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Author(s): D. Ohri and T. N. Khoshoo

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Nuclear DNA contents in the genus *Ficus* (*Moraceae*)

D. OHRI and T. N. KHOSHOO

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Abstract: Nuclear DNA contents in 15 species of large tropical hardwood genus *Ficus* have been determined by cytophotometry. The 2 C-values are rather low and uniform, suggesting no appreciable changes during speciation. The small genome size is discussed in relation to woody habit.

The pantropical genus *Ficus* comprises woody growth forms, i.e. trees, shrubs, climbers, and epiphytes. It has evolved in an extraordinary manner with its 600–1 500 species being important constituents of tropical rain forests (CONDIT 1964). The great majority of these species studied are diploid ($2n = 26$), only 8% polyploid (CONDIT 1964, HANS 1972). Besides, hybridization is very rare (REMIREZ 1970). Studies on the pollination mechanism have shown that speciation has occurred primarily in response to the variety of insect pollinators belonging to chalcidoid wasps of the family *Agaonidae* with a clear one-to-one relationship between the species of wasps and those of figs (REMIREZ 1970, 1974, 1977, STEBBINS 1974, WHITE 1978). The purpose of the present study is to find out about quantitative DNA changes at the diploid level during speciation in *Ficus*. Furthermore, DNA C-values have hitherto been studied mostly in temperate and crop plants, whereas tropical plants and particularly hardwoods have been widely ignored (BENNETT 1972, BENNETT & SMITH 1976, BENNETT & al. 1982). Besides, the nuclear DNA content has been shown to be positively correlated with the minimum cell cycle time (VAN'T HOF 1975) and minimum generation time (BENNETT 1972). Therefore, it appears worthwhile to evaluate the DNA C-values of a tropical hardwood genus like *Ficus* in terms of these parameters.

Material and methods

Root tips of *Ficus* species obtained from potted plants along with those of *Allium cepa* cv. Nasik Red were fixed in 1 : 3 acetic alcohol for two hours, washed in distilled water and hydrolyzed in 5 N HCl at room temperature (28 °C) for 1 hour. After washing for 1 minute the root tips were transferred to Feulgen solution, adjusted to pH 2.2, for one hour and given three washes of 10 minutes each in SO_2 water. The root tips were then squashed under a coverslip in glycerol. Four slides of each species were prepared, using single root tips. Forty 2 C nuclei at late telophase were read on a Vickers Microdensitometer at 565 nm. In each case means of arbitrary units were converted to picograms of DNA using the mean of an identical number of readings from *Allium cepa* root tips, processed simultaneously in the same tubes as the *Ficus* material. The 2 C value of *A. cepa* was taken as 33.5 pg (VAN'T HOF 1965). Voucher specimens of *Ficus* species are deposited in the herbarium of the National Botanical Research Institute, Lucknow.

Results and discussion

15 *Ficus* species (Table 1) were analysed for their chromosome numbers; there is agreement with the literature data (FEDOROV 1974). Except for *F. elastica* cv. Decora which is a triploid, all the others are diploid (2 n = 26). The DNA 2 C-values are rather low, ranging from 1.37 pg in *F. mysorensis* to 1.45 in *F. bengalensis*. The triploid *F. elastica* cv. Decora exhibits a 1.5-fold increase over the DNA content of *F. elastica*. The differences among diploid species are not significant ($P > 0.05$). Evidently, this shows that there is a general constancy of nuclear DNA content in all the species investigated (Table 1). Thus, speciation in this large genus has not been paralleled by appreciable changes in DNA content and despite striking differences in habit (e.g. *F. pumila* is a small climber in contrast to the other species representing large trees). This DNA stability may be linked to the fact that most *Ficus* species are members of climax vegetation and occupy stable and favourable habitats in tropical rain forests under comparatively uniform climatic conditions (STEBBINS 1966, 1974, ASHTON 1969, LEVIN & FUNDERBURG 1979).

The rather small genome size found in species of *Ficus* is as expected because hardwoods are known to possess small sized chromosomes (MEHRA 1976). Why woody dicots exhibit such small nuclear DNA contents is still uncertain; as a constant feature it must be of a highly adaptive value. This becomes relevant in

Table 1. 2 C Nuclear DNA contents in *Ficus*, using *Allium cepa* as a standard

Taxon	2n	2 C DNA $\bar{x} \pm$ S.E. (pg)
Ficus amplissima J. E. SM.	26	1.44 ± 0.02
F. bengalensis L.	26	1.45 ± 0.03
F. benjamina var. *comosa* KURZE	26	1.43 ± 0.02
F. carica L.	26	1.41 ± 0.01
F. elastica ROXB.	26	1.44 ± 0.04
F. elastica cv. Decora	39	2.12 ± 0.05
F. krishnae DC.	26	1.47 ± 0.01
F. mysorensis HEYNE	26	1.37 ± 0.02
F. pandurata HANCE	26	1.44 ± 0.03
F. pumila L.	26	1.38 ± 0.01
F. racemosa L.	26	1.44 ± 0.02
F. religiosa L.	26	1.41 ± 0.03
F. retusa L.	26	1.39 ± 0.02
F. rumphii BL.	26	1.38 ± 0.03
F. trigonata L.	26	1.43 ± 0.01

comparison with herbaceous angiosperms (BENNETT 1972) or gymnosperms (EHRENDORFER 1976, OHRI & KHOSHOO 1986). A possible explanation is proportionality between nuclear and cell size (PRICE & al. 1973), which means that a check is likely to be exercised by the smallest cells in the life of a plant. In woody dicots these are cambial cells which i.a. form wood fibres (see DARLINGTON 1937, STEBBINS 1950, KHOSHOO 1962). In contrast, however, MEHRA & BAWA (1969) have reported the presence of polyploid series in many woody taxa "which seem to tolerate different cell/nucleus ratios". Furthermore, the positive correlation between minimum generation time and DNA content as found in herbaceous angiosperms (BENNETT 1972) does not apply to woody angiosperms. The problem obviously lies in the genetical nature of what is called "secondary DNA" (HINEGARDNER 1976) in relation to particular eco-developmental attributes of woody in contrast to herbaceous angiosperms. Certainly, more informations are needed for further conclusions.

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Authors' addresses: Dr D. OHRI, Cytogenetics Laboratory, National Botanical Research Institute, Lucknow 226001, India. – Dr T. N. KHOSHOO, Distinguished Scientist CSIR, Tata Energy Research Institute, 7, Jor Bagh, New Delhi 110003, India.