Karyomorphology of Some Myrtaceae from Singapore

KAZUO OGINUMA[1], SHAWN K.Y. LUM[2], Y.H. LEE[3]
and HIROSHI TOBE[4]

[1]College of Child Development, Kochi Women's University, 132 Ohara-cho, Kochi 780, Japan
[2]Department of Integrative Biology, University of California, Berkeley, CA 94720, U.S.A.
[3]Botany Department, National University of Singapore, Singapore
[4]Department of Biology, College of Liberal Arts and Science,
Kyoto University, Kyoto 606, Japan

EFFECTIVE PUBLICATION DATE: 15 MAR 1993

Abstract

Karyomorphology of five species in three genera of Myrtaceae, namely *Callistemon*, *Melaleuca*, and *Syzygium*, is investigated. All five species examined have similar chromosome features at mitotic interphase, prophase, and metaphase. Mitotic metaphase of their somatic cells consistently show $2n=22$, of which 18 chromosomes have centromeres at median position and four at subterminal or terminal position. *Syzygium aromaticum* has a secondary constriction in the longest pair of chromosomes as in several other related and unrelated species of the family, a fact suggesting that the presence of the secondary constriction may be of some taxonomic use.

Introduction

The Myrtaceae consists of about 144 genera and 3,000 species native to tropical and subtropical regions throughout the world (Thorne, 1992). Their infrafamilial relationships are becoming clearer but additional information on systematic characters for detailed study is needed (Johnson and Briggs, 1984). In this paper, we report on the karyomorphology of five species in three genera *Callistemon*, *Melaleuca*, *Syzygium*. The basic chromosome number of the family is $x=11$ (Raven, 1975). However our knowledge on chromosome numbers is still restricted to less than 20 per cent of the species (i.e., some 450 species of 50 genera) largely on the basis of species from Australia and India (Smith-White, 1942, 1948, 1950, 1954; Atchison, 1947; Rye, 1979). Very little information is available on chromosome morphology at metaphase, and nothing is known concerning chromosome features at interphase and prophase.

Materials and Methods

Five species in three genera *Callistemon citrinus*, *Melaleuca cajuputi*, *M. genistifolia*, *M. dealbata*, and *Syzygium aromaticum*[1] (= *Eugenia caryophyllus* [Sprengel] Bullock

[1]Fourty species of "*Eugenia*", all or most of which have synonyms under the generic name *Syzygium*, are reported from Singapore (Keng, 1990). Morphologically and anatomically, a primarily Old World genus *Syzygium* is now clearly distinguished from (Schmid, 1972; Tobe and Raven, 1983), and may even be distantly related to (Johnson and Briggs, 1984), *Eugenia* which is a primarily New World genus. Therefore we adopt *Syzygium aromaticuum*, a synonym under *Syzygium* of "*Eugenia caryophyllus.*" According to Bullock and Harrison (1958), "*Eugenia caryophyllata* Thunb.," a name used occasionally in other studies (Vijayakumar and Subramanian, 1985), is an illegitimate name.

& Harrison; *Eugenia caryophyllata* Thunb.) were investigated in this study. The data collected is presented in Table 1 along with their chromosome numbers. Somatic chromosomes were examined following methods presented elsewhere (Tanaka and Oginuma, 1986). Chromosome numbers and morphology at metaphase were determined using at least three to five cells of young leaves for each collection.

Table 1
Studied taxa, and their collections and chromosome numbers. Vouchers are preserved at KYO.

Species	Collection	Chromosome number
Callistemon citrinus Skeels	*Oginuma 9101*	$2n=22$
Melaleuca cajuputi Powell	*Oginuma 9103*	$2n=22$
M. genistifolia Sm.	*Oginuma 9104*	$2n=22$
M. dealbata S.T. Blake	*Oginuma & Lum 9201*	$2n=22$
Syzygium aromaticum (L.) Merr. & Perry	*Oginuma 9102*	$2n=22$

Observations

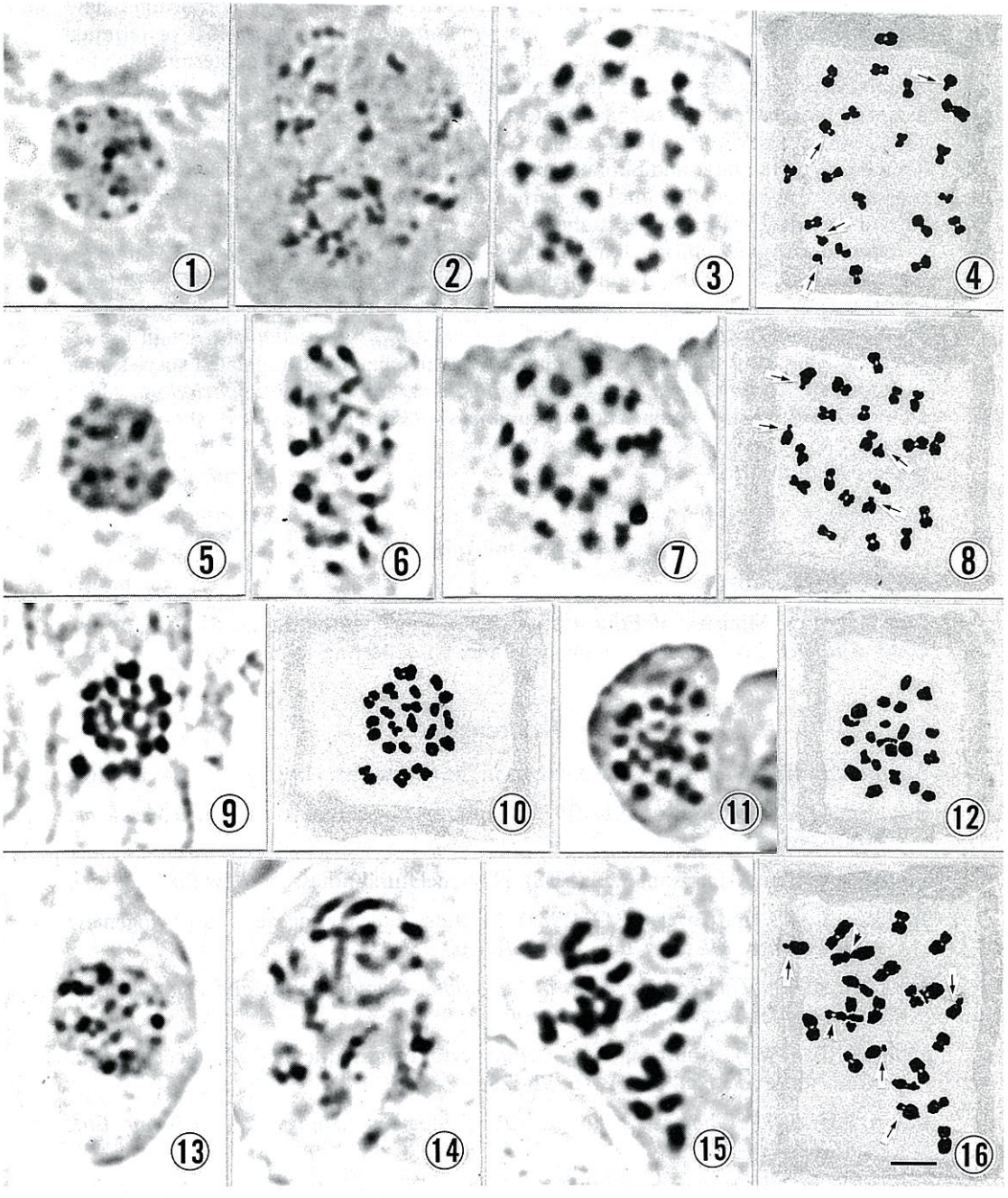
We reconfirmed the earlier report of $2n=22$ in *Callistemon citrinus* (Figs. 1–4) and *Syzygium aromaticum* (Fig. 13–16) (Smith-White, 1948; Vijayakumar and Subramanian, 1985), and further observed $2n=22$ in *Melaleuca cajuputi* (Figs. 5–8) and *M. genistifolia* (Figs. 9–10) (Brighton and Ferguson, 1976; Moussel, 1965).

Chromosomal features at both interphase and prophase are similar in all the species examined. The interphase nucleus (Figs. 1, 5, 13) has 16–20 dark-stained, condensed (heterochromatin) blocks along with chromatin threads and chromomeric granules. As such condensed blocks are fewer than the chromosome number, the nucleus is assigned to the "simple chromocenter type" as defined by Tanaka (1971, 1980). Chromosomes at prophase are differentiated by the presence of both early and late condensed segments (Figs. 2, 6, 14). In most chromosomes the early condensed segments are confined to the proximal regions of two arms, showing a clear transitional state into late condensed segments.

Chromosomes at metaphase are small and gradually vary in a range from about 1.8 μm. to about 0.3 μm. In all the species examined, except in *Melaleuca dealbata* and *M. genistifolia* whose detailed chromosome morphology are not studied, 18 of 22 chromosomes have centromeres at median position, and the remaining four at subterminal or terminal position. A secondary constriction is observed only at the proximal region of a long arm of the longest pair of chromosomes of *Syzygium aromaticum* but not in any chromosome of the other species examined. Satellite chromosomes are not observed.

Discussion

Chromosomal features are nearly consistent in all the five species of *Callistemon*, *Melaleuca*, and *Syzygium* examined. Interphase nuclei belong to the "simple chromocenter type," and chromosomes at metaphase are $2n=22$ ($x=11$) in agreement with most earlier reports on chromosome numbers of these genera. The morphology of



Figs. 1–16. Somatic chromosomes at interphase nucleus (1, 5, 13), prophase (2, 6, 14), and metaphase (3, 4, 7–21, 15, 16) in Myrtaceae. 1–4. *Callistemon citrinus* ($2n=22$). 5–8. *Melaleuca cajuputi* ($2n=22$). 9, 10. *M. genistifolia* ($2n=22$). 11, 12. *M dealbata* ($2n=22$). 13–16. *Syzygium aromaticum* ($2n=22$). Arrows point out chromosomes with centromeres at subterminal or terminal position. Arrowheads point out chromosomes with secondary constriction. Figures 4, 8, 10, 12 and 16 are drawings of respective preceding photographs. Scale = 2μm.

chromosomes at metaphase are also similar: that is, 18 of 22 chromosomes have centromeres at median position, and the remaining four at subterminal or terminal positions. The frequency of chromosomes having centromeres at subterminal or terminal position is consistently 18 per cent in the five species examined, in constrast with a higher frequency of 36 per cent in *Callistemon lanceolatus* and 36–45 per cent in three species of *Syzygium* (including *S. aromaticuum* [= *Eugenia caryophyllata* Thunb.]) (Viyayakumar and Subramanian, 1985). Such a difference in the chromosome morphology between this and the earlier observation needs confirmation in more careful observations in future studies.

Despite consistent chromosome numbers $2n=22$ in the five species of *Callistemon*, *Melaleuca*, and *Syzygium*, a conspicuous difference is found among them in the presence or absence of secondary constriction at the long arm of the longest chromosomes. Such a secondary constriction is found in *Syzygium aromaticum* but not in the remainder. This feature is also known in a few other related and unrelated species such as *Rhodomyrtus tomentosa*, *Syzygium iambolanum*, and *Eucalyptus citriodora*, which all have $2n=22$ (Vijayakumar and Subramanian, 1985). The presence of the secondary constriction in such species suggests that it may be useful in considering species or generic relationships.

Acknowledgements

The study was supported in part by a Grant-in-Aid (No. 03640591) for Scientific Research from Ministry of Education, Science and Culture, Japan to K.O. We are grateful to Mr. Tay Eng Pin for his assistance in collecting materials.

References

Atchison, E. (1947). Chromosome numbers in the Myrtaceae. *Amer. J. Bot.* 34: 159–164.

Brighton, C.A. and Ferguson, I.K. (1976). Chromosome counts in the genus *Melaleuca* (Myrtaceae). *Kew Bull.* 31: 27–32.

Bullock, A.A. and Harrison, S.G. (1958). Nomenclatural notes: IV. *Kew Bull.* 13: 409.

Johnson, L.A.S. and Briggs, B.G. (1984). Myrtales and Myrtaceae — a phylogenetic analysis. *Ann. Missouri Bot. Gard.* 71: 700–756.

Keng, H. (1990). *The Concise Flora of Singapore. Gymnosperms and Dicotyledons.* Singapore University Press, Singapore.

Moussel, B. (1965). Contribution à l'étude cytotaxinomique des Myrtacées. *Mem. Mus. Nat. Hist. Nat. Ser.* B 16: 91–125.

Raven, P.H. (1975). The bases of angiosperm phylogeny: cytology. *Ann. Missouri Bot. Gard.* 62: 724–764.

Rye, B.L. (1979). Chromosome numbers in the Myrtaceae. *Amer. J. Bot.* 34: 159–164.

Schmid, R. (1972). A resolution of the *Eugenia-Syzygium* controversy (Myrtaceae). *Amer. J. Bot.* 423–436.

Smith-White, S. (1942). Cytological studies in the Myrtaceae. I. Microsporogenesis in several genera of the tribe Leptospermoideae. *Proc. Linn. Soc. N. S. Wales* 67: 335–342.

_____. (1948). Cytological studies in the Myrtaceae. II. Chromosome numbers in the Leptospermoideae. *Proc. Linn. Soc. N. S. Wales* 73: 16–36.

_____. (1950). Cytological studies in the Myrtaceae. III. Cytology and phylogeny in the Chamaelaucoideae. *Proc. Lin. Soc. N. S. Wales* 75: 99–121.

_____. (1954). Cytological studies in the Myrtaceae. IV. The sub-tribe Euchamaelaucinae. *Proc. Linn. Soc. N. S. Wales* 79: 21–29.

Tanaka, R. (1971). Types of resting nuclei in Orchidaceae. *Bot. Mag. Tokyo* 84: 118–122.

_____. (1980). The karyotype. In, H. Kihara, Ed., *Plant Genetics.* I. pp. 335–358. Shokabo Book Co., Tokyo. (In Japanese.)

_____. and Oginuma, K. (1986). A method for the observation of chromosomes in woody plants. In, H Kitaura *et al.*, Eds., *Development of New Technology for Identification and Classification of Tree Crops and Ornamentals. Fruit Tree Research Station Reports* (Ministry of Agriculture, Forestry and Fisheries), pp. 69–72. Maeda Print Co., Tsukuba.

Thorne, R.F. (1992). An updated phylogenetic classification of the flowering plants. *Aliso* 13: 365–389.

Tobe, H. and Raven, P.H. (1983). An embryological analysis of Myrtales: its definition and characteristics. *Ann. Missouri Bot. Gard.* 70: 71–94.

Vijayakumar, N. and Subramanian, D. (1985). Cytotaxonomical Studies in South Indian Myrtaceae. *Cytologia* 50: 513–520.