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CYTOTAXONOMIC NOTES ON SOME GALIUM SPECIES

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It is well known that the chromosome number of a plant may be a character of importance to taxonomy; it can often give a better insight with respect to the place of a taxon in the System. It is, therefore, particularly important to determine for any species the chromosome number of as many individuals from as many localities as possible. Publications of lists of documented chromosome numbers as presented by LÖVE in the IOPB reports in Taxon are very valuable and so are lists of chromosome numbers of plants from more restricted areas (Greenland: JÖRGENSEN *et al.*, 1958; Iceland: LÖVE and LÖVE, 1956; the Netherlands: GADELLA and KLIPHUIS, 1963; Poland: SKALINSKA, 1950, SKALINSKA *et al.*, 1957, 1959, 1961; Sweden, Skåne: LÖVKVIST, 1962).

These lists enable us to ascertain whether or not there are differences in chromosome numbers within a species and whether or not there is a relation with the geographical distribution or the ecological preference. Apart from the number, however, the size and shape of the chromosomes and, consequently, their 'portrait' may be of value. In the *Angiospermae* this character plays an important role almost exclusively in the *Monocotyledones*.

Differences in chromosome number within a species or species complex are sometimes, but certainly not always correlated with differences in morphology (*Viola riviniana* with $2n = 35$, 40, 45, 46 and 47, GADELLA, 1963; *Listera ovata* with $2n = 34$, 35, 36 and 38, KLIPHUIS, 1963). Even on the level of polyploidy (*Galium verum* with $2n = 22$ and 44, LÖVKVIST, 1962), we encounter this situation. The reverse situation also occurs: the species *Galium mollugo* L., collected in 91 different localities, always appeared to be a tetraploid ($2n = 44$) but even though showing a great morphological variability which remains constant after several years of cultivation.

A careful analysis of the chromosome number of *Galium aparine* L., a species having a polyploid series with $2n = 22$, 44, 66 and, according to FAGERLIND (1934), $2n = 88$, clearly showed that the level of polyploidy rather than the exact number of chromosomes is important.

The hexaploids generally have $2n = 64$, but within the same plant metaphase plates from the same roottip may have $2n = 61$, 62, 63, 65 and the normal hexaploid number $2n = 66$. However, we also found plants with 66 chromosomes in all countable metaphase plates of the same roottip.

The same phenomenon has been found in *Cardamine pratensis* L. (Berg, 1966), and in *Symphytum officinale* L. (Gadella and Kliphuis, in press).

Before arriving at a final conclusion it may be necessary to investigate other characters besides the chromosome number. The *Dactylorchis maculata* complex has been shown to have a diploid with $2n = 40$ as well as a tetraploid with $2n = 80$ chromosomes. Vermeulen (1947) separated the diploid from the tetraploid and described it as *Dactylorchis fuchsii* (Druce) Vermln. Not only on account of those numbers but also because of morphological and ecological differences. Extensive biometric work by Heslop-Harrison (1948, 1951, 1954) on a considerable amount of material confirmed this conclusion.

Plants belonging to the *Dactylorchis maculata* complex occuring in the Netherlands were cultivated under identical conditions for several years. It was shown that differences between the diploid *Dactylorchis fuchsii* and the tetraploid *Dactylorchis maculata* became less clear, already after one year (Kliphuis, 1963).

From these examples it is clearly necessary to make cultivation experiments before expressing oneself definitely on such problems.

Galium hercynicum Weig. provides an example of a species in which morphological differences are correlated with the level of polyploidy. These differences remained constant during several years of cultivation. The diploid ($2n = 22$) is distinguished from the tetraploid ($2n = 44$) by a more fragile habit, more slender shoots, smaller flowers and leaves, and by the fact that it flowers about two weeks earlier than the tetraploid. *Galium hercynicum* is a common plant of Western Europe (southern Scandinavia, Denmark, Germany, Belgium, the Netherlands, France, northern Spain, Portugal and the British Isles).

The results of the measurements of the flowers are given in Table 1. In the first column: the investigated plants with the collection

Table 1

(Measurements of the flowers)

Flower 1963 in mm		*X*	*SD*	*SE*	*N*
No. plant: diploid $2n = 22$					
106	*L*	2.881	0.2047	0.0206	99
	W	0.811	0.1082	0.0108	100
244	*L*	3.038	0.2565	0.0257	100
	W	0.931	0.0896	0.0090	100
tetraploid $2n = 44$					
386	*L*	3.898	0.2224	0.0222	100
	W	0.953	0.1132	0.0113	100
414	*L*	3.992	0.1212	0.0121	100
	W	1.021	0.0608	0.0061	100

TABLE 2. (Measurements of the leaves)

Leaf 1963 in mm			I				II				III				IV			
			X	*SD*	*SE*	*N*	*X*	*SD*	*SE*	*N*	*X*	*SD*	*SE*	*N*	*X*	*SD*	*SE*	*N*
106 diploid $2n = 22$	1962	*L*	3.332	0.655	0.12	30	3.552	0.747	0.144	27	1.350	0.698	0.174	16	3.640	0.408	0.091	20
		W	0.582	0.265	0.045	33	1.028	0.131	0.025	27	0.690	0.397	0.099	16	1.288	0.222	0.049	20
	1963	*L*	4.432	0.800	0.080	100	4.200	0.498	0.050	100	2.656	0.635	0.090	50	4.112	0.824	0.117	50
		W	0.681	0.175	0.017	100	0.975	0.154	0.015	100	0.933	0.069	0.021	50	1.312	0.219	0.031	50
	1964	*L*	4.728	0.614	0.061	100	4.560	0.828	0.117	50	2.976	0.584	0.082	50	4.256	0.947	0.134	50
		W	0.763	0.118	0.012	100	1.173	0.270	0.038	50	1.085	0.295	0.042	50	1.291	0.178	0.025	50
244 diploid $2n = 22$	1962	*L*	4.713	1.016	0.126	64	4.880	1.286	0.181	50	2.984	0.723	0.218	11	4.512	1.272	0.127	100
		W	0.764	0.302	0.039	60	1.139	0.258	0.036	50	—	—	—	—	1.564	0.204	0.022	90
	1963	*L*	4.248	1.024	0.102	100	4.288	1.096	0.122	80	2.664	0.817	0.122	45	4.224	0.592	0.070	71
		W	0.641	0.265	0.027	95	0.964	0.270	0.031	75	0.788	0.293	0.046	40	1.626	0.271	0.033	66
	1964	*L*	4.336	0.896	0.090	100	4.328	1.109	0.111	100	2.720	0.775	0.110	50	4.272	0.712	0.071	100
		W	0.752	0.257	0.026	100	0.976	0.206	0.021	100	0.837	0.189	0.027	50	1.704	0.274	0.027	100
386 tetraploid $2n = 44$	1962	*L*	5.912	1.144	0.114	100	6.880	1.688	0.169	100	4.526	1.016	0.110	70	5.312	1.066	0.107	100
		W	0.841	0.324	0.032	100	1.448	0.191	0.019	100	1.520	0.372	0.044	70	2.326	0.284	0.028	100
	1963	*L*	6.120	1.208	0.121	100	6.792	1.144	0.114	100	3.560	0.673	0.067	100	5.768	1.472	0.147	100
		W	0.830	0.317	0.032	100	1.483	0.197	0.020	100	1.517	0.272	0.027	100	2.205	0.257	0.026	100
	1964	*L*	6.064	1.392	0.139	100	7.864	1.568	0.157	100	4.680	0.801	0.127	40	5.328	1.546	0.218	50
		W	0.839	0.084	0.008	100	1.636	0.215	0.022	100	1.582	0.233	0.039	40	2.059	0.256	0.026	100
414 tetraploid $2n = 44$	1962	*L*	5.128	0.917	0.092	100	7.072	1.046	0.105	100	3.400	0.869	0.087	100	4.480	1.212	0.169	50
		W	0.937	0.179	0.018	100	1.754	0.202	0.020	100	1.478	0.226	0.032	50	1.822	0.299	0.042	50
	1963	*L*	5.680	1.488	0.016	90	6.720	1.480	0.171	75	3.264	0.422	0.060	50	5.424	1.216	0.122	100
		W	0.993	0.297	0.031	90	1.734	0.493	0.057	75	1.654	0.349	0.049	50	2.435	0.322	0.032	100
	1964	*L*	5.736	1.167	0.118	100	7.128	1.168	0.117	100	3.656	0.730	0.073	100	5.200	0.960	0.096	100
		W	1.069	0.362	0.036	100	2.271	0.346	0.035	100	1.420	0.289	0.029	100	2.300	0.246	0.025	100

numbers, (the diploids: 106 and 244; the tetraploids: 386 and 414; localities: 106: Portugal, Botanical Garden Sacavem, 244: Portugal, Tras os Montes, Lisa do Alvoa; 386: the Netherlands, Zuid-Limburg, 414: the Netherlands, Duurswoude, prov. of Friesland). In the following columns is L = length, W = width both in mm, X = the mean of the length or width of the sample, SD the standard deviation, SE the standard error of the mean and N = the total number of the sample.

It is clear that there is a difference in length of the flowers between the diploid and tetraploid. Most striking, however, is the difference in size of the leaves. Three types of leaves can be distinguished on the flowering shoots: Type I, leaves on the upper third part of the shoot; Type II, those of the middle third part of the shoot, and Type III, the smallest leaves on the lowest part, mostly wilted. A fourth type is found on the non-flowering shoots.

The measurements of the leaves are given in Table 2. From these tables the differences between the diploid and tetraploid are evident. The same is true for the differences between the leave types mentioned before. It is also clear from the values given that these differences remain constant over the years.

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REFERENCES

Berg, C. C. 1966. Acta Bot. Neerl. **15**.

Fagerlind, F. 1934. Hereditas **19**: 223.

Gadella, Th. W. J. 1963. Acta Bot. Neerl. **12**: 17.

——— and E. Kliphuis. 1963. Acta Bot. Neerl. **12**: 195.

Heslop-Harrison, J. 1948. Transact. and Proc. Bot. Soc. Edinburgh **35**: 26.

———. 1951. Svensk Bot. Tidskr. **45**: 608.

———. 1954. Ber. Geob. Forsch. Inst. Rübel f. 1953.: 53.

Jörgensen, C. A. T., T. Sörensen and M. Westergaard. 1958. Dansk. Vid. S. Biol. Skr. **9**/4: 172.

Kliphuis, E. 1963. Acta Bot. Neerl. **12**: 172.

Lövkvist, B. 1962. Bot. Not. **115**: 261.

Skalinska, M. 1950. Acta Soc. Bot. Polon. **17**: 40.

———, M. E. Banach-Pogan *et al.* 1957. Acta Soc. Bot. Polon. **26**: 215.

———, M. Piotrowicz *et al.* 1959. Acta Soc. Bot. Polon. **28**: 487.

———, ———, A. Sokolowskaja-Kulzycka *et al.* 1961. Acta Soc. Bot. Polon. **30**: 463.

Vermeulen, P. 1947. Studies on Dactylorchis, Utrecht.