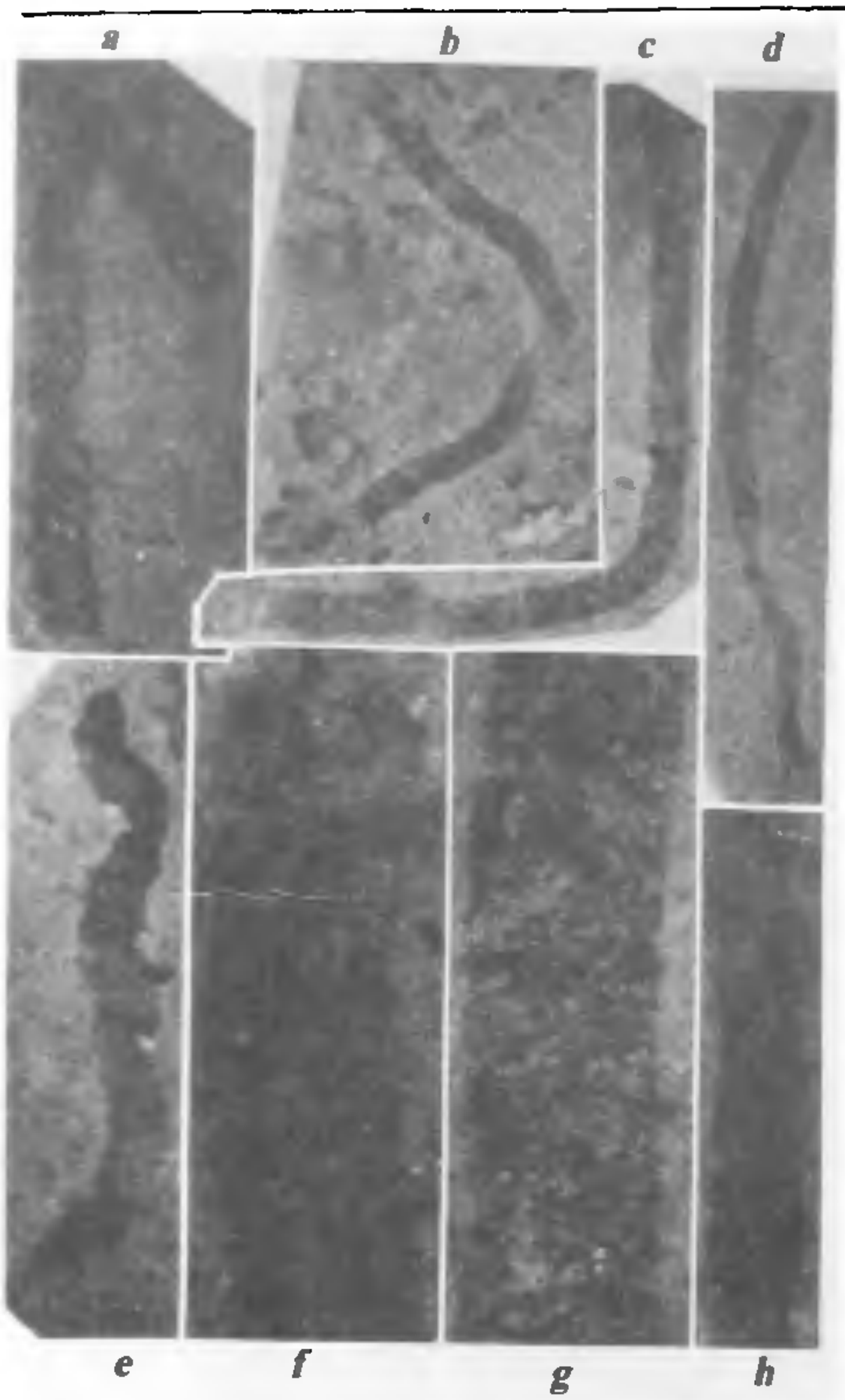

Figure 3. Variation in disposition and ornamentation in sabelliditids from the Bhima basin. *a*, A straight form twisted and folded over itself at an acute angle (× 7, specimen no. 25). *b*. Curved with a twist in the middle (× 4.5, specimen no. 23). *c*, Curved but not twisted (× 5, specimen no. 52). *d*, Sinuous (× 4.5, specimen no. 24). *e*, Folded and twisted (× 10, specimen no. 22). *f*, Structure resembling coalescence of closely spaced funnels (× 20, specimen no. 3b) *g*, Close-spaced wrinkles on the outer surface; absence of wrinkles on the inner surface suggested by white patches (× 25, specimen no. 3a). *h*, Frill of funnel-like projection in the bottom-left (× 12, specimen no. 56).

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A novel male sterility system in sorghum (*Sorghum bicolor* (L.) Moench)

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We discovered that A_2 cytoplasm in sorghum, *Sorghum bicolor* (L.) Moench, interacts with different genotypes, resulting in complete male sterility in some during the post-rainy season. The male sterility in these lines has broken down during the rainy and summer seasons, resulting in partial seed set to various extents in different genotypes. Seed harvested from such plants gave rise to completely male sterile progenies in the post-rainy season. This type of genotype–environment interaction with A2 cytoplasm makes it amenable for commercial exploitation more economically than other normally used systems.

CYTOPLASMIC genetic male sterility in sorghum was first reported by Stephens and Holland[1] in crosses between dwarf yellow sooner milo and Texas Black Hull Kafir. Using this cms system commercial sorghum hybrids

were developed in the US and subsequently in other countries. At present, throughout the world, commercial sorghum hybrids are produced using the cytoplasm of milo (A_1). Using a single cytoplasm makes the hybrids vulnerable to epidemics on a large scale. Accordingly, attempts were made since several years in both the US and India for identifying and utilizing cytoplasms other than that from milo[2-5]. The single most difficult aspect of utilizing alternate cytoplasms is the non-availability of fertility restorers. By far, one of the cytoplasms designated as A_2 has been investigated to a larger extent than any other. This cytoplasm was released[6] in 1977. The cytoplasm for the sterile line was from IS 12662C which is in the Caudatum Nigricans group (Guinea race) from Ethiopia. The source of nuclear genes and maintainer line is IS 5322C (SC 250) which is in the Roxburghii group (Guinea race) from India. Murty[7] using this A_2 cytoplasm observed that a larger number of germplasm and elite lines could be converted into male sterile lines. Some male fertility restorers like IS 2195, IS 2312, IS 5490, IS 5613, RTx 432 and SC 599 have also been identified.

In attempts to develop male sterile parents using A_2 cytoplasm, nine elite parents were crossed to $CKPA_2$ (a-four-dwarf combine kafir). Seed of $CKPA_2$ was generously provided by J. R. Quinby, USA. Sterile and partially fertile F_1 hybrids were backcrossed for ten generations to obtain male sterile lines with stable and complete male sterility. However, in several seasons, the observations on sterility were confounded due to insect attack, heavy rains, shedding of normal-looking but sterile pollen and damage by earhead worms and birds. In 1990 the plants were completely protected and data on pollen fertility and seed set were collected using standard methods. Five lines (CS 3541, MR 750, MR 840, 296 and SB 1085) exhibited complete male sterility and did not set seed when selfed (Table 1). The remaining four lines exhibited varying degrees of pollen fertility and seed set. It was concluded that the first five lines can be used in the production of commercial hybrids.

Accordingly, four of these male sterile lines (CS 3541, MR 840, MR 750 and 296) were grown along with their maintainer lines during the summer of 1991 for seed increase. Unexpectedly, these steriles, which were stable during post rainy season, exhibited varying degrees of pollen fertility as well as seed set, except in the case of 296. At first, it was thought that there was a contamination of the seed lots. However, on close scrutiny, it was found that the degree of fertility and seed set of these lines is less compared to their corresponding B lines. The maximum breakdown occurred in the case of CS 3541 A_2 (92%) and the minimum in MR 840 (15%) through MR 750 (57%) (Table 2). To rule out the possibility of any contamination, seed was collected from these partial fertilities and carried over to the rainy season of 1991 and again to the post-rainy season of 1991–92. The breakdown in male and female sterilities continued in the *kharif* but in the post-rainy season, all the four lines were completely sterile in respect of both pollen fertility

Table 1. Pollen fertility and seed set in nine elite lines with A_2 cytoplasm

Parent		Pollen fertility (%)	Seed set (%)
CS 3541	A_2	0	0
CS 3541	B_2	100	100
MR 750	A_2	0	0
MR 750	B_2	100	100
MR 840	A_2	0	0
MR 840	B_2	100	100
296	A_2	0	0
296	B_2	100	100
SB 1085	A_2	0	0
SB 1085	B_2	100	100
N 94	A_2	15	15
N 94	B_2	100	100
IS 84	A_2	20	75
IS 84	B_2	100	100
PVR 10	A_2	55	90
PVR 10	B_2	100	100
PD3-1-11	A_2	70	80
PD3-1-11	B_2	100	100

A_2: Male sterile line based on A_2 cytoplasm
B_2: Fertile line that maintains A_2 line

Table 2. Pollen fertilities (PF) and seed set (SS) in four genotypes carrying A_2 cytoplasm in three seasons

		Summer 1991		Rainy season 1991		Post-rainy season 1991-92	
		PF	SS	PF	SS	PF	SS
CS 3541 A_2	Range	3.2-92.2	0-909	10 62	75 80	0	0
	Mean	73.7	16.55	-		0	0
MR 750 A_2	Range	0 92.2	0-100	0 20	10 15	0	0
	Mean	56.7	37.73	12.00	-	0	0
MR 840 A_2	Range	0-34.2	0 55	0 3	0	0	0
	Mean	15.23	89.91	2.00	0	0	0
296 A_2	Range	0	0	0	0	0	0
	Mean	0	0	0	0	0	0

and seed set. Seed lots from A_2 steriles originally obtained from post-rainy season of 1990–1991 as well as those from A_2 steriles which have set seed in summer and rainy seasons (1991) behaved exactly similar and were all sterile. The breakdown of sterility is perhaps due to high temperatures of summer and rainy seasons. The sterility will perhaps be maintained only if the temperatures are low as in the case of post-rainy season. In addition, it is possible that the shorter photoperiod of the post-rainy season might also be affecting developmental changes to result in male sterility. Temperature and/or photoperiod effects can be distinguished if studies are made in growth chambers with controlled photoperiod and temperature.

These observations are of special significance in commercial seed production programmes. Normally, male sterile lines in sorghum and also other crops like maize and pearl millet are maintained by growing the male sterile lines and their maintainers side by side in isolated seed production plots. Seeds from only the sterile plants which are crossed by the maintainer are harvested. This results in reduced yields of A line. In addition to this reduction in seed quantity, production of male sterile seed is associated with several problems like synchronization of A and B lines, pollen dispersal, etc. These problems can be eliminated if the cytoplasmic system reported in the present study is utilized. The sterile parents using the cytoplasm can be simply maintained by growing them in the summer. Even if the seed set is less, still it will be economical since the other problems are eliminated.

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Giant spermatogonial cells generated by vincristine and their uses

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Vincristine treatment to albino rats has earlier been shown to cause formation of giant cells in the seminiferous tubules, by probably affecting spermatogenic mitosis. The present paper reports on the fate of the giant cells thus formed. These cells, highly intact, reach the caput epididymis, where also they maintain their identity, and then the cauda epididymis where they undergo fragmentation, cytolysis and phagocytosis. The study, in addition, demonstrates that vincristine can cause azoospermia and possibly sterility. It is also proposed that spermatogenic giant cells can thus be generated in animal models and conveniently collected from the caput epididymal tubule for use as a tool in cell biology.

In the reported background that combination cancer chemotherapeutic regimens containing the cytotoxic spindle poison vincristine as one of the drugs[1–7] can cause several side-effects like nausea, vomiting, leukopenia, alopecia, stomatitis, peripheral neuropathy, cardiopathy, hepatocellular damage, pulmonary fibrosis, etc[8], including male gonadal dysfunction like azoospermia, oligospermia, gynaecomastia and germinal aplasia[3,9–13], the specific gonadal toxicity of vincristine has not been studied while administration of total alkaloids of *Vinca rosea* (*Catharanthus roseus*; Apocynaceae), the plant from which vincristine is obtained, to adult male rats and mice brings about arrest of spermatogenesis, regression of Leydig cells and derangements in sperm[14–18], we reported that vincristine, when administered to rats, can cause thorough disorganization of the seminiferous tubules, narrowing down of the layers of cells in the latter, absence of meiotic elements and, more importantly, the occurrence of giant cells in the seminiferous tubules[19]. Giant cell formation in the testis has been reported under several experimental conditions[20–28], but invariably the cells undergo cytolysis and/or phagocytosis by macrophages[20]. Therefore the intact nature of the giant cells in the seminiferous tubules caused by vincristine is intriguing. Therefore the investigation was extended further to trace the fate of the giant cells at the epididymis.

The experimental protocol has already been reported[19]. It consisted essentially of administration of vincristine sulphate to Wistar strain adult male albino rats through intraperitoneal route (group I, 10 μg and group II, 20 μg/day/animal) with the control rats receiving the vehicle (group III). Rats were sacrificed on the day 16 by cervical dislocation and the testis and epididymis were dissected out. Slices of testis, caput epididymis and cauda epididymis were fixed in Bouin–Hollande fixative. Serial paraffin sections, 8 μm thick, were stained in Delafield haematoxylin and eosin[29] (Figure 1).