bore many female flowers like those of normal hybrid triploid female plants. But the sex expression changed from a strictly dioecious to monoecious. However, one female branch of the monoecious hybrid triploid produced several hermaphrodite flowers. The flowers were smaller in size and deep yellow in colour like those of diploid plants. The number of petals in the hermaphrodite flowers varied from 6 to 8. This number is always 5 in male and female triploid plants. The number of stamens in the hermaphrodite flowers varied between 1 and 3, whereas it is always 3 in the dioecious triploid male. No fruit setting occurred in the bisexual flowers. When pollen grains from the hermaphrodite flowers were dusted on diploid, triploid and tetraploid female flowers, no fruit formation took place. Pollen grains, when examined in acetocarmine, were found to be empty.

The report of hermaphrodite flowers on a dioecious species is an example of reversal of sex type to that of the bisexual progenitors. In some other cucurbits such as *Coccinia indica*[4] and *Momordica charantia*[5] also cases of this type have been recorded. This suggests that the bisexual type is the most primitive, from which monoecious and dioecious types have gradually evolved.

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EFFECT OF SODIUM CHLORIDE ON IONIC COMPOSITION OF *AZOLLA PINNATA*

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AZOLLA PINNATA has been used as nitrogen fertilizer for rice. Experimental work on *A. pinnata* has revealed that this water fern possesses the capacity to absorb and withstand sodium chloride in its system. This property of *Azolla* could be profitably employed for reclaiming salt-affected lands which are encroaching upon good agricultural lands and rendering the latter unfit for crop cultivation[1]. It was therefore of interest to study the effects of sodium chloride on the ionic composition of *A. pinnata* and to determine the maximum levels of sodium chloride that it could tolerate.

Experiments were conducted on aseptically cultured *Azolla pinnata* R.Br. in nitrogen-free medium[2]. *Azolla* (300 ± 20 mg) was subcultured in nitrogen-free medium (30 ml, control) and in medium (30 ml) supplemented with 5, 10, 20, 30, 40 and 50 mM sodium chloride. The pH of the medium was adjusted to 5.6 before autoclaving. Cultures were incubated at 25 ± 2°C in white fluorescent light (1000 lux), 16/8 h photoperiod, with weekly renewal of culture medium.

Azolla samples from each treatment were harvested and dried separately after three weeks of culture. Dried samples were ashed in a nickel crucible in a muffle furnace for 2 h at 500°C. Copper stubs with double-sided taps were pressed firmly into each ash sample and mineral composition of the ash was determined[3]. The analysis was carried out using a scanning electron microscope (Philips) provided with a computerized energy dispersive X-ray system.

Table 1 shows that *A. pinnata* cultured in nitrogen-free medium (control) contained maximum amounts of calcium, potassium and magnesium compared with samples cultured in sodium chloride-containing medium. In *Azolla* treated with sodium chloride, there was a linear increase in sodium and chloride, with a progressive decrease in biomass. At 40 mM sodium chloride in the culture medium, sodium and chloride were higher by 77% and 151% respectively compared with the control. This may be due to uptake and accumulation of sodium and chloride ions by *Azolla* from the medium. This is similar to the behaviour of other glycophytes[4] and sorghum[5].

It was observed that *Azolla* could grow in

Table 1 *Biomass and ionic composition of Azolla pinnata cultured in nitrogen-free medium supplemented with various levels of sodium chloride*

NaCl level (mM)	Fresh weight (mg)	Dry weight (mg)	Sodium (mg/g dry wt)	Chloride (mg/g dry wt)	Calcium (mg/g dry wt)	Potassium (mg/g dry wt)	Magnesium (mg/g dry wt)
Control (NaCl absent)	2590	103	4.3	7.9	8.9	29.8	4.9
5	2570	102	4.9	8.6	8.6	29.3	4.9
10	2530	101	5.1	9.1	8.5	29.0	4.9
20	1760	72	5.6	10.7	7.3	26.1	4.9
30	1080	39	6.3	15.3	6.1	19.8	4.7
40	720	29	7.6	19.8	5.3	11.4	4.5
50	—	—	—	—	—	—	—
CD at 5%	134	7.3	—	—	—	—	—

medium containing up to 40 mM sodium chloride indicating that this level is tolerable, but further increase did not allow growth.

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BIOCHEMICAL CHANGES IN TUKRA-AFFECTED EXOTIC MULBERRY PLANTS

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MEALYBUGS causing tukra disease[1] in mulberry were reported by Roy[2] and Paul[3] in 1941. The bugs feed on the tender leaves and shoots of mulberry. The affected plants show curling of leaves at the growing point and arrested growth. The disease is caused by a virus transmitted by the common mealybug, viz. *Maconellicoccus hirsutus*[4,5]. Rearing young-age silkworms is solely dependent on the tender leaves of mulberry.

In tukra the leaves are very badly damaged. Not only do the leaves show morphological changes (deformed, crinkled, wrinkled, etc.), but biochemically also they differ[6,7] from normal leaves. This affects the nutritional status of the leaves. During a survey, between August 1985 and February 1986, of mulberry plants in the germplasm bank in the Bangalore University campus, *Morus australis*, *M. cathyana*, *M. macroura* and *M. nigra* were reported to be free from tukra attack[8]. However, in May–June 1988, these plants were also severely affected in the same garden as all the other varieties were also attacked by the mealybugs. Biochemical changes in leaves of the four exotic species mentioned above were investigated.

Tukra-affected and unaffected leaf samples of *M. australis* Pair. (Australia, Indonesia, Philippines, South China), *M. cathyana* Hemsl. (Central China), *M. macroura* Mig. (China, Indonesia, Japan) and *M. nigra* L. (Persia, West Asia) were collected during May–June 1988 and oven-dried. The samples were analysed for total chlorophyll[9], protein[10], sugars[11], reducing sugars[12], phenols[13] and starch[14].

The data are given in table 1. There was a decrease in protein content of *Morus macroura* and *M. nigra* affected by tukra; the reduction was, however, negligible in *M. nigra*. Tukra caused an increase in protein content of the other two species, viz. *M. australis* and *M. cathyana*. In an earlier study[7] protein content decreased by 10.5% in mulberry variety Kajali while in variety Kanva-2 it increased significantly (40%). Increase in protein content may be due to induced synthesis of protein in response to the infection[15], while reduction in protein content may be attributed to hydrolysis by proteolytic enzymes secreted by the pathogen[16].

Morus macroura and *M. nigra* affected by tukra showed a decrease in the level of phenols. On the