Chromosome number of *Puccinellia maritima* (Huds.) Parl. in the British Isles

R. SCOTT and A. J. GRAY

Institute of Terrestrial Ecology, Colney Research Station, Colney Lane, Norwich

ABSTRACT

Chromosome counts were made on root-tip cells of *Puccinellia maritima* plants representing a wide range of localities and growth forms. All plants examined had $2n = 56$.

INTRODUCTION

The most frequently quoted chromosome number for British *Puccinellia maritima* (Huds.) Parl. is $2n = 63$ (Mills 1967, Newton 1965), which is nonaploid if $x = 7$ for the genus, and consistent with the suggestion (Tutin 1955) that the species usually reproduces vegetatively and may be apomictic. Mills also reported $2n = 56$, which is commonly listed for foreign material (Bernström 1948, Church 1949, Sørensen 1958). Other British counts are $2n = 14$, 49, and 77 (Brown-Packer 1961), and from foreign material $2n = 42$ (Church 1949), *c* 60 (Castro & Fontes 1946) and 70 (Wulff 1937, Rodrigues 1953).

The counts made by Mills (1967) and Newton (1965) are listed in Table 1, and suggest the possibility of differences in distribution of the octoploid and nonaploid plants in Britain. Because it also seemed possible that the wide range of phenotypic variation observed in the species might correspond to different cytological races, chromosome counts were made on a large number of plants collected as part of a study of infraspecific variation. Plants were sampled from a wide range of habitats and locations (Table 2), different growth forms being included when found adjacent to one another in the field. Growth form differences, often very large, were usually maintained after a period of collateral cultivation (Table 3).

The object of the work presented here was to relate chromosome number to the growth forms and geographical races of the plant.

TABLE 1. PREVIOUS LOCALIZED CHROMOSOME COUNTS FOR *PUCCINELLIA MARITIMA* IN THE BRITISH ISLES

Author	Location	No. of plants counted	Chromosome Number $2n$
A. R. Mills	Parkgate, Cheshire, v.c. 58	8	51–62
A. R. Mills	Silverdale, W. Lancs., v.c. 60	3	51–56
A. R. Mills	Ringhaddy, Down, v.c. H38	5	51–57
A. R. Mills	Baldoyle, Down, v..c. H38	1	*c* 56
A. R. Mills	Rye, E. Sussex, v.c. 14	1	*c* 60
A. R. Mills	Tollesbury, N. Essex, v.c. 19	1	*c* 63
A. R. Mills	West Mersea, N. Essex, v.c. 19	4	62–63
A. R. Mills	Mudeford, S. Hants., v.c. 11	1	*c* 63
L. E. Newton	Canvey Island, S. Essex, v.c. 18	1	*c* 63
L. E. Newton	Tollesbury (tall plant), N. Essex, v.c. 19	1	*c* 63
L. E. Newton	Tollesbury (dwarf plant), N. Essex, v.c. 19	1	*c* 63
L. E. Newton	Yantlet Creek, W. Kent, v.c. 16	1	*c* 63

TABLE 2. SITES OF *PUCCINELLIA MARITIMA* WITH $2n = 56$ DETERMINED IN THE PRESENT STUDY

Accession code	Grid reference	Location	Habitat type
P 1	34/465.795	Arnside, Westmorland, v.c. 69	Grazed saltmarsh
P 7	J/51.64	Strangford Lough, Down, v.c. H38	Ungrazed saltmarsh
P 17	54/355.032	Tetney, N. Lincs., v.c. 54	Tidal riverbank
P 28	34/202.758	Roanhead, Furness, v.c. 69b	Cattle-grazed saltmarsh
P 31	34/432.789	Holme Island, Furness, v.c. 69b	Ungrazed saltmarsh
P 35	34/437.791	Meathop, Westmorland, v.c. 69	Grazed saltmarsh
P 44	34/477.828	Gilpin Bridge, Westmorland, v.c. 69	Grazed saltmarsh
P 57	34/466.798	Arnside, Westmorland, v.c. 69	Grazed saltmarsh
P 58	34/452.759	Silverdale, Westmorland, v.c. 69	Grazed saltmarsh
P 59	34/450.758	Silverdale, Westmorland, v.c. 69	Grazed saltmarsh
P 77	34/324.833	Haverthwaite, Furness, v.c. 69b	Grazed saltmarsh
P 97	34/471.682	Carnforth, W. Lancs., v.c. 60	Grazed saltmarsh
P 98	34/471.682	Carnforth, W. Lancs., v.c. 60	Grazed saltmarsh
P 100	34/474.713	Warton, W. Lancs., v.c. 60	Grazed saltmarsh
P 102	34/484.716	Warton, W. Lancs., v.c. 60	Grazed saltmarsh
P 118	53/926.457	Wells, W. Norfolk, v.c. 28	Ungrazed saltmarsh
P 119	53/926.457	Wells, W. Norfolk, v.c. 28	Ungrazed saltmarsh
P 120	53/926.457	Wells, W. Norfolk, v.c. 28	Ungrazed saltmarsh
P 124	51/028.014	Littlehampton, W. Sussex, v.c. 13	Sandflat
P 127	63/487.065	Breydon Water, E. Suffolk, v.c. 25	Ungrazed saltmarsh
P 152	51/935.193	Rye Harbour, E. Sussex, v.c. 14	Creek bank
P 156	51/444.082	Beddingham, E. Sussex, v.c. 14	Tidal riverbank
P 165	40/183.918	Mudeford, S. Hants., v.c. 11	Sandy mudflat
P 167	30/255.907	Axmouth, S. Devon, v.c. 3	Stony, tidal river shore
P 177	20/116.579	Lostwithiel, E. Cornwall, v.c. 2	Stony, tidal river shore
P 183	21/205.064	Bude, E. Cornwall, v.c. 2	Stony, tidal river shore
P 188	31/550.753	Avon Gorge, W. Gloucs., v.c. 34	Ungrazed saltmarsh
P 236	34/208.855	Foxfield, Furness, v.c. 69b	Grazed saltmarsh
P 241	34/184.694	Vickerstown, Furness, v.c. 69b	Ungrazed saltmarsh
P 254	28/847.853	Morrich More, E. Ross, v.c. 106	Sandflats
P 255	16/715.821	Ulva Islands, S. Ebudes, v.c. 102	Gravelly shore
P 259	53/555.578	Gibraltar Point, N. Lincs., v.c. 54	Ungrazed saltmarsh
P 282	27/096.587	Loch Leven, Argyll Main, v.c. 98	Ungrazed saltmarsh
P 295	18/897.547	Loch Torridon, W. Ross, v.c. 105	Grazed saltmarsh
P 299	29/554.540	Kyle of Tongue, W. Sutherland, v.c. 108	Grazed saltmarsh
P 304	39/166.294	Dunbeath, Caithness, v.c. 109	Quay top
P 322	37/342.294	Kingoodie, Fife, v.c. 85	Ungrazed saltmarsh
P 326	46/082.426	Lindisfarne, Cheviot, v.c. 68	Ungrazed saltmarsh
P 329	54/384.018	North Cotes, N. Lincs., v.c. 54	Ungrazed saltmarsh
P 332	62/048.212	Wivenhoe, N. Essex, v.c. 19	Ungrazed saltmarsh
P 333	23/405.672	R. Cefni, Anglesey, v.c. 52	Ungrazed saltmarsh
P 337	33/648.512	Nantwich, Cheshire, v.c. 58	Inland saltmarsh
P 342	53/920.448	Wells, W. Norfolk, v.c. 28	Ungrazed saltmarsh
P 358	53/939.450	Wells, W. Norfolk, v.c. 28	Ungrazed saltmarsh

METHODS

Tillers taken from individual plants in the field were grown in plastic pots containing John Innes No. 3 potting compost and a basal layer of moss-peat. Portions of root-tip *c* 30 mm long were taken from the peat, where they were grit-free, pre-fixed for 3 hours in dilute 8-hydroxyquinoline at 5°C, fixed for 3 hours in 3:1 ethanol/acetic acid, and hydrolyzed for 10 minutes at 60°C in 1 N HCl, followed by staining in Feulgen reagent for 1.5 hours. After staining, the tips were treated in pectinase (Östergren & Heneen 1962) to facilitate cell spreading. The preparations were squashed in 45% acetic acid, and temporary mounts were made by ringing coverslips with rubber solution. Whenever possible chromosome counts were taken from replicated root-tips and plants.

TABLE 3. GROWTH FORM DIFFERENCES BETWEEN TWO CLONES OF *PUCCINELLIA MARITIMA* FROM WELLS, NORFOLK

Accession code	3rd leaf-blade length (cm)		Maximum vegetative tiller height from ground (cm)		No. of tillers
	(13/6/72 in field)	(13/6/73 at Norwich)	(13/6/72 in field)	(13/6/73 at Norwich)	(18/4/73 at Norwich)
P 348	2.26 (0.129)	3.76 (0.108)	2.68 (0.292)	7.42 (0.684)	19.5 (2.53)
P 353	8.38 (0.443)	7.54 (0.389)	7.94 (0.534)	14.64 (1.13)	11.25 (2.29)

Replicated single tillers were grown in non-saline soil outdoors at Norwich from Oct. 1972 to July 1973. Standard error in brackets.

CHROMOSOME NUMBERS

P. maritima has chromosomes which are relatively long and thin, which makes counting difficult because they are often intermingled with one another in imperfect squashes. In over-spread preparations splitting of chromatids frequently occurred, adding another difficulty to counting. In good cells 56 chromosomes were usually present, but a few cells appeared to contain numbers in the range 53–55, suggesting a degree of somatic aneuploidy. All plants, including representatives of extremes of growth form, had a number at or just below $2n = 56$, the octoploid ($x = 7$) level (Fig. 1). Some other counts ranged from 50 to 64, but in all instances where aberrant counts were investigated repetition on new material of the same plants led to the conclusion that $2n = c\ 56$.

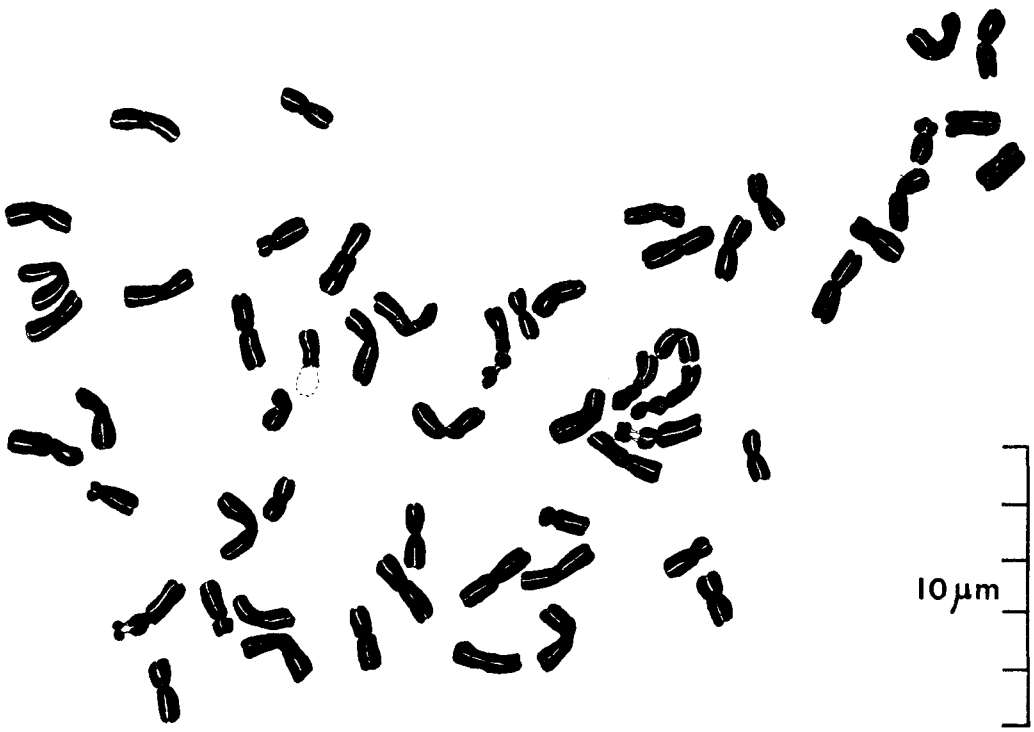

FIGURE 1. A root-tip cell of *Puccinellia maritima* showing a full complement of chromosomes, $2n = 56$ (accession P 35).

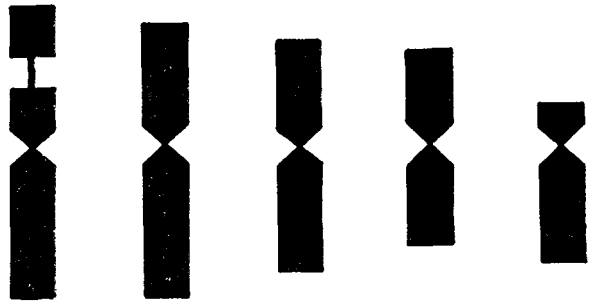

FIGURE 2. Chromosome types in *Puccinellia maritima*.

KARYOTYPE

Preparations were insufficiently clear for full karyotype analysis but Fig. 2 summarizes five categories of chromosome size and form. About six pairs of small acrocentric chromosomes are present; the rest are metacentric ranging in size up to twice as long as the acrocentrics. At least two pairs of the largest metacentrics have distinct satellites, and identical chromosomes have been seen in other species of the genus *Puccinellia*. All chromosomes showed bands of more intense staining which matched in several pairs and could be valuable in karyotype analysis.

DISCUSSION AND CONCLUSIONS

Chromosome number was found to be constant in plants of different growth form coming from a wide range of sites, suggesting that it is not a facet of variation in the species in the British Isles. The widespread occurrence of octoploids ($2n = 56$) with little aneuploidy is consistent with results of our unpublished breeding experiments which show that *P. maritima* is an active out-breeder with a low selfing rate.

The presence in its karyotype of sets of many similar chromosomes supports the idea that the species is a polyploid, but meiosis appears to be regular (Church 1949), and the plants are highly interfertile. Our evidence suggests that British plants are octoploid, but allowing for difficulties with counting it is not possible to rule out the existence of aneuploids. The wide range of morphological variability of the species is likely to be the produce of environmental selection on populations whose gene systems perform normal segregation and recombination, and not the expression of isolated lines maintained after a breakdown of sexuality.

ACKNOWLEDGMENTS

We thank W. E. Hughes, B. M. G. Jones, and A. R. Mills for information on *Puccinellia*. L. F. La Cour gave valuable advice on methods, and we are grateful to Miss N. Meek whose patient work added many new counts during 1974. F. T. Last and D. S. Ranwell made valuable comments on the text.

REFERENCES

BERNSTRÖM, P. (1948). In LÖVE, A. & LÖVE, D. Chromosome numbers of northern plant species. *Rep. Dep. Agric. Univ. Reykjavik*. Ser. B, **3**: 9–131.

BROWN-PACKER, A. K. (1961). In LÖVE, A. & LÖVE, D. Chromosome numbers of central and northwest European plant species. *Op. bot. Soc. Lund.*, **5**: 1–581.

CASTRO, D. DE & FONTES, F. C. (1946). Primeiro contacto citológico com a flora halófila dos salgados de Sacavém. *Bolm Soc. broteriana*, **15**: 38–46.

CHURCH, G. L. (1949). A cytotaxonomic study of *Glyceria* and *Puccinellia*. *Am. J. Bot.*, **36**: 155–165.

MILLS, A. R. (1967). *A cytotaxonomic study of variation in Puccinellia maritima in the British Isles*. M.Sc. thesis, University of Liverpool.

NEWTON, L. E. (1965). *Taxonomic studies on British species of Puccinellia*. M.Sc. thesis, University of London.

ÖSTERGREN, G. & HENEEN, W. K. (1962). A squash technique for chromosome morphological studies. *Hereditas*, **48**: 332–341.

RODRIGUES, J. E. DE (1953). Contribuição para o conhecimento cariológica das halófitas e psamófitas literais. *Diss. Dout. Coimbra. Univ.*

SØRENSEN, TH. (1958). In JØRGENSEN, C. A., SØRENSEN, TH. & WESTERGAARD, M. The flowering plants of Greenland. A taxonomical and cytological survey. *K. danske Vidensk. Selsk., Biol. Skr.*, **9(4)**: 1–172.

TUTIN, T. G. (1955). Species problems in plants with reduced floral structure, in LOUSLEY, J. E., ed. *Species studies in the British flora*, pp. 21–26. London.

WULFF, H. D. (1937). Karyologische Untersuchungen an der Halophytenflora Schleswig-Holstein. *Jb. wiss. Bot.*, **84**: 812–840.