Karyomorphological Studies on Three Species of *Cladophora* Kütz

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Recorded investigation on the chromosome number in the genus *Cladophora* Kütz. was initiated as early as 1910 by Nemec and since then a number of contributions have been made from time to time (cf. Foyn 1930, Higgins 1930, Schussnig 1930, 1938 and 1954, Geitler 1936, Sinha 1958, 1963, 1965 and 1968, Balakrishnan 1961, Patel 1961, and Verma 1969 and 1982). The chromosome numbers in 37 species belonging to this genus are known till to this time. In the present communication, the chromosome number has been reported for three species of *Cladophora* viz. *C. crystalina*, *C. intermedia* and *C. crispata*. Of the three, first two are new records. The present count in the last named species differs from the previous report made by Sinha (1958).

The previous works on the nuclear cytology of this genus are concerned only with the chromosome number. Patel (1961) has, however, reported the dimension of the chromosomes irrespective of centromeric position in 11 species of *Cladophora*. Therefore the karyotype study in this genus is altogether wanting. In order to make contributions along this line, karyotypes of the investigated three species have been worked out.

Materials and methods

Above noted three species of *Cladophora* have been collected from different corners of Bihar (cf. Verma 1981).

Fixations of the vegetative filaments were made on the collection spots during morning hours (between 8-10 AM) in acetic-ethanol (1 : 1). Iron-alum-aceto-carmine method (cf. Godward 1948) was adopted for cytological preparations.

TF% was calculated as given by Huziwara (1962). Coefficient of variation among the chromosomes of a karyotype and total chromatin length was computed as per Verma (1980).

Observation

The interphase nuclei in three species of *Cladophora* at hand seem identical being spherical and surrounded by a distinct nuclear membrane. The number of nuclei per cell and their diameter however, vary from each other (cf. Table 1). Presence of densely stained spherical nucleolus in the nuclei and darkly stained elongated chromocenter-like bodies in association with the former or anywhere in the

nuclear cavity have been noted as the common feature of all the three species under study. The number of nucleoli as well as of chromocenter-like bodies recorded for each species may be seen in the Table 1.

At the onset of prophase, nuclei become almost double of its original diameter

Figs. 1-3. Somatic chromosomes at metaphase. 1, *C. crystalina* $2n=24$ ($\times 1900$). 2, *C. crispata* $2n=36$ ($\times 3200$). 3, *C. intermedia* $2n=48$ ($\times 2500$). By the side of Fig. 1 and below the Figs. 2 and 3 are their outline drawings.

and further events of mitosis are accomplished in typical mitotic pattern. The number of chromosomes for each of the three species have been ascertained at metaphase (cf. Table 2 and Figs. 1-3). The length of the chromosomes with respect to the centromeric position has been measured and from this total chro-

matin length, TF% and coefficient of variation among the chromosome complements (C.V.) have been computed to characterise each of the three karyotypes (cf. Table 2). Also the idiograms of each karyotype have been made out (Figs. 4-6).

Table 1.

Name of the species	Nucleus		No. of nucleoli	No. of chromocenter-like bodies
	No. per cell	Diameter in μm		
1 <i>C. crystalina</i> (Roth.) Kütz.	45-70	5.5-6.0	1	1
2 <i>C. crispata</i> (Roth.) Kütz.	8-14-45	3.5-5.0	1-2	1-2
3 <i>C. intermedia</i> Fosl.	10-90	6.0-7.5	1-2	1-2

Figs. 4-6. Idiograms. 4, *C. crystalina*. 5, *C. crispata*. 6, *C. intermedia*.

Table 2.

Name of the species	Chromosomes		Total chromatin length	TF%	C.V.
	Number	Length in μm (Range)			
1 <i>C. crystalina</i> (Roth.) Kütz.	24	2.0-3.0	57.8	20.59	18.86
2 <i>C. crispata</i> (Roth.) Kütz.	36	2.3-6.1	143.8	31.71	29.36
3 <i>C. intermedia</i> Fosl.	48	1.6-4.6	113.8	43.93	37.57

Discussion

The number of nuclei in a cell has been recorded highest for *C. intermedia* and the lowest for *C. crispata*. Similarly the diameter of the interphase nuclei has been noted highest and lowest in the same two species respectively (cf. Table 1). Therefore, the direct relationship between the number of nuclei per cell and the diameter of the nuclei seem to exist. Further, *C. intermedia* in which the chromosome number has been ascertained as 48, the nuclei are comparatively smaller than those of

C. crystalina and *C. crispata* in which the chromosome numbers are 24 and 36 respectively (cf. Table 2). This fact goes against the conclusion drawn by Sinha (1958 and 1968) that the polyploids have bigger nuclei than the diploids in the species of *Cladophora*.

The number of nucleoli has been observed one for *C. crystalina* while it has been scored upto two for *C. crispata* and *C. intermedia* (cf. Table 1). Geitler (1936) and Sinha (1958) have indicated an association of single nucleolus with a set of 12 chromosomes in *C. fracta* and *C. refracta* respectively.

Observed association of chromocenter-like body with the nucleolus may be regarded as the nucleolar organizer region of the chromosome (cf. Sinha 1958, Noor 1965 and Verma 1969).

The chromosome numbers 24 and 48 have been ascertained for *C. crystalina* and *C. intermedia* respectively. There appears to be no literature on the chromosome number in the said two species, and hence the present two counts are the new records. The present count of $2n=36$ in *C. crispata* is a new addition to the species against the previous report of $2n=24$ (cf. Sinha 1958), and is of rare occurrence (cf. Godward 1966) being reported for the first time among the fresh water forms. Patel (1961) has, however, reported this count in one marine form of *C. pellucida*.

Previously reported chromosome numbers in the genus *Cladophora* fall under the range 12–144, in the multiple of six (cf. Godward 1966, Sinha 1958, Patel 1961, Balakrishnan 1961, Verma 1982). Schussnig (1954) proposed a basic number 12 for this genus. Godward (1966) asserted "the Cladophorales would seem to have an undoubted basic number (6)". Setting aside all the speculations, Sinha and Ahmad (1971) have confirmed the basic number 6 for this genus after reporting $n=6$ in *C. uberima* Lambert. Present three counts viz. 24, 36 and 48 further confirm the polyploid series in multiple of 6 for this genus.

The chromosome length in three species has been recorded between 1.5–6.2 μm (cf. Table 2) which further strengthen the reported range of chromosome length (1.5–6.7 μm) for this genus (cf. Godward 1966).

The TF% and coefficient of variation (C.V.) have been recorded in increasing series along with the increase in the chromosome number (cf. Table 2). Therefore, it may be concluded that not only the euploidy has played a significant role in this genus, rather the chromosomal differentiation also. It may be further suggested that on the basis of TF% and C.V. any conclusion concerning the relative primitiveness or advancement among the investigated three species is difficult to draw. On the one hand, the lowest TF% in *C. crystalina* advocates its advancement over the rest two, *C. intermedia* with highest C.V. may be regarded as the most advanced on the other. It may, therefore, be presumed that the karyotypic evolution in the genus has not taken place along a single line and that the karyotype of presently investigated three species belong to different evolutionary lines. The higher chromatin length in *C. crispata* ($2n=36$) as compared to *C. intermedia* ($2n=48$) further supports the above conclusion.

Summary and conclusions

Chromosome numbers 24 and 48 have been ascertained in *C. crystalina* and *C. intermedia* respectively which bear no previous report. In *C. crispata*, a count of 36 chromosomes has been ascertained by the author which is a new addition against the previous report of $2n=24$.

Karyotype analysis has been made for the first time in the above noted three species. On the basis of total chromatin length, TF% and coefficient of variation among the chromosome complements, it has been concluded that the three worked out karyotypes belong to three different evolutionary lines.

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