

P. 1.433

ISSN 0254-8844

International Organization of Plant Biosystematists

Newsletter

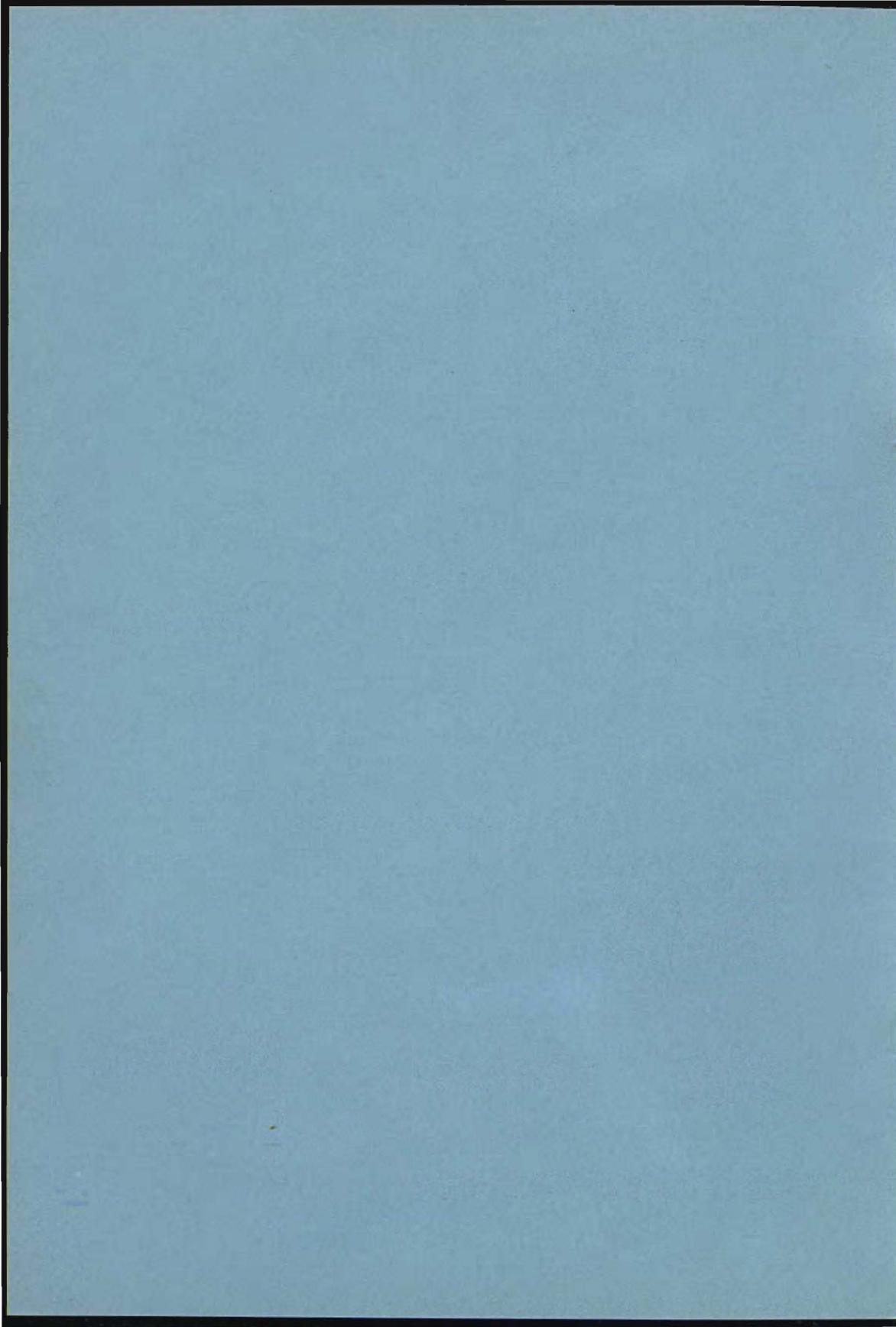
No. 12

Edited by K. M. Urbanska



Issued from
The Department of Geobotany
Swiss Federal Institute of Technology

Zürich 1989



06 JUL. 1989

P. 1423

International Organization of Plant Biosystematists

REAL JARDIN BOTANICO
C. S. I. C.
BIBLIOTECA
ADQUIRIDO EN

Newsletter No. 12



Contents

1. Editorial Comment
2. Lead Article
3. Profile of a Lab
4. Research News
5. Guidelines to IOPB Plant Chromosome Number Reports
6. Plant Chromosome Counts in China
7. IOPB Symposium 1989: Last news from the Organizing Committee
8. IOPB Symposium 1995
9. The First IOPB Award
10. Meetings, Past and Future
11. Publishing News
12. Requests for Material and Information
13. Miscellaneous News and Notes

Dear IOPB Members,

Here we are, with the latest issue of the Newsletter **and** with our **brand-new** Logo on the cover. We had to choose between two suggestions only; since I don't believe that the IOPB Members lack imagination, it must have been lack of time. Well, I hope you like the little logo.

Our fine Lead Article (p. 3) has been contributed by Dr. Hardy Eshbaugh. Thank you, Hardy, I am sure that this interesting paper will be widely read.

Profile of a Lab (p. 12) comes this time from West Germany. We are grateful to Drs Hurka and Neuffer for the well-structured report, and hope to hear more about the research progress in the future.

Very few research news this time (p. 13).... Are you **that** busy or just forgot about the deadline for the Newsletter?

No detailed chromosome number reports in this issue; it has been decided that a certain system in the presentation should be accepted first. Please read carefully the guidelines proposed by Dr. Stace (p. 14) and prepare your reports accordingly. From the next issue of the Newsletter on, the chromosome numbers will be published regularly. We have in this issue an interesting overview concerning plant chromosome counts in China (p. 15). Many thanks to Dr. Hsu for his contribution which may stimulate scientific cooperation between specialists from various countries.

Last news from Kyoto (p. 16): Japanese colleagues have provided a generous financial support to many persons attending the IOPB Symposium. Thank you cordially for this effort. Only a few weeks to go now; I hope to see many a Member in Kyoto.

Excellent news about the IOPB Symposium 1995: it is to be held in Scandinavia (p. 16). The offer has been gratefully accepted. More details to come, so stay with us and our Newsletter. Another highlight: The First IOPB Award has been unanimously granted to our Past President, Dr. Grant (p. 17). On behalf of the whole membership cordial congratulations, Bill. Please look up the brief report on the Carpathian Flora (p. 18) and also the request and information in this respect (p. 18). Another field for an international cooperation between specialists seems to be opening.

Well, I suppose that we have enough news to think over. I hope you continue to help your Editor, so that our winter issue will be contents-rich, too. Thanks for your contributions, now let's go field-tripping; the delightful expression is not mine, the original author is our Member Harlan Lewis (1983).

Data for Newsletter No. 13 should arrive here before end of November 1989.

Excellent summer to all of you

The Editor

NOTE: Please write in capital letters or use typewriter while preparing your 'Research News' sheet for the Newsletter. You don't want to have some words misspelled in print, do you? Please only use the new form.

2. Lead Article

By Carolyn D. Mitchell, W. Hardy Eshbaugh, Kenneth G. Wilson and Brenda K. Pittman, Department of Botany, Miami University, 316 Biological Science Building, Oxford, Ohio 45056, USA.

Patterns of chloroplast DNA variation in *Capsicum* (Solanaceae): A preliminary study

Introduction -Attempts to establish a clear taxonomy and phylogeny for *Capsicum* have been impeded because generic and specific boundaries have not been easily or well defined. Too often taxa separated by morphological characteristics cannot be clearly distinguished by isozyme analysis (MCLEOD et al., 1983b), and taxa separated by isozyme criteria are not always morphologically distinct (PICKERSGILL, 1988). Data are far too limited at present to establish the phylogenetic position of a number of wild *Capsicum* species. It is apparent that insights based on data from other character sets might be useful in elucidating phylogenetic patterns.

The plastid genome is the most conservatively evolving genome known, varying less than two-fold in size among all characterized land plants (PALMER et al., 1988). All angiosperm chloroplast DNAs (cpDNA) are circular molecules and most are in the size range of 135 to 160 kilobase pairs (Kb). With the exception of one group of leguminous plastomes, most angiosperm cpDNAs have the same linear order of genes and other sequences; this similarity extends to the cpDNA of at least one fern (*Osmunda cinnamomea*) and one gymnosperm (*Ginkgo biloba*) (PALMER and STEIN, 1986). Chloroplast genomes have, however, evolved, and measurement of their divergence provides a means for measuring evolutionary distances at various taxonomic levels. This divergence can be estimated by analysis of restriction enzyme fragment polymorphisms, a technique which has been reviewed in detail by PALMER (1985, 1986a, b). The interpretation of phylogenies of other genera in the Solanaceae by the use of this technique (PALMER and ZAMIR, 1982; KUNG et al., 1982; and HOSAKA et al., 1984) suggests that a similar analysis would be useful for *Capsicum*.

Materials and Methods -The four taxa investigated in this study included a recognized ancestor/domesticated pair, *C. baccatum* var. *baccatum* and *C. baccatum* var. *pendulum* (SMITH SA 205 MU, ESHBAUGH E 1861 MU), a second domesticated pepper, *C. annuum* var. *annuum* (ESHBAUGH E 1814 MU), and *C. ciliatum* (HEISER 7518 MU), one of the more divergent taxa that ESHBAUGH (1983) suggested might be removed from the genus based upon floral morphology, chromosome number, and absence of capsaicin.

We isolated purified chloroplast DNA from 5 gm of fresh young leaves utilizing a combination of the methods outlined by PALMER (1986) and KEMBLE (1987). Enough DNA was routinely obtained from this procedure to perform 10 -20 restriction analyses.

Purified plastid DNA from each of the taxa studied was restricted with one of four restriction enzymes, BglI, PvuII, SacI, or SalI, in each case using the conditions suggested by the supplier (IBI, New Haven, CT). The fragments were separated in 20 cm 0.5% agarose gels in 90 mM Tris-borate, 90 mM boric acid, 2 mM EDTA, pH 8 buffer (TBE) overnight at 25 V, together with suitable molecular weight standards. The gels were stained in 0.5 ug/ml ethidium bromide for 30 minutes, destained in distilled water,

illuminated with 300 nm UV light, and photographed with a Polaroid MP-4 camera, using Polaroid Type 55 positive/negative film and an orange filter. To facilitate the estimation of fragment sizes, the photographic negative of each gel was scanned with a Hoefer GS 300 scanning densitometer, utilizing the Hoefer GS 350 data system.

Results and Discussion -We restricted cpDNA with four different Class II restriction enzymes, SacI, Sall, BglI, and PvuII, and have analyzed the patterns of cpDNA restriction fragments produced by each.

The restriction enzyme Sall, which recognizes 9 sites in the cpDNA of C. annuum (GOUNARIS et al., 1986), showed no difference among the cpDNA of any of these four taxa. The restriction enzyme PvuII gave the pattern shown in Figure 1A, summarized in Table 1. Our analysis showed no discernible difference between C. annuum var. annuum and either of the two C. baccatum varieties. All three of these taxa showed three differences when compared to C. ciliatum however. We postulate that the following changes would account for the different patterns:

<u>C. annuum</u> or <u>C. baccatum</u>		<u>C. ciliatum</u>
Band A (44Kb)	-----	Band B (37Kb)
	-----	Band K (5.6Kb)
Band G (9.5Kb) + . .	-----	Band F (9.9Kb)
1 Band H (9.3Kb)	-----	Band J (6.3Kb)
	-----	Band O (2.8Kb)

The restriction enzyme SacI gave electrophoretic patterns (Figure 1B, Table 2) which revealed a slight change in the size of one restriction fragment allowing C. annuum var. annuum to be distinguished from the two C. baccatum taxa; like the preceding enzymes, it did not differentiate between these two. Four different changes can be observed between C. annuum var. annuum and C. ciliatum. We suggest that the changes listed below would account for the different patterns:

<u>C. baccatum</u>		<u>C. annuum</u> var. <u>annuum</u>		<u>C. ciliatum</u>
Band E (18Kb) --	Band E (18Kb)	-----	Band C (19.0Kb)	
Band U (1.7) --	Band U (1.7Kb)	-----		
Band O (3.5Kb) --	Band N (3.55Kb)	-----	Band P (3.45Kb)	
Band H (9.5Kb) --	Band H (9.5Kb)	-----	Band L (6.0Kb)	
		-----	Band Q (3.35Kb)	
Band G (10.1Kb) --	Band G (10.1Kb)	-----	Band F (10.7Kb)	

The restriction map of C. annuum Emerald Giant published by GOUNARIS et al. (1986) attests to the plausibility of the first of these hypothesized changes in Sac I restriction sites; the loss of one specific Sac I site in that taxon would eliminate 18.1 and 1.7 Kb fragments and yield a 19.8 SacI fragment instead. The restriction enzyme BglI distinguished the two C. baccatum taxa from both other taxa, and it distinguished C. annuum var. annuum from C. ciliatum (Figure 1C and Table 3). No discernible differences were demonstrated between the two C. baccatum varieties. We propose that the changes listed below would result in the observed differences:

<u>C. baccatum</u>	<u>C. annuum</u> var. <u>annuum</u>	<u>C. ciliatum</u>
Band C (20.4Kb) -----	Band C (20.7Kb) -----	1 Band A (27Kb)
Band K (6.0Kb) -----	Band K (6.0Kb) -----	
Band G (8.1Kb) -----	Band G (8.1Kb) -----	Band H (7.9Kb)
		-----2 Kb fragment
		(not observed)
Band E (16.6Kb) -----	Band E (16.6Kb) -----	Band B (21.2Kb)
Band M (4.2Kb) -----	Band M (4.2Kb) -----	
1 Band C (20.4Kb) ---	Band A (27Kb) -----	1 Band A (27Kb)
Band I (7.2Kb) -----		

Restriction fragment polymorphism data can be analyzed in several ways. In certain studies, taxa have been grouped into classes, in each of which the DNA from chloroplasts or mitochondria show identical restriction patterns (see, for example, HOSACKA, 1986). It is also possible to estimate divergence between taxa on the basis of the percentage of shared fragments between taxa, although detectable length mutations can make these interpretations ambiguous. A third method is the estimation of divergence between species on the basis of gain or loss of restriction point sites, since these alterations are most likely to reflect point mutations in the cpDNA.

In this initial study, we sampled 60 restriction sites, representing 360 nucleotide pairs. This limited sample represents approximately 0.25% of the total number of nucleotide pairs. The estimated divergence per nucleotide pair, p , based on the fraction of shared restriction sites, was calculated for each pair of taxa using equations [1] and [3] of BROWN et al. (1979), equation [6] of ENGELS (1981), and equations [8] and [10] of NEI and LI (1979), correcting [10] as suggested by ENGELS (1981). The estimated divergence per nucleotide pair based on the fraction of shared fragments was calculated using equations [20] and [21] of NEI and LI (1979) as detailed by NEI (1987). Slight changes in the size of homologous restriction fragments were not considered in these calculations. The divergence values we obtained are given in Table 4, and can be compared to values already determined in other genera. It can be noted at once that no divergence was detected between the two varieties of C. baccatum and they are therefore listed together in these comparisons.

PALMER and coworkers, utilizing equation [3] of BROWN et al. (1979), found a maximum divergence value of $p = 0.0259$ between species of Brassica (PALMER et al., 1983b), while the maximum divergence in Pisum was 0.0081, similar to values in Lycopersicon (PALMER et al., 1985). This interspecific divergence can be contrasted to intergeneric divergence values up to 0.13 between genera of legumes (PALMER et al., 1983b). PERL-TREVES and GALUN (1985), using the equation of ENGELS (1981), reported divergence values between 0.01 and 0.02 for many taxa in Cucumis. SYTSMA and GOTTLIEB (1986), calculating divergence among eight species of Clarkia sect. Peripetasma by one of the equations of NEI and LI (1979), found a range of divergence from 0.0017 to 0.0156. DEBONTE et al. (1984) described studies in the genus Daucus which, on the basis of shared plastome fragments, suggest a maximum divergence of 0.0171.

A recent report by COATES and CULLIS (1987) presented far higher values for divergence in the genus Linum, based on a

modification of the equations of NEI and LI (1979), with a maximum value of $p = .138$. We question, however, their use of the value F , which represents the proportion of shared restriction fragments, in NEI and LI'S equation [9]; the latter equation was derived to correlate estimated divergence with the proportion of shared restriction sites. A calculation of divergence based on NEI and LI'S equation [20] and the reported F values for Linum indicates that the divergence might range from .008 to .049.

The relationship between C. baccatum var. baccatum (wild) and C. baccatum var. pendulum (domesticated) has been examined in several studies. BALLARD et al. (1970) found the flavonoids of the two varieties to be identical, supporting the placement of these two taxa in a single species. Numerical analysis of a number of morphological characteristics separated the wild from the domesticated C. baccatum, but showed that the species was clearly separated from other Capsicum species (PICKERSGILL et al., 1979). Electrophoretic analysis (MCLEOD et al., 1983a,b) showed that the isozyme patterns of the two varieties were almost identical, with standard genetic distance $D = .02$. This standard genetic distance (NEI, 1972) is an estimate of the number of electrophoretically detectable codon differences per locus, based on comparison of fifteen nuclear coded proteins. Only an electrophoretic comparison of the soluble seed proteins (PANDA et al., 1986) suggested a wider divergence between the pair. In our initial study of cpDNA using a limited number of restriction enzymes, we found no divergence between the two plastomes, confirming a close relationship between the wild and domesticated varieties in this species.

Numerical analysis based on morphological characters of a number of accessions of C. annuum showed that the domesticated taxa in this species were clearly separated from other domesticated species and from wild C. annuum, but that the wild species were not clearly separated from wild species of C. chinense and C. frutescens (PICKERSGILL et al., 1979). Isozyme analysis (MCLEOD et al., 1979) indicated that C. annuum var. annuum differed from C. baccatum var. baccatum with a genetic distance $D = 0.24$, while it differed from C. baccatum var. pendulum by a genetic distance of 0.26 (The maximum genetic distance in their study of 12 taxa was $D = 0.79$, between C. praetermissum and C. tovarii.) In this initial study, we have ascertained that C. annuum and the two taxa of C. baccatum have an estimated plastome divergence of .0015 to .0030.

Capsicum ciliatum differs in floral morphology and chromosome number from almost all other Capsicum species. Its lack of capsaicin might indicate that it was not a true member of this genus, although wild non-pungent collections of many Capsicum species have been reported and non-pungent forms occur among the several domesticated taxa (ESHBAUGH, 1980). Previous comparisons of divergence between C. ciliatum and other taxa at the level of molecular evolution have not been published. Our analysis of restriction fragment polymorphism of plastome DNA indicates that although C. ciliatum diverges more from both C. annuum and C. baccatum than the latter diverge from each other, the magnitude of this divergence (.0105 to .0238) does not exceed interspecific divergence in several other genera, and does not provide a basis for questioning its assignment to this genus.



Fig. 1A. Comparison of PvuII restriction fragment patterns of *Capsicum* cpDNAs. CpDNAs from *C. annuum* var. *annuum* (A), *C. baccatum* var. *baccatum* (B), *C. baccatum* var. *pendulum* (P), and *C. ciliatum* (C) were digested with PvuII and the fragments were electrophoresed in a 0.5% agarose gel. Lane S1: lambda Sall fragments + lambda SmaI fragments + uncut lambda DNA (48.5 to 8.27 Kb markers). Lane S2: lambda DNA restricted with EcoRI + HindIII (21.7 to 3.48 Kb markers). Lane S3: lambda HindIII fragments (23.1 to 2.32 Kb markers). Size of selected markers is indicated on the left; on the right are indicated those cpDNA fragments which vary between taxa. Fig. 1B. Comparison of SacI restriction fragment patterns of *Capsicum* cpDNAs. Lane S1: lambda Sall fragments + lambda SmaI fragments + lambda HindIII fragments + lambda (48.5 to 2.0 KB markers). Lane S2: lambda DNA restricted with EcoRI + HindIII, fragments 1 and 5 partially annealed (25.2 to 1.9 KB markers). Fig. 1C. Comparison of BglII restriction fragment patterns of *Capsicum* cpDNAs. Lane S1: lambda Sall fragments + lambda SmaI fragments + lambda (48.5 to 8.27 KB markers). Lane S2: lambda DNA restricted with EcoRI + HindIII, fragments 1 and 5 partially annealed (25.2 to 1.9 KB markers). Lane S3: lambda HindIII fragments, fragments 1 and 4 partially annealed (27.5 to 2.0 KB markers).

Table 1. Distribution of PvuII restriction fragments from cpDNA of *C. annuum* var. *annuum* (A), *C. baccatum* var. *baccatum* (B), *C. baccatum* var. *pendulum* (P), and *C. ciliatum* (C). The estimated sizes are in Kbp.

Band	A	B	P	C
A	44	44	44	
B				37
C	18.7	18.7	18.7	18.7
D	16.2	16.2	16.2	16.2
E	11.1	11.1	11.1	11.1
F				9.9
G	9.5	9.5	9.5	
H	9.3 x 2	9.3 x 2	9.3 x 2	9.3
I	7.8	7.8	7.8	7.8
J				6.3
K				5.6
L	3.8 x 2	3.8 x 2	3.8 x 2	3.8 x 2
M	3.1	3.1	3.1	3.1
N	3.0	3.0	3.0	3.0
O				2.8
P	2.3 x 2	2.3 x 2	2.3 x 2	2.3 x 2

Table 2. Distribution of SacI restriction fragments from cpDNA of *C. annuum* var. *annuum* (A), *C. baccatum* var. *baccatum* (B), *C. baccatum* var. *pendulum* (P), and *C. ciliatum* (C). The estimated sizes are in Kbp.

Band	A	B	P	C
A	23	23	23	23
B	19.2	19.2	19.2	19.2
C				19
D	18.5	18.5	18.5	18.5
E	18	18	18	
F				10.7
G	10.1	10.1	10.1	
H	9.5	9.5	9.5	
I	8	8	8	8
J	6.7	6.7	6.7	6.7
K	6.5	6.5	6.5	6.5
L				6.0
M	5.8	5.8	5.8	5.8
N	3.55			
O		3.5	3.5	
P				3.45
Q				3.35
R	3.3 x 2	3.3 x 2	3.3 x 2	3.3 x 2
S	3	3	3	3
T	1.8 x 2	1.8 x 2	1.8 x 2	1.8 x 2
U	1.7	1.7	1.7	

Table 3. Distribution of BglI restriction fragments from cpDNA of *C. annuum* var. *annuum* (A), *C. baccatum* var. *baccatum* (B), *C. baccatum* var. *pendulum* (P), and *C. ciliatum* (C). The estimated sizes are in Kbp.

Band	A	B	P	C
A	27			27 x 2
B				21.2
C	20.7	20.4 x 2	20.4 x 2	
D	19.4	19.4	19.4	19.4
E	16.6	16.6	16.6	
F	10.6	10.7	10.7	10.6
G	8.1	8.1	8.1	
H				7.9
I	7.5 x 2	7.5 x 2	7.5 x 2	7.5 x 2
J		7.2	7.2	
K	6.0	6.0	6.0	
L	4.8	4.8	4.8	4.8
M	4.2	4.2	4.2	
N	3.4	3.4	3.4	3.4
O	1.8	1.8	1.8	1.8
P	1.5 x 2	1.5 x 2	1.5 x 2	1.5 x 2

Table 4. Estimated divergence per nucleotide pair between pairs of *Capsicum* species, calculated by several different equations as given in the footnotes.

Equation:	<i>C.ann.</i> vs <i>C.bacc.</i>	<i>C.ann.</i> vs <i>C.cil.</i>	<i>C.bacc</i> vs <i>C.cil.</i>
Brown et al.	.0030	.0210	.0238
Engels	.0015	.0105	.0119
Nei, Li [8]	.0015	.0109	.0124
Nei, Li [9]	.0016	.0110	.0122
Nei, Li [20]	.0015	.0108	.0164

Brown et al. (1979): [1] $s = z/(x + y - z)$; [3] $p = (-\ln s)/n$

Engels (1981): [6] $p = [c - n(m-k)]/jc$

Nei and Li (1979): [8] $\bar{D} = -(1nS)/r$

[10] $\bar{S} = \frac{(2n)}{xy} / \frac{(n + n)}{x y}$ in which n = sites

[9] $\bar{D} = -(3/2) \ln[(4S^{1/(2r)} - 1)/3]$

[20] $\bar{F} = P^4 / (3 - 2P)$; see Nei, 1987

[21] $\bar{F} = \frac{2n}{xy} / \frac{(n + n)}{x y}$ in which n=fragments

Acknowledgements -Financial support for this study was provided through a grant to WHE from the National Science Foundation (BSR 8411136).

Literature cited

- BALLARD, R.E., J.W. MCCLURE, W.H. ESHBAUGH, and K.G. WILSON. 1970. A chemosystematic study of selected taxa of Capsicum. Amer. J. Bot. 57:225-233.
- BROWN, W.M., N. GEORGE, Jr., and A.C. WILSON. 1979. Rapid evolution of animal mitochondrial DNA. Proc. Nat. Acad. Sci. USA 76:1967-1971.
- COATES, D. and C.A. CULLIS. 1987. Chloroplast DNA variability among Linum species. Amer. J. Bot. 74:260-268.
- DEBONTE, L.R., B.F. MATTHEWS and K.G. WILSON. 1984. Variation of plastid and mitochondrial DNAs in the genus Daucus. Amer. J. Bot. 71:932-940.
- ENGELS, W.R. 1981. Estimating genetic divergence and genetic variability with restriction endonucleases. Proc. Nat. Acad. Sci. USA 78:6329-6333.
- ESHBAUGH, W.H. 1980. Models of speciation in the genus Capsicum (Solanaceae). Abstracts - Second International Congress of Systematic and Evolutionary Biology, Vancouver, Canada, p. 192.
- ESHBAUGH, W.H. 1983. The genus Capsicum (Solanaceae) in Africa. Bothalia 14:845-848.
- GOUNARIS, I., C.B. MICHALOWSKI, H.J. BOHNERT and C.A. PRICE. 1986. Restriction and gene maps of plastid DNA from Capsicum annuum. Curr. Genet. 11:7-16.
- HOSAKA, K. 1986. Who is the mother of the potato? -- restriction endonuclease analysis of chloroplast DNA of cultivated potatoes. Theor. Appl. Genet. 72:606-618.
- HOSAKA, K., Y. OGIHARA, M. MATSUBAYASHI, and K. TSUNEWAKI. 1984. Phylogenetic relationship between the tuberous Solanum species as revealed by restriction endonuclease analysis of chloroplast DNA. Jpn. J. Genet. 59:349-369.
- KEMBLE, R.J. 1987. A rapid, single leaf, nucleic acid assay for determining the cytoplasmic organelle complement of rapeseed and related Brassica species. Theor. Appl. Genet. 73:364-370.
- KUNG, D.S., Y.S. ZHU, and G.F. SHEN. 1982. Nicotiana chloroplast genome. III. Chloroplast DNA evolution. Theor. Appl. Genet. 61:73-79.
- MCLEOD, M.J., W.H. ESHBAUGH, and S.I. GUTTMAN. 1979. An electrophoretic study of Capsicum (Solanaceae): the purple flowered taxa. Bull. Torrey Bot. Club 106:626-633.
- MCLEOD, M.J., S.I. GUTTMAN and W.H. ESHBAUGH. 1983a. Peppers (Capsicum), in S.D. Tanksley and T.J. Orton (eds.), Isozymes in Plant Genetics and Breeding, Elsevier Science Publishers B.V., Amsterdam. Pp. 189-201.
- MCLEOD, M.J., S.I. GUTTMAN, W.H. ESHBAUGH, and R.E. RAYLE. 1983b. An electrophoretic study of evolution in Capsicum (Solanaceae). Evolution 37:562-57
- NEI, M. 1972. Genetic distance between populations. Am. Nat. 106:283-292.
- NEI, M. 1987. Molecular Evolutionary Genetics. Columbia University Press, New York.

- NEI, M. and LI, W-H. 1979. Mathematical model for studying genetic variation in terms of restriction endonucleases. Proc. Natl. Acad. Sci. USA 76:5269-5273.
- PALMER, J.D. 1985. Chloroplast DNA and Molecular Phylogeny. BioEssays 2:263-267.
- PALMER, J.D. 1986. Isolation and structure of chloroplast DNA. In Methods in Enzymology, A. Weissbach and H. Weissbach, Eds., Academic Press, Orlando, Florida.
- PALMER, J.D., R.K. JANSEN, H.J. MICHAELS, M.W. CHASE, AND J.R. MANHART. 1988. Chloroplast DNA Variation and plant phylogeny. Ann. Missouri Bot. Gard. 75:1180-1206.
- PALMER, J.D., R.A. JORGENSEN and W.F. THOMPSON. 1985. Chloroplast DNA variation and evolution in Pisum: Patterns of change and phylogenetic analysis. Genetics 109:195-213.
- PALMER, J.D., C.R. SHIELDS, D.B. COHEN and T.J. ORTON. 1983a. Chloroplast DNA evolution and the origin of amphidiploid Brassica species. Theor. Appl. Genet. 65:181-189.
- PALMER, J.D., G.P. SINGH and D.T.N. PILLAY. 1983b. Structure and sequence evolution of three legume chloroplast DNAs. Molec. Gen. Genet. 190:13-19.
- PALMER, J.D. and D.B. STEIN. 1986. Conservation of chloroplast genome structure among vascular plants. Curr. Genet. 10:823-833.
- PALMER, J.D. and D. ZAMIR. 1982. Chloroplast DNA evolution and phylogenetic relationships in Lycopersicon. Proc. Natl. Acad. Sci. USA 79:5006-5010.
- PANDA, R.C., O.A. KUMAR and K.G. RAJA RAO. 1986. The use of seed protein electrophoresis in the study of phylogenetic relationships in Chili pepper (Capsicum L.). Theor. Appl. Genet. 72:665-670.
- PERL-TREVES, R. and E. GALUN. 1985. The Cucumis plastome: physical map, intrageneric variation and phylogenetic relationships. Theor. Appl. Genet. 71:417-429.
- PICKERSGILL, B. 1988. The genus Capsicum: a multidisciplinary approach to the taxonomy of cultivated and wild plants. Biol. Zentralbl. 107:381-388.
- PICKERSGILL, B., C.B. HEISER, Jr., and J. MCNEILL. 1979. Numerical taxonomic studies on variation and domestication in some species of Capsicum. In The Biology and Taxonomy of the Solanaceae, J.G. Hawkes, R.N. Lester, and A.D. Skelding, Eds., Academic Press, New York. Pp. 679-700.
- SYTSMA, K.J. and L.D. GOTTLIEB. 1986. Chloroplast DNA Evolution and phylogenetic relationships in Clarkia sect. Peripetasma (Onagraceae). Evolution 40:1248-1261.

3. Profile of a Lab

Profile of the Biosystematic Group, by Prof. Herbert Hurka and Dr. Barbara Neuffer, Universität Osnabrück, Fachbereich Biologie/Chemie, Spezielle Botanik, Barbarastrasse 11, D-4500 Osnabrück, FRG

At present, our Group consists of three scientists on permanent staff, five Ph D students, a number of Diploma students, and two technical assistants. One of us (Hurka) is also the Director of the Botanic Garden. Experiments are done in the laboratory, greenhouse, growth chambers and experimental field stations.

Our research program aims at understanding evolutionary processes, in particular population differentiation and adaptation, colonizing ability and speciation. Appropriate investigations are carried out with *Brassicaceae*, a family characterized by its high evolutionary potential.

Several lines of evidence are essential for the understanding of evolutionary events: the nature of genetic variation within and between populations; the effective breeding system and its variation over space and time; gene flow events; adaptive vs. non-adaptive variation; genotype - environment interactions; the role of history vs. selection and their influence on the genetic structure of a species.

Evolutionary studies can be done on three levels, (a) the DNA level, (b) the protein level, (c) the polygenic level. Studies at the DNA level are planned but not yet started. At the protein level, intensive studies were carried out with isozymes in the genus *Capsella*. Genetic structure of 2x and 4x populations, gene flow events, breeding systems and the role of history vs. selection were analyzed. These investigations are also strongly related to the population biology of colonizing plants. Studies on subcellular location of isozymes within *Brassicaceae* are promising tools to trace not only the evolution of isozyme coding genes and gene complexes, but also to shed light on evolutionary lines within *Brassicaceae*. Corresponding experiments are in progress. A protein of different qualities is the enzyme Ribulose-1,5-biphosphate carboxylase (Rubisco). This enzyme is composed of large (LSU) and small subunits (SSU). The LSU are coded by chloroplast DNA, the SSU by nuclear DNA. For this reason and because of its high species constancy, Rubisco may serve as a powerful phylogenetic marker. So far, isoelectric focussing patterns of Rubisco were analyzed within the genera *Capsella*, *Lepidium* and *Thlaspi*.

The role of the flavonoids in systematics has often been discussed and well known examples of their importance of both, taxonomic and evolutionary problems exist. However, *Brassicaceae* are only poorly documented in the literature. We therefore started a survey on flavonoid profiles in that family.

This leads to the level of polygenic traits. Recent interest in evolutionary biology switches back again to quantitative characters (fitness relevant characters as for instance life cycle components). In a series of experiments on the adaptation of life history traits of the common weed *Capsella bursa-pastoris* (greenhouse, growth chamber and experimental field station experiments). B. Neuffer and co-workers demonstrated that in addition to a genotypic component,

pronounced environmental interactions provide the plants with a strong component of phenotypic plasticity.

Selected publications:

- HURKA H., 1984: Influence of population parameters on the genetic structure of *Capsella* populations. In: WÖHRMANN K. and LOESCHCKE V. (eds.), Population, biology and evolution. Springer, Berlin/Heidelberg. 183-192.
- HURKA H., FREUDNER S., BROWN A.H.D. and PLANTHOLT U., 1989: Aspartate aminotransferase isozymes in the genus *Capsella* (*Brassicaceae*): Subcellular location, gene duplication, and polymorphism. *Biochem.Genetics* 27, 77-90.
- MUMMENHOFF K., 1989: Sippenstrukturen in der Gattung *Lepidium* L. (*Brassicaceae*): Isoelectrische Fokussierungsmuster bei Untereinheiten von Ribulose-1,5-Biphosphate Carboxylase/Oxygenase (Rubisco) als systematischer und phylogenetischer Marker. Ph.D Thesis, Univ. of Osnabrück.
- NEUFFER B. and BARTELHEIM S., 1989: Ecology of weed populations: the adaptive strategy of *Capsella bursa-pastoris* (*Brassicaceae*). *Oecologia* (in press).
- NEUFFER B. and HURKA H., 1988: Germination behaviour in populations of *Capsella bursa-pastoris* (*Cruciferae*). *Plant Syst.Evol.* 161, 35-47.

4. Research News

- CHINAPPA C.C., Department of Biological Sciences, University of Calgary, Calgary, Alberta T2N 1N4, Canada, sent the following publications:
- CHMIELEWSKI J.G and CHINAPPA C.C., 1987: The genus *Antennaria* (*Asteraceae: Inuleae*) in North America: multivariate analysis of variation patterns in *Antennaria rosea* sensu lato. *Can.J.Bot.* 66, 1583-1609.
- CHMIELEWSKI J.G and CHINAPPA C.C., 1988: The genus *Antennaria* (*Asteraceae: Inuleae*) in western North America. II. Additional chromosome counts. *Rhodora* 90(862), 133-137.
- CHMIELEWSKI J.G and CHINAPPA C.C., 1988: Taxonomic notes and chromosome numbers in *Antennaria* Gaertner (*Asteraceae: Inuleae*) from arctic North America. *Arctic and Alpine Research* 20(1), 117-124.
- MACDONALD S.E. and CHINAPPA C.C., 1988: Patterns of variation in the *Stellaria longipes* complex: effects of polyploidy and natural selections. *Amer.J.Bot.* 75(8), 1191-2000.
- MACDONALD S.E., CHINAPPA C.C. and REID D.M., 1988: Evolution and phenotypic plasticity in the *Stellaria longipes* complex: Comparisons among cytotypes and habitats. *Evolution* 42(5), 1036-1046.
- MACDONALD S.E., CHINAPPA C.C., REID D.M. and B.G. PURDY, 1987: Population differentiation of the *Stellaria longipes* complex within Saskatchewan's Athabasca sand dunes. *Can. J.Bot.* 65, 1727-1732.

ESHAUGH W. Hardy, Dr., Department of Botany, Miami University, Oxford, OH 45056, USA.

Current projects: Patterns of chloroplast DNA variation in *Capsicum* (*Solanaceae*). Taxonomic studies of the genus *Capsicum* (*Solanaceae*). Studies of the flora of the Bahama Archipelago.

Recent publications:

- ESHAUGH W.H., 1987: Plant-ant relationships and interactions - *Tillandsia* and *Crematogaster*. In: SMITH R. (ed.), 2nd Symposium of the Botany of the Bahamas, College Center of the Finger Lakes, San Salvador, Bahamas. 9-11.

- ESHBAUGH W.H., 1987: The genus *Capsicum* (*Solanaceae*) in the Bahamas. In: SMITH R. (ed.), 2nd Symposium of the Botany of the Bahamas, College Center of the Finger Lakes, San Salvador, Bahamas. 13-17.
- HICKEY R.J., GUTTMAN S.I. and ESHBAUGH W.H., 1989: Evidence for post-translational modifications of triose phosphate isomerase (TPI) in *Isoetes* (*Isoetaceae*). *Amer.J.Bot.* 76, 215-221.
- NICKRENT D.I., ESHBAUGH W.H. and WILSON T.K., 1988: The vascular flora of Andros Island, Bahamas. Kendall Hunt Publ. Co., Dubuque, Iowa. p. 185.

LIU Jiang Sheng, Ph D, Sichuan Academy of Forestry, 344 Jinhua Street, Chengdu Sichuan, The People's Republic of China.

Projects completed: A study on the systematic position of genus *Dipentodon* Dunn.

Projects started: Preliminary observations on the chromosomes of Sichuan *Listea* Lam., Flora Sichuanica, woody Flora of Sichuan.

Publications: A study on the systematic position of genus *Dipentodon* Dunn (in prep.).

5. Guidelines to IOPB Chromosome Number Reports

by Clive A. Stace, Professor, Department of Botany, University of Leicester, Leicester LE1 7RH, England.

This series will be resumed in the next issue of the IOPB Newsletter (No. 13, November 1989). You are hereby invited to send the lists for inclusion to Professor Stace. Items acceptable are first counts for a species, first counts of a new number for a species, or counts from a significantly new and important area of a species.

The format adopted should be that used in the earlier reports in TAXON. In addition, the number of plants and of populations that were studied should be indicated. Counts must be definite within the limits stated, and should be stated as either gametophytic (n) or sporophytic (2n); the former should **not** be converted to the latter by doubling.

Only material from wild, noted localities should be included, citation of vouchers is essential; if these are not exact vouchers (e.g. they are siblings or parents of studied plants or seeds), this should be made clear.

We do not know how popular this series will become. If we receive too much material for publishing, preference will be given to paid-up Members of IOPB or to others who can meet page-charges.

We hope also to include other kinds of data on the plant genome. Suggestions and contributions will be welcome.

6. Chromosome Counts in China

by P.S. Hsu, Department of Biology, Fudan University, Shanghai, The People's Republic of China.

Research work on plant chromosome cytology in China began in the 1930's. The pioneer Chinese cytologist D.T. Wang was the first to make plant chromosome counts of the Chinese flora. In his eight articles published in "Bulletin of Fan Memorial Institute of Biology, Botanical Series", Vols. 8-10, 1938-1940, data on eight species from eight genera were given. Between 1940 and 1960, only 22 articles containing some chromosome numbers were published, but they were concerned mainly with plant breeding (*Hemerocallis*, *Brassica*, *Oryza*, *Gossypium*, *Pinus*, etc.). In 1963, C.Y. Chao et al. published in "Botanical Bulletin of Academia Sinica", Vol. 4 of Taiwan, a research report on *Dioscorea* which is probably the first cytotaxonomical article in Chinese literature. In the 1970's, the total number of published papers increased to 55. Most of those publications were concerned with chromosome banding patterns and karyotypes of cultivated plants; several dealt with breeding of agronomic, horticultural and medicinal plants, induced pollen plants from anthers, and cytogenetical problems; some reported chromosome numbers of economic plants. Only a relatively small number of papers published by then had a bearing on cytotaxonomy; extensive chromosome counts of vascular plants of Taiwan carried out by C.C. Hsu and his students are of a special value (see their seven articles published in "Taiwania", Vols. 13-17 and 19, and in "Bot.Bull.Acad.Sin.", Vol. 19). The treatise on *Dioscorea* (PEI et al. 1976) is apparently the most significant paper on plant cytotaxonomy in the decade. This contribution has been published in Vol. 14 of "Acta Phytotaxonomica Sinica".

A big increase in the amount of papers regarding plant chromosome counts in 1981-1988 resulted in an average publication output of about 62 per year. Not only new chromosome counts, but also karyotype analysis of Chinese indigenous plants increased greatly. The two conferences on the subject of chromosomes, viz. "The First National Symposium on Plant Chromosomes" (Xincheng, Liaoning 1984) and the "Sino-Japanese Symposium on Plant Chromosomes" (Beijing 1987), as well as diverse teaching programs in plant biosystematics and chromosome techniques, have greatly stimulated the Chinese taxonomists and cytologists to make further efforts in plant chromosome research. This development resulted in a rather large amount of valuable cytological information in recent years. The two indices to plant chromosome numbers published so far by the author in "Investigatio et Studium Naturae", Vol. 5 in 1985, and Suppl. Vol. in 1988, compile all chromosome counts reported in Chinese literature before 1985. The third index is in preparation. Of special interest in these publications are the new chromosome number reports for many monotypic genera endemic to China, e.g. *Cathaya*, *Glyptostrobus*, *Tsoongi dendron*, *Kingdonia*, *Taihangia*, *Bretschneidera*, *Xanthoceras*, *Tapiscia*, *Changiium*, *Chuanminshen*, *Tetradoxa*, *Echonocodon*, *Siratia*, *Speirantha*, *Changnienia*, etc. Many families and genera, e.g. *Lycoris*, *Panax*, *Dendranthema*, *Brassica*, *Taxodiaceae*, *Dioscorea*, *Aspidistra*, *Paris*, *Paeonia*, *Magnoliaceae*, *Calligonum*, *Malus*, *Pyrus*, *Tamarix*, *Camellia*, *Umbelliferae*, *Zingiberaceae*, *Alismataceae*, *Najadaceae*,

Gossypium, *Nelumbo*, *Polygonatum*, *Adenophora*, *Streptolirion*, *Fagopyrum*, *Capsicum*, *Xanthium*, *Leonurus*, and also many ferns, were intensively studied cytologically, some studies being carried out on population level. On the other hand, data on chromosome numbers in fungi, algae, and bryophytes are very scarce. In 1988 Y.L. Zhou et al. furnished the first chromosome number report for Chinese bryophytes.

In spite of all the work done to date, the total number of genera and species studied cytologically is still very small because the Chinese flora is exceedingly rich and comprises diverse floristic elements. More chromosome counts both in totally unknown as well as insufficiently analyzed species are urgently needed.

7. IOPB Symposium 1989: Last News from the Organizing Committee

by Dr. S. Kawano, Chairman of the Organizing Committee

The local Organizing Committee of IOPB Symposium decided to support financially 17 persons from abroad, two invited speakers included. The list comprises ten scientists from China (airfare and accommodations), one scientist from the Soviet Union (accommodation and registration fee), one scientist each from Pakistan, Sri Lanka, Thailand, Australia as well as two scientists from India (airfare and accommodation for all).

By the time being, we have 180 registered participants (invited speakers included); 115 are Japanese, whereas 65 come from other countries. Altogether 25 nationalities are represented. The number of the poster papers submitted is 101.

79 participants will join the Nara excursion, and 38 (out of the 40 possible) will go to the post-Symposium trip to Tateyama.

Editor's note: On behalf of the IOPB, most sincere thanks to the Japanese scientists for the exceptionally generous support.

8. IOPB Symposium 1995

by Krystyna M. Urbanska, President of the IOPB

I have recently got an offer from Scandinavia to hold there the IOPB Symposium 1995. Preliminary inquiries indicate that the **meeting might possibly be held at a field research station high up north**, an excellent opportunity to see some plant life of Lapland.

The offer has been gratefully accepted. Many thanks (TACK/TAKK) to Scandinavian colleagues. Details will follow in due time.

9. The First IOPB Award

by Krystyna M. Urbanska, President of the IOPB

It is my pleasure to announce that our Past President, Dr. William F. Grant has been unanimously elected as the first recipient of the IOPB Award granted in the form of IOPB Life Membership.

The award will be officially granted in a special ceremony during the IOPB Symposium 1989 in Kyoto, Japan.

10. Meetings, Past and Future

Report on the Workshop "Carpathian Flora" held in September 1988 in Smolenice (Czechoslovakia) by Karol Marhold, Ústav Experimentálnej Biologie a Ekologie, Slovenskej Akadémie Vied, Dubravská cesta 14, 81434-Bratislava, Czechoslovakia.

The scientific program of the workshop was divided into four thematic groups: general problems, experimental taxonomy, protection of the phytogenifound, and national floras. 75 participants from Bulgaria, German Democratic Republic, Hungaria, Poland, Soviet Union, and Czechoslovakia attended the workshop. In the conclusion of the workshop, the Department of Systematic Botany, Institute of Experimental Biology and Ecology, Slovakian Academy of Sciences, Bratislava, was charged with the coordination of phytotaxonomical researches in the Carpathians and Pannonian Lowland.

Meetings 1989

September 19, Ordination in Classification, Rothamsted, UK. Information: Dr J.N. Perry, Rothamsted, Experimental Station, Harpenden, Herts AL5 2JQ, UK

11. Publishing News

Index to Plant Chromosome Numbers Reported in Chinese Literature. III (in press), by Hsu Ping-sheng, Department of Biology, Fudan University, Shanghai, People's Republic of China.

This is the third in a series of indices dealing with the plant chromosome numbers reported in Chinese literature from 1968 to 1988. The index comprises altogether 1013 chromosome counts corresponding to 799 species and infraspecific taxa of 325 genera (107 families). It will be published in "Observatio et Studium Naturae) of Shanghai Museum of Natural History in

first and the second indices were published in the same Journal in Vol. 3 of 1985 and Suppl. Vol. of 1988, respectively. Copies of the three indices can be ordered from Shanghai Museum of Natural History, 260 East Yanan Lu, Shanghai, People's Republic of China. Cost: US dol. 10.00 each, post paid.

12. Requests for Material and Information

ESHBAUGH W. Hardy, Dr., Department of Botany, Miami University, Oxford, OH 45056, USA, would appreciate seed collections of any species of *Capsicum* (*Solanaceae*).

LIU Jiang Sheng, Ph D, Sichuan Academy of Forestry, 344 Jinhua Street, Chengdu Sichuan, The People's Republic of China, would appreciate information on indexes of chromosome numbers (not specified).

MARHOLD Karol, Dr., Ustav Experimentalnej Biologie a Ekologie, Slovenskej Akademie Vied, Dubravska cesta 14, 81434-Bratislava, Czechoslovakia, writes: In order to intensify the international cooperation and improve information exchange concerning research projects in the Carpathian and Pannonian flora, we plan to publish a report entitled "Current research projects on the Carpathian and Pannonian flora", analogically as it was done by OPTIMA for the Mediterranean region. Thus we will be grateful for addresses of botanists working on phyto-taxonomical problems of the Carpathian and Pannonian flora, especially outside the countries mentioned.

RAI Ravishankar, Dr., Department of Botany, University of Mysore, Marasagangshi, Mysore, India, working on tissue culture and cytology of forest tree species in southern India, would appreciate the information on chromosome number(s) of *Syzygium aromaticum* (*Myrtaceae*).

STEDJE Brita, Dr., Department of Biology, Division of Botany, Box 1045, Blindern, N-0316 Oslo, Norway, would appreciate seeds or preferentially bulbs of *Ornithogalum*, subgenus *Beryllis* from the Mediterranean area.

13. Miscellaneous News and Notes

ESHBAUGH W. Hardy, Dr., Department of Botany, Miami University, Oxford, OH 45056, USA, has been elected President of the Botanical Society of America. Will serve in this capacity from 1988 through 1989.

GRANT William F., Department of Plant Science, Macdonald College of McGill University, Ste Anne de Bellevue, P.O. Box 4000, Quebec, Canada H9X 1C0, has been elected Member to the Royal Society of Canada.

URBANSKA Krystyna M., Geobotanical Institute, Swiss Federal Institute of Technology

Zürich, has been elected Vice-President of Botanical Society of Zürich. Will serve in this capacity from 1988 through 1990.

Change of address

Botanic Institute, University of Aarhus, Nordlandvej 68, DK-8240 Risskov, Denmark

Professor V.N. **Heywood**, IUCN, 53 The Green, Kew, Richmond, Surrey TW9 3AA, UK

Meredith A. **Lane**, who has been on the Faculty of the University of Colorado at Boulder since 1980, will become the Director of the Herbarium and Associate Professor of Botany at the University of Kansas as of July, 1989. The address of the University of Kansas Herbarium is 2045 Constant Ave., Lawrence Ks 66047, USA (Phone 913/864-4493). Dr. Lane will replace Dr. Ronald McGregor, who is retiring after 42 years of service at the University of Kansas, during which he built the Herbarium of over 300,000 specimens and initiated and was coordinator of the Great Plains Flora Project. Serving as acting Director until Dr. Lane's arrival, and as Assistant Director thereafter, will be Dr. Ralph Brooks.

International Organization of Plant Biosystematists Executive and Council Members

- President:** **Krystyna M. Urbanska**
Geobotanisches Institut ETH
Stiftung Rübel
Zürichbergstrasse 38
CH-8044 Zürich, Switzerland
- Vice-President:** **Shoichi Kawano**
Department of Biology
Faculty of Science
Kyoto University
Kyoto 606, Japan
- Past-President:** **William F. Grant**
Department of Plant Science
Macdonald College of McGill University
Ste Anne de Bellevue
P.O.Box 4000,
Quebec, Canada H9X 1C0
- Secretary-Treasurer:** **Liv Borgen**
University of Oslo
Botanical Garden and Museum
Trondheimsveien 23B
N-0562 Oslo 5, Norway
- Member ex officio for 1989 Symposium:**
Ichiro Fukuda
Division of Biology
Tokyo Woman's Christian University Zempukuji, Suginami
Tokyo 167, Japan
- Council:**
- J.F. Bain**, Department of Plant Science, Macdonald College of McGill University, Ste. Anne de Bellevue, P.O.Box 4000, Quebec, Canada H9X 1C0
- Maria A. Cardona**, Depto. Botanica, Facultad de Ciencias, Univ. Autonoma de Barcelona, 08193 Bellaterra (Barcelona), Spain
- W. Hardy Eshbaugh**, Department of Botany, Miami University, 175 Upham Hall, Oxford, Ohio 45056, USA
- J.R. Estes**, Dept. of Botany and Microbiology, 770 Van Vleet Oval, University of Oklahoma, Norman, Oklahoma 73019, USA
- Chen Jiakuan**, Department of Biology, Wuhan University, Wuchang, Hubei, Wuhan, The People's Republic of China
- B.E. Jonsell**, Bergius Botanic Garden, Box 50017, S-10405 Stockholm, Sweden
- J.C.M. Den Nijs**, Hugo de Vries Laboratory, University of Amsterdam, Plantage Middenlaan 2a, NL-1018 DD Amsterdam, The Netherlands
- Arne Rousi**, Department of Botany, University of Turku, SF-20500 Turku 50, Finland
- C.J. Webb**, Botany Division, DSIR, Private Bag, Christchurch, New Zealand
- Judy West**, The National Herbarium of Australia, CSIRO, Division of Plant Industry, P.O.Box 1600, Canberra City, ATC 2601, Australia

MEMBERSHIP APPLICATION FORM

International Organization of Plant Biosystematists

The International Organization of Plant Biosystematists (IOPB) was founded in 1960 to promote international cooperation in the study of biosystematics. The IOPB acts on several levels, from coordinating and publishing information on biosystematics to organizing conferences. The IOPB is open to all persons working or interested in biosystematics which is interpreted in a broad sense (see symposium volume "Plant Biosystematics", edited by W.F. Grant, 1984). The history and past activities of IOPB have been given in *Taxon* 31, 386-387, 1982.

An IOPB Newsletter is sent to all members. Such items as current research, requests for material and information, meeting reports, publications, etc. are reported. The Editor is Prof. Krystyna M. Urbanska, Geobotanisches Institut ETH, Zürichbergstrasse 38, CH-8044 Zürich, Switzerland.

At present, Membership is for the three year period between Symposia. The next Symposium will be held in Japan in 1989.

Membership fee 1987-1989: US\$ 20.00.

Make cheques or money orders payable to the International Organization of Plant Biosystematists (IOPB).

Send the form, and/or payment to: Dr. Liv. Borgen, Secretary-Treasurer, IOPB Botanical Garden and Museum, Trondheimsveien 23B, N-0562 Oslo, Norway.

IOPB - Membership application for

Last name

First name (Mr., Mrs.)

Title

Address

Date

Signature

THE UNIVERSITY OF CHICAGO

PH.D. THESIS

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

Research News
for the International Organization of Plant Biosystematists Newsletter
(IOPB Newsletter)
Typewritten or in capital letters

Last name

First name

Title

Address:

Personal news (Promotions etc.)

Publications during thre year:

Current projects:

Projects completed:

Projects started:

Requests for research material and information:

Articles and reports should be attached

To be sent to Krystyna M. Urbanska, Geobotanisches Institut ETH, Stiftung Rübel,
Zürichbergstrasse 38, CH-8044 Zürich, Switzerland

THE UNIVERSITY OF CHICAGO
DEPARTMENT OF CHEMISTRY
RESEARCH REPORT

No. 1000
1950

BY
J. H. GOLDSTEIN AND
M. L. HUGGINS

RECEIVED
MAY 15 1950

DEPARTMENT OF CHEMISTRY
5708 S. UNIVERSITY AVENUE
CHICAGO, ILLINOIS

COPYRIGHT © 1950 BY THE UNIVERSITY OF CHICAGO
ALL RIGHTS RESERVED

PRINTED IN THE UNITED STATES OF AMERICA

LIBRARY OF THE UNIVERSITY OF CHICAGO
5708 S. UNIVERSITY AVENUE
CHICAGO, ILLINOIS

