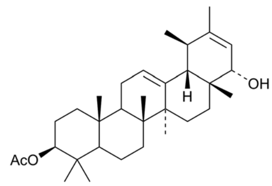

762

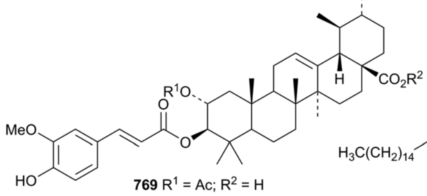

763

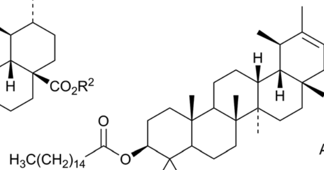

764 R = O
765 R = αOH, H

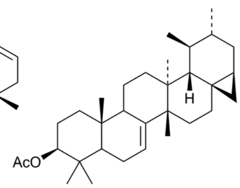

766

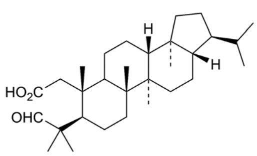

767

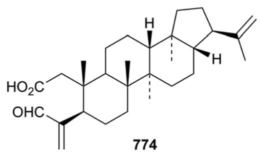

768

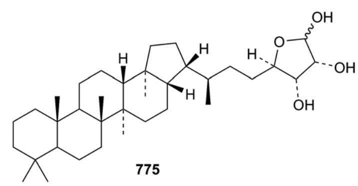

769 $R^1$ = Ac; $R^2$ = H
770 $R^1$ = H; $R^2$ = Me

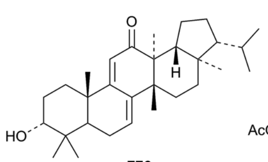

771

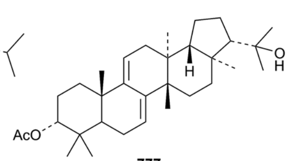

772

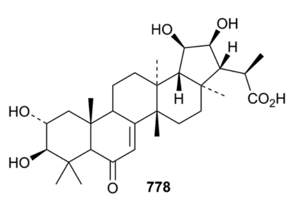

773


774

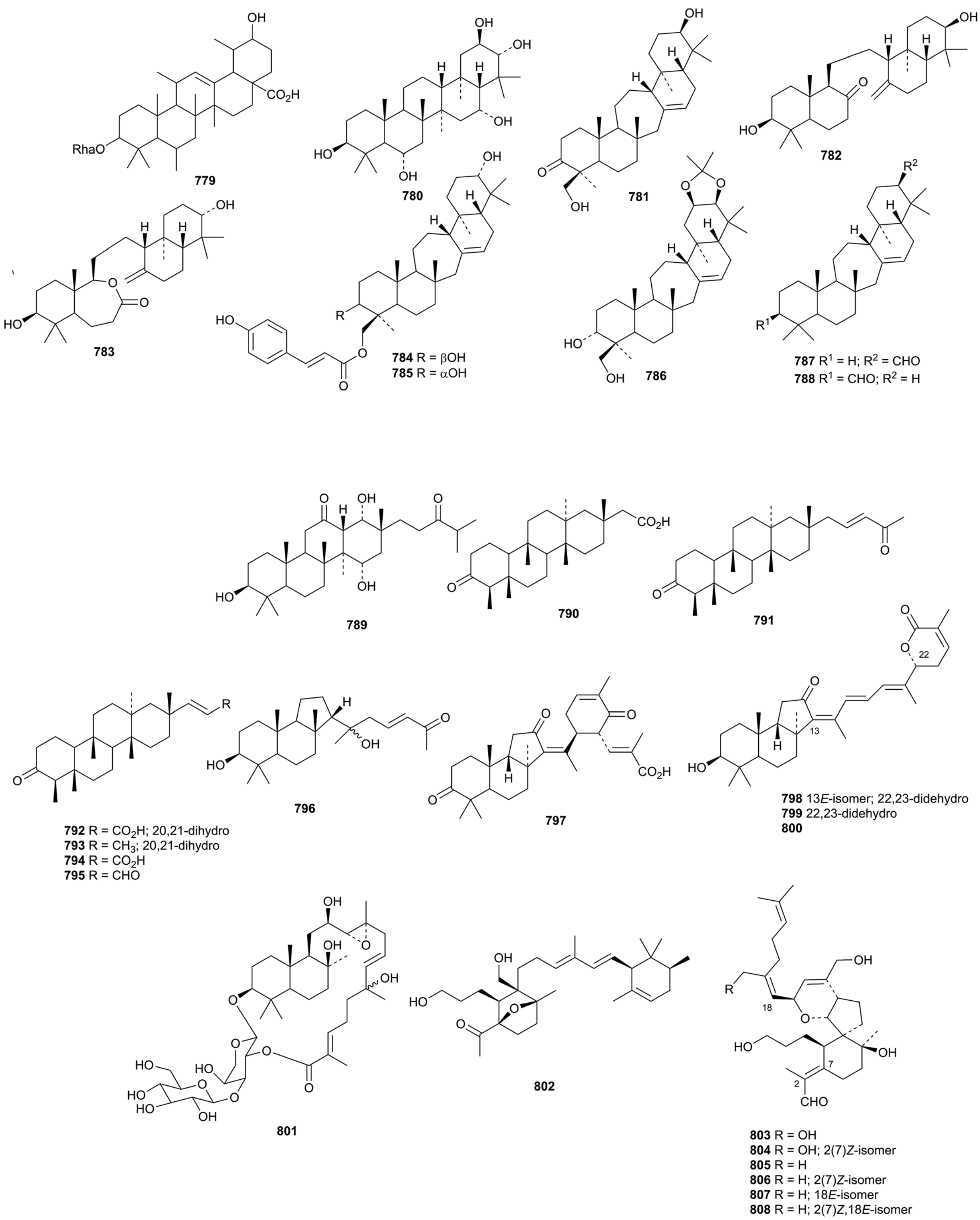

775


776


777


778

Fatsioside A, from fruit of *Fatsia japonica*, has the new bacchane genin **789**.[369] The structure of the norshionane derivative astershionone A **790**, from *Aster tataricus*, was established by X-ray analysis.[370] The related astershionones B **791**–F **795** were also isolated. Opaciniol A **796**, from *Garcinia opaca*, is a hexnormalabaracane derivative.[48] Further isomalabaricane derivatives, jaspiferins C **797**–F **800** have been found in the South China Sea sponge *Jaspis stellifera*.[371] Phyteujaposide **801** is an




unusual polypodane cyclic saponin from *Phyteuma japonicum*.[372] Further iridal triterpenoids from *Iris* species include irisgermanone **802** from *Iris germanica*[373] and spirioiridotectals A **803**–F **808** from *Iris tectorum*.[374]

## 10. Conflicts of interest

There are no conflicts of interest.

## 11. References

1 I. Podolak and Z. Janeczko, *Mini-Rev. Org. Chem.*, 2014, **11**, 280–291.
2 J.-m. Li, F. Zheng, L.-j. Zhai and Z.-h. Xue, *Zhongcaoyao*, 2014, **45**, 2265–2271.
3 W. Zhang, X. Men and P. Lei, *J. Cancer Res. Ther.*, 2014, **10**, 14–19.

4 R. Tundis, F. Menichini and M. R. Loizzo, *Stud. Nat. Prod. Chem.*, 2014, **41**, 1–32.
5 X.-J. Yan, L.-H. Gong, F.-Y. Zheng, K.-J. Cheng, Z.-S. Chen and Z. Shi, *Drug Discovery Today*, 2014, **19**, 482–488.
6 R. Paduch and M. Kandefer-Szerszen, *Mini-Rev. Org. Chem.*, 2014, **11**, 262–268.
7 J. A. R. Salvador, A. S. Leal, D. P. S. Alho, B. M. F. Goncalves, A. S. Valdeira, V. I. S. Mendes and Y. Jing, *Stud. Nat. Prod. Chem.*, 2014, **41**, 33–73.
8 J.-R. Du, F.-Y. Long and C. Chen, *Enzymes*, 2014, **36**, 95–130.
9 S. M. Kamble, S. N. Goyal and C. R. Patil, *RSC Adv.*, 2014, **4**, 33370–33382.
10 B. Han and Z. Peng, *J. Chem. Pharm. Res.*, 2014, **6**, 438–443.
11 R. V. Patel and S. W. Park, *Curr. Top. Med. Chem.*, 2014, **14**, 1940–1966.
12 L. Zhang, Q.-l. Li and L.-z. Li, *Wujing Houqin Xueyuan Xuebao, Yixueban*, 2014, **23**, 263–268.
13 G.-S. Jeong and J.-S. Bae, *Mini-Rev. Org. Chem.*, 2014, **11**, 316–329.
14 P. Ruszkowski and T. Bobkiewicz-Kozlowska, *Mini-Rev. Org. Chem.*, 2014, **11**, 307–315.
15 L. Zu, Y. Zhao and G. Gu, *J. Carbohydr. Chem.*, 2014, **33**, 269–297.
16 A. C. A. Yendo, F. de Costa, C. T. Da Costa, L. C. Colling, G. Gosmann and A. G. Fett-Neto, *Mini-Rev. Org. Chem.*, 2014, **11**, 292–306.
17 X. Li, L. Qu, Y. Dong, L. Han, E. Liu, S. Fang, Y. Zhang and T. Wang, *Molecules*, 2014, **19**, 18850–18880.
18 G. Di Fabio, V. Romanucci, A. De Marco and A. Zarrelli, *Molecules*, 2014, **19**, 10956–10981.
19 H. N. Murthy, M. I. Georgiev, Y.-S. Kim, C.-S. Jeong, S.-J. Kim, S.-Y. Park and K.-Y. Paek, *Appl. Microbiol. Biotechnol.*, 2014, **98**, 6243–6254.
20 W.-z. Yang, Y. Hu, W.-y. Wu, M. Ye and D.-a. Guo, *Phytochemistry*, 2014, **106**, 7–24.
21 G. Sachin, K. Dileep, M. Gopal and S. Shivali, *J. Drug Delivery Ther.*, 2014, **4**, 7–20.
22 J.-p. Cao, J. Tang, H.-s. Liu and X.-y. Qi, *Shipin Gongye Keji*, 2014, **35**, 384–388.
23 Y.-p. Jin, S. Yan, J.-x. Liu, Y. Yang, Y.-s. Wang and Y.-p. Wang, *Zhongcaoyao*, 2014, **45**, 137–143.
24 Y.-p. Jin, S. Yan, J.-x. Liu, Y. Yang, Y.-s. Wang and Y.-p. Wang, *Zhongcaoyao*, 2014, **45**, 1643–1650.
25 Y.-p. Jin, S. Yan, J.-x. Liu and Y.-p. Wang, *Zhongcaoyao*, 2014, **45**, 582–589.
26 R. Thimmappa, K. Geisler, T. Louveau, P. O'Maille and A. Osbourn, *Annu. Rev. Plant Biol.*, 2014, **65**, 225–257.
27 I. Abe, *Natural Poducts*, 2014, 297–316.
28 X. Yin, T. Feng, J.-H. Shang, Y.-L. Zhao, F. Wang, Z.-H. Li, Z.-J. Dong, X.-D. Luo and J.-K. Liu, *Chem.–Eur. J.*, 2014, **20**, 7001–7009.
29 N. A. Siddiqui, I.-M. Chung, P. Nagella, M. Ali, P. Alam and A. Ahmad, *Asian J. Chem.*, 2014, **26**, 6185–6188.
30 Q. Xia, H. Zhang, X. Sun, H. Zhao, L. Wu, D. Zhu, G. Yang, Y. Shao, X. Zhang, X. Mao, L. Zhang and G. She, *Molecules*, 2014, **19**, 17478–17535.
31 K. Ma, J. Ren, J. Han, L. Bao, L. Li, Y. Yao, C. Sun, B. Zhou and H. Liu, *J. Nat. Prod.*, 2014, **77**, 1847–1852.
32 X.-R. Peng, J.-Q. Liu, C.-F. Wang, X.-Y. Li, Y. Shu, L. Zhou and M.-H. Qiu, *J. Nat. Prod.*, 2014, **77**, 737–743.
33 W. Lakornwong, K. Kanokmedhakul, S. Kanokmedhakul, P. Kongsaeree, S. Prabpai, P. Sibounnavong and K. Soytong, *J. Nat. Prod.*, 2014, **77**, 1545–1553.
34 P. Kleinwaechter, N. Anh, T. T. Kiet, B. Schlegel, H.-M. Dahse, A. Haertl and U. Graefe, *J. Nat. Prod.*, 2001, **64**, 236–239.
35 L.-Y. Liu, H. Chen, C. Liu, H.-Q. Wang, J. Kang, Y. Li and R.-Y. Chen, *Fitoterapia*, 2014, **98**, 254–259.
36 L. Yu, T. Yao, M. Wang, L.-x. Chen, F. Qiu and D. Wang, *Zhongcaoyao*, 2014, **45**, 1363–1366.
37 D.-Z. Liu, Y.-Q. Zhu, X.-F. Li, W.-G. Shan and P.-F. Gao, *Chem. Biodiversity*, 2014, **11**, 982–986.
38 L.-l. Hu, Q.-y. Ma, S.-z. Huang, Z.-k. Guo, H.-x. Ma, J.-c. Guo, H.-f. Dai and Y.-x. Zhao, *Phytochem. Lett.*, 2014, **7**, 11–13.
39 C.-L. Hsu and G.-C. Yen, *Enzymes*, 2014, **36**, 33–56.
40 C. Liu, C. Zhao, H.-H. Pan, J. Kang, X.-T. Yu, H.-Q. Wang, B.-M. Li, Y.-Z. Xie and R.-Y. Chen, *J. Nat. Prod.*, 2014, **77**, 35–41.
41 Y.-M. Ying, L.-Y. Zhang, X. Zhang, H.-B. Bai, D.-E. Liang, L.-F. Ma, W.-G. Shan and Z.-J. Zhan, *Phytochemistry*, 2014, **108**, 171–176.
42 A. Umeyama, C. Ohta, Y. Shino, M. Okada, Y. Nakamura, T. Hamagaki, H. Imagawa, M. Tanaka, A. Ishiyama, M. Iwatsuki, K. Otoguro, S. Omura and T. Hashimoto, *Tetrahedron*, 2014, **70**, 8312–8315.
43 D. A. Bui, M. K. Vu, H. D. Nguyen, L.-T. T. Nguyen, S. V. Dang and L.-H. D. Nguyen, *Phytochem. Lett.*, 2014, **10**, 123–126.
44 Y.-L. Li, Y.-X. Gao, H.-Z. Jin, L. Shan, X.-S. Liang, X.-K. Xu, X.-W. Yang, N. Wang, A. Steinmetz, Z. Chen and W.-D. Zhang, *Phytochemistry*, 2014, **106**, 116–123.
45 X.-W. Yang, S.-M. Li, Y.-L. Li, L. Feng, Y.-H. Shen, S. Lin, J.-M. Tian, H.-W. Zeng, N. Wang, A. Steinmetz, Y. Liu and W.-D. Zhang, *Phytochemistry*, 2014, **105**, 164–170.
46 A. Suman, M. Ali, I. Rais and S. S. Husain, *Chem. Nat. Compd.*, 2014, **50**, 293–297.
47 A. Ali, M. Jameel and M. Ali, *Nat. Prod. J.*, 2014, **4**, 248–253.
48 R. Mori, A. E. Nugroho, Y. Hirasawa, C. P. Wong, T. Kaneda, O. Shirota, A. H. A. Hadi and H. Morita, *J. Nat. Med.*, 2014, **68**, 186–191.
49 S. Klaiklay, Y. Sukpondma, V. Rukachaisirikul and S. Phongpaichit, *Phytochemistry*, 2013, **85**, 161–166.
50 N. Jamila, M. Khairuddean, N. S. Yaacob, N. N. S. N. M. Kamal, H. Osman, S. N. Khan and N. Khan, *Bioorg. Chem.*, 2014, **54**, 60–67.
51 S. H. Ansari, M. Ali and K. J. Naquvi, *J. Saudi Chem. Soc.*, 2014, **18**, 561–565.
52 M. Shuaib, M. Ali and K. J. Naquvi, *Int. J. Pharm. Pharm. Sci.*, 2014, **6**, 372–375.
53 R. A. Mosa, M. L. Nhleko, T. V. Dladla and A. R. Opoku, *J. Med. Plants Res.*, 2014, **8**, 686–702.

54 R. A. Mosa, J. J. Naidoo, F. S. Nkomo, S. E. Mazibuko, C. J. F. Muller and A. R. Opoku, *Planta Med.*, 2014, **80**, 1685–1691.
55 S. Aichour, H. Haba, M. Benkhaled, D. Harakat and C. Lavaud, *Phytochem. Lett.*, 2014, **10**, 198–203.
56 N. Chaudhary, S. S. Husain and M. Ali, *J. Pharmacogn. Phytochem.*, 2014, **3**, 149–154.
57 M. Shimada, M. Ozawa, K. Iwamoto, Y. Fukuyama, A. Kishida and A. Ohsaki, *Chem. Pharm. Bull.*, 2014, **62**, 937–941.
58 M.-m. Zhang, L.-l. Sun, C. Li, W. Gao, J.-b. Yang, A.-g. Wang, Y.-l. Su and T.-f. Ji, *Zhongguo Zhongyao Zazhi*, 2014, **39**, 1834–1837.
59 L.-K. Wang, C.-J. Zheng, X.-B. Li, G.-Y. Chen, C.-R. Han, W.-H. Chen and X.-P. Song, *Molecules*, 2014, **19**, 7621–7628.
60 L.-K. Wang, C.-J. Zheng, X.-B. Li, G.-Y. Chen, C.-R. Han, W.-H. Chen and X.-P. Song, *Molecules*, 2015, **20**, 20268.
61 I.-M. Chung, Y.-O. Kim, M. Ali, S.-H. Kim, I. Park, E.-H. Kim, Y.-S. Yang, H.-R. Park, E.-S. Son and A. Ahmad, *Bioorg. Med. Chem. Lett.*, 2014, **24**, 4203–4208.
62 I.-M. Chung, S. Yang, S.-H. Kim and A. Ahmad, *Asian J. Chem.*, 2014, **26**, 7789–7791.
63 J.-I. Park, H.-R. Bae, C. Gun Kim, V. A. Stonik and J.-Y. Kwak, *Front. Chem.*, 2014, **2**, 1–14.
64 D. L. Aminin, E. A. Pislyagin, E. S. Menchinskaya, A. S. Silchenko, S. A. Avilov and V. I. Kalinin, *Stud. Nat. Prod. Chem.*, 2014, **41**, 75–94.
65 A. S. Silchenko, A. I. Kalinovsky, S. A. Avilov, P. V. Andryjaschenko, P. S. Dmitrenok, E. A. Yurchenko, I. Y. Dolmatov, A. M. Savchenko and V. I. Kalinin, *Nat. Prod. Commun.*, 2014, **9**, 1421–1428.
66 M. Elbandy, J. R. Rho and R. Afifi, *Eur. Food Res. Technol.*, 2014, **238**, 937–955.
67 X.-H. Wang, Y.-H. Yi, H. Han, L. Li, M.-X. Pan and Z.-R. Zou, *Mar. Drugs*, 2014, **12**, 2004–2018.
68 Y. Bahrami, W. Zhang, T. Chataway and C. Franco, *Mar. Drugs*, 2014, **12**, 4439–4473.
69 V. P. Careaga, C. Bueno, C. Muniain, L. Alché and M. S. Maier, *Nat. Prod. Res.*, 2014, **28**, 213–220.
70 R. S. Popov, S. A. Avilov, A. S. Silchenko, A. I. Kalinovsky, P. S. Dmitrenok, B. B. Grebnev, N. V. Ivanchina and V. I. Kalinin, *Biochem. Syst. Ecol.*, 2014, **57**, 191–197.
71 A. S. Silchenko, A. I. Kalinovsky, S. A. Avilov, P. V. Andryjashchenko, S. N. Fedorov, P. S. Dmitrenok, E. A. Yurchenko, V. I. Kalinin, A. V. Rogacheva and A. V. Gebruk, *Nat. Prod. Commun.*, 2014, **9**, 1259–1264.
72 P. T. Nguyen, B. T. T. Luyen, L. T. Vien, B. H. Tai, L. D. Dat, X. C. Nguyen, H. N. Nguyen, V. K. Phan, V. M. Chau and Y. H. Kim, *Nat. Prod. Commun.*, 2014, **9**, 615–618.
73 A. S. Silchenko, A. I. Kalinovsky, S. A. Avilov, P. V. Andryjaschenko, P. S. Dmitrenok, V. I. Kalinin, E. A. Yurchenko and S. S. Dautov, *Nat. Prod. Commun.*, 2014, **9**, 391–399.
74 D.-Z. Liu, *Nat. Prod. Res.*, 2014, **28**, 1099–1105.
75 M. Clericuzio, G. Vidari, C. Cassino, L. Legnani and L. Toma, *Eur. J. Org. Chem.*, 2014, 5462–5468.
76 Y.-l. Zhang, R.-q. Mei, X. Liu, G.-m. Liu and B. Wu, *Zhongcaoyao*, 2014, **45**, 2293–2298.
77 X.-B. Chen, G.-Y. Chen, J.-H. Liu, M. Lei, Y.-H. Meng, D.-A. Guo, X. Liu and L.-H. Hu, *Fitoterapia*, 2014, **94**, 88–93.
78 X. Xu, H. Bai, L. Zhou, Z. Deng, H. Zhong, Z. Wu and Q. Yao, *Bioorg. Med. Chem. Lett.*, 2014, **24**, 2159–2162.
79 J. L. Perez, G. K. Jayaprakasha and B. S. Patil, *ACS Symp. Ser.*, 2014, **1185**, 51–78.
80 J.-C. Chen, X.-X. Yuan, L. Zhou, J.-Q. Liu, Y. Nian, Z.-R. Li, Y. Li, M.-J. Xie and M.-H. Qiu, *Helv. Chim. Acta*, 2014, **97**, 1546–1554.
81 P. H. Yen, D. T. Dung, X. N. Nguyen, L. T. A. Hoang, D. T. T. Hang, D. T. H. Yen, T. C. Nguyen, N. K. Ban, V. M. Chau and V. K. Phan, *Nat. Prod. Commun.*, 2014, **9**, 383–386.
82 G.-T. Zhao, J.-Q. Liu, Y.-Y. Deng, H.-Z. Li, J.-C. Chen, Z.-R. Zhang, L. Zhou and M.-H. Qiu, *Fitoterapia*, 2014, **95**, 75–82.
83 Y.-B. Zhang, H. Liu, C.-Y. Zhu, M.-X. Zhang, Y.-L. Li, B. Ling and G.-C. Wang, *J. Asian Nat. Prod. Res.*, 2014, **16**, 358–363.
84 L. Ma, A.-H. Yu, L.-L. Sun, W. Gao, M.-M. Zhang, Y.-L. Su, H. Liu, T.-F. Ji and D.-Z. Li, *J. Asian Nat. Prod. Res.*, 2014, **16**, 476–482.
85 A. Jardón-Delgado, G. A. Magos-Guerrero and M. Martínez-Vázquez, *Nat. Prod. Commun.*, 2014, **9**, 15–16.
86 I. Prakash and V. S. P. Chaturvedula, *Molecules*, 2014, **19**, 3669–3680.
87 Z.-X. Qing, Y. Zhou, X.-B. Liu, P. Cheng and J.-G. Zeng, *Nat. Prod. Res.*, 2014, **28**, 1165–1170.
88 E. J. Jeong, J.-Y. Bae, J.-R. Rho, Y. C. Kim, M.-J. Ahn and S. H. Sung, *Bull. Korean Chem. Soc.*, 2014, **35**, 2945–2949.
89 Y.-M. Shi, L.-Y. Wang, X.-S. Zou, X.-N. Li, S.-Z. Shang, Z.-H. Gao, C.-Q. Liang, H.-R. Luo, H.-L. Li, W.-L. Xiao and H.-D. Sun, *Tetrahedron*, 2014, **70**, 859–868.
90 Y.-M. Shi, J. Yang, L. Xu, X.-N. Li, S.-Z. Shang, P. Cao, W.-L. Xiao and H.-D. Sun, *Org. Lett.*, 2014, **16**, 1370–1373.
91 C.-Q. Liang, R.-H. Luo, J.-M. Yan, Y. Li, X.-N. Li, Y.-M. Shi, S.-Z. Shang, Z.-H. Gao, L.-M. Yang, Y.-T. Zheng, W.-L. Xiao, H.-B. Zhang and H.-D. Sun, *Arch. Pharmacal Res.*, 2014, **37**, 168–174.
92 P. T. H. Minh, D. T. Lam, Q. T. Nguyen, N. T. Nguyen, V. P. Nhung, V. H. Nong, V. K. Phan, X. N. Nguyen, V. M. Chau, S. J. Park and S. H. Kim, *Nat. Prod. Commun.*, 2014, **9**, 373–374.
93 J.-h. Yeon, L. Cheng, Q.-q. He and L.-y. Kong, *Zhongguo Tianran Yaowu*, 2014, **12**, 782–785.
94 H. Wang, R. Ning, Y. Shen, Z. Chen, J. Li, R. Zhang, Y. Leng and W. Zhao, *J. Nat. Prod.*, 2014, **77**, 1910–1920.
95 R.-n. Ning, H.-m. Wang, Y. Shen, Z.-h. Chen, R.-j. Zhang, Y. Leng and W.-m. Zhao, *Bioorg. Med. Chem. Lett.*, 2014, **24**, 5395–5398.
96 L.-H. Mu, H.-J. Li, D.-H. Guo, J.-Y. Zhao and P. Liu, *Fitoterapia*, 2014, **92**, 41–45.
97 N.-M. Bao, Y. Nian, G.-L. Zhu, W.-H. Wang, L. Zhou and M.-H. Qiu, *Fitoterapia*, 2014, **99**, 191–197.

98 J.-Y. Chen, P.-L. Li, X.-L. Tang, S.-J. Wang, Y.-T. Jiang, L. Shen, B.-M. Xu, Y.-L. Shao and G.-Q. Li, *J. Nat. Prod.*, 2014, **77**, 1997–2005.
99 Y. Su, L. Wu, Q. Wang, B. Yang and H. Kuang, *Bioorg. Med. Chem. Lett.*, 2014, **24**, 5688–5691.
100 J.-X. Mo, Y. Bai, B. Liu, C.-X. Zhou, L. Zou and L.-S. Gan, *Helv. Chim. Acta*, 2014, **97**, 887–894.
101 N. Wang, G. Xu, Y. Fang, T. Yang, H. Zhao and G. Li, *Molecules*, 2014, **19**, 6623–6634.
102 J. Namukobe, B. T. Kiremire, R. Byamukama, J. M. Kasenene, V. Dumontet, F. Guéritte, S. Krief, I. Florent and J. D. Kabasa, *Phytochemistry*, 2014, **102**, 189–196.
103 Y. Nomoto, L. Harinantenaina, S. Sugimoto, K. Matsunami and H. Otsuka, *J. Nat. Med.*, 2014, **68**, 513–520.
104 J. D. Simo Mpetga, H.-P. He, X.-J. Hao, Y. Leng and P. Tane, *Phytochem. Lett.*, 2014, **7**, 52–56.
105 P. T. T. Huong, C. N. Diep, N. Van Thanh, V. A. Tu, T. H. Hanh, N. T. Cuong, N. P. Thao, N. X. Cuong, D. T. Thao, T. H. Thai, N. H. Nam, N. K. Ban, P. Van Kiem and C. Van Minh, *Nat. Prod. Commun.*, 2014, **9**, 1255–1257.
106 G. A. Mohamed, *Nat. Prod. Res.*, 2014, **28**, 976–983.
107 K.-L. Ji, P. Zhang, H.-B. Hu, S. Hua, S.-G. Liao and Y.-K. Xu, *J. Nat. Prod.*, 2014, **77**, 1764–1769.
108 G. Rajeev and S. C. Jain, *Res. J. Chem. Sci.*, 2014, **4**, 7–11.
109 X. Kuang, W. Li, Y. Kanno, M. Mochizuki, Y. Inouye and K. Koike, *Bioorg. Med. Chem. Lett.*, 2014, **24**, 5423–5427.
110 P. Sakava, E. Talla, M. Chelea, A. T. Tiabou, E. Z. o. Menkem, S. Laurent, L. Vander Elst, M. T. Fotsing, A. J. Y. Gbaweng, A. A. De Théodore and J. M. Tanyi, *J. Appl. Pharm. Sci.*, 2014, **4**, 1–9.
111 N. Denizli, I. Horo, D. Gülcemal, M. Masullo, M. Festa, A. Capasso, Ö. Koz, S. Piacente and Ö. Alankuş-Çalişkan, *Fitoterapia*, 2014, **92**, 211–218.
112 F. Xu, X. Zhao, L. Yang, X. Wang and J. Zhao, *Molecules*, 2014, **19**, 13422–13431.
113 L.-H. Mu, H.-J. Li, D.-H. Guo, J.-Y. Zhao and P. Liu, *J. Nat. Med.*, 2014, **68**, 604–609.
114 D.-f. Zhu, Y. Nian, H.-y. Wang, Z.-r. Zhang, Y.-b. Song, R.-t. Li and M.-h. Qiu, *Zhongguo Tianran Yaowu*, 2014, **12**, 294–296.
115 L. N. Gvazava and V. S. Kikoladze, *Chem. Nat. Compd.*, 2014, **50**, 1012–1015.
116 H.-J. Yan, J.-S. Wang and L.-Y. Kong, *J. Nat. Prod.*, 2014, **77**, 234–242.
117 A. E. Nugroho, T. Momota, R. Sugiura, M. Hanzawa, E. Yajima, Y. Nagakura, N. Yasuda, Y. Hirasawa, C. P. Wong, T. Kaneda, A. H. A. Hadi, H. Fukaya and H. Morita, *Tetrahedron*, 2014, **70**, 9661–9667.
118 C. Tantapakul, W. Maneerat, T. Sripisut and T. Ritthiwigrom, *Nat. Prod. Commun.*, 2014, **9**, 1553–1556.
119 N. P. Thao, B. T. T. Luyen, B. H. Tai, S. Y. Yang, S. H. Jo, N. X. Cuong, N. H. Nam, Y. I. Kwon, C. V. Minh and Y. H. Kim, *Bioorg. Med. Chem. Lett.*, 2014, **24**, 1192–1196.
120 J.-H. Yu, Y. Shen, H.-B. Liu, Y. Leng, H. Zhang and J.-M. Yue, *Org. Biomol. Chem.*, 2014, **12**, 4716–4722.
121 Y.-j. Huang, H. Lu, X.-l. Yu, S.-w. Zhang, W.-q. Wang, L.-y. Fen and L.-j. Xuan, *J. Nat. Prod.*, 2014, **77**, 1201–1209.
122 M.-M. Ding, F.-L. Yan, J. Tan, Y.-X. Bai, X. Wang and Y.-X. Yang, *Nat. Prod. Res.*, 2014, **28**, 18–23.
123 T.-L. Tran, Y.-R. Kim, J.-L. Yang, D.-R. Oh, T.-T. Dao and W.-K. Oh, *Bioorg. Med. Chem.*, 2014, **22**, 499–504.
124 J.-L. Yang, T.-K.-Q. Ha, B. Dhodary, K.-H. Kim, J. Park, C.-H. Lee, Y.-C. Kim and W.-K. Oh, *J. Nat. Prod.*, 2014, **77**, 1615–1623.
125 L. Han, M.-Y. Lin, Q. Zheng, H.-Y. Liu, H.-Y. Liu, G. Dong, J.-P. Liu and P.-Y. Li, *Nat. Prod. Res.*, 2014, **28**, 935–939.
126 L. Shi, D.-H. Tan, Y.-E. Liu, M.-X. Hou and Y.-Q. Zhao, *Helv. Chim. Acta*, 2014, **97**, 1333–1339.
127 X.-L. Piao, S.-F. Xing, C.-X. Lou and D.-J. Chen, *Bioorg. Med. Chem. Lett.*, 2014, **24**, 4831–4833.
128 N. Li, Z.-D. Tuo, S.-S. Xing, S.-Z. Qi, H.-S. Lee and L. Cui, *Bull. Korean Chem. Soc.*, 2014, **35**, 3122–3124.
129 Y. Wu, Y.-Y. Li, X. Wu, Z.-Z. Gao, C. Liu, M. Zhu, Y. Song, D.-Y. Wang, J.-G. Liu and Y.-L. Hu, *Biochem. Syst. Ecol.*, 2014, **57**, 216–220.
130 Y. Tang, J.-Q. Cao, W. Li, W. Li and Y.-Q. Zhao, *Helv. Chim. Acta*, 2014, **97**, 268–277.
131 Y. Ou, H.-B. Liu, Y. Ge, H. Li and H. Zhang, *Chem. Nat. Compd.*, 2014, **50**, 298–301.
132 A. Ladhari, R. Haouala and M. DellaGreca, *Chem. Nat. Compd.*, 2014, **50**, 684–686.
133 L. Ali, S. Ali, J. Hussain, A. Al-Harrasi, A. Latif Khan, S. Tasleem Hussain Shah and T. Shamim Rizvi, *Helv. Chim. Acta*, 2014, **97**, 556–560.
134 L.-f. Wang, J. Zhao, W.-z. Tang and X.-j. Wang, *Zhongcaoyao*, 2014, **45**, 161–163.
135 F. Ullah Khan, J. Hussain, I. Ullah Khan, N. Muhammad, S. Badshah, M. W. Aslam, S. Jan, H. Khan, R. A. Khan and H. Khan, *Asian J. Chem.*, 2014, **26**, 119–121.
136 Y. Liu, M.-Q. Zhang, X.-L. Li, T.-H. Xu, S.-X. Xie, Y.-J. Xu and D.-M. Xu, *J. Asian Nat. Prod. Res.*, 2014, **16**, 206–209.
137 Z. Yu, X.-S. Wang and Z.-H. Hu, *J. Asian Nat. Prod. Res.*, 2014, **16**, 200–205.
138 D. Li, J. Cao, X. Bi, X. Xia, W. Li and Y. Zhao, *J. Ginseng Res.*, 2014, **38**, 28–33.
139 X. Wu, J. Zhang, G. Sun, Y. Tian, X. Sun, X. Zhang, X. Zhong and X. Xu, *Rec. Nat. Prod.*, 2014, **8**, 422–425.
140 L. Qiu, Y. Jiao, G.-K. Huang, J.-Z. Xie, J.-H. Miao and X.-S. Yao, *Helv. Chim. Acta*, 2014, **97**, 102–111.
141 S.-X. Jing, S.-H. Luo, C.-H. Li, J. Hua, Y.-L. Wang, X.-M. Niu, X.-N. Li, Y. Liu, C.-S. Huang, Y. Wang and S.-H. Li, *J. Nat. Prod.*, 2014, **77**, 882–893.
142 C. Y. Ragasa, O. B. Torres, D. D. Raga, E. H. Mandia, M.-J. Don and C.-C. Shen, *Pharm. Lett.*, 2014, **6**, 290–294.
143 J. Hu, Y. Song, H. Li, B. Yang, X. Mao, Y. M. Zhao and X. Shi, *Fitoterapia*, 2014, **99**, 86–91.
144 J. Sichaem, P. Siripong, S. Tip-pyang and J. Phaopongthai, *Nat. Prod. Commun.*, 2014, **9**, 367–368.
145 K. Phontree, J. Sichaem, S. Khumkratok, P. Siripong and S. Tip-pyang, *Nat. Prod. Commun.*, 2014, **9**, 1253–1254.
146 S.-i. Kurimoto, Y. Takaishi, F. A. Ahmed and Y. Kashiwada, *Fitoterapia*, 2014, **92**, 200–205.

147 L. Chen, J.-X. Zhang, B. Wang, S.-Z. Mu and X.-J. Hao, *Fitoterapia*, 2014, **97**, 204–210.
148 W.-G. Shan, Z.-L. Gao, Y.-M. Ying, J.-G. Xiang, F.-S. Wang and Z.-J. Zhan, *Helv. Chim. Acta*, 2014, **97**, 1526–1530.
149 N. H. T. Phan, N. T. D. Thuan, N. T. Ngoc, P. T. M. Huong, N. P. Thao, N. X. Cuong, N. Van Thanh, N. H. Nam, P. Van Kiem and C. Van Minh, *Phytochem. Lett.*, 2014, **9**, 78–81.
150 J. Hu, Y. Song, H. Li, X. Mao, Y. Zhao, X. Shi and B. Yang, *Phytochem. Lett.*, 2014, **10**, 219–223.
151 M. F. Khan, A. K. Rawat, B. Pawar, S. Gautam, A. K. Srivastava and D. S. Negi, *Fitoterapia*, 2014, **98**, 98–103.
152 Z.-F. Zhou, O. Taglialatela-Scafati, H.-L. Liu, Y.-C. Gu, L.-Y. Kong and Y.-W. Guo, *Fitoterapia*, 2014, **97**, 192–197.
153 J. Sichaem, S. Khumkratok, P. Siripong and S. Tip-pyang, *J. Nat. Med.*, 2014, **68**, 436–441.
154 Y. Bai, X. Jin, X. Jia, W. Tang, X. Wang and Y. Zhao, *Phytochem. Lett.*, 2014, **10**, 118–122.
155 W.-B. Wu, H. Zhang, S.-H. Dong, L. Sheng, Y. Wu, J. Li and J.-M. Yue, *J. Asian Nat. Prod. Res.*, 2014, **16**, 709–716.
156 W.-M. Zhang, J.-Q. Liu, X.-R. Peng, L.-S. Wan, Z.-R. Zhang, Z.-R. Li and M.-H. Qiu, *Nat. Prod. Bioprospect.*, 2014, **4**, 157–162.
157 R. Tundis, M. R. Loizzo and F. Menichini, *Crit. Rev. Food Sci. Nutr.*, 2014, **54**, 225–250.
158 P. Jolanta, S. D. Jan, K. Agata and L. Stanislaw, *Mini-Rev. Org. Chem.*, 2014, **11**, 269–279.
159 O. Tzakou, *Pharmakeutike*, 2014, **26**, 6–16.
160 R. Romeo and M. A. Chiacchio, *Med. Aromat. Plants–Ind. Profiles*, 2014, **51**, 427–448.
161 S. Nagini, *Enzymes*, 2014, **36**, 131–147.
162 L. N. Bodduluru, E. R. Kasala, N. Thota, C. C. Barua and R. Sistla, *Toxicol. In Vitro*, 2014, **28**, 1026–1035.
163 E. S. Park, I. K. Bae, H. J. Jeon and S.-E. Lee, *Entomol. Res.*, 2014, **44**, 158–162.
164 M.-L. Han, Y. Shen, Y. Leng, H. Zhang and J.-M. Yue, *RSC Adv.*, 2014, **4**, 19150–19158.
165 Z.-F. Zhou, H.-L. Liu, W. Zhang, T. Kurtán, A. Mándi, A. Bényei, J. Li, O. Taglialatela-Scafati and Y.-W. Guo, *Tetrahedron*, 2014, **70**, 6444–6449.
166 J.-J. Xia, X.-Y. Li, S.-Z. Zhang, J.-Q. Liu, W.-M. Zhang, Y.-x. Yan, Z.-T. Ding and M.-H. Qiu, *Tetrahedron Lett.*, 2014, **55**, 2104–2106.
167 G.-Y. Zhu, G. Chen, L. Liu, L.-P. Bai and Z.-H. Jiang, *J. Nat. Prod.*, 2014, **77**, 983–989.
168 G.-Y. Zhu, L.-P. Bai, L. Liu and Z.-H. Jiang, *Phytochemistry*, 2014, **107**, 175–181.
169 Q. Jin, C. Lee, J. Woo Lee, J. Yeon Choi, J. Tae Hong, Y. Kim, M. Kyeong Lee and B. Yeon Hwang, *Helv. Chim. Acta*, 2014, **97**, 1152–1157.
170 J.-Q. Zhao, Y.-M. Wang, H.-T. Zhu, D. Wang, S.-H. Li, R.-R. Cheng, C.-R. Yang, Y.-F. Wang, M. Xu and Y.-J. Zhang, *Nat. Prod. Bioprospect.*, 2014, **4**, 233–242.
171 W. Kitdamrongtham, K. Ishii, K. Ebina, J. Zhang, M. Ukiya, K. Koike, H. Akazawa, A. Manosroi, J. Manosroi and T. Akihisa, *Chem. Biodiversity*, 2014, **11**, 73–84.
172 H.-M. Xia, C.-J. Li, J.-Z. Yang, J. Ma, X.-G. Chen, D. Zhang, L. Li and D.-M. Zhang, *J. Nat. Prod.*, 2014, **77**, 784–791.
173 P. Qian, H.-W. Jin and X.-W. Yang, *J. Asian Nat. Prod. Res.*, 2014, **16**, 333–344.
174 L.-L. Wang, C.-S. Jiang, Y. Fu, F.-F. Chen, L.-F. Lan, H.-Y. Zhang and Y.-W. Guo, *Helv. Chim. Acta*, 2014, **97**, 1301–1306.
175 Y. Zhang, J.-S. Wang, Y.-C. Gu and L.-Y. Kong, *Helv. Chim. Acta*, 2014, **97**, 1354–1364.
176 B. Siva, B. Poornima, A. Venkanna, K. R. Prasad, B. Sridhar, V. Lakshma Nayak, S. Ramakrishna and K. S. Babu, *Phytochemistry*, 2014, **98**, 174–182.
177 L. Liu, Y.-L. Zhao, G.-G. Cheng, Y.-Y. Chen, X.-J. Qin, C.-W. Song, X.-W. Yang, Y.-P. Liu and X.-D. Luo, *Nat. Prod. Bioprospect.*, 2014, **4**, 335–340.
178 M. Takagi, Y. Tachi, J. Zhang, T. Shinozaki, K. Ishii, T. Kikuchi, M. Ukiya, N. Banno, H. Tokuda and T. Akihisa, *Chem. Biodiversity*, 2014, **11**, 451–468.
179 H. Kato-Noguchi, M. A. Salam, O. Ohno and K. Suenaga, *Molecules*, 2014, **19**, 6929–6940.
180 M. J. Gualtieri, N. Malafronte, A. Vassallo, A. Braca, R. Cotugno, M. Vasaturo, N. De Tommasi and F. Dal Piaz, *J. Nat. Prod.*, 2014, **77**, 596–602.
181 A. Manosroi, W. Kitdamrongtham, K. Ishii, T. Shinozaki, Y. Tachi, M. Takagi, K. Ebina, J. Zhang, J. Manosroi, R. Akihisa and T. Akihisa, *Chem. Biodiversity*, 2014, **11**, 505–531.
182 X. Pan, M. Matsumoto, Y. Nakamura, T. Kikuchi, J. Zhang, M. Ukiya, T. Suzuki, K. Koike, R. Akihisa and T. Akihisa, *Chem. Biodiversity*, 2014, **11**, 987–1000.
183 X. Pan, M. Matsumoto, Y. Nishimoto, E. Ogihara, J. Zhang, M. Ukiya, H. Tokuda, K. Koike, M. Akihisa and T. Akihisa, *Chem. Biodiversity*, 2014, **11**, 1121–1139.
184 V. G. P. Severino, S. D. L. de Freitas, P. A. C. Braga, M. R. Forim, M. F. das, G. F. da Silva, J. B. Fernandes, P. C. Vieira and T. Venâncio, *Molecules*, 2014, **19**, 12031–12047.
185 C.-P. Liu, J.-B. Xu, Y.-S. Han, M. A. Wainberg and J.-M. Yue, *Org. Lett.*, 2014, **16**, 5478–5481.
186 Y. Zhang, J.-S. Wang, Y.-C. Gu, X.-B. Wang and L.-Y. Kong, *Tetrahedron*, 2014, **70**, 6594–6606.
187 J.-Y. Cai, D.-Z. Chen, S.-H. Luo, N.-C. Kong, Y. Zhang, Y.-T. Di, Q. Zhang, J. Hua, S.-X. Jing, S.-L. Li, S.-H. Li, X.-J. Hao and H.-P. He, *J. Nat. Prod.*, 2014, **77**, 472–482.
188 L.-R. Fu, Q.-Y. Ma, S.-Z. Huang, H.-F. Dai, Z.-K. Guo, Z.-F. Yu and Y.-X. Zhao, *J. Asian Nat. Prod. Res.*, 2014, **16**, 1054–1059.
189 X.-Y. Wang, C.-M. Yuan, G.-H. Tang, T. Zou, F. Guo, J.-H. Liao, H.-Y. Zhang, G.-Y. Zuo, G.-X. Rao, Q. Zhao, X.-J. Hao and H.-P. He, *J. Asian Nat. Prod. Res.*, 2014, **16**, 795–799.
190 M.-Y. Li, Q. Xiao, T. Satyanandamurty and J. Wu, *Chem. Biodiversity*, 2014, **11**, 262–275.
191 W. Chen, L. Shen, M. Li, Q. Xiao, T. Satyanandamurty and J. Wu, *Fitoterapia*, 2014, **94**, 108–113.
192 Y.-B. Wu, X. Qing, C.-H. Huo, H.-M. Yan, Q.-W. Shi, F. Sauriol, Y.-C. Gu and H. Kiyota, *Tetrahedron*, 2014, **70**, 4557–4562.
193 Z.-F. Zhou, L.-Y. Kong, T. Kurtán, H.-L. Liu, A. Mándi, J. Li, Y.-C. Gu and Y.-W. Guo, *Planta Med.*, 2014, **80**, 949–954.

194 Y. Wu, Y. Bai, X. Guo, J. Qi, M. Dong, F. Sauriol, Q. Shi, Y. Gu and C. Huo, *Chem. Nat. Compd.*, 2014, **50**, 314–316.
195 C. Sarigaputi, D. Sommit, T. Teerawatananond and K. Pudhom, *J. Nat. Prod.*, 2014, **77**, 2037–2043.
196 T. Inoue, Y. Matsui, T. Kikuchi, Y. In, O. Muraoka, T. Yamada and R. Tanaka, *Fitoterapia*, 2014, **96**, 56–64.
197 Y. Matsui, T. Kikuchi, T. Inoue, O. Muraoka, T. Yamada and R. Tanaka, *Molecules*, 2014, **19**, 17130–17140.
198 K.-L. Ji, S.-G. Liao, X.-L. Zheng, Z. Na, H.-B. Hu, P. Zhang and Y.-K. Xu, *Molecules*, 2014, **19**, 3004–3011.
199 W.-B. Wu, H. Zhang, H.-C. Liu, S.-H. Dong, Y. Wu, J. Ding and J.-M. Yue, *Tetrahedron*, 2014, **70**, 3570–3575.
200 F. Zhang, C.-R. Zhang, X. Tao, J. Wang, W.-S. Chen and J.-M. Yue, *Bioorg. Med. Chem. Lett.*, 2014, **24**, 3791–3796.
201 H.-L. Liu, X.-L. Chen, W. Xiao and Y.-W. Guo, *Helv. Chim. Acta*, 2014, **97**, 1445–1451.
202 S. Razafimahefa, F. Mutulis, I. Mutule, E. Liepinsh, M. Dambrova, H. Cirule, B. Svalbe, S. Yahorava, A. Yahorau, B. Rasolondratovo, P. Rasoanaivo and J. E. S. Wikberg, *Planta Med.*, 2014, **80**, 306–314.
203 P. A. Yadav, G. Suresh, M. S. A. Rao, G. Shankaraiah, P. Usha Rani and K. S. Babu, *Bioorg. Med. Chem. Lett.*, 2014, **24**, 888–892.
204 Y.-B. Cheng, Y.-T. Chien, J.-C. Lee, C.-K. Tseng, H.-C. Wang, I. W. Lo, Y.-H. Wu, S.-Y. Wang, Y.-C. Wu and F.-R. Chang, *J. Nat. Prod.*, 2014, **77**, 2367–2374.
205 J.-L. Yin, X. Fang, E.-D. Liu, C.-M. Yuan, S.-F. Li, Y. Zhang, H.-P. He, S.-L. Li, Y.-T. Di and X.-J. Hao, *Planta Med.*, 2014, **80**, 1304–1309.
206 S.-M. Hu, J. Luo, L. Yang and L.-Y. Kong, *Tetrahedron Lett.*, 2014, **55**, 815–817.
207 S. Park, N. X. Nhiem, P. V. Kiem, C. V. Minh, B. H. Tai, N. Kim, H. H. Yoo, J.-H. Song, H.-J. Ko and S. H. Kim, *Bioorg. Med. Chem. Lett.*, 2014, **24**, 3835–3840.
208 D. Meng, X. Li, L. Han, L. Zhang, W. An and X. Li, *Fitoterapia*, 2014, **92**, 105–110.
209 T. V. A. Tran, C. Malainer, S. Schwaiger, A. G. Atanasov, E. H. Heiss, V. M. Dirsch and H. Stuppner, *J. Nat. Prod.*, 2014, **77**, 483–488.
210 X.-L. Yang, Y.-L. Yuan, D.-M. Zhang, F. Li and W.-C. Ye, *Nat. Prod. Res.*, 2014, **28**, 1432–1437.
211 J.-e. Yi, J. Wu, L.-x. Wen, W. Xia, R.-c. Zhu, W.-w. Jiang and Z.-l. Tan, *Zhongcaoyao*, 2014, **45**, 2118–2124.
212 R. Csuk, *Expert Opin. Ther. Pat.*, 2014, **24**, 913–923.
213 S. Jeelani and M. A. Khuroo, *Chem. Nat. Compd.*, 2014, **50**, 681–683.
214 J. Zhou, C.-J. Li, J.-Z. Yang, J. Ma, Y. Li, X.-Q. Bao, X.-G. Chen, D. Zhang and D.-M. Zhang, *J. Nat. Prod.*, 2014, **77**, 276–284.
215 L.-S. Shi, C.-H. Wu, T.-C. Yang, C.-W. Yao, H.-C. Lin and W.-L. Chang, *Fitoterapia*, 2014, **97**, 184–191.
216 M.-H. Yu, Z.-F. Shi, B.-W. Yu, E.-H. Pi, H.-Y. Wang, A.-J. Hou and C. Lei, *Fitoterapia*, 2014, **98**, 143–148.
217 L. Ali, J. Hussain, A. Al-Rawahi and A. Al-Harrasi, *Rec. Nat. Prod.*, 2014, **8**, 407–411.
218 S. Rungsimakan and M. G. Rowan, *Phytochemistry*, 2014, **108**, 177–188.
219 J. Hu, Y. Song, B. Yang, X. Zuo, X. Mao and X. Shi, *Arch. Pharmacal Res.*, 2014, **37**, 1515–1521.
220 A. Latif, S. H. Hussain, M. Ali, M. Arfan, M. Ahmed, R. J. Cox, T. J. Simpson and G. Uddin, *Rec. Nat. Prod.*, 2014, **8**, 19–24.
221 P. S. Ghosh, I. S. Sarma, N. Sato, Y. Harigaya and B. Dinda, *Indian J. Chem., Sect. B: Org. Chem. Incl. Med. Chem.*, 2014, **53B**, 1284–1287.
222 O. Estrada, W. Contreras, G. Acha, E. Lucena, W. Venturini, A. Cardozo and C. Alvarado-Castillo, *Molecules*, 2014, **19**, 21215–21225.
223 Y. Wang, C.-L. Zhang, Y.-F. Liu, D. Liang, H. Luo, Z.-Y. Hao, R.-Y. Chen and D.-Q. Yu, *Planta Med.*, 2014, **80**, 215–222.
224 C. B. Colloca, L. A. Espinar and V. E. Sosa, *Nat. Prod.: Indian J.*, 2014, **10**, 61–68.
225 C. Guang, J. Chen, S. Sang and S. Cheng, *J. Agric. Food Chem.*, 2014, **62**, 8247–8255.
226 K. Jatczak and G. Grynkiewicz, *Acta Biochim. Pol.*, 2014, **61**, 227–243.
227 N. R. Parikh, A. Mandal, D. Bhatia, K. S. Siveen, G. Sethi and A. Bishayee, *Phytochem. Rev.*, 2014, **13**, 793–810.
228 A. Paszel-Jaworska, A. Romaniuk and M. Rybczynska, *Mini-Rev. Org. Chem.*, 2014, **11**, 330–342.
229 M. K. Shanmugam, X. Dai, A. P. Kumar, B. K. H. Tan, G. Sethi and A. Bishayee, *Cancer Lett.*, 2014, **346**, 206–216.
230 Q.-F. Luo, J.-H. Liu and L. Chen, *Mini-Rev. Org. Chem.*, 2014, **11**, 355–361.
231 X. Huang and Y. Yang, *Guoji Zhongliuxue Zazhi*, 2014, **41**, 96–99.
232 G. Lozano-Mena, M. Sánchez-González, M. E. Juan and J. M. Planas, *Molecules*, 2014, **19**, 11538–11559.
233 R. Zhong, R. Shu, X. Ni, C. Xu and L. Li, *Yaoxue Xuebao*, 1996, **31**, 398–400.
234 M. E. Wright, J. Byrd, C. He and N. Dunlap, *J. Nat. Prod.*, 2014, **77**, 2566–2569.
235 S.-J. Liu, Z.-X. Liao, C. Liu, G.-Y. Yao and H.-S. Wang, *Phytochem. Lett.*, 2014, **9**, 11–16.
236 I.-H. Chen, Y.-C. Du, T.-L. Hwang, I. F. Chen, Y.-H. Lan, H.-F. Yen, F.-R. Chang and Y.-C. Wu, *Molecules*, 2014, **19**, 4608–4623.
237 J. Zhang, J. Liu, B. Xu, Y. Zhuang, M. Yosikawa and B. Yin, *Asian J. Chem.*, 2014, **26**, 4521–4522.
238 E.-S. A. El-Kashoury, H. I. El-Askary, Z. A. Kandil, S. M. Ezzat, M. A. Salem and A. A. Sleem, *J. Med. Plants Res.*, 2014, **8**, 747–755.
239 M. N. Uddin, G. Sharma, J.-L. Yang, H. S. Choi, S.-I. L. Lim, K. W. Kang and W. K. Oh, *Phytochemistry*, 2014, **103**, 99–106.
240 H.-j. Shang, W.-j. Wang, D.-y. Li, H.-m. Hua and Z.-l. Li, *Zhongcaoyao*, 2014, **45**, 1207–1210.
241 K. Jiang, J.-Q. Bai, J. Chang, J.-J. Tan, S.-J. Qu, H.-F. Luo, C.-H. Tan and D.-Y. Zhu, *Helv. Chim. Acta*, 2014, **97**, 64–69.
242 J. Wang, Q.-L. Xu, M.-F. Zheng, H. Ren, T. Lei, P. Wu, Z.-Y. Zhou, X.-Y. Wei and J.-W. Tan, *Molecules*, 2014, **19**, 4301–4312.

243 S. Ji, Q. Wang, X. Qiao, H.-c. Guo, Y.-f. Yang, T. Bo, C. Xiang, D.-a. Guo and M. Ye, *J. Pharm. Biomed. Anal.*, 2014, **90**, 15–26.
244 R. Chib, M. Kumar, M. Rizvi, S. Sharma, A. Pandey, S. Bani, S. S. Andotra, S. C. Taneja and B. A. Shah, *RSC Adv.*, 2014, **4**, 8632–8637.
245 M.-M. Li, X.-Q. Su, J. Sun, Y.-F. Gu, Z. Huang, K.-W. Zeng, Q. Zhang, Y.-F. Zhao, D. Ferreira, J. K. Zjawiony, J. Li and P.-F. Tu, *J. Nat. Prod.*, 2014, **77**, 2248–2254.
246 Y.-b. Zhang, W.-z. Yang, C.-l. Yao, R.-h. Feng, M. Yang, D.-a. Guo and W.-y. Wu, *Fitoterapia*, 2014, **96**, 39–47.
247 O. Aiyelaagbe, O. Olaoluwa, I. Oladosu and S. Gibbons, *Rec. Nat. Prod.*, 2014, **8**, 7–11.
248 B. N. Irungu, J. A. Orwa, A. Gruhnojic, P. A. Fitzpatrick, G. Landberg, F. Kimani, J. Midiwo, M. Erdélyi and A. Yenesew, *Molecules*, 2014, **19**, 14235–14246.
249 Z.-Y. Wu, Y.-B. Zhang, K.-K. Zhu, C. Luo, J.-X. Zhang, C.-R. Cheng, R.-H. Feng, W.-Z. Yang, F. Zeng, Y. Wang, P.-P. Xu, J.-L. Guo, X. Liu, S.-H. Guan and D.-A. Guo, *J. Nat. Prod.*, 2014, **77**, 2342–2351.
250 H. Lakhal, A. Kabouche, A. Alabdul Magid, L. Voutquenne-Nazabadioko, D. Harakat and Z. Kabouche, *Phytochemistry*, 2014, **102**, 145–151.
251 J. Cai, L. Zhao, E. Zhu and J. Guo, *Nat. Prod. Res.*, 2014, **28**, 2163–2168.
252 J.-H. Wei, Y.-F. Zheng, C.-Y. Li, Y.-P. Tang and G.-P. Peng, *J. Asian Nat. Prod. Res.*, 2014, **16**, 1044–1053.
253 W. Song, L. Si, S. Ji, H. Wang, X.-m. Fang, L.-y. Yu, R.-y. Li, L.-n. Liang, D. Zhou and M. Ye, *J. Nat. Prod.*, 2014, **77**, 1632–1643.
254 Y. Shao, D.-W. Ou-Yang, W. Gao, L. Cheng, X.-X. Weng and D.-Y. Kong, *Helv. Chim. Acta*, 2014, **97**, 992–998.
255 C. Chen, W. Gao, L. Cheng, Y. Shao and D.-Y. Kong, *J. Asian Nat. Prod. Res.*, 2014, **16**, 231–239.
256 H. Zhou, C. Z. Wang, J. Z. Ye and H. X. Chen, *Phytochem. Lett.*, 2014, **8**, 46–51.
257 K. Matsuzaki, K. Murano, Y. Endo and S. Kitanaka, *Nat. Prod. Commun.*, 2014, **9**, 1695–1698.
258 H. Xiong, X. Ding, X.-z. Yang, G.-z. Yang and Z.-n. Mei, *Planta Med.*, 2014, **80**, 710–718.
259 F.-M. Xi, C.-T. Li, J. Han, S.-S. Yu, Z.-J. Wu and W.-S. Chen, *Bioorg. Med. Chem.*, 2014, **22**, 6515–6522.
260 M. Masullo, L. Calabria, D. Gallotta, C. Pizza and S. Piacente, *Phytochemistry*, 2014, **97**, 70–80.
261 Y. Jiang, K.-W. Zeng, B. David and G. Massiot, *Phytochemistry*, 2014, **107**, 111–118.
262 N. B. Sarikahya, *Phytochem. Lett.*, 2014, **8**, 149–155.
263 B. K. Ponou, R. N. Nono, R. B. Teponno, A. L. Tapondjou, M.-A. Lacaille-Dubois, L. Quassinti, M. Bramucci and L. Barboni, *Phytochem. Lett.*, 2014, **10**, 255–259.
264 F. R. Melek, I. A. A. Kassem, T. Miyase and W. Fayad, *Phytochemistry*, 2014, **100**, 110–119.
265 X. Pang, H.-X. Yan, Z.-F. Wang, M.-X. Fan, Y. Zhao, X.-T. Fu, C.-Q. Xiong, J. Zhang, B.-P. Ma and H.-Z. Guo, *J. Asian Nat. Prod. Res.*, 2014, **16**, 240–247.
266 S.-G. Li, X.-J. Huang, M.-M. Li, M. Wang, R.-B. Feng, W. Zhang, Y.-L. Li, Y. Wang and W.-C. Ye, *Chem. Pharm. Bull.*, 2014, **62**, 35–44.
267 B.-S. Cui, Y.-Q. Qiao, Y. Yuan, L. Tang, H. Chen, Y. Li and S. Li, *Planta Med.*, 2014, **80**, 1647–1656.
268 S.-l. Yan, Y.-f. Su, X.-y. Xie, C.-y. Guo, M. Que and L. Chen, *Zhongcaoyao*, 2014, **45**, 23–27.
269 L. Qiao, Y.-f. Su, C.-y. Guo, X.-y. Xie, M. Que and L. Chen, *Zhongcaoyao*, 2014, **45**, 1211–1218.
270 P. Kayce, N. Boke Sarikahya and S. Kirmizigul, *Phytochem. Lett.*, 2014, **10**, 324–329.
271 X.-J. Huang, J.-Q. Tang, M.-M. Li, Q. Liu, Y.-L. Li, C.-L. Fan, H. Pei, H.-N. Zhao, Y. Wang and W.-C. Ye, *J. Asian Nat. Prod. Res.*, 2014, **16**, 910–921.
272 N. P. Alza, E.-M. Pferschy-Wenzig, S. Ortmann, N. Kretschmer, O. Kunert, G. N. Rechberger, R. Bauer and A. P. Murray, *Chem. Biodiversity*, 2014, **11**, 311–322.
273 Y. Lei, S.-P. Shi, Y.-L. Song, D. Bi and P.-F. Tu, *Chem. Biodiversity*, 2014, **11**, 767–775.
274 Y. Zhou, K. Zeng, J. Zhang, N. Li, X. Chai, Y. Jiang and P. Tu, *Fitoterapia*, 2014, **97**, 98–104.
275 F. D. Mabou, P. L. F. Tebou, D. Ngnokam, D. Harakat and L. Voutquenne-Nazabadioko, *Magn. Reson. Chem.*, 2014, **52**, 32–36.
276 Q.-J. Li, Z. Zhu, X.-S. Yang and X.-J. Hao, *Helv. Chim. Acta*, 2014, **97**, 839–846.
277 M. Kuroda, T. Shizume and Y. Mimaki, *Chem. Pharm. Bull.*, 2014, **62**, 92–96.
278 Y. Zhang, T. A. Adelakun, L. Qu, X. Li, J. Li, L. Han and T. Wang, *Fitoterapia*, 2014, **99**, 78–85.
279 X. Li, J. Zhao, C. Peng, Z. Chen, Y. Liu, Q. Xu, I. A. Khan and S. Yang, *Planta Med.*, 2014, **80**, 590–598.
280 J. Zhang, M. Kurita, T. Shinozaki, M. Ukiya, K. Yasukawa, N. Shimizu, H. Tokuda, E. T. Masters, M. Akihisa and T. Akihisa, *Phytochemistry*, 2014, **108**, 157–170.
281 C. Bäcker, K. Jenett-Siems, K. Siems, M. Wurster, A. Bodtke and U. Lindequist, *Z. Naturforsch., C: J. Biosci.*, 2014, **69**, 191–198.
282 C. Bäcker, K. Jenett-Siems, K. Siems, M. Wurster, A. Bodtke, T. H. J. Niedermeyer and U. Lindequist, *Z. Naturforsch., B: J. Chem. Sci.*, 2014, **69**, 1026–1044.
283 T. Morikawa, K. Ninomiya, K. Imura, T. Yamaguchi, Y. Akagi, M. Yoshikawa, T. Hayakawa and O. Muraoka, *Phytochemistry*, 2014, **102**, 169–181.
284 Y. Zhao, X. Wang, H. Wang, T. Liu and Z. Xin, *Food Chem.*, 2014, **151**, 101–109.
285 W.-b. Wei, Y.-j. Huang, H.-j. Cong, S.-w. Zhang, D.-r. Pan and L.-j. Xuan, *Phytochem. Lett.*, 2014, **8**, 101–104.
286 Y. Wang, L. Wang, W.-J. Wang, X.-Q. Zhang, H.-Y. Tian, Q.-W. Zhang, Y.-L. Li and W.-C. Ye, *Carbohydr. Res.*, 2014, **385**, 65–71.
287 C.-Q. Wang, Y. Wang, W.-J. Wang, L. Wang and W.-C. Ye, *Phytochem. Lett.*, 2014, **10**, 268–271.
288 H. K. Cho, C. S. Kim, W. S. Suh, K. H. Kim and K. R. Lee, *Heterocycles*, 2014, **89**, 2619–2626.
289 I. Arslan, *Chem. Biodiversity*, 2014, **11**, 445–450.

290 Y. Chen, F. Yang, S. Wang, D.-b. Wang, J. Xu and G.-z. Yang, *Bull. Korean Chem. Soc.*, 2014, **35**, 1212–1214.
291 N. Asati and R. N. Yadava, *Int. J. Pharm. Res. Bio-Sci.*, 2014, **3**, 341–349.
292 X. Wang, M. Wang, M. Xu, Y. Wang, H. Tang and X. Sun, *Molecules*, 2014, **19**, 2121–2134.
293 B. Huang, H.-Z. Fu, W.-K. Chen, Y.-H. Luo and S.-C. Ma, *Chem. Pharm. Bull.*, 2014, **62**, 695–699.
294 B. K. Mehta, D. Mehta and H. Misra, *J. Indian Chem. Soc.*, 2014, **91**, 1583–1590.
295 M. Zhao, N. Ma, F. Qiu, W.-L. Hai, H.-F. Tang, Y. Zhang and A.-D. Wen, *Planta Med.*, 2014, **80**, 942–948.
296 Z.-H. Pan, D.-S. Ning, J.-L. Liu, B. Pan and D.-P. Li, *Nat. Prod. Res.*, 2014, **28**, 48–51.
297 F.-M. Xi, C.-T. Li, J.-L. Mi, Z.-J. Wu and W.-S. Chen, *Nat. Prod. Res.*, 2014, **28**, 35–40.
298 M. Kowalczyk, M. Masullo, B. Thiem, S. Piacente, A. Stochmal and W. Oleszek, *Nat. Prod. Res.*, 2014, **28**, 653–660.
299 E. G. Montes, A.-C. Mitaine-Offer, J. M. Amaro-Luis, T. Paululat, C. Delaude, L. Pouysegu, S. Quideau, L. B. Rojas, S. Delemasure, P. Dutartre and M.-A. Lacaille-Dubois, *Phytochemistry*, 2014, **98**, 236–242.
300 H.-M. Wang, Q.-F. Liu, Y.-W. Zhao, S.-Z. Liu, Z.-H. Chen, R.-J. Zhang, Z.-Z. Wang, W. Xiao and W.-M. Zhao, *J. Asian Nat. Prod. Res.*, 2014, **16**, 20–28.
301 Y. Liu, T.-h. Xu, M.-q. Zhang, X. Li, Y.-j. Xu, H.-y. Jiang, T.-h. Liu and D.-m. Xu, *Zhongguo Tianran Yaowu*, 2014, **12**, 300–304.
302 D. Pertuit, S. Avunduk, A.-C. Mitaine-Offer, T. Miyamoto, C. Tanaka, T. Paululat, S. Delemasure, P. Dutartre and M.-A. Lacaille-Dubois, *Phytochemistry*, 2014, **102**, 182–188.
303 J. Y. Eskander, E. G. Haggag, M. R. El-Gindi and M. M. Mohamedy, *Med. Chem. Res.*, 2014, **23**, 717–724.
304 M. A. Tantry, G. A. Bhat, A. Idris, J. A. Dar, S. Yousef Al Omar, K. Z. Masoodi, B. A. Ganai, A. N. Kamili and A. S. Shawl, *Helv. Chim. Acta*, 2014, **97**, 1497–1506.
305 L. Ma, A.-H. Yu, L.-L. Sun, W. Gao, M.-M. Zhang, Y.-L. Su, H. Liu and T. Ji, *Molecules*, 2014, **19**, 2238–2246.
306 D. Gülcemal, M. Masullo, Ö. Alankuş-Çalişkan and S. Piacente, *Fitoterapia*, 2014, **92**, 274–279.
307 F. Feng, X.-y. Xu, F.-l. Liu, W.-y. Liu and N. Xie, *Zhongguo Tianran Yaowu*, 2014, **12**, 43–46.
308 M. J. Manase, A.-C. Mitaine-Offer, T. Miyamoto, C. Tanaka, S. Delemasure, P. Dutartre and M.-A. Lacaille-Dubois, *Phytochemistry*, 2014, **100**, 150–155.
309 M. Kuroda, T. Shizume and Y. Mimaki, *Nat. Prod. Commun.*, 2014, **9**, 379–382.
310 T. Murata, M. Nakano, T. Miyase and F. Yoshizaki, *Chem. Pharm. Bull.*, 2014, **62**, 608–612.
311 X.-M. Zhang, D.-P. Yang, Z.-Y. Xie, X. Xue, L.-P. Zhu, D.-M. Wang and Z.-M. Zhao, *Nat. Prod. Res.*, 2014, **28**, 1058–1064.
312 Q. Wu, G. Tu and H. Fu, *J. Chin. Pharm. Sci.*, 2014, **23**, 246–250.
313 G. Şenel, D. Gülcemal, M. Masullo, S. Piacente and T. Karayildirim, *Chem. Biodiversity*, 2014, **11**, 408–418.
314 W. Li and X. Li, *Chem. Nat. Compd.*, 2014, **50**, 100–102.
315 X.-L. Zhou, C.-J. Xiao, L.-B. Wu, B. Huang, X. Dong and B. Jiang, *J. Asian Nat. Prod. Res.*, 2014, **16**, 555–564.
316 M. Iqbal, M. Bilal, R. Iqbal, M. Akram, I. B. Baloch and M. K. Baloch, *Journal of Chemistry*, 2014, 396436.
317 R. F. Ngamgwe, R. Yankam, J. R. Chouna, C. Lanz, J. Furrer, S. Schurch, M. Kaiser, B. N. Lenta, S. Ngouela, E. Tsamo and R. Brenneisen, *Iran. J. Pharm. Res.*, 2014, **13**, 1425–1430.
318 C. Berto, F. Maggi, P. C. B. Nya, A. Pettena, I. Boschiero and S. Dall'Acqua, *Nat. Prod. Commun.*, 2014, **9**, 1691–1694.
319 M. Ye, J. Xiong, J.-J. Zhu, J.-L. Hong, Y. Zhao, H. Fan, G.-X. Yang, G. Xia and J.-F. Hu, *J. Nat. Prod.*, 2014, **77**, 178–182.
320 R. L. M. Al Muqarrabun, N. Ahmat, S. R. S. Aris, N. Norizan, N. Shamsulrijal, F. Z. M. Yusof, M. N. Suratman, M. I. M. Yusof and F. Salim, *Nat. Prod. Res.*, 2014, **28**, 1003–1009.
321 Q.-W. Tan, M.-A. Ouyang, Q.-J. Chen and Z.-J. Wu, *Molecules*, 2014, **19**, 17619–17631.
322 O. A. Omoyeni, M. Meyer, E. Iwuoha, I. Green and A. A. Hussein, *Molecules*, 2014, **19**, 3389–3400.
323 M. Zhao, N. Ma, F. Qiu, X. Tian, Y. Zhang, H. Tang and X. Liu, *Fitoterapia*, 2014, **97**, 234–240.
324 V. E. Rasamison, L. H. Rakotondraibe, C. Slebodnick, P. J. Brodie, M. Ratsimbason, K. TenDyke, Y. Shen, L. M. Randrianjanaka and D. G. I. Kingston, *Org. Lett.*, 2014, **16**, 2626–2629.
325 T. Kikuchi, S. Ueda, J. Kanazawa, H. Naoe, T. Yamada and R. Tanaka, *Molecules*, 2014, **19**, 4802–4813.
326 N. M. Al Musayeib, R. A. Mothana, S. R. M. Ibrahim, A. A. El Gamal and S. M. Al-Massarani, *Nat. Prod. Res.*, 2014, **28**, 1142–1146.
327 D.-b. Pu, Y. Gao, R.-t. Li and H.-z. Li, *Bopuxue Zazhi*, 2014, **31**, 437–447.
328 D. Chen, X. Cheng, Y. Sun and P. Liu, *Chem. Nat. Compd.*, 2014, **50**, 93–96.
329 W.-H. Tang, S.-T. Bai, L. Tong, W.-J. Duan, J.-W. Su, J.-X. Chen and Y. Xie, *Biochem. Syst. Ecol.*, 2014, **54**, 78–82.
330 M. González-Cortazar, M. Herrera-Ruiz, A. Zamilpa, E. Jiménez-Ferrer, S. Marquina, L. Álvarez and J. Tortoriello, *Planta Med.*, 2014, **80**, 90–96.
331 G. Faria de Sousa, D. C. F. Soares, W. d. N. Mussel, N. F. E. Pompeu, G. D. d. F. Silva, S. A. Vieira Filho and L. P. Duarte, *J. Braz. Chem. Soc.*, 2014, **25**, 1338–1345.
332 S. Wittayalai, C. Mahidol, V. Prachyawarakorn, H. Prawat and S. Ruchirawat, *Phytochemistry*, 2014, **99**, 121–126.
333 J. A. R. Salvador, R. C. Santos, S. A. C. Figueiredo and Y. Jing, *Mini-Rev. Org. Chem.*, 2014, **11**, 400–407.
334 Y.-l. Sun and H. Luo, *Yixue Zongshu*, 2014, **20**, 656–658.
335 L.-l. Zang, B.-n. Wu, Y. Lin, J. Wang, L. Fu and Z.-y. Tang, *Chin. J. Integr. Med.*, 2014, **20**, 72–79.
336 Q.-W. Tan, M.-A. Ouyang and B. Gao, *Molecules*, 2014, **19**, 4897–4906.
337 W.-L. Wang, X. Zhou, Y.-L. Liu, Q.-M. Xu, X.-R. Li and S.-L. Yang, *J. Asian Nat. Prod. Res.*, 2014, **16**, 175–180.

338 R. Hossain, R. Sultana, A. Adhikari, M. I. Choudhary, Y. Ali and S. Zaman, *Nat. Prod. Commun.*, 2014, **9**, 371–372.
339 X.-P. Wu, X.-P. Zhang, G.-X. Ma, M. Han, M.-D. Xu, H.-F. Wu, X.-Y. Huang, Z. Huang, J.-S. Yang, J.-Q. Yuan, X.-D. Xu and X.-M. Zhong, *J. Asian Nat. Prod. Res.*, 2014, **16**, 422–425.
340 L. P. Sandjo, C. G. Fru, V. Kuete, F. Nana, S. O. Yeboah, R. Mapitse, B. M. Abegaz, T. Efferth, T. Opatz and B. T. Ngadjui, *Z. Naturforsch., C: J. Biosci.*, 2014, **69**, 276–282.
341 P. Srivastava, Jyotshna, N. Gupta, A. K. Maurya and K. Shanker, *Nat. Prod. Res.*, 2014, **28**, 306–311.
342 P. Rudrapaul, N. Das, U. C. De and B. Dinda, *Phytochem. Lett.*, 2014, **9**, 7–10.
343 X.-f. Cao, J.-s. Wang, P.-r. Wang and L.-y. Kong, *Zhongguo Tianran Yaowu*, 2014, **12**, 628–631.
344 Q.-Q. He, L. Yang, J.-Y. Zhang, J.-N. Ma and C.-M. Ma, *J. Food Sci.*, 2014, **79**, C1970–C1983.
345 H.-P. Yang, S. Que, Y.-P. Shi and L.-T. Ban, *J. Chem. Pharm. Res.*, 2014, **6**, 1986–1990.
346 A. Qiao, Y. Wang, L. Xiang, Z. Zhang and X. He, *Fitoterapia*, 2014, **98**, 137–142.
347 C. Wu, Y.-H. Duan, W. Tang, M.-M. Li, X. Wu, G.-C. Wang, W.-C. Ye, G.-X. Zhou and Y.-L. Li, *Fitoterapia*, 2014, **92**, 127–132.
348 M. I. Anjum, E. Ahmed, A. Sharif, A. Jabbar, A. Malik, T. Hussain, Z. H. Farooqi and A. Nawaz, *Asian J. Chem.*, 2014, **26**, 7386–7388.
349 M. N. Samy, S. Sugimoto, K. Matsunami, H. Otsuka and M. S. Kamel, *Phytochem. Lett.*, 2014, **10**, 86–90.
350 L. Li, L.-S. Feng and Y.-X. He, *J. Asian Nat. Prod. Res.*, 2014, **16**, 830–835.
351 S. A. Sasmakov, Z. M. Putieva and U. Lindequist, *Pharmazie*, 2007, **62**, 957–959.
352 Y. Liu, L. Cheng, Q.-q. He, J.-h. Yeon and D.-y. Kong, *Zhongcaoyao*, 2014, **45**, 2742–2747.
353 H. K. Cho, C. S. Kim, K. W. Woo and K. R. Lee, *Bull. Korean Chem. Soc.*, 2014, **35**, 1553–1555.
354 S. S. Khan, A. Khan, A. Khan, U. Farooq, A. Ahmed, A. Zahoor, V. Uddin Ahmad, B. Sener and N. Kucukboyaci, *Rec. Nat. Prod.*, 2014, **8**, 354–359.
355 Y.-x. Ding, T.-y. Wang, Y.-w. Zhang, Y.-m. Huang, L. Ma, D.-d. Li, D.-q. Dou and Q. Li, *Zhongguo Zhongyao Zazhi*, 2014, **39**, 4225–4229.
356 W. Wang, J. Zhao, S. Li, Y. Lu, Y. Liu, Q. Xu, X. Li, I. A. Khan and S. Yang, *Fitoterapia*, 2014, **99**, 40–47.
357 S. Li, J. Zhao, Y. Liu, Z. Chen, Q. Xu, I. A. Khan and S. Yang, *J. Agric. Food Chem.*, 2014, **62**, 488–496.
358 J. Chen, C.-l. Fan, Y. Wang and W.-c. Ye, *Zhongguo Tianran Yaowu*, 2014, **12**, 218–221.
359 J. Mi, C. Wu, C. Li, F. Xi, Z. Wu and W. Chen, *Nat. Prod. Res.*, 2014, **28**, 52–56.
360 Y. Wu, Y. Yang, M. Dong, F. Sauriol, Q. Shi, Y. Gu and C. Huo, *Chem. Nat. Compd.*, 2014, **50**, 850–852.
361 Q.-H. Wang, N.-R.-C.-K.-T. Han, N.-Y.-T. Dai, X.-L. Wu, W.-Q. Tai, J.-S. Wu and R.-J. Wu, *Z. Naturforsch., B: J. Chem. Sci.*, 2014, **69**, 1021–1025.
362 C. Liu, Z.-X. Liao, S.-J. Liu, L.-J. Ji and H.-F. Sun, *Planta Med.*, 2014, **80**, 936–941.
363 W. Liu, E. Sakr, P. Schaeffer, H. M. Talbot, J. Donisi, T. Härtner, E. Kannenberg, E. Takano and M. Rohmer, *ChemBioChem*, 2014, **15**, 2156–2161.
364 D. Khan, M. Afzal, S. Woodward and S. Khan, *Rec. Nat. Prod.*, 2014, **8**, 121–127.
365 A. I. Hamed, M. Masullo, L. Pecio, D. Gallotta, U. A. Mahalel, S. Pawelec, A. Stochmal and S. Piacente, *J. Nat. Prod.*, 2014, **77**, 657–662.
366 S. Sharma, S. K. Chattopadhyay, M. Singh, D. U. Bawankule and S. Kumar, *Phytochemistry*, 2014, **100**, 132–140.
367 Y. Zhang, P. Yi, Y. Chen, Z.-n. Mei, X. Hu and G.-z. Yang, *Fitoterapia*, 2014, **96**, 95–102.
368 X. Wang, D. Yu and S. Yu, *Chin. J. Chem.*, 2014, **32**, 1007–1010.
369 S. Yu, X. Ye, W. Xin, K. Xu, X.-Y. Lian and Z. Zhang, *Planta Med.*, 2014, **80**, 315–320.
370 W.-B. Zhou, G.-Z. Zeng, H.-M. Xu, W.-J. He, Y.-M. Zhang and N.-H. Tan, *Fitoterapia*, 2014, **93**, 98–104.
371 D.-J. Jin, S.-A. Tang, G.-S. Xing, W.-J. Zhao, C. Zhao, H.-Q. Duan and W.-H. Lin, *J. Asian Nat. Prod. Res.*, 2014, **16**, 427–433.
372 C. S. Kim, O. W. Kwon, S. Y. Kim, K. H. Kim and K. R. Lee, *Heterocycles*, 2014, **89**, 1913–1922.
373 O. Potterat, C. Herzog, M. Raith, S. N. Ebrahimi and M. Hamburger, *Helv. Chim. Acta*, 2014, **97**, 32–38.
374 C.-L. Zhang, Y. Wang, Y.-F. Liu, G. Ni, D. Liang, H. Luo, X.-Y. Song, W.-Q. Zhang, R.-Y. Chen, N.-H. Chen and D.-Q. Yu, *J. Nat. Prod.*, 2014, **77**, 411–415.