Pyrrolizidine-alkaloid Content of the Genus *Senecio*

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Summary: Various pyrrolizidine alkaloids have been reputed for their biological and physiological activities. This article describes the pyrrolizidine alkaloids isolated so far from the genus *Senecio*.

Introduction

The pyrrolizidine nucleus contains one nitrogen at the bridge of five-membered ring (1), a system also known as 1-azabicyclo [0,3,3] octane. The alkaloid is composed of two parts:

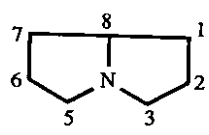
1. the diol portion called the necine and
2. the acid moiety called the necic acid, which may be mono-, or dicarboxylic acid esterified to one or both the hydroxy groups of necine.

Structural variation among the necines is slight. Only about a dozen are known, and they differ from one another mostly in stereochemistry or the degree of hydrogenation. The principle necines are:

1. Supinidine (2)
2. Heliotridine (3)
3. Retronecine (4) and
4. Platynecine (5)

The most important of these is retronecine (4). Most of the necic acids have 10 carbon atoms, but the acids *Crotalaria* species differ in having only 6 or 8 carbon atoms, and a few other exceptions are also known [1]. Several of the alkaloids occur naturally as quaternary N-oxides from which the parent base can be obtained by reduction with zinc dust.

The pyrrolizidine alkaloids are found in the genera *Senecio* and *Petasites* in the Compositae: *Heliotropium, Trichodesma, Echium* and *Trachelanthus* in the Boraginaceae: and *Crotalaria* in the Leguminoseae. The genus *Crotalaria* is restricted to tropical and sub-tropical regions but *Senecio* and *Heliotropium* are of worldwide distribution. Because of their first discovery and extensive occurrence in the genus *Senecio*, these alkaloids are often called as "Senecio alkaloids".



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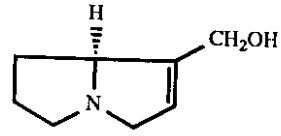

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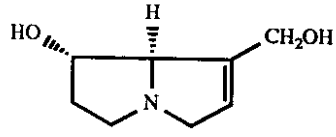

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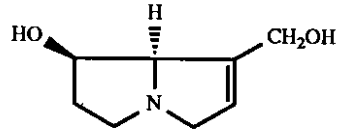

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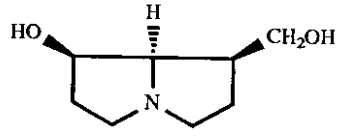

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The genus *Senecio* the largest of the family Compositae, includes about 1450 species [2], many of which are used in folk medicine [3]. The genus is composed of herbs and shrubby plants distributed chiefly in the temperate regions and the hills of tropics. A few herbaceous species of the genus are grown as ornament for their flower heads, foliage of climbing habit. The various types of CINERARIA of florists are all included in this genus. These are said

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Table-1

S.No.	Name of Compound	Physical Data	Source	Ref. No.
1.	Acetylanonamine $C_{21}H_{29}NO_8$ MW=423	m.p.=124-25° $[\alpha]_D^{25}$ +17.99° (c, 0.91, $CHCl_3$)	*S. anonymus*	[5]
2.	7-Angelylretronecine $C_{13}H_{19}NO_3$ MW=237	m.p.=76-77° (74°) $[\alpha]_D^{24}$ +49° (c, 1.38, EtOH)	*S. nemorensis* ssp. *fuchsii*, *S. sylvaticus*, *S. triangularis* *S. integrifolius* ssp. *aucheri*	[6] [7] [8] [9]
3.	Aucherine	-	*S. deferens*	[10]
4.	Acetylsenkirkine-15,20-epoxide $C_{21}H_{29}NO_8$ MW=423	-		
5.	Anonamine $C_{19}H_{27}NO_7$ MW=381	m.p.=202° $[\alpha]_D^{27}$ +33.5° (c, 1.0, $CHCl_3$)	*S. anonymus*	[11]
6.	Anacrotine $C_{18}H_{25}NO_6$ MW=351	m.p.=191-92° $[\alpha]_D$ +30° (EtOH)	*S. vira-vira*	[12]
7.	18-Acetoxysenkirkine (19-Acetoxysenkirkine) $C_{21}H_{29}NO_8$ MW=423	-	*S. laricifolius*	[13]
8.	7-Angelyl-9-sarracinyl-retronecine $C_{18}H_{25}NO_5$ MW=335	Gum, $[\alpha]_D^{25}$ +6.1° (c, 1.7, MeOH)	*S. triangularis*, *S. cacaliaster*	[8] [14]
9.	Aretine	-	*S. othonnae*	[15]
10.	Alkaloid H $C_{19}H_{23}NO_4$ MW=329	m.p.=184-85° $[\alpha]_D^{19}$ +170° (c, 1.4, $CHCl_3$)	*S. renardii*	[16]
11.	"Alkaloid"	-	*S. adonidifolius*	[17]
12.	"A new Alkaloid" $C_{18}H_{25}NO_5$ MW=335	-	*S. vernalis*	[18]
13.	"A new Alkaloid" $C_{19}H_{27}NO_6$ MW=365	-	*S. vernalis*	[18]
14.	Alkaloid A2	m.p.=222-24° $[\alpha]_D^{28}$ +19° (c, 2.0, $CHCl_3$)	*S. aegyptius*	[19]
15.	Alkaloid P1 $C_{18}H_{27}NO_6$ MW=353	m.p.=166-67° (95-100 °) $[\alpha]_D^{28}$ -25.7° (c, 2.0, $CHCl_3$)	*S. petasitis*	[19]
16.	"A new Alkaloid" $C_{19}H_{27}NO_6$ MW=365	m.p.=190-91° $[\alpha]_D$ +2.42° (c, 2.1, $CHCl_3$)	*S. kleinia*	[20]
17.	"The Alkaloid" MW=333-335	m.p.=217-18° $[\alpha]_D^{20}$ -73.2°	*S. coronopifolius*	[21]
18.	Alkaloid A	-	*S. kirkii*	[22]
19.	Alkaloid C	-	*S. kirkii*	[22]

Table 1 Cont.

S.No.	Name of Compound	Physical Data	Source	Ref. No.
20.	"A new Alkaloid"	m.p.=213-15° $[\alpha]_D$ -103.4° ($CHCl_3$)	*S. nudicaulis*	[23]
21.	Angularine $C_{15}H_{25}NO_6$ MW=315	m.p.=200-201° $[\alpha]_D^{25}$ -98° (c, 0.22, EtOH)	*S. angulatus*	[24]
22.	"A new Alkaloid" $C_{18}H_{23}NO_5$ MW=333	-	*S. borysthenicus*	[25]
23.	"A new Alkaloid" $C_{18}H_{25}NO_5$ MW=335	m.p.=232-44° $[\alpha]_D^{20}$ +66.8°	*S. brasiliensis*	[26]
24.	"Alkaloid" $C_{18}H_{27}NO_6$ MW=353	m.p.=175-76° $[\alpha]_D^{25}$ -62.4° (c, 1.5, MeOH)	*S. hygrophilus*	[27]
25.	Bisline $C_{18}H_{27}NO_6$ MW=353	m.p.=169°	*S. othonniformis*	[28]
26.	Bulgarsenine $C_{18}H_{27}NO_5$ MW=337	m.p.=115° (112-13°) $[\alpha]_D^{24}$ -54° (c, 0.78, $CHCl_3$) $[\alpha]_D^{20}$ -74.2° (EtOH)	*S. nemorensis s*, sp. *fuchsii*,	[6]
			S. nemorensis, sp. *nemorensis*,,	[29]
			S. doronicum,	[30]
			S. fuchsii,	[30]
			S. abrotanifolius, ssp. *abrotanifolius*,	[31]
			S. abrotanifolius, ssp. *abrotanifolius* var. *tiroliensis*,	[31]
			S. cacaliaster,	[14]
			S. nemorensis,	[32]
			S. doronicum	[33]
27.	Brasilinecine	m.p.=169-71° (dec.) $[\alpha]_D^{20}$ -68.2° ($CHCl_3$)	*S. brasiliensis*	[34]
28.	$C_{13}H_{19}NO_3$ (1) MW=237	-	*S. variabilis*	[13]
29.	$C_{13}H_{19}NO_3$ (2) MW=237	-	*S. variabilis*, *S. cacaliaster*, *S. caudatus*	[13]
30.	$C_{18}H_{25}NO_5$ (3) MW=335	-	*S. variabilis*, *S. cacaliaster*, *S. caudatus*	[13]
31.	$C_{18}H_{27}NO_6$ (4) MW=353	-	*S. caudatus*	[13]
32.	$C_{20}H_{29}NO_7$ (5) MW=395	-	*S. caudatus*	[13]
33.	$C_{18}H_{27}NO_7$ (6) MW=369	-	*S. caudatus*	[13]
34.	$C_{13}H_{19}NO_3$ (7) MW=237	-	*S. caudatus*	[13]
35.	$C_5H_3NO_3$ (8) MW=171	-	*S. caudatus*	[13]
36.	$C_{13}H_{19}NO_4$ (9) MW=253	-	*S. caudatus*	[13]

Table 1 Cont.

S.No.	Name of Compound	Physical Data	Source	Ref. No.
37.	$C_{18}H_{25}NO_6$ (10) MW=351	-	*S. umgeniensis*, *S. caudatus*	[13]
38.	$C_{18}H_{26}NO_7$ (11) MW=369	-	*S. caudatus*	[13]
39.	$C_{20}H_{29}NO_8$ (12) MW=411	-	*S. caudatus*	[13]
40.	$C_{13}H_{21}NO_3$ (13) MW=239	-	*S. caudatus*	[13]
41.	$C_{13}H_{21}NO_3$ (14) MW=239	-	*S. caudatus*	[13]
42.	$C_{18}H_{23}NO_6$ (19) MW=349	-	*S. megaphyllus*	[13]
43.	$C_{18}H_{23}NO_6$ (20) MW=349	-	*S. megaphyllus*	[13]
44.	$C_{18}H_{23}NO_7$ (21) MW=365	-	*S. dolichodoryius*	[13]
45.	$C_{23}H_{27}NO_7$ (24) MW=353	-	*S. stapeliaeformis*	[13]
46.	Cruentine A $C_{18}H_{25}NO_5$ MW=335	m.p.=218-20° $[\alpha]_D$ -94.1° ($CHCl_3$)	*S. cruentus*	[35]
47.	Cruentine B $C_{18}H_{25}NO_6$ MW=351	m.p.=200-202° $[\alpha]_D$ -63.4° ($CHCl_3$)	*S. cruentus*	[35]
48.	$C_{18}H_{25}NO_8$ MW=383	-	*S. retrorsus*	[36]
49.	Doronenine (1,2-didehydrobulgarsenine) $C_{18}H_{25}NO_5$ MW=335	m.p.=124-27° $[\alpha]_D^{20}$ +123.4° (EtOH)	*S. nemorensis*, ssp. *nemorensis*, *S. doronicum*, *S. fuchsii*, *S. abrotanifolius*, ssp. *abrotanifolius*, *S. abrotanifolius*, ssp. *abrotanifolius* var. *tiroliensis*	[29] [30] [30] [30] [30]
50.	Dihydroretrorsine (18-Hydroxyplatyphylline) $C_{18}H_{27}NO_6$ MW=353	m.p.=62-63° $[\alpha]_D^{20}$ -2.68° (c, 0.078, $CHCl_3$)	*S. subulatus*, *S. subulatus*, var. *erectus*	[37] [38]
51.	Doronine $C_{21}H_{30}ClNO_8$ MW=459	m.p.=113-14° (dec.) $[\alpha]_D$ +45.4° (c, 1.1, $CHCl_3$)	*S. abrotanifolius*, sp. *abrotanifolius*, *S. abrotanifolius*, ssp. *abrotanifolius* var. *tiroliensis*, *S. othonnae*	[31] [31] [15]
52.	1,2-Dehydrofuchsisenecionine $C_{13}H_{19}NO_3$ MW=237	-	*S. nemorensis*, ssp. *fuchsii*	[29]
53.	Desacetyldoronine	-	*S. inaequidens*	[39]
54.	8-Ethoxy-3-oxo-1,2-dehydroretrorsine $C_{20}H_{27}NO_8$ MW=409	-	*S. grisebachii*	[40]

Table 1 Cont.

S.No.	Name of Compound	Physical Data	Source	Ref. No.
55.	Erucifoline	m.p.=195-97°	*S. argunesis,*	[41]
	(Alkaloid S-C)	$[\alpha]_D^{22}$ -108°	*S. aegypticus,*	[42]
	$C_{18}H_{23}NO_6$	(c, 0.99, $CHCl_3$)	*S. erucifolius,*	[43]
	MW=349		*S. erraticus,* ssp. *barbaraeifoliu*	[44]
56.	Floridanine	m.p.=195-96°	*S. aureus,*	[45]
	(12-Acetylonetine)	$[\alpha]_D$ +66.5°	*S. othonnae,*	[15]
	$C_{21}H_{31}NO_9$	(c, 0.8, $CHCl_3$)	*S. erraticus*	[46]
	MW=441			
57.	Florosenine	m.p.=101-103°	*S. glabellus,*	[47]
	$C_{21}H_{29}NO_8$	$[\alpha]_D$ +31.9°	*S. adonidifolius,*	[48]
	MW=423	(c, 1.38, $CHCl_3$)	*S. quebradensis,*	[61]
			S. aureus,	[93]
			S. fluviatilis	[49]
58.	Fuchsisenecionine	$[\alpha]_D^{22}$ -120.2°	*S. nemorensis,* ssp. *fuchsii,*	[6]
	(*O*-Senecioylplatynecine)			
	$C_{13}H_{21}NO_3$		*S. nemorensis,* ssp. *nemorensis,*	[6]
	MW=239		*S. fuchsii*	[50]
59.	Franchetine	m.p.=124-25°	*S. francheti*	[51]
60.	Gramminifoline	m.p.=236°	*S. gramminifolius*	[52]
	$C_{18}H_{23}NO_5$			
	MW=333			
61.	Hadiensine	Colorless gum	*S. hadiensis*	[53]
	(1α-Hydroxyplatyphylline)			
	$C_{18}H_{27}NO_6$			
	MW=353			
62.	21-Hydroxyintegerrimine	Gum	*S. argunesis*	[41]
	$C_{18}H_{25}NO_6$	$[\alpha]_D$ -2°		
	MW=351	(c, 1.5, EtOH)		
63.	2α-Hydroxy-9-angelyloxy-	Colorless resin	*S. deferens*	[10]
	(-)-trachelanthamidine-			
	N-oxide			
	$C_{13}H_{21}NO_4$			
	MW=255			
64.	Hydroxysenkirkine	m.p.=124-25°	*S. anonymus*	[11]
	(18-Hydroxysenkirkine)	$[\alpha]_D^{26}$ +5.3°		
	$C_{19}H_{27}NO_7$	(c, 0.682, EtOH)		
	MW=381			
65.	18-Hydroxysenkirkine		*S. laricifolius*	[13]
	(19-Hydroxysenkirkine)			
	$C_{19}H_{27}NO_7$			
	MW=381			
66.	Hygrophylline	m.p.=176° (173-74°)	*S. hygrophyllus*	[54]
	$C_{18}H_{27}NO_6$	$[\alpha]_D^{20}$ -67.3°		
	MW=353	(c, 2.9, EtOH)		
67.	Integerrimine	m.p.=172°	*S. argunesis,*	[41]
	(Alkaloid S-D)	$[\alpha]_D$ -29°	*S. glabellus,*	[47]
	(Squalidine)	($CHCl_3$)	*S. sanguisorbae,*	[55]
	$C_{18}H_{25}NO_5$		*S. integrifolius,* ssp. *aucheri,*	[9]
	MW=335			
			S. vernalis,	[56]
			S. anonymus,	[11]
			S. murorum,	[57]

Table 1 Cont.

S.No.	Name of Compound	Physical Data	Source	Ref. No.
			S. glabellus,	[58]
			S. longilobus,	[58]
			S. brasiliensis,	[59]
			S. ragonesei,	[37]
			S. glandulosus,	[37]
			S. leucostachys,	[37]
			S. inaequidens,	[60]
			S. vulgaris,	[61]
			S. faberi,	[62]
			S. tenuifolius,	[63]
			S. alpinus,	[64]
			S. durieui	[65]
			S. taiwanensis,	[66]
			S. morrisonensis,	[66]
			S. antieuphorbium,	[67]
			S. alpinus,	[68]
			S. subalpinus,	[68]
			S. incanus,	[68]
			S. kleinia,	[20]
			S. brasiliensis	[69]
			S. magnificus,	[70]
			*S. erraticus,*spp. *barbaraeifolius,*	[44]
			S. integerrimus,	[71]
			S. squalidine	[72]
			S. richii,	[13]
68.	Isosenaetnine $C_{20}H_{23}NO_7$ MW=389	m.p.=198.5° $[\alpha]_D^{24}$ -34.8° (c, 1.0, $CHCl_3$)	*S. barbertonicus*	[73]
69.	Isopterophorine $C_{20}H_{23}NO_7$ MW=389	Oil $[\alpha]_D$ -25° ($CHCl_3$)	*S. mandralicae*	[13]
70.	Isoline (Bisline acetate) $C_{20}H_{29}NO_7$ MW=395	m.p.=173° $[\alpha]_D^{29}$ -4.8° (c, 1.78, EtOH)	*S. petasitis,* *S. othonniformis*	[28] [74]
71.	Isatidine (Retrorsine-N-oxide) $C_{18}H_{25}NO_7$ MW=367	m.p.=145° $[\alpha]_D$ -8.2° (H_2O)	*S. discolor,* *S. paucicalyculatus,* *S. sceleratus,* *S. retrorsus,* *S. isatideus*	[75] [76] [77] [36] [78]
72.	Jacobine $C_{18}H_{25}NO_6$ MW=351	m.p.=228° (219°) $[\alpha]_D^{17}$ -40° ($CHCl_3$)	*S. alpinus,* *S. jacobaea,* *S. cineraria,* *S. brasiliensis*	[64] [79] [80] [81]
73.	Jacoline $C_{18}H_{27}NO_7$ MW=369	m.p.=221.5° $[\alpha]_D$ +48° (c, 1.155, $CHCl_3$)	*S. jacobaea,* *S. pseudoorientalis*	[79] [82]
74.	Jaconine $C_{20}H_{26}ClNO_6$ MW=411	m.p.=147° $[\alpha]_D$ +52.5° (c, 1.144, EtOH)	*S. alpinus,* *S. jacobaea*	[64] [79]

Table 1 Cont.

S.No.	Name of Compound	Physical Data	Source	Ref. No.
75.	Jacozine $C_{18}H_{23}NO_6$ MW=349	m.p.=228° $[\alpha]_D$ -140° (c, 1.9, $CHCl_3$)	*S. alpinus*, *S. jacobaea*, *S. subalpinus*	[64] [79] [68]
76.	Longilobine $C_{18}H_{23}NO_5$ MW=333	m.p.=217-18° (dec.) $[\alpha]_D^{25}$ -79.2° (c, 2.95, EtOH)	*S. longilobus*	[71]
77.	Ligularizine $C_{21}H_{29}NO_8$ MW=423	-	*S. gallicus*	[48]
78.	Merenskine (Chlorodeoxysceleratine) $C_{18}H_{26}ClNO_6$ MW=387	m.p.=196° (194.5-195°) $[\alpha]_D^{20.4}$ +32.6° (c, 0.24, EtOH)	*S. sceleratus*	[83]
79.	Merenskine-N-oxide $C_{18}H_{26}ClNO_7$ MW=403	m.p.=146° (dec.) $[\alpha]_D^{20}$ +26.1° (c, 0.33, EtOH)	*S. latifolius*	[84]
80.	Macrophylline $C_{13}H_{21}NO_3$ MW=239	m.p.=42-44° $[\alpha]_D^{20}$ +34.5° (c, 1.68, EtOH)	*S. schvetzovi*, *S. macrophyllus*	[85] [86]
81.	*Neo*-rosmarinine $C_{18}H_{27}NO_6$ MW=353	Gum	*S. hadiensis*	[53]
82.	*Nor*-senecicaudatin-9-*O*-senecioate	-	*S. caudatus*	[13]
83.	*Neo*-triangularine $C_{18}H_{25}NO_5$ MW=335	Yellow oil	*S. triangularis*	[87]
84.	*Neo*-platyphylline (15*E*-Isomer of platyphylline) $C_{18}H_{27}NO_5$ MW=337	m.p.=131-33° $[\alpha]_D$ +1.95°	*S. vira-vira*, *S. rhombifolius*, *S. platyphyllus*	[12] [88] [89]
85.	*Neo*-senkirkine (15*E*-isomer of senkirkine) $C_{19}H_{27}NO_6$ MW=365	m.p.=175° $[\alpha]_D^{23}$ -21° (c, 1.08, $CHCl_3$)	*S. anonymus*, *S. grandifolius*, *S. leptolobus*, *S. pierotii*, *S. auricule*	[11] [13] [90] [91] [65]
86.	Nemorensine $C_{18}H_{27}NO_5$ MW=337	m.p.=132-34° $[\alpha]_D^{24}$ -58° (c, 2.33, $CHCl_3$)	*S. nemorensis*, ssp. *fuchsii*, *S. nemorensis*	[6] [32]
87.	12-*O*-acetylneohadiensine $C_{20}H_{29}NO_7$ MW=395	-	*S. hadiensis*	[53]
88.	12-*O*-acetylrosmarinine $C_{20}H_{29}NO_7$ MW=395	Pale amber oil $[\alpha]_D$ -36° (c, 1.8, EtOH)	*S. hadiensis*	[53]
89.	12-*O*-acetylhadiensine $C_{20}H_{29}NO_7$ MW=395	-	*S. hadiensis*	[53]
90.	*O*-Acetylsenkirkine $C_{21}H_{29}NO_5$ MW=407	m.p.=195-96° $[\alpha]_D^{25}$ -34° (c, 0.44, MeOH)	*S. illinitus*, *S. tenuifolius*, *S. kirkii*	[92] [63] [22]

Table 1 Cont.

S.No.	Name of Compound	Physical Data	Source	Ref. No.
91.	Oxynemorensine $C_{18}H_{27}NO_6$ MW=353	m.p.=160-63° $[\alpha]_D^{20}$ -35° (c, 1.0, $CHCl_3$)	*S. nemorensis*	[32]
92.	Onetine $C_{19}H_{29}NO_8$ MW=399	m.p.=192-93° $[\alpha]_D$ +73° (c, 2.5, $CHCl_3$)	*S. othonnae*	[93]
93.	Otosenine (Othosenine) (Tomentosine) $C_{19}H_{27}NO_7$ MW=381	m.p.=219° (232°) $[\alpha]_D$ +20.8° (+14°) ($CHCl_3$)	*S. argunesis,* *S. glabellus,* *S. sanguisorbae,* *S. aquaticus,* *S.anonymus,* *S. aureus,* *S. aegyptius,* *S. desfontainei,* *S. othonnae,* *S. cineraria,* *S. renardii,* *S. erraticus,* *S. fluviatilis,* *S. jacobaea,* *S. erraticus,* ssp. *barbaraeifolius,* *S. tomentosus*	[41] [47] [55] [94] [11] [45] [95] [95] [15] [80] [16] [46] [49] [96] [97] [98]
94.	Platyphylline $C_{18}H_{27}NO_5$ MW=337	m.p.=129° (124-25°) $[\alpha]_D$ -56° ($CHCl_3$)	*S. nemorensis,* ssp. *fuchsii,* *S. pseudo-orientalis,* *S. vernalis,* *S. platyphylloides,* *S. pojarkovae,* *S. rhombifolius,* *S. tourneforlii,* *S. platyphyllus,* *S. hygrophilus,* *S. adnatus* *S. tourneforlii,* *S. platyphyllus*	[29] [99] [100] [101] [102] [88] [103] [104] [105 [52] [98] [106]
95.	Platyphylline-N-oxide $C_{18}H_{27}NO_6$ MW=353	m.p.=180-81° $[\alpha]_D$ -44.6° ($CHCl_3$), -59° (H_2O)		
96.	Pterophine $C_{18}H_{23}NO_5$ MW=333	-	*S. ilicifolius,* *S. pterophorus*	[36] [36]
97.	Petitianine (2α-Hydroxy-1,2-dihydro-retrorsine) $C_{18}H_{27}NO_7$ MW=369	m.p.=207-209° $[\alpha]_D$ -60° (c, 0.5, MeOH)	*S. hadiensis*	[53]
98.	Petasinine $C_{13}H_{21}NO_3$ MW=239	Amorphous powder $[\alpha]_D^{25}$ +16° (c, 2.5, EtOH)	*S. doronicum,* *S. fuchsii*	[30] [30]
99.	Procerine $C_{13}H_{21}NO_5$ MW=271	m.p.=238-90° (dec.)	*S. procerus*	[107]
100.	"A Pyrrolizidine alkaloid"	-	*S. petasitis*	[73]

Table 1 Cont.

S.No.	Name of Compound	Physical Data	Source	Ref. No.
101.	Pterophorine	-	*S. pterophorus,*	[108]
	$C_{20}H_{23}NO_7$		*S. inaequidens*	[108]
	MW=389			
102.	Ruwenine*	m.p.=175.5-79°	*S. ruwenzoriensis*	[109]
	$C_{18}H_{27}NO_6$	(dec. from 164°)		
	MW=353			
103.	Ruzorine*	m.p.=161-63°	*S. ruwenzoriensis*	[109]
	$C_{18}H_{27}NO_8$	(dec. from 134°)		
	MW=385			
104.	Retroisosenine	m.p.=127°	*S. nemorensis,* ssp. *fuchsii,*	[6]
	(Alkaloid SN-A)	$[\alpha]_D^{24}$ +118°		
	$C_{18}H_{25}NO_5$	(c, 0.69, $CHCl_3$)	*S. nemorensis,* ssp. *nemorensis*	[29]
	MW=335			
105.	Rivularine	m.p.=116-17°	*S. salignus,*	[13]
	(7-Angelylheliotridine)	$[\alpha]_D^{24}$ -18°	*S. ovirensis,*	[110]
	$C_{13}H_{19}NO_3$	(c, 0.78, $CHCl_3$),	*S. rivularis*	[111]
	MW=237	+19° (c, 0.66, EtOH)		
106.	Reddelliine	m.p.=196-97°	*S. longilobus*	[112]
	(Reddelline)	$[\alpha]_D^{29}$ -114°	*S. mikanoides*	[19]
	(Alkaloid M_1)	(c, 2.0, $CHCl_3$)	*S. aegyptius*	[42]
	$C_{18}H_{27}NO_6$		*S. desfontainei*	[42]
	MW=353		*S. reddellii*	[113]
			S. parksii	[114]
			S. douglasii	[114]
			S. pseudo-orientalis	[99]
107.	Rosmarinine	m.p.=209° (205-208°)	*S. hadiensis,*	[53]
	$C_{18}H_{27}NO_6$	$[\alpha]_D$ -120° ($CHCl_3$),	*S. taiwanensis,*	[66]
	MW=353	-94° (MeOH)	*S. morrisonensis,*	[66]
			S. brachypodus,	[105]
			S. hygrophilus,	[105]
			S. adnatus,	[105]
			S. pauciligulatus,	[27]
			S. brachypodus,	[27]
			S. rosmarinifolius	[115]
108.	Retrorsine		*S. brasiliensis*	[59]
	(20,21(*E*)-Isomer)			
	$C_{18}H_{25}NO_6$			
	MW=351			
109.	Retrorsine	m.p.=217° (207-208°)	*S. vulgaris,*	[116]
	(β-Longilobine)	$[\alpha]_D^{20}$ -62.4°	*S. integrifolius,* ssp. *aucheri*	[9]
	$C_{18}H_{25}NO_6$	(c, 1.0, $CHCl_3$)		
	MW=351		*S. deferens,*	[10]
			S. vernalis,	[56]
			S. anonymus,	[11]
			S. grisebachii,	[117]
			S. discolor,	[13]
			S. brasiliensis,	[59]
			S. longilobus,	[58]
			S. pseudo-orientalis,	[94]
			S. filaginoides,	[37]
			S. seratophiloides,	[37]
			S. ragonesei,	[37]

Table 1 Cont.

S.No.	Name of Compound	Physical Data	Source	Ref. No.
			S. subulatus,	[37]
			S. glandulosus,	[37]
			S. uspallatensis,	[37]
			S. gilliesiana,	[37]
			S. phillipicus,	[92]
			S. inaequidens,	[60]
			S. subulatus, var. *erectus,*	[38]
			S. glandulosus,	[38]
			S. cineraria,	[180]
			S. selloi,	[118]
			S. erucifolius,	[17]
			S. jacobaea,	[17]
			S. swaziensis,	[119]
			S. ambrosioides,	[81]
			S. isatideus,	[105]
			S. paucicalyculatus,	[76]
			S. eremophilus,	[114]
			S. douglasii,	[114]
			S. ampullaceus,	[114]
			S. parksii,	[114]
			S. sceleratus,	[77]
			S. gramminifolius,	[52]
			S. ilicifolius,	[52]
			S. retrorsus	[52]
110.	7-Senecioylretronecine $C_{13}H_{19}NO_3$ MW=237	Oil $[\alpha]_D^{20}$ -2° (EtOH)	*S. nemorensis* ssp. *fuchsii,* *S. triangularis,* *S. cacaliaster*	[6] [8] [14]
111.	7-Senecioylplatynecine $C_{13}H_{21}NO_3$ MW=239	-	*S. nemorensis,* ssp. *fuchsii*	[6]
112.	Senecicaudatinal Semiacetal $C_{13}H_{19}NO_4$ MW=253	-	*S. caudatus*	[13]
113.	Sencalenine $C_{18}H_{25}NO_5$ MW=335	Oil $[\alpha]_D^{20}$ -8° (EtOH)	*S. cacaliaster*	[14]
114.	7-Senecioyl-9-sarracinoylretronecine $C_{18}H_{25}NO_5$ MW=335	Oil $[\alpha]_D^{24}$ +4° (EtOH)	*S. triangularis*	[8]
115.	Senecicannabine $C_{18}H_{23}NO_7$ MW=365	m.p.=198° $[\alpha]_D^{25}$ -8.9° ($CHCl_3$)	*S. cannabifolius*	[120]
116.	Senecicaudatin (**16**) $C_{18}H_{29}NO_6$ MW=271	-	*S. caudatus*	[13]
117.	Senecicaudatin (**17**) $C_{18}H_{27}NO_6$ MW=353	-	*S. caudatus*	[13]

Table 1 Cont.

S.No.	Name of Compound	Physical Data	Source	Ref. No.
118.	Spartioidine	m.p.=178°	*S. vulgaris,*	[121]
	(15(*E*)-isomer of	$[\alpha]_D$ -83.7°	*S. spartioides*	[122]
	Seneciphylline)	(c, 1.73, 95% EtOH)		
	$C_{18}H_{23}NO_5$			
	MW=333			
119.	Sceleratine-N-oxide	m.p.=152° (dec.)	*S. latifolius*	[123]
	$C_{18}H_{27}NO_8$	$[\alpha]_D^{20}$ +48.4°		
	MW=385	(c, 1.27, MeOH)		
120.	Sceleratine	m.p.=176.5-177°	*S. latifolius,*	[123]
	$C_{18}H_{27}NO_7$	$[\alpha]_D^{20}$ +55°	*S. sceleratus*	[124]
	MW=369	(c, 1.09, EtOH)		
121.	Senecifoline	m.p.=194-95°	*S. latifolius*	[125]
	$C_{18}H_{27}NO_8$	$[\alpha]_D$ +28.8°		
	MW=385	(c, 3.85, EtOH)		
122.	Senecifolidine	m.p.=212°	*S. latifolius*	[125]
	$C_{18}H_{25}NO_7$	$[\alpha]_D$ -13.56°		
	MW=367	(c, 2.87, EtOH)		
123.	Swazine	m.p.=165°	*S. swaziensis*	[126]
	$C_{18}H_{23}NO_6$	$[\alpha]_D^{20}$ -104°		
	MW=349	(c, 1.16, EtOH)		
124.	Seneciphylline	m.p.=217-18° (dec.)	*S. argunesis,*	[41]
	(α-Longilobine)	$[\alpha]_D^{17}$ -139°	*S. vulgaris,*	[116]
	(Jacodine)	($CHCl_3$)	*S. aquaticus,*	[94]
	$C_{18}H_{23}NO_5$		*S. integrifolius,* ssp. *aucheri,*	[9]
	MW=333			
			S. vernalis,	[56]
			S. multivenius,	[13]
			S. laricifolius,	[13]
			S. longilobus,	[58]
			S. phillipicus,	[92]
			S. patagonicus,	[127]
			S. aegyptius,	[95]
			S. desfontainei,	[95]
			S. platyphylloides,	[101]
			S. alpinus,	[64]
			S. jacobaea,	[79]
			S. cineraria,	[80]
			S. scandens,	[128]
			S. renardii,	[16]
			S. erucaefolius,	[17]
			S. pojarkovae,	[102]
			S. lampsanoides	[129]
			S. fluviatilis,	[49]
			S. propinquus,	[130]
			S. rhombifolius,	[88]
			S. kubensis,	[88]
			S. adonidifolius,	[131]
			S. krylovii,	[132]
			S. incanus,	[68]
			S. paucifolius,	[85]
			S. borysthenicus,	[133]
			S. poludosus,	[133]

Table 1 Cont.

S.No.	Name of Compound	Physical Data	Source	Ref. No.
			S. cannabifolius,	[133]
			S. chrysanthemoides,	[134]
			S. platyphyllus,	[135]
			S. subalpinus,	[136]
			S. othonnae,	[93]
			S. erucifolius,	[43]
			S. racemosus,	[137]
			S. poludosus	[185]
			S. palmatus,	[138]
			S. erraticus, ssp. *barbaraeifolius*	[139]
			S. brasiliensis,	[81]
			S. fremanti,	[81]
			S. ambrosioides,	[81]
			S. carthamoides,	[98]
			S. douglaasii,	[114]
			S. ampullaceus,	[114]
			S. eremophilus,	[114]
			S. spartioides	[71]
125.	Seneciphylline-N-oxide $C_{18}H_{23}NO_6$ MW=349		*S. vulgaris,* *S. platyphyllus*	[116] [106]
126.	Senkirkine (Renardine) $C_{19}H_{27}NO_6$ MW=365	m.p.=196.5-197.5° $[\alpha]_D^{25}$ -16° (c, 1.89, MeOH)	*S. glabellus,* *S. integrifolius,* ssp. *aucheri,*	[97] [9]
			S. vernalis,	[56]
			S. deferens,	[10]
			S. anonymus,	[11]
			S. gallicus,	[48]
			S. grandifolius,	[11]
			S. laricifolius,	[11]
			S. quebradensis,	[11]
			S. illinitus,	[92]
			S. tenuifolius,	[63]
			S. pierotii,	[91]
			S. procerus,	[107]
			S. renardi,	[16]
			S. kleinia,	[140]
			S. antieuphorbium,	[67]
			S. jacobaea,	[96]
			S. kirkii	[141]
127.	Senecionine-N-oxide $C_{18}H_{25}NO_6$ MW=351		*S. vulgaris,* *S. deferens,* *S. gallicus,* *S. pimpinellifolius*	[116] [10] [48] [13]
128.	Senecionine (Aureine) $C_{18}H_{25}NO_5$ MW=335	m.p.=232-33° $[\alpha]_D$ -56° ($CHCl_3$)	*S. argunesis,* *S. vulgaris,* *S. sanguisorbae* *S. glabellus,* *S. nemorensis,* ssp. *fuchsii,*	[41] [116] [55] [47] [29]
			S. aquaticus, *S. integrifolius,* ssp. *aucheri,*	[94] [9]

Table 1 Cont.

S.No.	Name of Compound	Physical Data	Source	Ref. No.
			S. vernalis,	[56]
			S. gallicus,	[48]
			S. anonymus,	[11]
			S. grisebachii,	[117]
			S. pimpinellifolius,	[13]
			S. laricifolius,	[13]
			S. multivenius,	[13]
			S. longilobus,	[58]
			S. seratophiloides,	[37]
			S. leucostachys,	[37]
			S. ragonesei,	[37]
			S. subulatus,	[37]
			S. gilliesiano,	[37]
			S. inaequidens,	[37]
			S. argentino,	[37]
			S. flaginoides,	[37]
			S. illinitus,	[92]
			S. patagonicus,	[127]
			S. subulatus, var. *erectus,*	[38]
			S. tenuifolius,	[63]
			S. aegyptius,	[95]
			S. desfontainei,	[95]
			S. alpinus,	[64]
			S. fuchsii,	[142]
			S. cineraria,	[80]
			S. jacobaea,	[79]
			S. scandens,	[128]
			S. erucaefolius,	[17]
			S. erraticus,	[46]
			S. erucifolius,	[131]
			S. incanus,	[68]
			S. brasiliensis,	[69]
			S. subalpinus,	[136]
			S. pampeanus,	[143]
			S. erraticus, ssp. *barbaraeifolius,*	[97]
			S. tomentosus,	[98]
			S. fremonti,	[81]
			S. ambrosioides,	[81]
			S. carthamoides,	[113]
			S. eremophilus,	[113]
			S. ampullaceus	[113]
			S. squalidus,	[114]
			S. aureus,	[114]
			S. ilicifolius,	[114]
			S. viscosus	[114]
			S. pseudoarnica,	[71]
			S. integerrimus	[71]
129.	Supinine $C_{15}H_{25}NO_4$ MW=283	m.p.=148-49° (146-147.5°) $[\alpha]_D$ -23.8° (EtOH), -12.1° (c, 1.98, EtOH)	*S. doronicum,* *S. fuchsii*	[30] [30]

Table 1 Cont.

S.No.	Name of Compound	Physical Data	Source	Ref. No.
130.	Sarracine-N-oxide	m.p.=123-24°	*S. francheti,*	[51]
	$C_{18}H_{27}NO_6$	$[\alpha]_D$ -81.65° (H_2O)	*S. sarracenius*	[144]
	MW=353		*S. platyphyllus*	[145]
			S. mikanoides	[146]
			S. sarracenius	[147]
131.	Sarracine	m.p.=51-52°	*S. nemorensis, ssp. fuchsii,*	[6]
	(Mikanoidine)	(45-46°)		
	$C_{18}H_{27}NO_5$	$[\alpha]_D$ -129.7°	*S. sylvaticus,*	[7]
	MW=337		*S. rhombifolius,*	[148]
			S. pojarkovae,	[150]
			S. platyphylloides,	[149]
			S. rhombifolius,	[149]
			S. platyphyllus,	[135]
			S. mikanoides,	[120]
			S. sarracenius	[144]
132.	Sarracine		*S. nemorensis, ssp. fuchsii*	[29]
	(Stereoisomer)			
	$C_{18}H_{27}NO_5$			
	MW=337			
133.	Senecicaudatin (**15**)	-	*S. caudatus*	[13]
134.	14*E*-Senaetnine	Oil	*S. mandralicae*	[13]
	(14,15-*trans*-Senaetnine)			
	$C_{20}H_{23}NO_7$			
	MW=389			
135.	Senaetnine	m.p.=183.5°	*S. richii,*	[13]
	$C_{20}H_{23}NO_7$	$[\alpha]_D^{24}$ +10.6°	*S. mandralicae,*	[13]
	MW=389	(c, 2.5, $CHCl_3$)	*S. barbertonicus*	[73]
136.	Senecivernine	m.p.=105-107° (dec.)	*S. vernalis,*	[56]
	$C_{18}H_{25}NO_5$	$[\alpha]_D^{20}$ -34.9°	*S. seratophiloides,*	[37]
	MW=335		*S. inaequidens*	[60]
137.	Silvasenecine	-	*S. silvaticus*	[150]
	$C_{12}H_{21}NO_4$			
	MW=243			
138-141.	Senampelines A,B,C,D.	Oils	*S. cissampelinus*	[151]
	$C_{25}H_{31}NO_8$			
	MW=473			
142.	Triangularine	Oils	*S. nemorensis, ssp. fuchsii,*	[29]
	$C_{18}H_{25}NO_5$	$[\alpha]_D^{25}$ +22°		
	MW=335	(c, 1.0, $CHCl_3$)	*S. sylvaticus,*	[7]
			S. triangularis	[87]
143.	12,13,19-Trihydroxy-	m.p.=200°	*S. adonidifolius*	[48]
	15,20-epoxy-dihydro	$[\alpha]_D$ +84.74°		
	(12*S*, 15*R*, 20*R*) sene-	(c, 0.78, MeOH)		
	cionan-11,16-dione			
	$C_{18}H_{25}NO_8$			
	MW=383			
144.	Usaramine	m.p.=182.5-183.5°	*S. deferens,*	[10]
	(Usuramine)	$[\alpha]_D^{25}$ +7.1°	*S. vulgaris,*	[121]
	(Mucronatine)	(c, 1.83, EtOH)	*S. murorum,*	[57]
	$C_{18}H_{25}NO_6$		*S. seratophiloides,*	[37]
	MW=351		*S. glandulosus*	[37]

Table 1 Cont.

S.No.	Name of Compound	Physical Data	Source	Ref. No.
145.	Uspallatine $C_{18}H_{25}NO_6$ MW=351	m.p.=205-207° $[\alpha]_D^{20}$ +4.11° (c, 0.0764, MeOH)	*S. vira-vira,* *S. leucostachys,* *S. uspallatensis,* *S. argentino,* *S. seratophiloides*	[12] [37] [37] [37] [37]

Bold numberings associated with compounds 29-46, 116, 117 and 133 refer to the actual compound no. mentioned in reference [13].

*Recently it has been suggested that Ruwenine is Isoline and Ruzorine may be Bisline. [Michael Ben and Obuya Were, *Phytochemistry*, **31**, 3, 295 (1992)].

to be hybrids, with one of the parents being *S. cruentus*, a native Canary Island, the other parent being some other species of *Senecio* [4].

A large number of the pyrrolzidine alkaloids have so far been reported from various *Senecio* species which differ in structures and complexity. A summarized account is present herein in tabulated form (Table 1).

We have also carried out phytochemical investigations of the alcoholic extract of fresh and undried *Senecio racemosus* with particular reference to the isolation and structural elucidation of some pyrrolizidine alkaloids. The technics employed for the purpose follow various forms of adsorption chromatography. This eventally resulted in the isolation of four new and five unreported alkaloids [152-155].

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