Review

Xia Qing, Ting Zhao, Rui-Xia Guo, Yi-Bing Wu, Qing-Wen Shi*, Yu-Cheng Gu and Hiromasa Kiyota*

Chemical constituents of plants from the genus *Neolitsea*

Abstract: The genus *Neolitsea* (Lauraceae) contains over 85 species distributed around the world. These plants have been found to be rich in sesquiterpenes, triterpenes, steroids, and alkaloids. This review summarizes the phytochemical progress and list of all the constituents isolated from the genus *Neolitsea* over the past few decades. Some biological activities of compounds isolated from this genus are also included.

Keywords: biological activity; chemical composition; *Neolitsea*; plant.

***Corresponding authors: Qing-Wen Shi,** School of Pharmaceutical Sciences, Hebei Key Laboratory of Forensic Medicine, Hebei Medical University, Shijiazhuang 050017, Hebei Province, China, e-mail: shiqingwen@hebmu.edu.cn; and **Hiromasa Kiyota,** Graduate School of Environmental and Life Science, Okayama University, 1-1-1 Tsushima-Naka, Kita-ku, Okayama 700-8530, Japan, e-mail: kiyota@okayama-u.ac.jp
Xia Qing, Ting Zhao and Yi-Bing Wu: School of Pharmaceutical Sciences, Hebei Key Laboratory of Forensic Medicine, Hebei Medical University, Shijiazhuang 050017, Hebei Province, China
Rui-Xia Guo: School of Pharmaceutical Sciences, Hebei Key Laboratory of Forensic Medicine, Hebei Medical University, Shijiazhuang 050017, Hebei Province, China; and College of Chemical Engineering, Shijiazhuang University, The Yangtze River, Road No. 6, Shijiazhuang, Hebei Province, 050035, China
Yu-Cheng Gu: Syngenta Jealott's Hill International Research Centre, Berkshire, RG42 6EY, UK

Introduction

The genus *Neolitsea* (Lauraceae) comprises nearly 85 species that are distributed throughout tropical and subtropical Asia and America. In particular, there are 45 species widespread in South China, East China, and Southwest China. The plants of genus *Neolitsea* have been found to be rich in sesquiterpenes, triterpenes, alkaloids, and steroids [1, 2]. The occurrence of a small number of flavonoids, benzenoids, monoterpenes, and benzoquinone has also been reported [3]. Constituents of the *Neolitsea* genus (Lauraceae) have been reported to possess diverse bioactivities, such as antioxidant, antibacterial, anti-inflammatory activities, and cytotoxicity [3].

This review summarizes the phytochemical progress involving all constituents isolated from the genus *Neolitsea* over the past few decades. Some biological activities of compounds isolated from this genus are also included.

Chemical constituents

The reported chemical constituents from this genus include sesquiterpenes, triterpenes, alkaloids, steroids, flavonoids, essential oils, and some other compounds. Their structures are shown in the following sections, and their names and the corresponding plant sources are collected in Tables 1–5.

Sesquiterpenes (Table 1 and Figure 1)

Sesquiterpenes are the characteristic constituents within the genus *Neolitsea*. From 1966 to 2013, 67 compounds have been isolated. The researched plants include *Neolitsea zeylanica, Neolitsea parvigemma, Neolitsea aciculata, Neolitsea acutotrinervia, Neolitsea hiiranensis,* and *Neolitsea sericea*, among others. In 1966, six sesquiterpenes **1**–**6** were isolated from *N. zeylanica* [1]. In the course of further investigation on the chemical constituents of this plant, four novel sesquiterpenes of the furanogermacrane type **7**–**10** have been isolated from the stems of *N. parvigemma* [2]. In 2011, investigation of *N. hiiranensis* revealed seven new sesquiterpenoids **12**–**18** and 12 known sesquiterpenoids **19**–**30** from the leaves of this plant [3]. In 1983, Nozaki et al. isolated a new sesquiterpene dilactone **31**, named neoliacine, from the leaves of *N. aciculata*, and they further examined chemical components of the same plant and isolated the sesquiterpene acid **32** [14, 15]. Four known furanosesquiterpene

Table 1 Sesquiterpenes.

No.	Name	Source	Part	References
1	Linderalactone	*N. zeylanica/N. villosa*	Root	[1, 4]
		N. parvigemma	Stem/root	[2, 5–7]
		N. dealbata	Bark	[8]
		N. aciculata	Root/trunk	[9]
2	Linderane	*N. zeylanica*	Root	[1, 4]
		N. villosa	Stem	[5, 6]
		N. parvigemma	Root/trunk	[9]
		N. aciculata	Root	[10]
		N. acutotrinervia	Root	[11]
		N. buisanensis		
3	Neolinderane	*N. zeylanica*	Root	[1]
		N. aciculata	Root/trunk	[9]
4	Zeylanine	*N. zeylanica*	Root	[1]
		N. aciculata	Root/trunk	[9]
		N. acutotrinervia	Root	[10]
5	Zeylanicine	*N. zeylanica*	Root	[1]
		N. parvigemma	Stem/root	[2, 5, 6, 12]
6	Zeylanidine	*N. zeylanica*	Root	[1, 6]
		N. parvigemma	Stem/root	[2, 5, 7]
		N. dealbata	Bark	[8]
7	Deacetylzeylanine	*N. parvigemma*	Stem	[2, 7]
8	Parvigemonol	*N. parvigemma*	Stem	[2]
9	Parvigemon	*N. parvigemma*	Stem	[2, 6]
10	Neolitrane	*N. parvigemma*	Stem	[2, 6, 7]
11	Pseudoneolinderane	*N. parvigemma*	Stem	[2,6, 7]
		N. dealbata	Bark	[8]
		N. aciculata	Root/trunk	[9]
		N. villosa	Root	[4]
12	Hiiranlactone A	*N. hiiranensis*	Leaf	[3]
13	Hiiranlactone B	*N. hiiranensis*	Leaf	[3]
14	Hiiranlactone C	*N. hiiranensis*	Leaf	[3]
15	Hiiranlactone D	*N. hiiranensis*	Leaf	[3]
16	(+)-*ent*-6α-Methoxyeudesm-4(15)-en-1β-ol	*N. hiiranensis*	Leaf	[3]
17	(+)-Villosine	*N. hiiranensis*	Leaf	[3]
		N. villosa	Root	[4]
18	Hiiranepoxide	*N. hiiranensis*	Leaf	[3]
19	(6α,7α)-4β-Hydroxy-10α-methoxyaromadendrane	*N. hiiranensis*	Leaf	[3]
20	Spathulenol	*N. hiiranensis*	Leaf	[3]
21	(-)-*ent*-4β-Hydroxy-10α-methoxyaromadendrane	*N. hiiranensis*	Leaf	[3]
22	4β,10α-Dihydroxyaromadendrane	*N. hiiranensis*	Leaf	[3]
23	Pipelol A	*N. hiiranensis*	Leaf	[3]
24	Deoxysericealactone	*N. hiiranensis*	Leaf	[3]
		N. sericea		[3]
25	Neoliacinolide A	*N. hiiranensis*	Leaf	[3]
		N. aciculata		[13]
26	Pseudoneoliacine	*N. hiiranensis*	Leaf	[3]
		N. acutotrinervia	Root	[10]
		N. villosa		[4]
27	β-Caryophyllene oxide	*N. hiiranensis*	Leaf	[3]
28	Kobusone	*N. hiiranensis*	Leaf	[3]
29	Caryolane-1,9-diol	*N. hiiranensis*	Leaf	[3]
30	*trans*-Phytol	*N. hiiranensis*	Leaf	[3]
31	Neoliacine	*N. acciculata*	Leaf	[14]
32	Neoliacinic acid	*N. acciculata*	Leaf	[15]
33	Deacetylzeylanidine	*N. parvigemma*	Leaf/stem	[5, 6]
34	Isolinderalactone	*N. aciculata*	Root/trunk	[9]
		N. villosa	Root	[4]

(**Table 1** Continued)

No.	Name	Source	Part	References
35	Litsealactone	*N. aciculata*	Root/trunk	[9]
36	Litseaculane	*N. aciculata*	Root/trunk	[9]
37	Zeylanane	*N. aciculata*	Root/trunk	[9]
		N. acutotrinervia	Root	[10]
38	Linderadine	*N. aciculata*	Root/trunk	[9]
		N. acutotrinervia		[4, 10]
		N. villosa	Root	
39	Sericenine	*N. sericea*	Leaf	[16]
40	Sericenic acid	*N. sericea*	Leaf	[17]
41	Isosericenine	*N. sericea*	Leaf	[17]
42	Neosericenine	*N. sericea*	Leaf	[17]
43	Neolitacumone A	*N. acuminatissima*	Stem bark	[18]
44	Neolitacumone B	*N. acuminatissima*	Stem bark	[18]
45	Neolitacumone C	*N. acuminatissima*	Stem bark	[18]
46	1β-Acetoxyeudesma-4(15),7(11),8-trien-8,12-olide	*N. acuminatissima*	Stem bark	[18]
47	Acutotrine	*N. acutotrinervia*	Root	[10]
48	Acutotrinone	*N. acutotrinervia*	Root	[10]
49	Zeylaninone	*N. acutotrinervia*	Root	[10]
50	Acutotrinol	*N. acutotrinervia*	Root	[10]
51	Linderanine A	*N. buisanensis*	Root	[11]
52	Linderanine C	*N. buisanensis*	Root	[11]
53	Linderanine B	*N. buisanensis*	Root	[11]
54	Linderanine D	*N. buisanensis*	Root	[11]
55	Daibulactone A	*N. daibuensis*	Root	[19]
56	Daibulactone B	*N. daibuensis*	Root	[19]
57	Daibuoxide	*N. daibuensis*	Root	[19]
58	Sericealactone	*N. sericea*	Leaf	[8]
59	Neoliacinolide B	*N. aciculata*	Leaf	[13]
60	Neoliacinolide C	*N. aciculata*	Leaf	[13]
61	Sericealactonecarboxylic acid	*N. aciculata*	Leaf	[13]
62	Aciculatalactone	*N. aciculata*	Leaf	[13]
63	Furanogermenone	*N. pallens*	Leaf/bark	[20]
64	Germacrene D	*N. pallens*	Leaf	[20]
65	β-Caryophyllene	*N. pallens*	Leaf	[20]
66	10-epi-γ-Eudesmol	*N. pallens*	Bark	[20]
67	Curcumenol	*N. pallens*	Bark	[20]

lactones **1**, **2**, **5**, **6**, along with a new derivative, deacetylzeylanidine **33**, were isolated from *N. parvigemma* [5]. From *N. sericea*, three new elemane-type sesquiterpenoids **24**, **41**, **58** and two new germacrane-type sesquiterpenoids **39**, **40** were isolated by column chromatography and thin layer chromatography [8]. In 1970, components of *N. aciculata* were investigated, and ten furan sesquiterpenes **1**–**4**, **11**, **34**–**38** were isolated from the root and trunk [9]. At the same time, neosericenine **42**, an isomer of sericenine **39**, along with compounds **40** and **41** were isolated from the leaf of *N. sericea* [16, 17]. Phytochemical investigation of *Neolitsea acuminatissima* resulted in the isolation of three new eudesmanolide sesquiterpenes **43**–**45** and a known eudesmanolide sesquiterpene **41** [18]. Investigation of *N. acutotrinervia* revealed numerous sesquiterpene lactones, including four known furanogermacranolides **2**, **4**, **37**, **38**, one known germacranediolide **35**, and four new germacranediolides **47**–**50** [10]. Chen et al. have isolated two novel sesquiterpenes of the furanogermacrane type, namely parvigemone **9** and neolitrane **10**, along with six known compounds **1**–**2**, **5**–**6**, **11**, **33** from the stems of *N. parvigemma* [6]. Compounds **51**–**54** are not produced naturally in plant, but formed by oxidation of **2** [11]. Seven sesquiterpene lactones **1**, **2**, **11**, **17**, **26**, **34**, **38** were isolated from the roots of *Neolitsea villosa*, in which three compounds **17**, **26**, **38** are new [4]. Three new compounds **55**–**57** were isolated from the roots of *Neolitsea daibuensis* [19]. In the continuing studies on Lauraseae plants, which are widely distributed in Japan, three germacranes **25**, **59**, **60** and two elemanes **61**, **62** have been isolated from the fresh leaves of *N. aciculata* Koidz [13]. The major constituents of the leaf and bark oil of *Neolitsea pallens* are compounds **63**–**67** [20].

Table 2 Triterpenes.

No.	Name	Source	Part	References
68	Taraxerone	*N. dealbata*	Bark	[8]
69	Taraxerol	*N. dealbata*	Bark	[8]
70	Hiiranterpenone	*N. hiiranensis*	Leaf	[3]
71	3β-Methoxy-24,24-dimethyllanosta-9(11),25-diene	*N. pulchella*	Stem	[13, 20]
72	24,24-Dimethyllanosta-9(11),25-dien-3-one	*N. pulchella*	Stem	[13, 20]
73	24,24-Dimethyllanosta-9(11),25-dien-3β-ol	*N. pulchella*	Stem	[20]
74	24ξ-Hydroxy-3β-methoxy-24,25-dimethyl-lanost-9(11)-ene	*N. pulchella*	Stem	[13, 20]
75	24ξ-Methoxy-24,25-dirnethyllanost-9(11)-en-3-one	*N. pulchella*	Stem	[20]
76	3β,24ξ-Dimethoxy-24,25-dimethyllanost-9(11)-ene	*N. pulchella*	Stem	[20]
77	Sericeol	*N. sericea*	Heartwood	[21]
78	24*Z*-Ethylidenelanost-8-en-3-one	*N. sericea*	Bark	[22]
79	24-Methylenelanost-8-en-3-one	*N. sericea*	Bark	[22]
80	24*Z*-Ethylidenelanost-8-en-3β-ol	*N. sericea*	Bark	[22]
81	24-Methylenelanost-8-en-3β-ol	*N. sericea*	Bark/stem	[22, 23]
82	Cycloartenol	*N. sericea*	Stem	[23]
83	24-Methylenecycloartanol	*N. sericea*	Stem	[23, 24]
		N. aciculata		
84	24*E*-Ethylidenccycloartanol	*N. sericea*	Stem	[23]
85	24*Z*-Ethylidenecycloartanol	*N. sericea*	Stem	[23]
86	24-Methylene-25-methylcycloartanol	*N. sericea*	Stem	[23, 24]
		N. aciculata		
87	24β-Ethyl-25-dehydrocycloartanol	*N. aciculata*	Stem	[24]
88	24,24-Dimethyl-25-dehydrocycloartanol	*N. aciculata*	Stem	[24]
89	24*E*-Ethylidenelanost-8-enol	*N. sericea*	Stem	[23]
90	24*Z*-Ethylidenelanost-8-enol	*N. sericea*	Stem	[23]
91	24-Methylene24(25)-dihydroparkeol (IXe)	*N. sericea*	Stem	[23, 24]
		N. aciculata		
92	Parkeol	*N. aciculata*	Stem	[24]
93	24β-Methyllanosta-9(11),25-dien-3-ol	*N. aciculata*	Stem	[24]
94	24β-Ethlylanosta-9(11),25-dien-3-ol	*N. aciculata*	Stem	[24]
95	24,24-Dimethyllanosta-9(11),25-dien-3-ol	*N. aciculata*	Stem	[24]
96	24-Methylenelanosta-7,9(11)-dienol (Xe)	*N. sericea*	Stem	[23]
97	24-Methylenedammarenol	*N. sericea*	Stem	[23]
98	Lupeol	*N. sericea*	Stem	[23, 24]
		N. aciculata		
99	Lupenone	*N. fuscata*	Bark	[25]
100	β-Amyrin	*N. sericea*	Stem	[23]

Triterpenes (Table 2 and Figure 2)

Most of the triterpenes reported in the genus *Neolitsea* are tetracyclic, and a few of them are pentacyclic. These triterpenes are dammaranes, lanostanes, cycloartanes, oleananes, and lupanes. A phytochemical investigation of the crude chloroform extract of the *Neolitsea dealbata* bark revealed two common triterpenes **68**, **69**, which were reported for the first time from this plant [21]. Investigation of the ethyl acetate-soluble extract of the leaves of *N. hiiranensis* led to the isolation of hiiranterpenone **70** [3]. Chan and Hui isolated three C_{32} triterpenes **71**–**73** by column chromatography of the light petroleum extract [23]. In addition, analysis of a larger quantity of a similar extract led to the discovery of three related minor triterpenes **74**–**76** [22, 23]. Compound **77**, a new cycloartane, was reported from *N. sericea* in 1993, and further investigation of this plant revealed three new lanostanes **78**–**80**, along with a known compound **81** [24, 43]. In 1992, several triterpenes **81**–**99** were isolated from the alcohol extract of *N. sericea*, among which **86**, **93**, and **94** are new compounds [39, 40]. Lupenone **100** was isolated from the stem bark of *Neolitsea fuscata* [25].

Alkaloids (Table 3 and Figure 3)

In 2001, 15 alkaloids **101**–**103**, **106**, **107**, **124–129**, **133–135**, **137** were isolated from the stem bark of *N. acuminatissima*.

Table 3 Alkaloids.

No.	Name	Source	Part	References
101	Laurolitsine/(+)-Norboldine	*N. villosa/N. sericea*	Stem/leaf	[12, 26]
		N. acuminatissima	Stem bark	[18, 27]
		N. konishii/N. aurata	Bark	[28, 29]
		N. paraciculata		[30]
		N. buisanensis		
102	Boldine	*N. acuminatissima*	Stem/leaf	[18, 31]
		N. villosa/N. parvigemma		[26, 27]
		N. konishii/N. sericea		[12, 29]
103	Isoboldine	*N. acuminatissima*	Stem/leaf	[18, 29]
		N. konishii/N. fuscata		[12, 25]
104	Isocorydine	*N. sericea/N. aurata*	Stem/leaf	[12]
105	Laurotetanine	*N. aciculata/N. villosa*	Stem/leaf	[26, 32]
		N. konishii/N. sericea		[29, 30]
				[12]
106	*N*-Methyllaurotetanine	*N. acuminatissima*	Stem/leaf	[18, 26]
		N. villosa/N. konishii		[12, 29]
107	(-)-Thalicsimidine	*N. acuminatissima*	Stem bark	[18]
108	(+)-11-Methoxynorboldine	*N. aurata paraciculata*	Bark	[28]
109	Hernovine	*N. aurata paraciculata*	Bark	[28, 33]
		N. variabillima.		
110	10-*O*-Methylhernovine	*N. aurata paraciculata*	Bark	[28]
111	Lindcarpine	*N. aurata paraciculata*	Bark	[28]
112	*N,O*-Dimethylhernovine	*N. aurata paraciculata*	Bark	[28]
113	Glaucine	*N. parvigemma*	–	[31]
		N. konishii		
114	Corydine	*N. parvigemma*	–	[31]
		N. konishii		
115	Neolitsinine	*N. pulchella*	Leaf	[34]
116	Isomeric pulchelline	*N. pulchella*	Leaf	[34]
117	Corytuberine	*N. konishii*	–	[29]
118	Nnornuciferine	*N. konishii*	–	[29]
119	*N*-Methylhernovine	*N. variabillima*	Bark	[33]
120	Nuciferine	*N. sericea*	Bark	[30]
121	Glaziovine	*N. konishii*	Stem/leaf	[29]
		N. sericea/N. aurata	Stem	[12]
122	Stepharine	*N. konishii*	–	[29]
123	Isodomesticine	*N. villosa*	Stem/leaf	[12, 26]
124	Neolitacumonine	*N. acuminatissima*	Stem bark	[18]
125	Liriodenine	*N. acuminatissima*	Stem bark	[18]
126	(-)-Norushisunine	*N. acuminatissima*	Stem bark	[18]
127	(+)-Cassythine	*N. acuminatissima*	Stem bark	[18]
128	(-)-Anonaine	*N. acuminatissima*	Stem bark	[18, 35]
		N. aurata/N. sericea		[30]
129	Actinodaphnine	*N. acuminatissima*	Stem bark	[18, 31]
		N. konishii/N. sericea/N.	Stem	[26, 29]
		parvigemma/N. villosa	wood	[30]
130	(+)-11-Methoxynorcassythicine	*N. aurata paraciculata*	Bark	[28]
131	Nandigerine	*N. aurata paraciculat*	Bark	[28, 33]
		N. variabillima.		
132	Roemerine	*N. parvigemma*	Leaf	[18, 31]
		N. konishii/N. sericea		[35]
		N. aurata		[30]
133	*N*-Methylactinodaphnine	*N. parvigemma*	Stem bark	[18, 31]
		N. konishii		
		N. acuminatissima		
134	(+)-*O*-Methylflavinantine	*N. acuminatissima*	Stem bark	[18]
135	(+)-Reticuline	*N. acuminatissima*	Stem bark	[18, 32]

(**Table 3** Continued)

No.	Name	Source	Part	References
		N. aciculata/N. villosa		[29]
136	(+)-Norjuziphine	*N. villosa*	Stem	[26]
137	Oxoglaucine	*N. acuminatissima*	Stem bark	[18, 31]
		N. parvigemma/N.konishii		
138	(+)-11-Methoxynorneolitsine	*N. aurata paraciculata*	Bark	[28]
139	Neolitsine	*N. pulchella*	Leaf	[34]
140	Ovigerine	*N. aurata paraciculata*	Bark	[28]
141	*N*-Methylovigerine	*N. aurata paraciculata*	Bark	[28]
142	Methoxyannomontine	*N. parvigemma*	–	[31]
		N. konishii		
143	(+)-Coclaurine	*N. villosa*	Stem	[26]
144	(+)-Juziphine	*N. villosa*	Stem	[26]
145	Pallidine	*N. villosa/N. konishii*	Stem	[26, 29]
146	Litsericine	*N. sericea/N. aurata*	Leaf	[27, 35]
		N. buisanensis		[30]
147	*N*-Methyllitsericine	*N. aurata*	–	[35]
148	Daibucarboline A	*N. daibuensis*	Root	[19]
149	Daibucarboline C	*N. daibuensis*	Root	[19]
150	DaibucarbolineB	*N. daibuensis*	Root	[19]
151	(6a*R*)-Normecambroline	*N. dealbata*	Bark	[36]

Table 4 Steroids.

No.	Name	Source	Part	References
152	24α-Ethylcholestan-3α-ol	*N. sericea*	Stem	[23]
153	24α-Ethylcholest-4-en-3-one	*N. sericea*	Stem	[23]
154	24α-Ethylcholesta-4,22-dien-3-one	*N. sericea*	Stem	[23]
155	β-Sitosterol	*N. hiiranensis*	Leaf	[3]
		N. parvigemma	Root	[4, 5, 11]
		N. buisanensis	Stem bark	[18]
		N. villosa	Wood	[37]
		N. acuminatissima		
		N. sericea		
156	Stigmasterol	*N. acuminatissima*	Stem bark	[18]
		N. sericea	Wood	[37]
157	*β*-Sitosteryl-D-glucoside	*N. acuminatissima*	Stem bark	[18]
158	Stigmasteryl-*β*-D-glucoside	*N. acuminatissima*	Stem bark	[18]
159	Campesterol	*N. sericea*	Wood	[37]
160	14α,24α-Dimethyl-5α-cholest-9(11)-en-3α-ol	*N. aciculata*	Stem	[38]
161	14α,24β-Dimethyl-5α-cholest-9(11)-en-3α-ol	*N. aciculata*	Stem	[38]
162	14α-Methyl-24α-ethyl-5α-cholest-9(11)-en-3α-ol	*N. aciculata*	Stem	[38]
163	24-Methylcholesterol	*N. sericea*	Stem	[39]
164	24β-Methyl-22-dehydrolathosterol	*N. sericea*	Stem	[39]
165	24α-Ethylcholestan-3β-ol	*N. sericea*	Stem	[39]
166	Citrostadienol	*N. aciculata*	Stem and branch	[40]
167	24-Methylene-31-norlanost-9(11)-enol	*N. aciculata*	Stem and branch	[40]
168	24α-Ethyl-31-norlanost-9(11)-enol	*N. sericea*	Stem and branch	[40]
169	24β-Ethyl-31-norlanosta-9(11)-25-dienol	*N. sericea*	Stem and branch	[40]
170	(24*S*)-24-Ethylcholest-4-ene-1-ol-3-one	*N. sericea*	Heartwood	[41]
171	(24*S*)-24-Ethylcholest-4-ene-6-ol-3-one	*N. sericea*	Heartwood	[41]

Table 5 Other compounds.

No.	Name	Source	Part	References
172	13^2-Hydroxy-(13^2S)-pheophytin	*N. hiiranensis*	Leaf	[3]
173	α-Tocopheryl quinine	*N. hiiranensis*	Leaf	[3]
174	α-Tocopherol	*N. hiiranensis*	Leaf	[3]
175	Ficaprenol-11	*N. hiiranensis*	Leaf	[3]
176	Linolenic acid	*N. hiiranensis*	Leaf	[3]
177	Syringaldehyde	*N. hiiranensis*	Leaf	[3]
178	Syringic acid	*N. hiiranensis*	Leaf	[3]
179	(+)-Lyoniresinol	*N. acuminatissima*	Stem bark	[18]
180	(+)-Syringaresinol	*N. acuminatissima*	Stem bark	[18]
181	(±)-Glaberide I	*N. acuminatissima*	Stem bark	[18]
182	Vanillin	*N. hiiranensis*	Leaf	[3]
		N. acuminatissima	Stem bark	[18]
183	Isovanillin	*N. acuminatissima*	Stem bark	[18]
184	*p*-Methoxybenzoic acid	*N. acuminatissima*	Stem bark	[18]
		N. hiiranensis	Leaf	[3]
185	Methylparaben	*N. acuminatissima*	Stem bark	[18]
186	2,6-Dimethoxy-*p*-benzoquinone	*N. acuminatissima*	Stem bark	[18]
187	Kaempferol 3-*O*-rhamnoside	*N. pavigemma*	–	[31]
		N. konishii		
188	Quercetin 3-*O*-rhamnoside	*N. pavigemma*	–	[31]
		N. konishii	Leaf	[42]
		N. sericea		
189	Taxifolin 3-*O*-rhamnoside	*N. pavigemma*	–	[31]
		N. konishii		
190	Qercetin 3-*O*-β-D-glucoside	*N. sericea*	Leaf	[42]
191	Neoastilbin	*N. sericea*	Leaf	[42]
192	Isoastilbin	*N. sericea*	Leaf	[42]
193	Neoisoastilbin	*N. sericea*	Leaf	[42]
194	Docosanyl ferulate	*N. pavigemma*	–	[31]
		N. konishii		
195	Tetracosanyl ferulate	*N. pavigemma*	–	[31]
		N. konishii		
196	Hexacosanyl ferulate	*N. pavigemma*	–	[31]
		N. konishii		
197	Blumenol A	*N. pavigemma*	–	[31]
		N. konishii		
198	Roseoside	*N. pavigemma*	–	[31]
		N. konishii		
199	*N-trans*-Feruloylmethoxytyramine	*N. pavigemma*	–	[31]
		N. konishii		
200	*trans*-β-Ocimene	*N. pallens*	Fruit	[20]
201	Sabinene	*N. pallens*	Fruit	[20]

Among them, compound **124** was a new benzylisoquinoline alkaloid. Their structures were established on the basis of analysis of NMR and mass spectral data [18]. The first chemical investigation of *N. villosa* (Bl.) Merr. led to the isolation of ten known isoquinoline alkaloids **101**, **104–106**, **121**, **128**, **133**, **136**, **143**, **144** from the stem of this plant [26]. In 1965, three new alkaloids **115**, **139**, **145** were found in the ethanolic extract of the dried leaves of *Neolitsea pulchella* [34]. Kozuka et al. reported the isolation and identification of two alkaloids **104**, **134** from *Neolitsea ariculuta* in 1984 [32]. Three new oxygenated noraporphine alkaloids **130**, **137**, **138** along with eight known aporphine alkaloids **121**, **108–112**, **140**, **141** were isolated from the bark of the Chinese tree, *Neolitsea aurata* var. *paraciculata*, which was the first report of chemical constituents of this plant [28]. In 1998, Chen et al. reported eight alkaloids **101**, **113**, **114**, **128**, **129**, **131**, **132**, **142** from *N. parvigemma* and *Neolitsea konishii*, and compounds **129**, **113**, **114**, **131**, **132** were isolated for the first time from this genus [31]. In 2001, 15 alkaloids were isolated from the

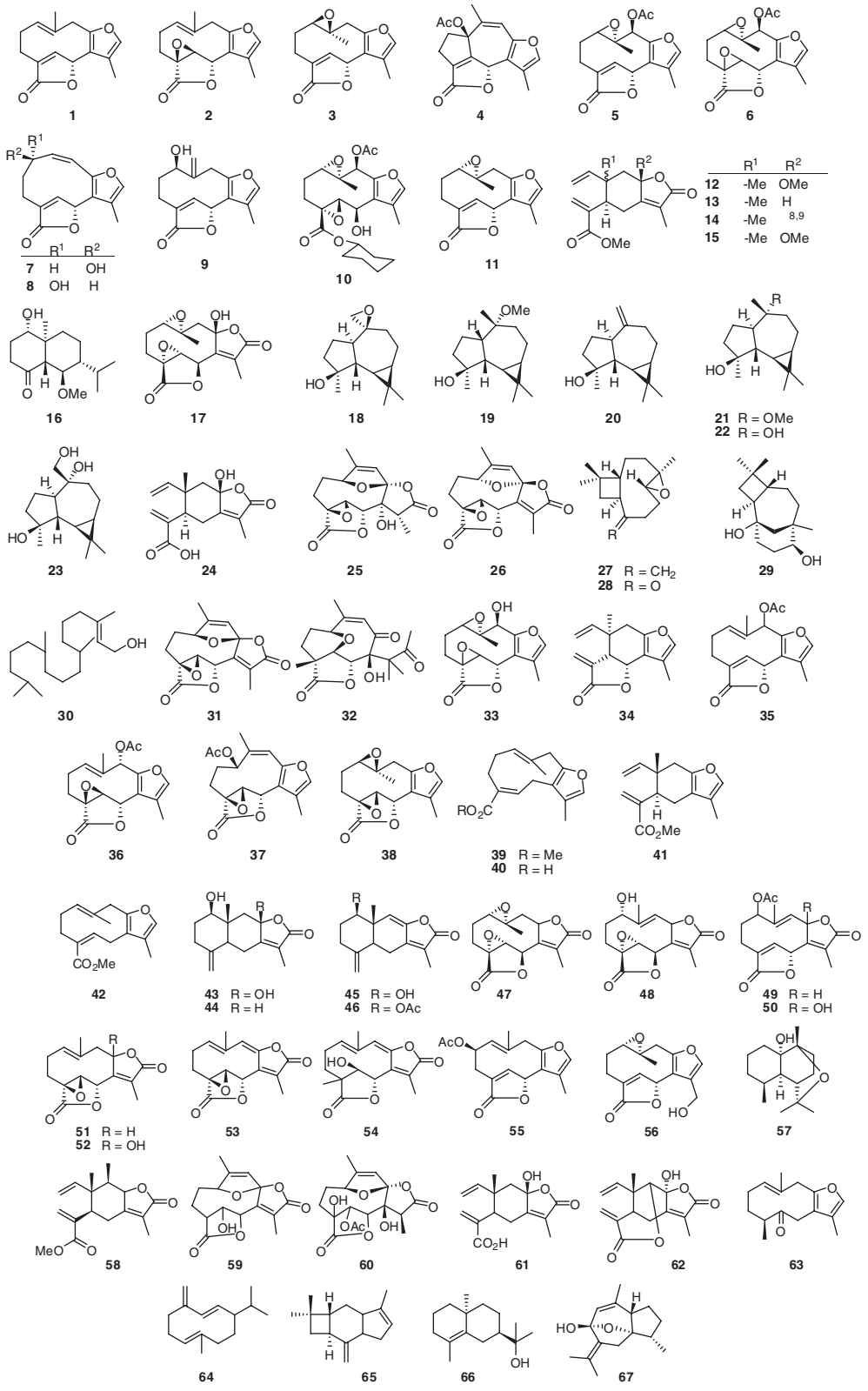


Figure 1 Sesquiterpenoid structures.

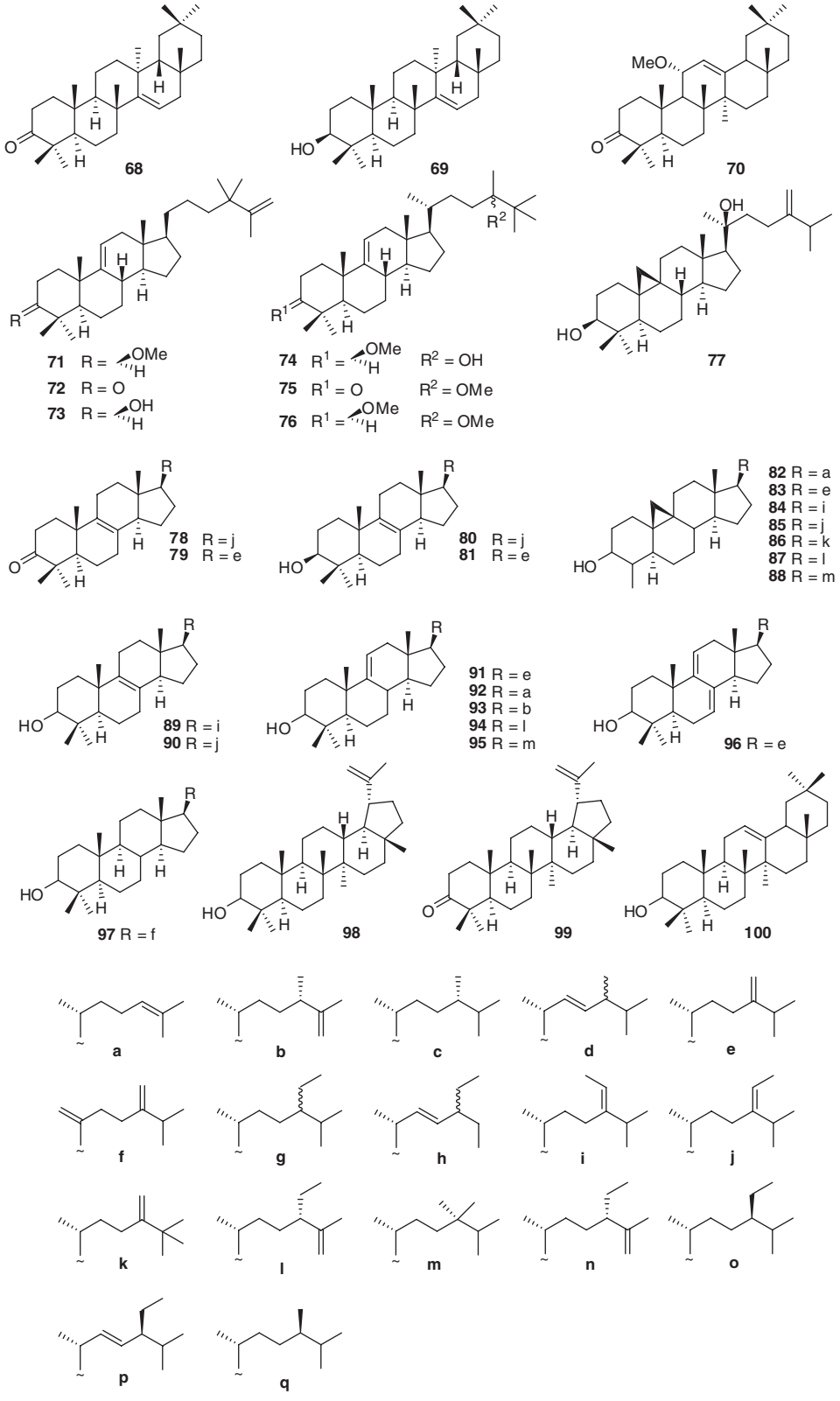
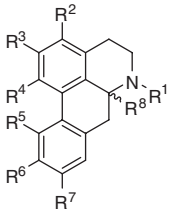
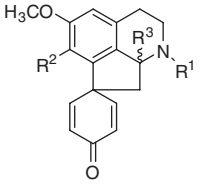


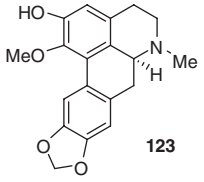
Figure 2 Triterpenoid structures.



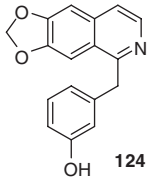
	R^1	R^2	R^3	R^4	R^5	R^6	R^7	R^8
101	H	H	OH	OMe	H	OMe	OH	H
102	Me	H	OH	OMe	H	OMe	OH	H
103	Me	H	OMe	OH	H	OMe	OH	H
104	Me	H	OMe	OMe	OH	OMe	H	H
105	H	H	OMe	OMe	H	OMe	OH	H
106	Me	H	OMe	OMe	H	OMe	OH	H
107	Me	OMe	OMe	OMe	H	OMe	OMe	H
108	H	H	OH	OMe	OMe	OMe	OH	H
109	H	H	OH	OMe	OMe	OH	H	H
110	H	H	OH	OMe	OMe	OMe	H	H
111	H	H	OH	OMe	OH	OMe	H	H
112	H	H	OH	OMe	OMe	OMe	H	H
113	Me	H	OMe	OMe	H	OMe	OMe	H
114	Me	H	OMe	OH	OMe	OMe	H	H
115	H	H	OH	OMe	H	OMe	OH	H
116	H	H	OMe	OH	H	OMe	OH	H
117	Me	H	OMe	OH	OH	OMe	H	H
118	H	H	OMe	OMe	H	H	H	H
119	Me	H	OH	OMe	OMe	OH	H	H
120	Me	H	OMe	OMe	H	H	H	H



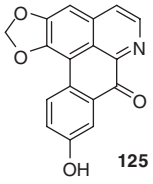
	R^1	R^2	R^3
121	Me	OH	H
122	H	OMe	H



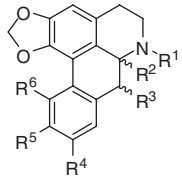
123



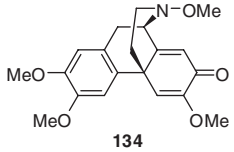
124



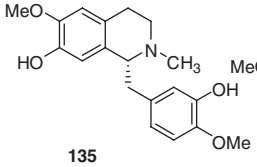
125



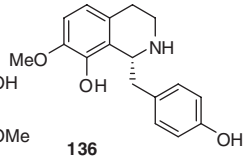
	R^1	R^2	R^3	R^4	R^5	R^6
126	H	H	OH	H	H	H
127	Me	H	H	OH	OMe	H
128	Me	H	H	H	H	H
129	H	H	H	OH	OMe	H
130	H	H	H	OH	OMe	OMe
131	H	H	H	H	OMe	OMe
132	H	H	H	H	H	H
133	Me	H	H	OH	OMe	H



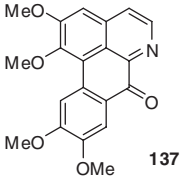
134



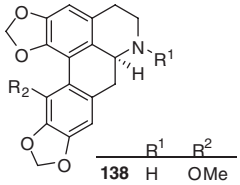
135



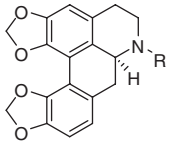
136



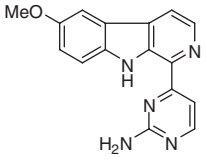
137



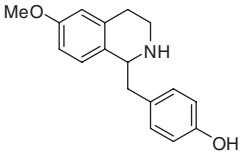
	R^1	R^2
138	H	OMe
139	Me	H



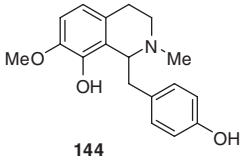
140 R = H
141 R = Me



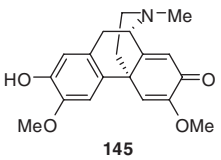
142



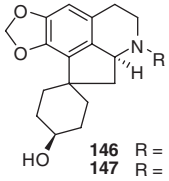
143



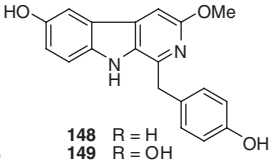
144



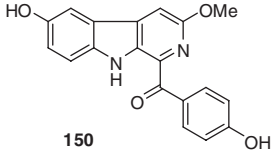
145



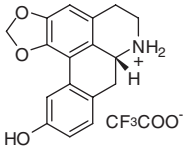
146 R = H
147 R = Me



148 R = H
149 R = OH



150



151

Figure 3 Alkaloid structures.

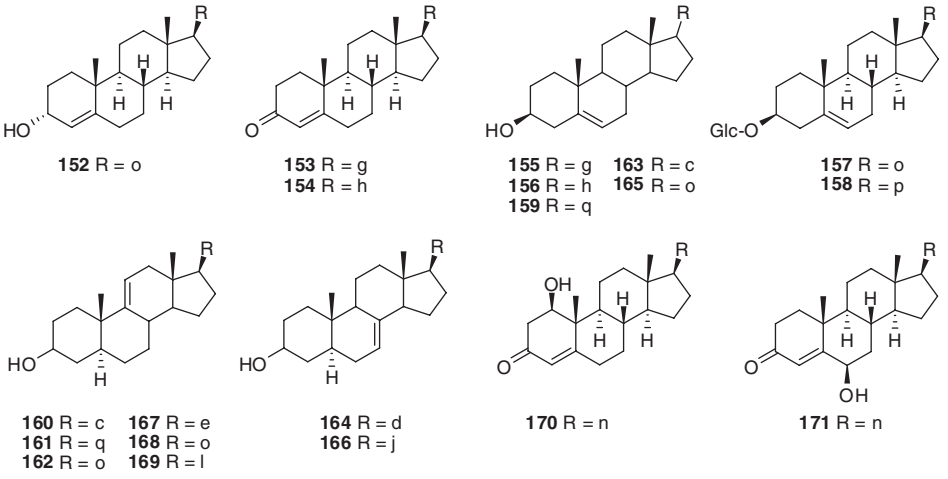


Figure 4 Steroids (see Figure 2 for definition of the R groups).

stem bark of *N. acuminatissima*. Among them, compound **123** is a new benzylisoquinoline alkaloid, whose structure was established on the basis of analysis of NMR and mass spectral data [18]. By combination of centrifugal partition chromatography and common separation methods, 12 known alkaloids were isolated from *N. konishii* and characterized [29]. Compounds **121** and **117** were isolated from *Neolitsea buisanensis, N. sericea*, and *N. aurata* [27, 30]. In addition, compounds **118**, **131**, **135** were isolated from *N. aurata* [35]. Lu and Su isolated three alkaloids **108**, **112**, **147** from *Neolitsea variabillima* [33]. In 2010, a new aporphine alkaloid **149** was reported from the bark of *N. dealbata* [36]. In 2011, Wong et al. reported three new β-carboline alkaloids **120**, **148**, **150** from the root of *N. daibuensis* [19]. A total 14 new alkaloids and 37 known alkaloids were reported from this genus.

Steroids (Table 4 and Figure 4)

Four steroids, a mixture of **155** and **156**, and a mixture of **157** and **158**, were isolated from *N. acuminatissima* [18]. Komae and Hayashi detected phytosterols (**155**, **156**, **159**) in the wood of *N. sericea* by using gas chromatography [37]. *Neolitsea sericea* and *Daemia extensa* (Asclepiadaceae) seem to be the only plants containing 3α-hydroxy sterols in a higher plant. Yano et al. investigated the constituents of the stem of this plant and isolated two new 4α-methylsterols and three new 3α-hydroxy-14α-methyl-$\Delta^{9(11)}$ sterols; they are compounds **168** and **169**, 24α- and 24β-epimers of 14α,24-dimethyl-5α-cholest-9(11)-en-3α-ol, compounds **160** and **161**, and 14α-methyl-24α-ethyl-5α-cholest-9(11)-en-3α-ol **162** [38, 40]. The ethyl acetate extract from the wood of *N. sericea* contained two new steroidal compounds **170** and **171** [41]. Further study on the sterols from *N. sericea* extract led to the isolation of compounds **163**–**167** [39, 40].

Others (Table 5 and Figure 5)

From the fruit oil of *N. pallens*, Padalia et al. isolated *trans*-β-ocimene **200** and sabinene **201** [20]. Investigation of *N. sericea* var. *aurata* revealed occurrence of six flavone rhamnosides **187–193** [42]. In 1998, three flavonoids, kaempferol-3-*O*-rhamnoside **187**, quercetin-3-*O*-rhamnoside **188**, and taxifolin-3-*O*-rhamnoside **189**, three ferulates, docosanyl ferulate **194**, tetracosanyl ferulate **195**, and hexacosanyl ferulate **196**, two cyclohex-2-en-1-ones, blumenol A **197**, and roseoside **198**, and one amide, *N-trans*-feruloylmethoxytyramine **199** were isolated from *Neolitsea pavigemma* and *N. konishii* [31]. From the leaves of *Neolitsea cassia*, de Silva et al. isolated a water-soluble arabinoxylan [44]. Chang et al. isolated three lignans, (+)-lyoniresinol **179**, (+)-syringaresinol **180**, and (±)-glaberide I **181**, four benzenoids, vanillin **182**, isovanillin **183**, *p*-methoxybenzoic acid **184**, and methylparaben **185**, together with one paraquinone, 2,6-dimethoxy-*p*-benzoquinone (**186**), from the stem bark of *N. acuminatissima* [18]. The following compounds were also isolated from the leaves of *N. hiiranensis*: 13²-hydroxy-(13²*S*)-pheophytin (**172**), α-tocopheryl quinine (**173**), α-tocopherol (**174**), ficaprenol-11 (**175**), linolenic acid (**176**), syringaldehyde (**177**), syringic acid (**178**), vanillin (**182**) and *p*-anisic acid (**184**) [3].

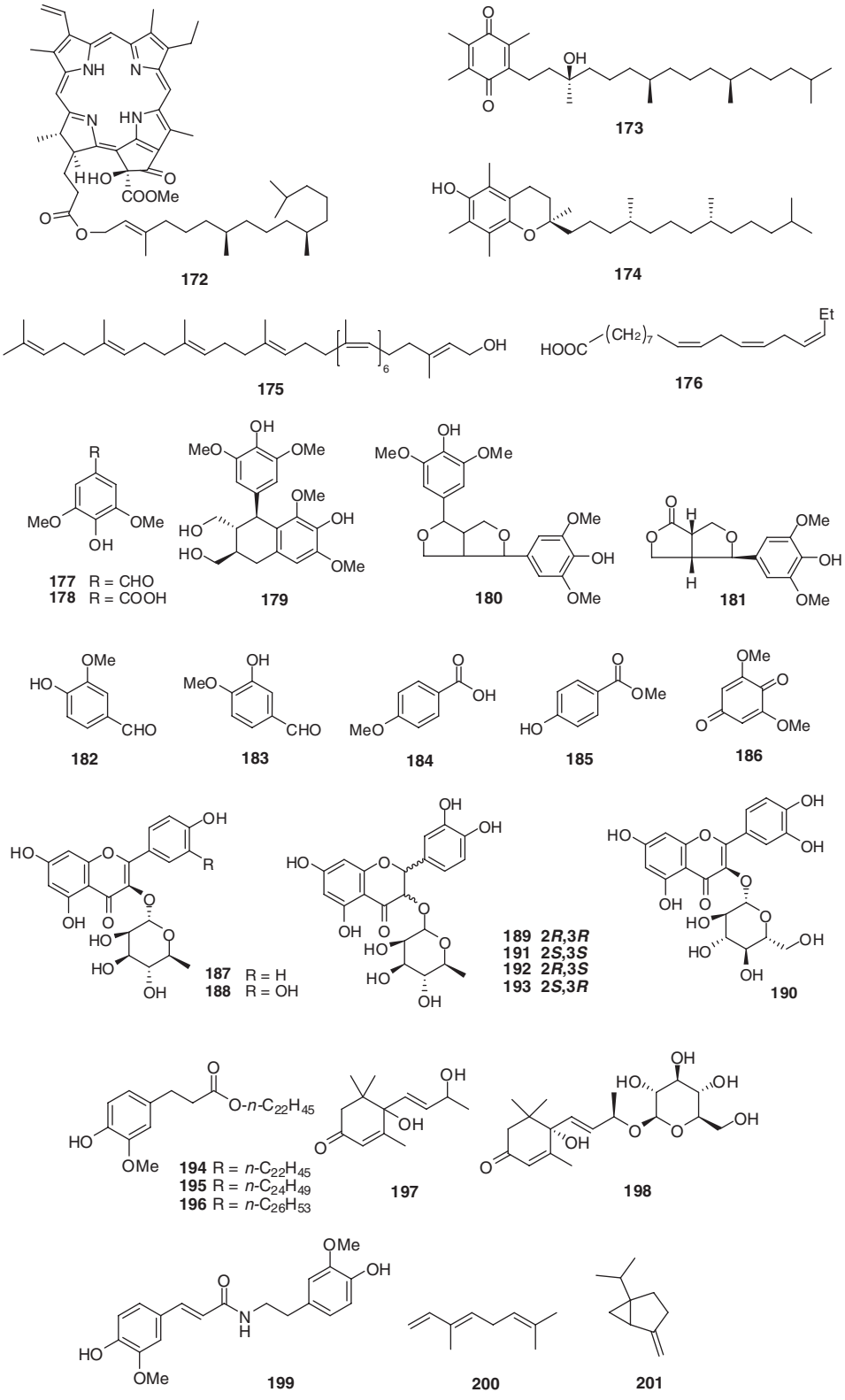


Figure 5 Structures of other compounds.

Biological activities

Anti-inflammatory activity

The anti-inflammatory effects of compounds **13** and **15** were evaluated by their suppression of the N-formyl- methionyl-leucyl-phenylalanine (fMLP)-induced generation of the superoxide anion, an inflammatory mediator produced by neutrophils. And the inhibitory activity against fMLP-induced superoxide production with IC_{50} values of 21.86±3.97 and 25.78±4.77 μM, respectively [3]. Six furanogermacranes **1**, **5**–**7**, **10**, **11** were tested for anti-inflammatory activities. Among them, compounds **1** and **11** show significant inhibitory effects on superoxide anion generation by human neutrophils in response to fMLP/CB: the IC_{50} of compounds **1** and **11** were found to be 3.21 and 8.48 mg/mL, respectively [7]. Compounds **34** and **163**, 7-*O*-methylnaringenin and prunetin, which were isolated from *N. daibuensis*, exhibit moderate inducible nitric oxide synthase inhibitory activity, with IC_{50} values of 18.41, 0.30, 19.55, and 10.50 mM, respectively [19]. The essential oil of *N. aciculata* exhibit moderate to strong antibacterial activity against drug-susceptible and -resistant *Propionibacterium acnes* and *Staphylococcus epidermidis*, which are known as acne-causing bacteria. In addition, the essential oil reduces the *P. acnes*-induced secretion of tumor necrosis factor-alpha (TNF-α) and interleukin-8 (IL-8) in THP-1 cells, highlighting its anti-inflammatory effects [45].

Antitumor activity

Neoliacine **31**, a sesquiterpene lactone isolated from the leaves of *N. aciculata*, exhibits moderate cytotoxicity in HeLa cell culture *in vitro* [14]. Compounds **44**, **45**, and **184** selectively inhibit Hep 2,2,15 cells with IC_{50} values in the range of 0.24–0.04 μg/mL. 2,6-Dimethoxy-*p*-benzoquinone is marginally cytotoxic to Hep G2 cells [18]. A known elemane-type sesquiterpene, isolinderalactone **34**, shows promising antitumor activity *in vitro* against all tumor cells tested: KB (EDSo=2.990 ppm), P-388 (0.816 ppm), A-549 (1.420 ppm), and HI-29 (1.528 ppm) [4]. Recently, Su et al. reported the chemical components and *in vitro* anticancer activities of the essential oil isolated from the leaf of *N. variabillima*. The anticancer activities of oil were evaluated and the results showed that the oil exhibits cytotoxic activity against human oral, liver, lung, colon, melanoma, and leukemic cancer cells [46]. The presence of β-caryophyllene, τ-cadinol, and α-cadinol significantly contributes to the anticancer activity of *N. variabillima* leaf oil [46]. Compound **164** selectively inhibits the growth of cervical cancer cells (HeLa) with an IC_{50} of 4.0 μM [40].

Vasoconstricting activity

Thaliporphine, isolated from *N. konishii*, has been found to possess vasoconstricting action and selectively inhibits expression of inducible, but not constitutive, nitric oxide synthase [29].

Antifungal and antibacterial activities

The hydro-distilled leaf essential oil of *N. parvigemma* exhibits antifungal activity against seven fungi, including *Aspergillus clavatus*, *Aspergillus niger*, *Chaetomium globosum*, *Cladosporium cladosporioides*, *Myrothecium verrucaria*, *Penicillium citrinum*, and *Trichoderma viride*. Besides, the oil also possesses anti-wood-decay activity induced by fungi *Trametes versicolor*, *Phaneochaete chrysosporium*, *Phaeolus schweintizii*, and *Lenzites sulphureu* [47]. The essential oil isolated from *N. aciculata* and *N. sericea* possesses antimicrobial activities [45, 48].

Others

The bark and leaves of *N. cassia* can be used for the treatment of fractures [44]. Several antiplatelet aggregation sesquiterpenes and alkaloids were also isolated from *N. konishii, N. villosa, N. parvigemma, N. variabillima*, and *N. aurata* and characterized [2]. Aporphine alkaloids, commonly present in this genus, have been shown to possess various pharmacological activities, such as choleretic and smooth muscle relaxing properties for boldine and hypotensive and hyperlipidemia-reducing properties in tested animals for dicentrine [12].

Conclusions

The genus *Neolitsea* includes 85 species, and some of them have been used as traditional herbal medicines. The chemical investigation of the *Neolitsea* genus has revealed that this genus contains numerous and complicated constituents, and many components with significant bioactivities have been isolated. This review reveals that only a few species have been investigated, with many species receiving little or no attention. Further phytochemical and biological studies should be carried out on these plants.

Acknowledgments: The authors gratefully acknowledge financial support from the National Natural Science Foundation of China (81072551, 81241101), Key Projects of Science and Technology of Hebei Province (11276103D-89). We also wish to extend our sincere thanks to Syngenta Ltd. (2013-Hebei Medical University-Syngenta-04) and JSPS KAKENHI (grant numbers 19580120, 22560112, 25450144) for financial support.

Received December 17, 2013; accepted February 13, 2014

References

[1] Joshi, B. S.; Kamat, V. N.; Govindachari, T. R. Sesquiterpenes of *Neolitsea zeylanica* Merr.-I isolated of some constituents. *Tetrahedron* **1967**, *23*, 261–265.

[2] Chen, K. S.; Wu, Y. C. Sesquiterpenoids from *Neolitsea parvigemma*: isolation, oxidation products and antiplatelet actions. *Tetrahedron* **1999**, *55*, 1353–1366.

[3] Liou, B. J.; Chang, H. S.; Wang, G. J.; Chiang, M. Y.; Liao, C. H.; Lin, C. H.; Chen, I. S. Secondary metabolites from the leaves of *Neolitsea hiiranensis* and the anti-inflammatory activity of some of them. *Phytochemistry* **2011**, *72*, 415–422.

[4] Li, W. S.; Duh, C. Y. Sesquiterpene lactones from *Neolitsea villosa*. *Phytochemistry* **1993**, *32*, 1503–1507.

[5] Li, W. S. Chemical constituents of *Neolitsea parvigemma*. *J. Nat. Prod.* **1990**, *53*, 1581–1584.

[6] Chen, K. S.; Chang, F. R. Two novel sesquiterpenes from *Neolitsea parvigemma*. *J. Nat. Prod.* **1996**, *59*, 704–706.

[7] Chen, K. S.; Hsieh, P. W.; Hwang, T. L.; Chang, F. R.; Wu, Y. C. Anti-inflammatory furanogermacrane sesquiterpenes from *Neolitsea parvigemma*. *Nat. Prod. Res*. **2005**, *19*, 283–286.

[8] Hayashi, N. Sesquiterpenoids in the essential oil of *Neolitsea sericea*. *Physics Chem*. **1969**, *33*, 107–133.

[9] Takeda, K.; Horibe, I.; Teraoka, M.; Minato, H. Sesquiterpenes of *Lauraceae* plants. Part 1. Components of *Neolitsea aciculate* Koidz. *J. Chem. Soc. (C)* **1970**, *7*, 973–980.

[10] Li, W. S. Sesquiterpene lactones from the root of *Neolitsea acutotrinervia*. *J. Nat. Prod.* **1992**, *55*, 1614–1619.

[11] Li, S.; Li, W. S. Terpenoids from *Neolitsea buisanensis*. *Phytochemistry* **1991**, *30*, 4160–4162.

[12] Sun, S. W.; Lee, S. S.; Huang, H. M. Determination of lauraceous aporphine alkaloids by high-performance liquid chromatography. *J. Pharm. Biomed. Anal*. **1996**, *14*, 1383–1387.

[13] Takaoka, D.; Tani, H.; Nozaki, H.; Tada, S.; Nakayama, M. Structures of highly oxygenated sesquiterpenoids of *Lauraceae, Neolitsea aciculata* Koidz. *Tennen Yuki Kagobutsu Toronkai Koen Yoshishu* **1992**, *34*, 424–431.

[14] Nozaki, H.; Hiroi, M.; Takaoka, D.; Nakayarna, M. Neoliacine, a novel germacranolide sesquiterpene dilactone from *Neolitsea acciculata* Koidz.:X-ray crystal structure. *J.Chem.Soc.Chem. Commun*. **1983**, *19*, 1107–1108.

[15] Takaoka, D.; Nozaki, H.; Nakayama, M. Structure of neoliacinic acid, a new highly oxidized sesquiterpene from *Neolitsea acciculata* Koidz. *J. Chem. Soc. Chem. Commun*. **1987**, *24*, 1861–1862.

[16] Takeda, K.; Tori, K.; Horibe, I.; Minato, H. Structure of sericenine. *J. Chem. Soc. (C)* **1970**, *7*, 985.

[17] Takeda, K.; Horibe, I.; Minato, H. Sesquiterpenes of *Lauraceae* plants. Part II. Neosericenine, a component of *Neolitsea sericea* Koidz. *J. Chem. Soc. (C)* **1970**, *11*, 1547–1549.

[18] Chang, F. R.; Hsieh, T. J.; Huang, T. L.; Chen, C. Y.; Kuo, R. Y.; Chang, Y. C.; Chiu, H. F.; Wu, Y. C. Cytotoxic constituents of the stem bark of *Neolitsea acuminatissima*. *J. Nat. Prod*. **2002**, *65*, 255–258.

[19] Wong, S. L.; Chang, H. S.; Wang, G. J.; Chiang, M. Y.; Huang, H. Y.; Chen, C. H.; Tsain, S. C.; Lin, C. H.; Chen, I. S. Secondary metabolites from the roots of *Neolitsea daibuensis* and their anti-inflammatory activity. *J. Nat. Prod.* **2011**, *74*, 2489–2496.

[20] Padalia, R. C.; Chanotiya, C. S.; Thakuri, B. C.; Mathela, C. S. Germacranolide rich essential oil from *Neolitsea pallens*. *Nat. Prod. Commun*. **2007**, *2*, 591–593.

[21] Wu, X. J.; Vogler, B.; Jackes, B. R.; Setzer, W. N. Terpenoids from *Neolitsea dealbata*. *Nat. Prod. Commun*. **2008**, *3*, 129–132.

[22] Hui, W. H.; Luk, K.; Arthur, H. R.; Loo, S. N. Structures of three C_{32} triterpenoids from *Neolitsea puchella*. *J. Chem. Soc. (C)* **1971**, *16*, 2826–2829.

[23] Chan, W. S.; Hui, W. H. Further C_{32} triterpenoids from *Neolitsea puchella*. *J. Chem. Soc. (C)* **1973**, *5*, 490–492.

[24] Sharma, M. C.; Ohira, T.; Yatagai, M. Sericeol, a cycloartane triterpene from *Neolitsea sericea*. *Phytochemistry* **1993**, *33*, 721–722.

[25] Gunatilaka, A. A. L.; Sotheeswaran, S.; Sriyani, B.; Balasubramaniam, S. Isoboldine and lupenone from *Neolitsea fuscata*. *Planta Med*. **1981**, *43*, 309–310.

[26] Lee, S. S.; Wang, P. H.; Chiou, C. M.; Chen, I. S.; Chen, C. H. Isoquinoline alkaloids from *Litsea garciae* and *Neolitsea villosa*. *Chin. Pharmaceut. J*. **1995**, *47*, 69–75.

[27] Tatsuo, N.; Shozo, N. Alkaloids of lauraceous plants. III. Alkaloids isolated from the leaves of *Neolitsea sericea*. *Yakugaku Zasshi* **1959**, *79*, 1267–1272.

[28] Buchanan, M. S.; Carroll, A. R.; Pass, D.; Quinn, R. J.; Buchanan, M. S.; Carroll, A. R.; Pass, D.; Quinn, R. J. Aporphine alkaloids from the Chinese tree *Neolitsea aurata paraciculata*. *Nat. Prod. Commun*. **2007**, *2*, 255–259.

[29] Lee, S. S.; Yang, H. C. Isoquinoline alkaloids from *Neolitsea konishii*. *J. Chin. Chem. Soc*. **1992**, *39*, 189–194.

[30] Tatsuo, N.; Shozo, A.; Yuri, K. Alkaloids of *Lauraceae* plants. V. Alkaloids isolated from the trunk bark of *Neolitsea sericea*. *Yakugaku Zasshi* **1966**, *86*, 129–134.

[31] Chen, K. S.; Chang, F. R.; Chia, Y. C.; Wu, T. S.; Wu, Y. C. Chemical constituents of *Neolitsea parvigemma* and *Neolitsea konishii*. *J. Chin. Chem. Soc.* **1998**, *45*, 103–110.

[32] Kozuka, M.; Takeuchi, M.; Sawada, T. Alkaloid from *Neolitsea aciculata*. *J. Nat. Prod.* **1984**, *47*, 1062.

[33] Lu, S. T.; Su, T. L. Alkaloids of formosan *Lauraceous* plants. XVI. Alkaloids of *Neolitsea variabillima*. *J. Chin. Chem. Soc*. **1973**, *20*, 75–81.

[34] Hui, W. H.; Loo, S. N.; Arthur, H. R. New aporphine alkaloids from *Neolitsea pulchella*. *J. Chem. Soc. (C)* **1965**, *3*, 2285–2286.
[35] Lu, S. T.; Su, T. L.; Wang, E. C. Studies on the alkaloids of formosan lauraceous plants. XVIII. Alkaloids of *Neolitsea buisanensis Yamamoto et Kamikoti* and *Neolitsea aurata* (Hay.) Koidz. *J. Chin. Chem. Soc*. **1975**, *22*, 349–353.
[36] Tran, T. D.; Pham, N. B.; Fechner, G.; Quinn, R. J.; Ronald, J. Chemical investigation of drug-like compounds from the Australian tree *Neolitsea dealbata*. *Bioorg. Med. Chem. Lett.* **2010**, *20*, 5859–5863.
[37] Komae, H.; Hayashi, N. Palmitone and phytosterols from *Neolitsea sericea*. *Phytochemistry* **1971**, *10*, 1953–1954.
[38] Yano, K.; Akihisa, T.; Tamura, T.; Matsumoto, T. 3α-Hydroxy-14-methyl-$\Delta^{9(11)}$ sterol from *Neolitsea acicutala*. *Phytochemistry* **1992**, *31*, 2902–2904.
[39] Yano, K.; Akihisa, T.; Kawaguchi, R.; Tamura, T.; Matsumoto, T. 24-Methylene-25-methylcycloartanol and 24α-ethyl-5α-cholestan-3α-ol from *Neolitsea sericea*. *Phytochemistry* **1992**, *31*, 1941–1946.
[40] Yano, K.; Akihisa, T.; Tamura, T.; Matsumoto, T. Four 4α-methylsterols and triterpene alkaloids from *Neolitsea aciculata*. *Phytochemistry* **1992**, *31*, 2093–2098.
[41] Sharma, M. C.; Ohira, T.; Yatagai, M. Extractives of *Neolitsea sericea* a new hydroxy steroidal ketone, and other compounds from the heartwood of *Neolitsea sericea*. *Mokuzai Gakkaishi* **1993**, *39*, 939–943.
[42] Lam, S. H.; Chen, C. K.; Wang, J. S.; Lee, S. S. Investigation of flavonoid glycosides from *Neolitsea sericea* var. *aurata* via the general method and HPLC-SPE-NMR. *J. Chin. Chem. Soc*. **2008**, *55*, 449–455.
[43] Sharma, M. C.; Ohira, T.; Yatagai, M. Lanostane triterpenes from the bark of *Neolitsea sericea*. *Phytochemistry* **1994**, *37*, 201–203.
[44] de Silva, S. S. M.; Kumar, N. S. Structural studies of an arabinoxylan isolated from the leaves of *Neolitsea cassia*. *Carbohydr. Res*. **1986**, *152*, 229–236.
[45] Suk, K. S.; Eun, K. J.; Hyun, C. G.; Lee, N. H. *Neolitsea aciculata* essential oil inhibits drug-resistant skin pathogen growth and propionibacterium acnes-induced inflammatory effects of human monocyte leukemia. *Nat. Prod. Commun*. **2011**, *8*, 1193–1198.
[46] Su, Y. C.; Hsu, K. P.; Wang, E. I. C.; Ho, C. L. Composition and in vitro anticancer activities of the leaf essential oil of *Neolitsea variabillima* from Taiwan. *Nat. Prod. Commun*. **2013**, *8*, 531–532.
[47] Ho, C. L.; Liao, P. C.; Wang Eugene, I. C.; Su, Y. C. Composition and antifungal activities of the leaf essential oil of *Neolitsea parvigemma* from Taiwan. *Nat. Prod. Commun*. **2011**, *6*, 1357–1360.
[48] Hyun, C. G.; Yoon, W. J.; Lee, N. H. Essential oils of *Neolitsea sericea* having anti-inflammatory and antimicrobial activities. *Korean Kongkae Taeho Kongbo* **2011**, KR 2011036318 A 20110407.