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F_1 HYBRIDS OBTAINED FROM *HIBISCUS CANNABINUS* × *H. RADIATUS*, WITH REFERENCE TO THE GENOME RELATIONSHIP

(Studies on interspecific and intergeneric hybridization in the Malvaceae XV)

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Hibiscus cannabinus × *H. radiatus* の F_1 植物

(アオイ科の種，属間雑種に関する研究 XV)

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Reciprocal crosses were made between *H. cannabinus* (2n=36) and *H. radiatus* (2n=72). An F_1 plant was obtained only when *H. cannabinus* was used as the female parent. The F_1 plant grew vigorously and was totally sterile. In pollen mother cells, $18_{II}+18_I$ was most freguently observed. Judging from these results, the tetraploid species, *H. radiatus*, contains one genome which is homologous with that of *H. cannabinus* and another genome which is not.

H. cannabinus (2n=36) と *H. radiatus* (2n=72) との相反交雑では，前者を母親にした場合のみ，交雑が成功した。F_1 は著しく雑種強勢を示したが，完全に不稔であった。F_1 植物の体細胞の染色体数は 2n=54 で，成熟分裂では大部分の細胞が $18_{II}+18_I$ を示した。したがって，*H. radiatus* には，*H. cannabinus* と相同のゲノム1つと，全く非相同のゲノム1つを有すると推定した。

Introduction

Studies of the chromosome number of *H. cannabinus* and *H. radiatus* have been made by SKOVSTED (1944)[10], TOXOPEUS (1947)[12] and TJIO (1948)[11], and these two species were found to be 2n=36 diploid and 2n=72 tetraploid, respectively. Several studies of the interspecific hybridization between these two species have been made, investigating the elongation of pollen tube in reciprocal crossing[8], their crossability[10,12,1], the genome relationship[9,7,3,4,5,6].

The interspecific hybridization of *H. acetosella* (2n=72) and *H. cannabinus* (2n=36) has been reported previously[2] as a series of studies on the interspecific and intergeneric hybridizations in the Malvaceae. The present paper reports the results of the hybrid of *H. cannabinus* × *H. radiatus*, and some considerations will be also given to their genome relationship.

Materials and Methods

The materials used in this study were three cultivars of *H. cannabinus*, "Hyderabat" (No. 2), "Ariyabas" (No. 5) which were obtained from Indian Agricultural Research Institute, "Tashikent" (No. 6) which was maintained in our laboratory, and one cultivar of *H. radiatus* which was obtained from Florida State University, Tallahassee, Florida, U. S. A.

Plants for crossing, with the exception of "Tashikent" (No. 6), were grown in a green house under a short-day treatment. Emasculation was made in the afternoon before the opening

of flowers. Crosses were made by touching the stigma with the staminal column of the pollen parent.

Buds for cytological study were peeled to expose the staminal column, fixed in fresh acetic alcohol and stored in a refrigerated 70% alcohol solution. Meiotic and mitotic chromosomes were studied by temporary acetic orcein squash of PMC's and of root tips, respectively.

Results and Discussion

1. Crossing

The data for reciprocal crosses between *H. cannabinus* and *H. radiatus* are given in Table 1.

Table 1. Results of reciprocal crosses between *H. cannabinus* and *H. radiatus*

Cross	Year	No. of flowers crossed	No. of pod set	Pod set %	No. of seeds obtained a	b	c	No. of seeds per pod	sown	germinated	Germination %
	1969	4	0	0.0	—	—	—	—	—	—	—
H. cannabinus	1970	18	8	44.4	36	0	0	4.5	36	1	0.03
×	Total										
H. radiatus	or Mean	22	8	36.4	36	0	0	4.5	36	1	0.03
	1969	10	1	0.0	0	0	0	0.0	—	—	—
H. radiatus	1970	36	7	19.4	0	38	39	11.0	77	0	0.00
×	Total										
H. cannabinus	or Mean	46	8	17.4	0	38	39	9.6	77	0	0.00

a: Viable seeds (large)
b: Immature seeds with a small embryo (medium)
c: Shrunken immature seeds (extremely small)

Although the number of flowers used in crossing was small, the percentage of pod setting for *H. cannabinus* × *H. radiatus* was higher than for the reciprocal cross. A number of large viable seeds were obtained from *H. cannabinus* × *H. radiatus*, but from the reciprocal cross, the only seeds obtained were either medium and immature, with a small embryo, or small, shrunken and immature.

The germination of the F_1 seeds obtained from reciprocal crossing was very poor, and only one seed obtained from *H. cannabinus* × *H. radiatus* germinated, consequently only one F_1 plant from this cross combination was obtained. The cause of the poor germination of F_1 seeds obtained from the reciprocal crossing remains unknown, but seems to be due to the genetical differences of the chromosomes and genomes of the parent plants.

The results of crossing experiments are summarized in Table 2. The success of this species-crossing differs with different investigators, that is, there some authors who succeeded in crossing in both directions, with only a difference in the degree of difficulty experienced, depending on the cross direction, while there are some authors who succeeded in crossing in only one direction.

2. Characteristics of F_1

The charateristics of the F_1 plant are compared with those of the parents in Table 3. The F_1 and its parents are shown in Fig. 1. The F_1 plant grew vigorously, showing heterosis. It was taller, had more nodes and branches and larger leaves and a bigger stem than its parents.

Table 2. Crosses between *H. cannabunus* and *H. radiatus*

Cross and authority	Crossing	Fertility
H. cannabinus × *H. radiatus*		
Skovsted (1944)	Unsuccessful (empty seed)	—
Toxopeus (1949)	Unsuccessful (embryos immature)	—
Sanyal & Kundu (1959)	Unsuccessful	—
Ghosh & Sanyal (1960)	Successful (easily)	—
Rakshit et al. (1961)	Successful	Extremely poor
Menzel & Wilson (1961)	Easy	Fairly fertile
Menzel & Wilson (1969)	Successful	—
Present study	Successful	Almost complete sterile
H. radiatus × *H. cannabinus*		
Skovsted (1944)	Easy	Sterile
Toxopeus (1949)	Difficult	F_2 and F_3 obtained
Sanyal & Kundu (1959)	Successful	Highly sterile
Ghosh & Sanyal (1960)	Successful*	—
Rakshit et al (1961)	Successful**	Extremely poor
Menzel & Wilson (1961)	Easy	Fairly fertile
Menzel & Wilson (1969)	Successful	—
Present study	Unsuccessful (embryo immature)	—

*: More easily than the reciprocal

**: The percentage of pod setting was more than the reciprocal

Table 3. Characteristics of F_1 and parent plants

Characteristics	*H. cannabinus*	F_1	*H. radiatus*
Plant height (cm)	180.0	256.0	181.0
Stem	Green Prickles 0	Green Prickles a few	Green Prickles a few
Petiole	Green Prickles 0	Green, partially light red-purple, light red-purple prickles a few	Green, partially light red-purple, red-purple prickles a few
Lamina	5 deeply palmately lobed, margin serrated, Green	3 — 7 deeply palmately lobed, margin deeply serrated, Green with light red-purple margin	5 deeply palmately lobed, margin deeply serrated, Green with red-purple margin

The green stem color and green leaf color of the F_1 plant was the same as it's parents'. The colors of the leaf margin and petiole of the F_1 plant resembled the *H. radiatus* in which they are light red-purple, while those of *H. cannabinus* are green. The F_1 plant has a few prickles on the petiole resembling *H. radiatus*.

The leaf shape of the F_1 plant was intermediate between it's parents, but the width of lamina of the F_1 leaves were somewhat wider than average value of it's parents'. The lamina width of *H. cannabinus* is narrow while that of *H. radiatus* is comparatively broad. At an early stage

Fig. 1. F_1 hybrid and parent plants
a: *H. cannabinus*
b: F_1
c: *H. radiatus*

in the first year of growth the young leaves at the upper part of the F_1 plant were 5-lobed, but at the lower part 3-lobed, resembling to *H. radiatus*.

3. Chromosome numbers and meiosis of the F_1 plant

The chromosome numbers in root tips of *H. cannabinus*, *H. radiatus* and their F_1 hybrid were 2n=36, 2n=72 and 2n=54, respectively. The parental species showed regular meiosis in the PMC's at MI. The F_1 plant showed $18_{II}+18_{I}$ configurations mostly in the PMC's at MI. Furthermore the cells of uni-, tri- and quadrivalent chromosomes were also observed. The highest and lowest number of bivalent chromosomes was 18 and 16, respectively.

The pollen fertility of the F_1 plant was extremely low at 22.09%, and the seed was completely sterile. The diameter of pollen grains in the F_1 plant varied widely ranging 117.0 μ — 175.0 μ, while those of *H. cannabinus* and *H. radiatus* were 130.0 μ and 136.5 μ, respectively.

Judging from the above-mentioned results, the tetraploid species, *H. radiatus*, contains one genome which is homologous with that of *H. cannabinus* and another genome which is not.

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