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ALKALOID CHEMOTAXONOMY OF THE GENUS *SOPHORA*

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Abstract—Cytisine and matrine alkaloids detected in *Sophora* species have been used to classify the genus chemotaxonomically.

The genus *Sophora* (Leguminosae) consists of about 80 species and is considered to be very heterogeneous [1]. Several of the species are known to contain alkaloids of the matrine series, which are believed to be responsible for their pharmacological activity, characterized by neurological and muscular disorders [2]. The matrine alkaloids, which are not found in the other genera, have recently been useful in the treatment of some types of cancer [3]. Among the members of this genus, *S. secundiflora* is unique in its hallucinogenic effects [4], and the seeds, known as mescal and big drunk beans, have been used in Indian rituals in the Southwestern United States. The toxicity of this plant is believed to be due to the alkaloid cytisine [4,5].

Alkaloid chemistry has been used for biochemical classification of plants for more than a decade. However, these data generally have been applied at the tribal levels and above, and it has been suggested that alkaloid data cannot be used in separating species into phyletic groups [6]. Previous studies on the chemistry of cytisine and matrine alkaloids, as well as other lupine or quinolizidine alkaloids, have led to chemical classification of the tribe Sophoreae as a primitive tribe of the subfamily Lotoideae (Papilionoideae), of the Leguminosae [6].

Table 1 summarizes a survey of approximately twenty-five species of the genus *Sophora* and suggests that the genus can be divided into four subgenera based on the presence of these alkaloids. Species containing only the cytisine series would appear to represent the most primitive members of the genus because of the universal occurrence of cytisine within the tribe Sophoreae. Those species containing both the cytisine and matrine alkaloids form a second subgenera which may be considered more advanced. The third subgroup or phyletic group is distinguished only by the presence of the matrine alkaloids, and a fourth group is characterized by the total absence of all these alkaloids.

It should be noted that *S. japonica* from Russia has been reported to contain a number of alkaloids [10], whereas those examined in the present study from Mengtze, China, and Kyoto Takeda Herbal Gardens did not contain detectable alkaloids. Also, *S. griffithii* from the herbarium of the University of Texas at Austin (U.S.A.) showed an absence of any detectable alkaloids. In contrast, the same species from the U.S.S.R., was previously reported to contain alkaloids [12].

EXPERIMENTAL

Finely ground seeds (200 mg) were extracted by shaking overnight with 5·0 ml of 50% v/v EtOH. The mixture was centrifuged and the supernatant applied to TLC plates (Adsorbosil-5, 250 μm thickness; Applied Science Labs). Chromatographs were developed with a mixture of $CHCl_3$: MeOH (3:1) and alkaloids visualized with Dragendorff reagent. R_f values of the alkaloids were compared with authentic standards of cytisine. *N*-methylcytisine, anagyrine, termopsine and matrine. R_f values of the alkaloids were further confirmed using solvents and chromatographic methods described by White and Cambie [16, 19]. Distinction between cytisine and matrine alkaloids was made using the $FeCl_3$–H_2O_2 color test [20].

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Table 1

Sophora species	Source	Matrine series§	Cytisine series¶	Number**
S. japonica	China	–	–	–
S. griffithii	‡	–	–	–
S. affinis	Texas	–	–	–
S. spyostriata [5]	Japan	+	–	1
S. pachycarpa [7]	East Siberia	+	–	1
S. angostifolia [8]	East Siberia	+	–	8
S. lupinoides [9]	U.S.S.R.	+	–	2
S. japonica [10]	U.S.S.R.	+	+	6
S. allopecuroides [11,12]	Chuya Valley U.S.S.R.	+	+	8
S. flavescens [8,13]	East Siberia	+	+	12
S. griffithii [14]	U.S.S.R.	+	+	3
S. microphylla Ait [15]	New Zealand	+	+	2
S. tomentosa [16]	New Zealand	+	+	3
S. tetraptera sensu [17]	New Zealand	+	+	2
S. macrocarpa [18]	New Zealand	+	+	5
S. stenophylla	*	+	+	2
S. chrysophylla	Hawaii	+	+	3
S. longesmem	†	+	+	2
S. tomentosa	New Zealand and Texas	+	+	2
S. nuteliana	Texas	–	+	1
S. masafeurana	†	–	+	4
S. moorcrofiana	†	–	+	3
S. leachiana	North America	–	+	1
S. mollis	Kashmir	–	+	3
S. arizonica	Arizona	–	+	3
S. formosa	Arizona	–	+	4
S. gypsophylla	Texas	–	+	4
S. secundiflora	Texas	–	+	3

* From Herbarium of Southern Methodist University of Dallas, Texas.
† From Herbarium of University of California, Berkeley, California.
‡ From Herbarium of University of Texas, Austin, Texas.
§ Matrine or matrine *N*-oxide.
¶ Cytisine, *N*-methylcytisine, and anagyrine.
** Number of other alkaloids reported in literature or observed.

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