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On the cause of seed failure or seed setting in 4n wild *Corchorus capsularis* L. x 2n wild *C. capsularis* L. and 4n wild *C. olitorius* L. x 2n wild *C. olitorius* L. and their reciprocals through cytogenetical studies.

INTRODUCTION

After the partition of India in 1947, the Botany Division of the Jute Agricultural Research Institute at Hoogly crossed 2n C.G. x 4n C.G. (a cultivated strain of *C. olitorius*) and raised the population of auto-triploids in 1949. Their cytogenetical analyses were not done till 1953 when PATEL and DATTA (in press) took up the problem. They stated that the chromosome numbers of the population of 2n C.G. x 4n C.G. varied from 20 to 35. The female parent showed normal meiosis (7 II) and the occurrence of such aneuploid, euploid and pentaploid plants in addition to the expected triploids (3n = 21) was, therefore, naturally due to the functioning of the numerically unbalanced gametes from the pollen parent. Chromosome pairing was found to vary much. The mean number of various combinations of chromosomes per p.m.c. in the triploids was 2.48 I, 4.64 II, 0.58 III, 1.60 IV and 0.064 fragments. Univalents and laggards were very common in the first division. Multispindles, bridges and elimination of chromosomes in the cytoplasm were noticed in both the divisions. The ultimate distribution of the chromosomes to the spindle poles was very haphazard. About 20% of the tetrads wer with one or more micronuclei in them besides four microspores and with monads to octads with or without

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micronuclei. The potentially viable pollen grains varied from 46 to 81% in different plants; their sizes also varied greatly. The abnormal meiotic pairing and the subsequent irregular behaviour of chromosomes resulted in the production of un-balanced gametes adversely affecting the fertility of 2n x 4n population. Most of the seeds were shrivelled. The induction of colchiploids in the wild types of both the species were done in 1953 and their cytogenetical analysis was completed by them. In order to find out the pollen and the egg fertility of the wild as well as the cultivated colchiploids they crossed the following in 1955 and 1956 and obtained the followings results:

		No. of full seeds.
4n C.G. x 2n C.G. (Cultivated *olitorius* strain)		0
2n C.G. x 4n C.G. (Cultivated *olitorius* strain)		15 and 34
4n D154 x 2n D154 (Cultivated *capsularis* strain)		0
2n D154 x 4n D154 (Cultivated *capsularis* strain)		0 and 2
4n wild *olitorius* green (a wild type)	2n wild *olitorius* green	2 and 2
2n wild *olitorius* green (a wild type)	4n wild *olitorius* green	168 and 140
4n wild *capsularis* (Kulkarni Gr. 5 — a wild type)	2n wild *capsularis* (Kulkarni Gr. 5)	0 and 0
2n wild *capsularis* (Kulkarni Gr. 5 — a wild type)	4n wild *capsularis* (Kulkarni Gr. 5)	0 and 0

The crossing results in case of cultivated strains show that full seeds obtained were a few and they somewhat varied in size. In case of 2n ♀ x 4n ♂ (*olitorius*) seeds obtained germinated. But in case of 2n ♀ x 4n ♂ (*capsularis*) 2 seeds obtained in 1956 did not germinate at all. Full seeds obtained were a few in case of 4n wild *olitorius* green x 2 wild *olitorius* green but a good number of seeds was obtained in its reciprocal. In case of wild *capsularis* strain 4n and 2n crosses reciprocally failed

to produce any seeds. As the seeds were handed over to the Jute Agricultural Research Institute, their germination capacities were not studied by them.

In order to have a preliminary idea whether crossability of autotetraploids with their corresponding diploids reciprocally is feasible, the present work was undertaken in 1958 Jute Season.

MATERIALS AND METHODS

Seeds of 2n and 4n wild *Corchorus olitorius* (Green) and 2n and 4n wild *Corchorus capsularis* (Kulkarni Grade 5) were obtained from the collections of Sri R.M. Datta. They were sown in separate pots and kept in the Department of Agriculture, Calcutta University for further studies.

Flowers were carefully emasculated in the previous afternoon with a finely pointed loose sterile forceps and bagged with cellophane paper bags. Next morning the bags were removed and after pollination the emasculated flowers were rebagged and labelled.

One week after pollination the bas were removed and records were taken as to whether the flowers had set pods or fallen in the bags. Every set pod was then labelled. Each week the set pods were checked individually whether they are continuing to grow or had fallen off. In these crosses, the number of flowers pollinated, the number of pods set and harvested, were recorded. The cross pods were harvested after their full maturity. The seeds were extracted podwise; they were then classified as to full and shrivelled seeds and their percentages were calculated. Normal-looking full seeds when obtained were weighed and compared with the same number of seeds of their female parent taken randomly from the bulk of the selfed seeds.

For studying cytogenetical aspects some cross pods (from each group) were fixed in Navashin's fixative at 1, 2 and 3 days.

They were then dehydrated in ethyl alcohol series and the paraffin schedule was followed.

Sections were cut at 10-12 μ thick and stained in Haidenhain's haematoxylin to see the details of the fertilization processes.

OBSERVATIONS

In case of 2n wild *olitorius* green ♀ x 4n wild *olitorius* green ♂ the egg is observed unfertilized and no trace of pollen is noticed in the micropyle of the ovule (Fig. 1) in 1 day. In 2 days the pollen tube is seen discharging two sperms. One is observed near the egg and the other is seen near the polar nuclei (Fig. 2). Polar nuclei fuse first and the secondary nucleus gets fertilized later or they simultaneously fuse to form the primary endosperm nucleus. The size of the egg is oftentimes observed to be bigger than the polar nuclei. Shape of the sperms varies in course of migration. Sometimes it is round; sometimes it is elliptical. In 3 days double fertilization is complete but two nucleoli persist in the egg and three in the secondary nucleus (Fig. 3). Later complete fusion takes place and the fertilized egg is swollen a little (Fig. 4).

In case of its reciprocal (4n wild *olitorius* green ♀ x 2n wild *olitorius* green ♂) the egg is observed to be unfertilized and there is trace of pollen tube in the micropyle of the ovule (Fig. 5) in 1 day. In 2 days the unburst pollen tube is clearly observed in the embryosac (Fig. 6). Here the egg is observed in the embryosac to be much bigger in size than the polar nuclei. In 3 days the egg is fertilized and it swells much (Fig. 7). Here double fertilization is also found to be complete.

In case of 2n wild *capsularis* (Kulkarni Grade 5) ♀ x 4n wild *capsularis* (Kulkarni Grade 5) ♂ in 1 day the pollen tube is observed to be entering the embryosac but it does not burst. The egg is found to be intact (Fig. 8). In 2 days the tip of the pollen tube swells but it is still in unburst condition. Polar nuclei lie side by side and the egg is bigger than the polar nuclei (Fig. 9). In 3 days fertilization takes place but it is a little bit slower when compared to 2n wild *olitorius* green ♀ 4n *olitorius* green ♂ and its reciprocal (Fig. 10).

TABLE IA

Summary of the reciprocal crosses between 4n wild *olitorius* green and 2n wild *olitorius* green and also the selfing of the respective parents.

| Cross | | No. of flowers pollinated | No. of pod set | % of pod set | No. of pod harvested | % of pods harvested | Nature of seeds. | | % of seeds | |
Parent ♀	Parent ♂						Non-full	Full	Non-full	Full
4n (.01 gm)	2n	42	6	14.3	4	66.6	51	4 (.005)	91.4	7.2
2n (.02 gm)	4n	40	13	32.5	10	76.9	89	12 (.015)	88.2	11.8
4n	4n	45	20	44.4	16	80.0	321	246	56.7	43.3
2n	2n	40	36	90.0	34	94.4	21	1221	1.8	98.3

TABLE I B

Summary of the reciprocal crosses between 4n wild *capsularis* Kulkarni Grade 5 and 2n wild *capsularis* Kulkarni Grade 5 and also the selfing of the respective parents.

Cross		No. of flowers pollinated	No. of pods set	% of pods set	No. of pods harvested	% of pods harvested	Nature of seeds		% of seeds	
Parent ♀	Parent ♂						Non-full	Full	Non-full	Full
4n	2n	36	0	0	0	—	—	—	—	—
2n (.015 gm)	4n	45	11	24.4	6	54,5	78	3 (.005 gm)	96,2	3.7
4n	4n	35	0	0	0	—	—	—	—	—
2n	2n	40	36	90	32	88.8	18	814	2.1	97,8

4n and 2n wild *olitorius* green.

Cross		Mean No. of days taken from pollination to maturity of pods.	Mean length of pod in cm.	Mean lenght of seed bearing portion. (cm.).
Parent ♀	Parent ♂			
4n	2n	44	4.5	3.6
2n	4n	40	5.6	4.8
4n	4n	36	4.6	3.8
2n	2n	35	5.7	4.9

TABLE IIIA

4n and 2n wild *olitorius* green.

Plants	Average No. of ovules in a pod.	No. of seeds per gramme
4n	116	482
2n	200	656

TABLE IV A

4n and 2n wild *olitorius* green.

Analytical data showing the important developmental changes inside the ovule up to 3 days after polination.

Items of study	4n ♀ x 2n ♂ cross.	2n ♀ x 4n ♂ cross.	4n ♀ x 4n ♂ cross.	2n ♀ x 2n ♂ cross.
1. Percentage of normal ovule.	32.5	44	62	86.5
2. Percentage of abnormal (shrivelled) ovule	67.5	56	38	13,5
3. Percentage of entrance of pollen tube through micropylar end.	13	21	42	73
4. Percentage of fusion of egg cell and sperm or a tendency to fuse.	4	12	34	62
5. Percentage of fusion of polar nuclei and sperm or a tendency to fuse.	—	2	6	16
6. Percentage of presence of pro-embryo or embryo.	—	—	—	—
7. Percentage of initiation of formation of endosperm.	—	—	—	2

TABLE II B
4n and 2n wild *capsularis* Kulkarni Grade 5

Cross		Mean No. of days taken from pollination to maturity	Mean length of pod in cm.	Mean length of seed bearing portion (cm.).
Parent ♀	Parent ♂			
4n	2n	After crossing ovaries fell down after one day.	—	—
2n	4n	46	0.85	0.65
4n	4n	After crossing ovaries fell down after one day.	—	—
2n	2n	44	0.92	0.65

TABLE III B
4n and 2n wild *capsularis* Kulkarni Grade 5

Plants	Average No. of ovules in a pod.	No. of seeds per gram.
4n	44	466
2n	50	532

TABLE IV B
4n and 2n wild *capsularis* Kulkarni Grade 5
Analytical data showing the important developmental changes inside the ovule up to 3 days after pollination.

Items of studies	Cross		Cross	
	2n ♀ x 2n ♂	2n ♀ x 4n ♂	4n ♀ x 2n ♂	4n ♀ x 4n ♂
1. Percentage of normal ovule	—	16	—	92
2. Percentage of abnormal ovule (shrivelled).	—	84	—	8
3. Percentage of entrance of pollen tube through micropylar end.	—	12	—	64
4. Percentage of fusion of egg cell and sperm or a tendency to fuse.	—	2	—	46
5. Percentage of fusion of polar nuclei and sperm or a tendency to fuse.	—	—	—	16
6. Percentage of presence of proembryo and embryo.	—	—	—	—
7. Percentage of presence of initiation of formation of endosperm.	—	—	—	—

In case of 4n wild *capsularis* (Kulkarni Grade 5) ♀ x 2n wild *capsularis* (Kulkarni Grade 5) ♂ the ovary falls in the bag within 24 hours and no further study could be made.

Table IA shows the summary of the reciprocal crosses between 4n and 2n wild *olitorius* green. In the case of 4n ♀ x 2n ♂ only 4 seeds were obtained which are underweighed when compared to the same number of seeds taken at random from the pistillate parent. In the case of 2n ♀ x 4n ♂ 12 seeds were obtained but they were also under-weighed. From Table IIA it is clear that the mean number of days taken from pollination to maturity of pods is more in 4n ♀ x 2n ♂ than in 2n x 4n. When this is compared, it is observed that the maturity takes place a few days earlier in the case of the pistillate parents, both 4n and 2n. Table IIIA shows the comparative number of ovules and seeds per gramme in 4n and 2n materials.

The 4n pods being shorter contain less number of ovules. Seeds being bigger, their number is less per gramme.

Table IVA shows that the percentage of entrance of the pollen tube through the micropyles is less in 4n ♀ x 2n ♂ than in 2n ♀ x 4n ♂. It is also clear that normal ovules are less in 4n mother and fertilization is much less.

Table IB shows the summary of reciprocal crosses between 4n wild *capsularis* (Kulkarni Grade 5) and 2n wild *capsularis* (Kulkarni Grade 5). In case of 4n ♀ x 2n ♂ wild *capsularis* no pod set; consequently no full seeds were obtained. Ovaries fall down in course of 24 hours. In case of 2n ♀ x 4n ♂ only 3 seeds obtained which were also underweighed. It is noteworthy to observe that in case of 4n ♀ x 4n ♂ no pod set last year. PATEL and DATTA (in press) stated that pod set was quite heavy in 4n wild *capsularis* but only a few seeds were obtained in 4n selfed cases which, however, germinated to become 4n plants (out of 529 pods average per plant, only 9.1 full seeds were obtained). It was with great care that this generation is being continued.

Table IIB shows that the ovaries fell down after 24 hours in the case of 4n ♀ x 4n ♂ and 4n ♀ x 2n ♂ crosses. But it is clear that more days are taken from pollination to maturity of pods in case of 2n ♀ x 4n ♂ than the normal (2n ♀ x 2n ♂).

Pods of 4n are a little larger and much thicker than those of 2n. Table IIB shows the formation of less number of ovules in 4n material. Seeds being bigger in size their number is less per gramme.

Table IVB shows that the percentage of entrance of the pollen tube through micropyles is less in 2n ♀ x 4n ♂ than in 2n ♀ x 2n ♂. As fertilized ovaries fall away within 24 hours, 4n x 2n and 4n x 4n, no data can be recorded.

DISCUSSION

With a view to determine the pollen and the egg fertility of the autotetraploids of the cultivated and the wild types of both the jute species (*C. olitorius and C. capsularis*), PATEL and DATTA (in press) calculated after crossing reciprocally 2n x 4n the pollen and egg fertility percentage of 4n and 2n C.G. (Cultivated *olitorius*), 4n and 2n D154 (Cultivated *capsularis*), 4n and 2n wild *olitorius* green and 4n and 2n wild *capsularis* (Kulkarni Grade 5) for two successive years (1955-56). Percentage of ovule set was found to be quite less below 7 per cent in 1955 and below 14 per cent in 1956 — in all the autotetraploids. Germination of pollen was observed to be always much lower in all the 4n's than in their correspondig 2n's. The high sterility of the pollen and the egg of all these 4n's is supposedly due to the production of mostly unfunctioning gametos of variable chromosome numbers as a consequence of irregular meiosis as exhaustively studied by them. A wide range of variability in the size of 4n pollen with much lower germination points out this fact.

The crossing results (1955 and 1956) of these authors will be illustrative in this connection.

		Total No. of seeds	No. f full see
4n wild *olitorius* green	× 2n wild *olitorius* green	430 (1955)	2
		548 (1956)	2
2n wild *olitorius* green	× 4n wild *olitorius* green	472 (1955)	168
		810 (1956)	140
4n wild *capsularis* (Kulkarni Grade 5)	× 2n wild *capsularis* (Kulkarni Grade 5)	40 (1955)	0
		12 (1956)	0
2n wild *capsularis* (Kulkarni Grade 5)	× 4n wild *capsularis* (Kulkarni Grade 5)	21 (1955)	0
		0 (1956)	0

These results tally with our findings obtained during 1958. The present authors are unable to ascribe any definite reason for failure of full-seed formation especially in 4n x 2n reciprocal crosses in case of wild *capsularis* (Kulkarni Grade 5). In certain plants, e.g., *Phelum, Stellaria, Vicia,* etc. reciprocal crossings between 4n and 2n have resulted in seed failure. It is very likely that they are incompatible in both directions as MUNTZING (1935) has shown.

WATKINS (1932) and MUNTZING (1932) discussed this subject in exhaustive details and listed a few similar cases where seed formation of seed failure took place between 2n and 4n crosses and *vice versa.*

RENNER (1939) obtained triploids (*Semigigas* plants) in *Oenothera* easily formed as a result of crossing 2n x 4n but reciprocally seed formation was small and seeds did not germinate. In *Oenothera* crosses endosperm and embryo had the same chromosome number because of the presence of one polar nucleus. JOHNSON (1945) was successful in getting viable seeds in 2n x 4n *Populus tremula* but the reciprocal crossing was not done. RASMUSSON (1948) obtained triploids in both 2n x 4n and 4n x 2n sugar beet. MORINGA and KURIVAMA (1951) reported to have obtained triploids from the cross between 2n and 4n rice by using various time intervals between emasculation and pollination. CUA (1952) observed fertilization to occur in 2n x 4n and 4n x 2n rice. Later disintegration of endosperm followed by collapse of embryo results in shrivelled nonviable seed. Nevertheless triploid plants were occasionally obtained from such matings. PANDEY (1955) noticed that in 2n x 4n *Trifolium pratense* fertilization was generally poor to a lesser extent. Embryo development was slow at first but grew rapidly later. By so doing it simply hastened its own death by drawing too fast upon the slow-growing resources of endosperm.

On the contrary, JORGENSEN (1928) did not definitely say that 2n x 4n crosses in *Solanum lycopersicum* and *Solanum nigrum* failed. According to BUCHOLZ and BLAKESLEE (1929) the relation of pollen tube: style in diploid ♀ x tetraploid ♂ *Datura* is 1: less than 2. So growth was poor and a large proportion of tubes burst. It has been a general experience of LINDSTROM and HUMPHREY (1933) and NILSON (1950) that 4n x 2n and its reciprocal crosses in tomato were very difficult to

effect, though JORGENSEN (1928), UPCOTT (1935) and RICK (1956) were successful in deriving 3n seedlings from the cross 4n x 2n. RICK (1956) however stated that 2n x 4n cross was very difficult to obtain in tomato. NILSSON (1950) concluded *inter alia* that « It is apparent that it is difficult to find any genic or physiological condition which can by itself explain results of the reciprocal crossings. ...As to the physiological side of the question, it might be presumed that changes in pollen tube growth, unbalance between the tissues of the ovule and possibly differences as regards parthenocarpy and hormone production interact to give the result which was to be explained. »

SANSONE, SATINA and BLAKESLEE (1942) observed that in 2n x 4n *Datura* the course of seed abortion was due to failure of fertilization and bursting of the pollen tubes in the styles. SANSONE (unpublished referred to in WATKINS, 1932) noted that in 2n x 4n *Primula sinensis* only 2 per cent of pollen germinated; 2n tubes were short and stunted and would not enter the diploid styles. CHUI (1942-43) reported that 2n x 4n rye was entirely incompatible owing to failure of pollen tube growth. RANDOLPH (1935) found that in 2n x 4n maize only 10 per cent of the well-filled grains germinated. The high degree of incompatibility exhibited by 4n was attributed to quantitative rather than qualitative chromosome numbers, since the induced 4n stock had the same or very similar kinds of genes as the parental diploids with which they subsequently proved to be cross sterile. COOPER (1951) recorded defective caryopsis in 2n x 4n maize. Here double fertilization occurred at normal interval. Rate of 3n embryo growth gradually slowed down and ultimately ceased. There was irregularity in endosperm development later. MANGELSDORF and REEVES (1931) described a similar type of abnormal endosperm development. HAKANSSON (1952) reported fertilization in 2n x 4n *Galeopsis* but endosperm became defective and completely disappeared. He opined that clearly degenerating or small endosperm could not produce adequate growth substances so that further development of ovules stopped. Embryo development seemed interrupted through endosperm degeneration. He ascribed the reason as due to a difference in the function of haploid and diploid pollen tubes, haploid pollen tubes functioning better than diploid ones in diploid and tetra-

ploid styles. PANDEY (1955) also supported him. JULIEN (1950) measured the speed of pollen tubes in the styles of 4n *Trifolium pratense* and noted that the speed of haploid tubes was greater than diploid ones per minute. But in our materials reverse situation is observed. Previously HAKANSSON and ELLERSTRON (1950) recorded that fertilization occurred readily in 2n x 4n and 4n x 2n rye. In 2n x 4n endosperm mitotic irregularities were very common and cell formation very belated and usually failed. They were of opinion that arrest of growth and death of embryo seemed to be secondary to this disintegration. Disturbed relations of the chromosome numbers between endosperm and maternal tissue must me an important factor, though not the only one causing seed sterility. PANDEY (1956) found no seed in case of 2n x 4n, although a few capsules developed to a small extent. He stated that the stimulation of the ovary indicated that pollen germinated and entered the style but seed development failed either due to failure of pollen tubes to reach the embryosacs thus leaving the egg unfertilized or after fertilization, due to abortion of the triploid zygote or embryo. His conjecture and surmises were not based on cytological findings. Seed abortion after reciprocal autoploid crosses led MUNTZING (1930b) to conclude that a fixed quantitative relation between the chromosome numbers of maternal tissue; endosperm: embryo is necessary for normal seed development. Normally this relation is 2 : 3 : 2, but after crosses between plants having different genomes this relation is changed and is different, e.g., in 2n x 4n it is 2 : 4 : 3.

What occurs in jute is stated in Table V.

TABLE V

Quantitative relationship (proportional) of the maternal tissue: endosperm: embryo in wild *C. olitorius* green.

Maternal tissue	Endosperm.	Embryo.
2n selfed — 2	3	2
4n selfed — 2(4)	3(6)	2(4)
2n x 4n — 4	4	3
4n x 2n — 4	5	3

The same author (1941) had shown that autotetraploid *pubescens* and *speciosa* of *Galeopsis* were completely incompatible with their diploid forms, both reciprocal crosses failing to give any seeds. This quantitative chromosome relationships play the greater role, being elaborated by KOSTOFF and KENDAL (1934) and COOPER and BRINK (1945). The latter authors stressed the course of seed failure in 2n x 4n *Lycopersicum pimpinellifolium* as due to importance of endosperm in seed development. Death of embryo was a secondary phenomenon originating in abnormal development of other parts of seed. Somatic changes such as excessive nucellar growth or integument tissue, excessive development of endothellium layer, deficient development of the ways leading nutrients to endosperm, which might appear rather early, were considered to be primary being a cause of disintegration of endosperm (Somatoplastic sterility hypothesis of COOPER and BRINK (1940) or embryo lethality hypothesis of FAGERLIND (1944)).

It would be of interest to quote an excerpt from BRINK and COOPER's review (1947) on the endosperm in seed development — « Failure of the seed to develop normally, in the opinion of FAGERLIND (74), is due to disturbance of equilibrium between embryo, endosperm and maternal tissue. Species, genera and even families are assumed to differ in their sensitivity to an unbalance between these structures. The same tissues are not necessarily always involved. Sometimes the relation between endosperm and embryo may be unbalanced, in others, the disturbance may affect embryo and maternal tissue. FAGERLIND is inclined to attribute to the embryo the leading role in seed development following species crosses in *Rosa*, on the grounds that ripe seed is non-endospermic. It is suggested also that disturbance of the equilibrium between embryo, endosperm and maternal tissue may be a secondary effect of the stimulating influence on these tissues of the pollen tube and its nuclei (p. 493) ».

Recently SHIBATA (1937) observed a clear difference between compatible and incompatible cross combinations with regard to the capacity of capsules set in the reciprocal crosses of 4n x 2n *Brassica*. On the contrary, he found no clear differences between both cross combinations with regard to seed fertility

and germination capacity of F_1 hybrids. The capsules set on compatible cross combinations were more longer and wider than the capsule set on incompatible one in 4n x 2n and there was no clear difference between both cross combinations in 2n x 4n. On the compatible cross combination in 2n x 4n, numerous empty, shrivelled seeds were obtained than on the incompatible one. Seed fertilities on the compatible cross combinations in the reciprocal crosses of 4n x 2n were lower than the ones in the same cross combinations among 4n and 2n respectively. In the offspring obtained by the reciprocal crosses of 4n x 2n, he found a few 2n, 3n-1 and 4n plants in addition to 3n.

Thus it is evident from the works of various authors that there is a variety of causes leading to seed abortion or seed set in diploid *versus* autoploid reciprocal crosses. It is also clear that these causes are different in different species. In jute endosperm development is slower from the start or it may not grow and ovules start collapsing. GANESAN, SHAH and SWAMINA-THAN (1957) in ascribing the cause of seed failure or seed setting in the cross *C. olitorius* x *C. capsularis* at 2n level stated that the abortion of the young seed was attributable to an impaired capacity for growth of the endosperm, which itself in turn might be due to tendency of the adjacent maternal tissue to develop excessively. They ascribed this phenomenon as essentially a malnutritional one associated with genotypic diversity of the tissues within the seed. Probably such changes take place later on in our materials. It is necessary to study further details to arrive at a definite conclusion. These studies will be undertaken in the next jute season.

SUMMARY

A cytogenetical study on the intraspecific crossing between diploid and tetraploid and its reciprocal in the wild varieties of *Chorchorus oli-torius* Linn. and *C. capsularis* Linn. was done.

In 2n wild *C. olitorius* ♀ x 4n wild *C. olitorius* ♂ the pod set was 32.5 per cent and the percentage of harvested pod was 76.9 (out of the set pods) and in the reciprocal, it was 14.3 per cent and 66.6 per cent respectively.

In 2n wild *C. capsularis* ♀ x 4n wild *C. capsularis* ♂ the pod set was 24.4 per cent and the percentage of harvested pod was 54.5 (out of the set pods) and in the reciprocal, no pod set was observed and hence percentage of pod harvested was nil.

From cytological observations of the fertilization processes in 3 days, it can be concluded that there may be some disbalance in the quantitative and qualitative relationship between the maternal tissue, embryo, endosperm. And this disbalance may be the cause of not getting any viable seed, though fertilization in 3 days was observed in some cases except in 4n wild *C. capsularis* ♀ x 2n wild *C. capsularis* ♂, where ovaries fell down within 24 hours.

In the end we offer our sincere thanks to Dr. P. K. SEN, KHAIRA Professor and Head of the Department of Agriculture, Calcutta University for granting all facilities to complete this investigation.

RIASSUNTO

E' stato eseguito uno studio citogenetico sulla ibridazione intraspecifica fra varietà spontanee diploidi e tetraploidi e reciprocamente in due specie: *Corchorus olitorius* Linn e *C. capsularis* Linn.

In *C. olitorius* 2n ♀ x *C. olitorius* 4n ♂ la maturazione dei frutti risultò del 32,5 per cento e la percentuale dei frutti raccolti (oltre quelli maturi) fu di 76,9. Nell'ibridazione reciproca tali percentuali risultarono di 14,3 e 66,6 rispettivamente.

In *C. capsularis* 2n ♀ x *C. capsularis* 4n ♂ la maturazione dei frutti fu del 24,4 per cento e la percentuale dei frutti (oltre quelli maturi) fu di 54,5. Nell'ibridazione reciproca non fu osservata alcuna maturazione nei frutti, per cui anche il loro raccolto risultò nullo.

Dalle osservazioni citologiche dei processi fecondativi seguiti durante tre giorni si può concludere che la causa determinante la mancanza assoluta della produzione di semi può essere attribuita a qualche sorta di squilibrio esistente nei rapporti quantitativi e qualitativi fra il tessuto materno, l'embrione e l'endosperma, benchè in alcuni casi fu osservata la fecondazione, tranne nell'incrocio fra *C. capsularis* 4n ♀ x *C. capsularis* 2n ♂, dove gli ovari abortirono entro le 24 ore.

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EXPLANATION OF FIGURES:

FIG. 1.
An embryosac in one day's material of the cross 4n wild *C. olitorius* 0 x 2n wild *C. olitorius* 0. shows the unfertilized egg cell and absence of pollen tube inside. (x 3300).

FIG. 2.
An embryosac in 2 days' material of the cross 2n wild *C. olitorius* 0 x 4n wild *C. olitorius* 0 shows that the pollen tube has discharged the two sperms of which one sperm is near the egg and the other near the polar nuclei. (x 2000).

FIG. 3.
An embryosac in 3 days' material of the cross 2n wild *C. olitorius* 0 x 4n wild *C. olitorius* 0 shows that the double fertilization has occured. But the egg still contains 2 nucleoli and the secondary nucleus contains 3 nucleoli. (x 1200).

FIG. 4.
An embryosac in 3 days' material of the cross 2n wild *C. olitorius* 0 x 4n wild *C. olitorius* 0 shows a fertilized egg. (x 1200).

FIG. 5.
An embryosac in 1 day's material of the cross 4n wild *C. olitorius* 0 x 2n wild *C. olitorius* 0 shows the unfertilized egg and no entrance of pollen tube. (x 1200).

FIG. 6.
An embryosac in 2 days' material of the cross 4n wild *C. olitorius* 0 x 2n wild *C. olitorius* 0 shows the clear unburst pollen tube. (x 1200)

FIG. 7.

An embryosac in 3 days' material of the cross 4n wild *C. olitorius* 0 x 2n *C. olitorius* 0 shows the fertilized egg. (x 1200).

FIG. 8.

An embryosac in 1 day's material of the cross 2n wild *C. capsularis* 0 x 4n wild *C. capsularis* 0 shows the unburst pollen tube and the intact egg. (x. 1200).

FIG. 9

An embryosac in 2 days' material of the cross 2n wild *C. capsularis* 0 x 4n wild *C. capsularis* 0 shows the swollen unburst pollen tube. (x 1200).

FIG. 10.

An embryosac in 3 days' material of the cross 2n wild *C. capsularis* 0 x 4n wild *C. capsularis* 0 shows the fertilized egg. (x 1200).