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The Alkaloids of *Senecio bupleuroides* D.C.

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Introduction.

Senecio bupleuroides is found mainly in Natal and Zululand. Although it grows in fairly large quantities in certain areas, there is no record of cases of poisoning being attributed to it. A physiological test, in which a sheep was dosed with 1,200 grams of *Senecio bupleuroides* (Steyn, 1931), gave a negative result. In the present chemical investigation the species has been found to contain toxic alkaloids which, in other species of Senecio (*S. retrorsus* and *S. isatideus*) are responsible for cirrhosis of the liver in sheep, cattle and horses. Since, however, *Senecio bupleuroides* contains these alkaloids in smaller quantity than the above-mentioned two species, it would probably be necessary to administer a quantity of the plant to an animal over a prolonged period to produce any physiological effects.

Botanical Description.

Senecio bupleuroides is a perennial herb about 2 feet high. The root-stock is woolly at the crown. Stems are glabrous, striate, sparsely leafy with no radical leaves. The leaves are all sessile, glabrous, mostly longlanceolate, occasionally ovate-lanceolate, denticulate, the denticulations mostly remote; the leaf-base is long or shortly decurrent. The stem ends in a lax, flat-topped inflorescence with long peduncle, involucre nearly nude at the base, of about 8 scales which are glabrous, oblong, acute, mostly with scarious margins; receptacle nude; rays about 5, fertile, conspicuous; disc florets about 16; achenes glabrous, striate.

The species is most readily recognisable in the field by its conspicuous, spreading yellow inflorescence, the sparsely leafy stems and the whitish nervation on the underside of its leaves. The leaves are generally about 8 inches long and less than ½ inch broad, rarely over 1 inch in width, and are decurrent on the stem for varying lengths.

The plant comes into flower in the early spring and flowers until December and January. It has been recorded in flower in June in Zululand.

Distribution.

The National Herbarium has records of the species from the following districts of Natal and Zululand: Richmond, Camperdown, Pietermaritzburg, Estcourt, Dundee, Newcastle, Eshowe.

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Material used for Investigation.

The investigation was carried out with plant in the post-seeding stage, collected near Magut, Zululand. The above-ground portions of the plant were air-dried and finely ground for the extraction of the alkaloids. The dried plant was stored for about a month before the extraction was commenced.

Physiological Test.

3·5 Kilograms of the ground plant were administered to a sheep, at the rate of 1 Kilogram per day, by drenching. No physiological effects were observed.

Alkaloids Present in the Plant.

In the present work, *Senecio bupleuroides* has been found to contain retrorsine and isatidine, the two alkaloids which occur also in *Senecio retrorsus* (Manske, 1931; Barger and Blackie, 1936; de Waal, 1939) and *Senecio isatideus* (Blackie, 1937). The following is a comparison of the alkaloid contents of the three plants:—

Senecio Species.	*Retrorsine, Per Cent.*	*Isatidine, Per Cent.*
Retrorsus	1·0–1·5 (de Waal, 1940)	0·3 (de Waal, 1939).
Isatideus	[0·15 (Blackie, 1937)].	[1·14 (Blackie, 1937)].
	[0·5 (de Waal, 1940)]	[1·2–1·5 (de Waal, 1940)].
Bupleuroides	0·16	0·7.

From these figures a relatively low toxicity of *Senecio bupleuroides* is to be expected, since the plant contains much less alkaloid than either of the other two species and contains moreover, a comparatively small amount of retrorsine, which has been shown to be the more toxic of these two alkaloids (de Waal, 1940).

Extraction of the Alkaloids.

The methods of extraction applied were essentially the same as those used by previous workers.

Method for Retrorsine.

Four Kilograms of the dried, ground plant were extracted for some days with 96 per cent. alcohol in a copper extractor of the Soxhlet type. The extract was fanned down to remove alcohol, treated with 10 grams of citric acid in aqueous solution and the mixture (about 1 litre) allowed to stand for some days with occasional shaking. After filtering, the filtrate and washings (about 1·5 litres) were extracted with 2·5 litres of ether in three portions and then with 2 litres of chloroform in six portions; this process rendered the solution free from ether and chloroform-soluble impurities (oil, colouring matter, etc.).

The solution was now rendered alkaline with ammonia and extracted with chloroform till no further alkaloid was extracted. Evaporation of the solvent gave 6·25 grams (=0·156 per cent.) of crude retrorsine.

No isatidine could be obtained from the aqueous residue. As this alkaloid is relatively unstable, it is concluded that the long boiling of the alcoholic extract in the copper vessel resulted in its breakdown.

Method for Isatidine.

One Kilogram of the dried ground plant was extracted with cold 96 per cent. alcohol in a glass percolator, until only faint alkaloid tests were given by the percolate (5 to 10 days). The percolate was treated as in the method for retrorsine, of which 0·035 per cent. was obtained.

The aqueous residue was evaporated by fanning (de Waal, 1939), when isatidine crystallised out. In two experiments, respectively 6·05 and 6·3 grams (=0·6 per cent.) of crude isatidine were obtained. With due allowance for the isatidine still remaining in aqueous solution, the quantity of isatidine extractable from the plant by cold alcohol percolation is 0·7 per cent.

Purification and Identification of the Alkaloids.

Retrorsine.

Purification.—The crude solid was washed with acetone and recrystallised from alcohol-water (Barger *et al.*, 1935).

Melting Point.—The purified material had a corrected melting point of 217-219° C., and gave no depression of melting point on admixture with retrorsine from *Senecio retrorsus.*

Appearance, Crystalline Form, Solubilities.—These properties were found to be identical with the corresponding properties of retrorsine from *Senecio retrorsine.*

Micro-Analysis.	Carbon, Per Cent.	Hydrogen, Per Cent.	Nitrogen, Per Cent.	Molecular Weight.
Found.....	61·58, 61·42	7·06, 7·12	4·13, 4·20	358, 348
Calculated for $C_{18}H_{25}O_6N$.....	61·55	7·12	3·99	351

Nitrate.—Prepared from 1 gram of the alkaloid by dissolving in water, adding the theoretical quantity of decinormal nitric acid and fanning to dryness. Crystallised from alcohol-ether (Barger *et al*, 1935). The product melted from 110° C. Loss of weight on drying at 95° C. in vacuum, 6·4, 6·6 per cent., calculated for $C_{18}H_{25}O_6N.HNO_3.\frac{1}{2}C_2H_5OH$, 5·3 per cent.

There is thus no doubt that the chloroform-soluble alkaloid of *Senecio bupleuroides* is identical with retrorsine from *Senecio retrorsus.*

Isatidine.

Purification.—The crude alkaloid was washed with a little cold water and recrystallised first from alcohol and then from water.

Melting Point.— The purified material darkened at about 100° C., melted to a yellow liquid at 137·5° C. and decomposed to dark red liquid at 144-146° C. (all temperatures corrected). There was no depression of the melting or decomposition points on admixture with isatidine from *Senecio isatideus.*

Appearance, Crystalline Form, Solubilities.—These properties were identical with the corresponding properties of isatidine from *Senecio isatideus*.

Micro-Analysis.	Carbon, Per Cent.	Hydrogen, Per Cent.	Nitrogen, Per Cent.
Found	53·75, 53·91	7·07, 6·87	3·11, 3·18
Calculated for $C_{18}H_{25}O_7N\ 2H_2O$	53·60	7·20	3·47

Picrate.—Prepared from alcoholic solutions, the picrate had no melting point, but decomposed gradually from about 168° C. Micro-analysis gave:—

Micro-Analysis.	Carbon, Per Cent.	Hydrogen, Per Cent.	Nitrogen, Per Cent.
Found	48·20, 48·20	4·73, 4·49	10·1, 10·1
Calculated for $C_{18}H_{25}O_7N.\ C_6H_3N_3O_7$	48·33	4·70	9·40

The chloroform-insoluble alkaloid of *Senecio bupleuroides* is thus identical with isatidine from *Senecio isatideus*.

Summary.

1. *Senecio bupleuroides* contains the same two alkaloids as *Senecio retrorsus* and *Senecio isatideus*, viz. retrorsine and isatidine.

2. The quantities of these alkaloids extractable from the dried plant, collected in the post-seeding stage, are: retrorsine, 0·16 per cent.; isatidine, 0·7 per cent.

3. The plant is of low toxicity compared with *Senecio retrorsus* and *isatideus*. A negative result was obtained in a physiological test.

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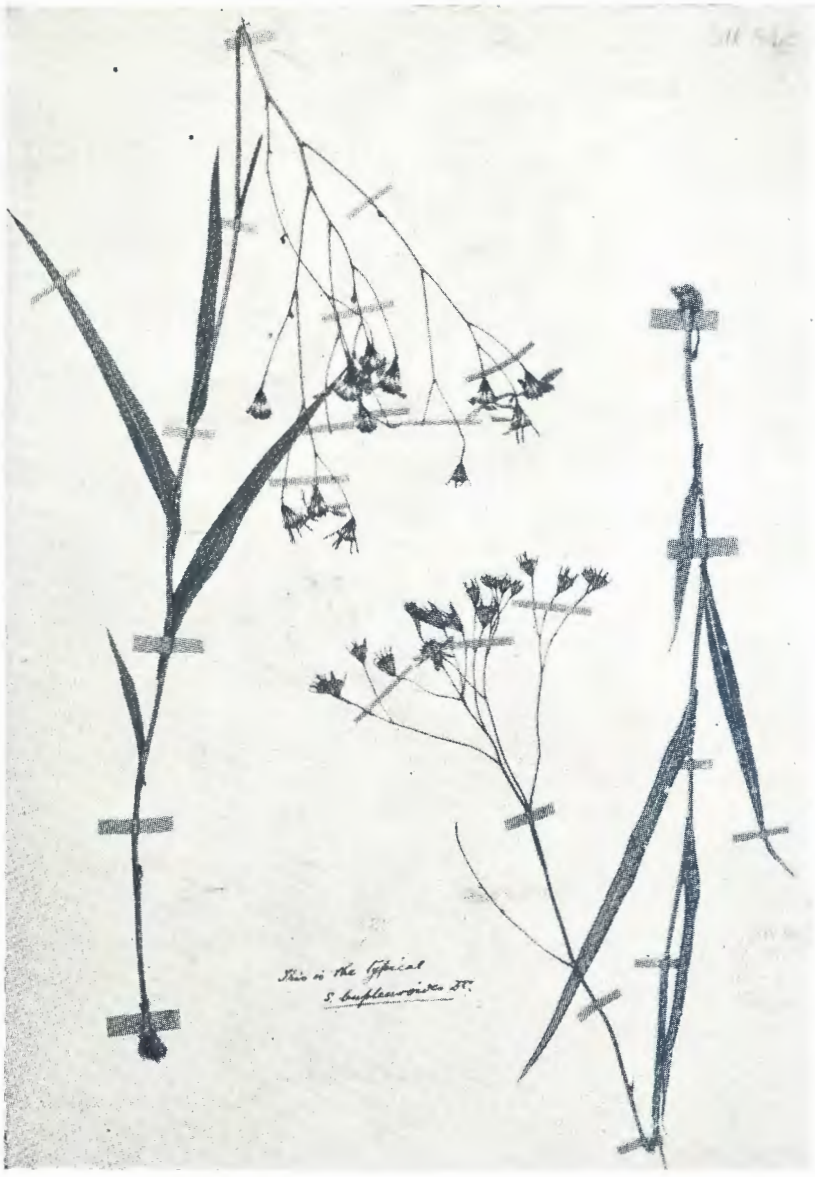

Specimens of *Senecio bupleuroides* D.C. in the National Herbarium, Pretoria.