Chemotaxonomical Investigations
of the Symphytum officinale Polyploid Complex and
S. asperum (Boraginaceae): The Pyrrolizidine Alkaloids*

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Abstract: By means of thin layer chromatography in conjunction with mass spectrometry the pyrrolizidine alkaloid patterns derived from Symphytum asperum, several cytotypes of S. officinale agg. and the artificial hybrids of the former taxa, were compared. The obtained patterns were not essentially affected by variation in cytotype, harvesting times and location of plants. Lycopsamine, acetyl-lycopsamine and symphytine or their isomers were generally found in the S. officinale cytotypes, echimidine and symphytine in S. asperum. The interspecific hybrids contained all alkaloids mentioned. The definite lack of echimidine in the 2n = 40 cytotype proves that it is conspecific with S. officinale and does not belong to a hybrid-swarm S. asperum × S. officinale with 2n = 48.

Symphytum officinale and S. asperum are allopatric taxa, which are able to intercross and to form interspecific hybrids with different chromosome numbers. The species differ not only in a number of morphological characters but also ecologically, S. asperum being a species of higher elevations (upper montane zone), S. officinale of lowland and the lower montane zone. S. asperum is a Caucasian species, which has the chromosome number 2n = 32. It was introduced from the Caucasus into Europe as a fodder plant. S. officinale is variable, contains cytotypes with 2n = 24, 48, 56, 40 and occurs in the larger part of Europe.

* Part I of this series of contributions.
The most common chromosome number of *S. officinale* is \(2n = 48\). Scattered diploid \((2n = 24)\) populations occur in Western, Central and Eastern Europe; they are white-flowered throughout. The tetraploids are white- or purple-flowered in W. Europe and purple in E. Europe. Populations in which purple- and white-flowered individuals occur intermingled are very common in W. Europe. In E. Europe, mixed populations (which seem to be rare) consist of white-flowered diploid plants with purple-flowered tetraploid plants. We did not find comparable situations in W. Europa. In one population in the Netherlands, white-flowered di- and tetraploids grew intermingled with purple-flowered tetraploids.

The cytotype \(2n = 56\) was found only once in a population from the Tatra mountains in Czechoslovakia.

The cytotype \(2n = 40\) is very common in low-lying peat regions in the Netherlands. Judging from the descriptions given by Basler (1972) these plants seem to occur also in Schleswig-Holstein. The plants are nearly always purple-flowered, only very exceptionally white. We differ from Basler, however, on the taxonomical position of the plants with \(2n = 40\). Basler refers all plants with \(2n = 40\) to *S. × uplandicum* Nymp., the hybrid between *S. asperum* \((2n = 32)\) and *S. officinale* \((2n = 48)\).

A detailed description of the difference between the artificially produced hybrid *S. × uplandicum* \((2n = 40)\) and the form with the same chromosome number from the low-lying peat lands in the Netherlands has been presented by Gadelia & Kliphuis (1973). However, the possibility should not be excluded that the hybrid shows segregation in later generations, producing the forms resembling the plants with \(2n = 40\). No segregation of the *S. × uplandicum* \((2n = 40)\) hybrid, however, occurred in the F-1 and F-2 generation, all plants retained the characters of *S. × uplandicum* and did not show the slightest resemblance to the Dutch plants with \(2n = 40\). Therefore, Gadelia & Kliphuis are of the opinion that the latter plants are conspecific with *S. officinale*.

Besides morphological studies, phytochemical studies might also contribute to the elucidation of this taxonomic problem. It is because of the widespread use of comfrey (*Symphytum officinale* and its hybrids) in "green drinks" and as fodder (Farnsworth 1979, Hills 1976) that it appeared of interest to focus on a possible use of the hepatotoxic pyrrolizidine alkaloids as chemotaxonomical markers in this microsystematical study. Earlier attempts to use these alkaloids in chemotaxonomy concern the tribe *Senecioneae*, the genus *Crotalaria* (Culvenor 1978) and the family *Boraginaceae* (Huizing & Malin&egrave; 1981a).