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A chemotaxonomic survey of phenolic compounds in Swiss willow species

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A phytochemical atlas of all *Salix* species found in Switzerland has been created (Shao 1991), based on both known (total = 24) and unknown phenolics in the bark and leaves using the HPLC method. The known compounds have been quantitatively analysed while the unknown compounds, so far as possible, have been classified according to the on line UV spectra detected by the diode array system (Meier & Sticher 1986). A chemotaxonomical classification of the willow species into groups with a high yield of salicin-derivatives showed a homogeneous result for the subgenus *Chametia*. All species except *S. herbacea* L. are rich (>1% in dried material) in salicortin (2′-O-Acetylsalicortin) in their bark and leaves. *S. herbacea* contains phenolic glycosides only in its bark. The species of the subgenus *Amerina* can be divided into two groups; one rich in derivatives of salicin (2′-O-Acetylsalicin) e.g. *S. pentandra* L. and *S. fragilis* L., and the other poor in these compounds e.g. *S. alba* L., *S. triandra* L. Until now, high amounts of acetylates of salicin and salicortin have been detected only in the species of this subgenus. The subgenus *Caprisalix* could also be divided into the same two groups. The main salicin derivatives are tremulacin and salicortin.

The cluster analyses showed only small differences between pairs within the species of the section *Caprea* (*S. caprea* L., *S. cinerea* L., *S. aurita* L., *S. appendiculata* Vill., *S. laggeri* Wimmer) in leaves and their barks. *Capreae* is the most homogeneous section of the subgenus *Caprisalix* and belongs to the group poor in salicin derivatives. The main phenolic glycoside in the bark of all species is triandrin.

Similar to earlier results, the new data shows a fairly constant spectra of phenolic compounds, at least the phenolic glycosides, within a species. This leads to the possibility to confirm hybrid forms with a phytochemical analysis. Hybrids of *S. hastata* × *waldsteiniana* have been detected with this technique (Meier *et al.* 1989). The hypothesis of Lautenschlager to declare *S. hegetschweileri* Heer. as a hybrid of *S. bicolor* Ehrh. and *S. nigricans* ssp. *alpicola* Buser was confirmed by comparing the HPLC-chromatograms of the leaves of all three species. No differences were detected in their barks. Other than for Finnish and Swiss willows there is a general lack of information for world-wide willow species. Will chemotaxonomy be a useful tool for the classification of willows? Only time will tell, but techniques already exist which obtain valid results by GC and HPLC (Meier *et al.* 1988; Julkunen-Tiitto

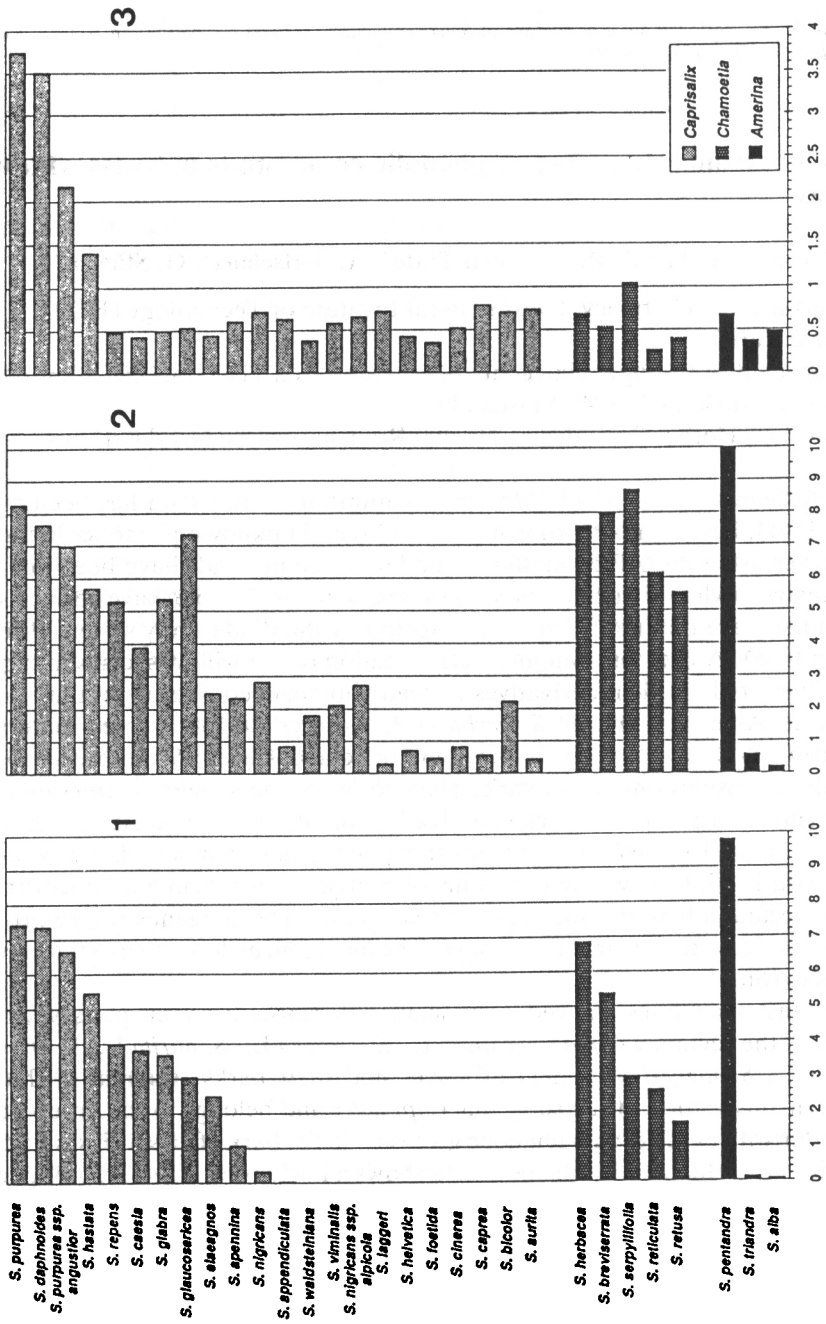

Figure 1. Distribution of phenolic compounds in the bark of Swiss willow species. (1) Total amount of salicin derivatives; (2) total amount of phenolic glycosides; (3) total amount of flavonoides (all in % per dry weight).

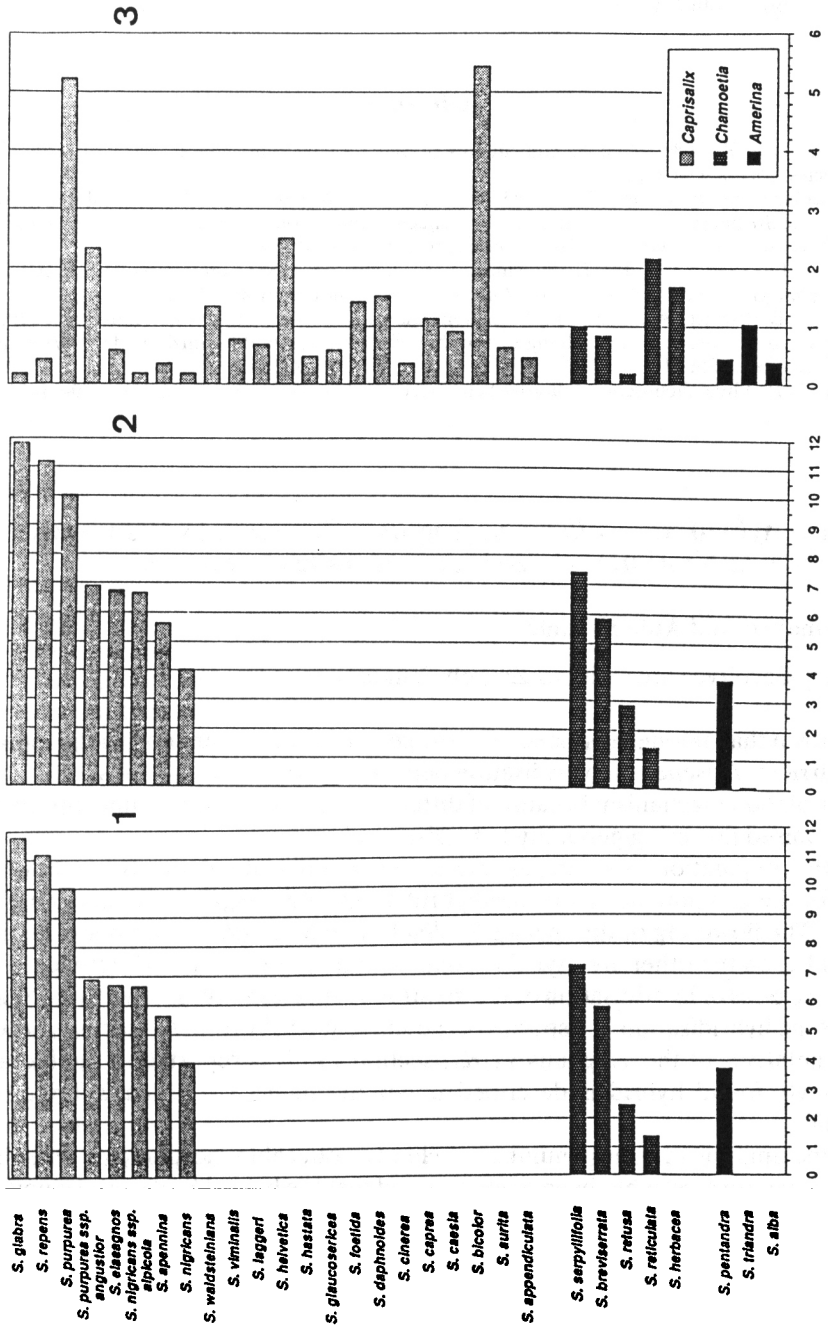

Figure 2. Distribution of phenolic compounds in the leaves of Swiss willow species. (1) Total amount of salicin derivatives; (2) Total amount of phenolic glycosides; (3) Total amount of flavonoides (all in % per dry weight).

1989). Until now, the chemical composition appears to be only partly consistent with morphological classification.

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Natural hybrid *Salix alba* × *S. fragilis* × *S. caprea* (*S.* ×*savensis* Trinajstić et Krstinić) – inheritance of some characters

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It is known that among most species of the genus *Salix* there are no genetic reproductive barriers. Absence of hybridisation between various species is most often caused by an isolation mechanism because of differences in the flowering time. Species with synchronised flowering generally hybridise easily.

In the populations of various species of willows along the River Sava near Zagreb, the spontaneous trispecies hybrid *S alba* × *S. fragilis* × *S. caprea* has been found. The flowering of the species *S. alba* L. and *S. fragilis* L., on one side, and *S. caprea* L., on the other are asynchronous, with a significant time difference. Therefore the causes of hybridisation of the mentioned species are unknown to us. Since no case of the hybridisation of a species of the subgenus *Salix* from the section *Salix* with representatives of the subgenus *Vetrix*: section *Vetrix* is reported in the literature, this newly found hybrid is described under the name *S.* × *savensis* Trinajstić et Krstinić.

By the analysis of a large number of clearly noticeable morphologic and physiologic characteristics, it has been demonstrated that the hybrid *S.* × *savensis* unites the properties of three species: *S. alba, S. fragilis* and *S. caprea*.

From both *S. alba* and *S. fragilis*, the hybrid inherited the capability of rooting, from *S. alba* the red colour and tough branchlets and from *S. fragilis* the shape of buds and morphology of lateral, summer branchlets. From *S. caprea* an early flowering (pre-leafing), one nectary, pilosity of filaments, bracts, shoots and leaves have been inherited. Some properties such as leaf shape, dentate leaf blade are intermediary.

Under the experimental conditions of rooting, shoots of *S.* × *savensis* first developed branchlets and then roots, whilst the control *S. caprea* simultaneously