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HYBRIDIZATION IN *SIDA OVATA* COMPLEX II. EVIDENCE FROM BREEDING STUDIES

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Abstract

Breeding studies reconfirmed the hybridization between *Sida ovata* Forssk., and *Sida tiagii* Bhandari. All the three taxa i.e., *S. ovata* Forssk., *S. tiagii* Bhandari and the hybrid are facultative autogamous as indicated by pollen - ovule ratios and breeding experiments. *Chrysis* sp., (Hymenoptera) seems to be responsible for pollen transfer between *S. ovata* and *S. tiagii* in natural populations. Certain insect pollinators were specific such as *Bembix* sp., and *Bombus* sp., for *S. ovata*, *Apis* sp., and *Vespa* sp., for *S. tiagii* and *Ponera* sp., for the hybrid. The limited number of hybrids may be due to less frequent visitation of common pollinator (*Chrysis* sp.) alongwith the incomplete reproductive barrier between both the parents. The restricted gene flow is also evident by least fruit and seed set in hand pollinated reciprocal crosses of the putative parents as compared to the self pollination. It seems that back crosses are impeded due to the absence of common pollinators between the parents and hybrid and meiotic irregularities as indicated by the failure of hand pollinated (back crosses) experiments.

Introduction

The evidences of hybridization between *Sida ovata* Forssk., and *Sida tiagii* Bhandari, with reference to morphology, cytology, chemistry, seed viability and seedling survival have been reported (Dawar *et al*., in press). A small population and restricted distribution of hybrid as compared to the parental species were noted. The breeding system not only affects the fitness of the individual plant but also determines the spread of genetic variability of the population. The present paper gives an account of the phenology, breeding behaviour with reference to hand pollination and pollen - ovule ratios, frequency and foraging behaviour of the visiting insects particularly pollinating insects in *S. ovata*, *S. tiagii* and its hybrid.

Materials and Methods

Populations located within the Karachi University Campus viz., (i) Geology Dept. (ii) Office of Dean Faculty of Science (iii) Chemistry Dept. (iv) Crop Diseases Research Institute (v) Girls Hostel and (vi) Boys Hostel, provided the material for the present study during 1990.

Morphology and Phenology: For all the three taxa viz., *Sida ovata* Forssk., *Sida tiagii* Bhandari and hybrid, 10 young floral buds/plant (5 plants /population) were tagged to determine the morphology and phenology.

Insects (Pollinators and Visitors): Foraging behaviour of flower visiting insects of all the three taxa was recorded. The insects were collected by hand net, chloroformed and observed microscopically for the pollen load. Insects carrying pollen were evaluated as pollinators.

Pollen - Ovule Ratio: Mature floral buds (5 buds/plant, 5 plants/population) of all the three taxa were collected from each population. The pollen ovule ratio of each taxa was calculated following the method of Cruden (1977).

Breeding System: Following experiments were performed in mature floral buds (25 buds/plant, 5 plants/population) just prior to anthesis of all the three taxa .
Control (Open pollinated): Floral buds were tagged with out manipulation and left to determine the normal mode of pollination in natural population.
Direct Autogamy: Floral buds were bagged without manipulation to determine the self pollination.
Indirect Autogamy: Floral buds were hand pollinated (pollen and the stigmas of the same flower were used) and bagged to determine the self pollination.
Apomixis: Floral buds were emasculated and bagged to test the apomixis.
Geitonogamy: Floral buds were hand pollinated with the pollen grains of other flowers of the same plant and bagged to test the geitonogamy.
Xenogamy: Floral buds were cross pollinated by hand with the pollen grains of different plants of the same species to test the xenogamy.

Table 1. Insects associated with the flowers of *Sida ovata* complex.

Floral visitors			*Sida ovata*	Hybrid	*Sida tiagii*
Hymenoptera:	Apidae				
		Apis sp.	-	-	+ +
		Bombus sp.	+ +	-	-
	Chrysidae				
		Chrysis sp.	+ +	-	+ +
	Formicidae				
		Ponera sp.	-	+ +	-
	Halictidae				
		Halictus sp.	+	-	-
	Sphecidae				
		Sphecius sp.	-	-	+
		Bembix sp.	+ +	-	-
	Vespidae				
		Vespa sp.	-	-	+ +
Hemiptera:	Coridae				
		Liorhyssus sp.	+	-	-
Lepidoptera:					
		Coletis sp.	+	+	+
		Cosmophila sp.	+	-	-
		Pieris rapea L.	+	+	+
		Pieris sp.	-	-	+
		Sylepta deurogata	-	+	+

+ + = pollinators, + = visitors, - = absent.

Hybridization: Reciprocal crosses were made between *S. ovata* Forssk., and *S. tiagii* Bhandari. Floral buds were emasculated and reciprocally crossed to test the hybridization.

Back Crosses: Floral buds of both the parents and hybrid were reciprocally crossed to test the back crosses.

From each treatment fruit set, seed set and seed weight were determined. The data was statistically analyzed using One - way ANOVA and Duncan's Multiple Range Test following Gomez & Gomez (1984).

Observations and Results

Morphology and Phenology: Generally, the plants are erect-suberect, perennial herbs. Leaves alternate, petiolate, stipulate, ovate, ovate-oblong or elliptic, serrate-crenate. *S. ovata* has white flowers, hybrid off-white and *S. tiagii* yellow, pedicellate, axillary, solitary or paired with faint fruity smell. Calyx 5 lobed, alternating the petals, angular-subangular, lobes triangular-deltoid, acuminate, with a ring shaped nectary located at the base of each sepal formed by the glandular hairs, as also pointed out by Cronquist (1970). Corolla 5 lobed, oblique, unguiculate, claw hairy. Staminal column usually included, hairy, divided above into 19-24 antheriferous filaments. Carpels 7-8, style branches, stigmas and locules as many as carpels, stigma capitate, each locule 1- ovuled. Fruit depressed, globose, completely or incompletely enclosed by calyx; mericarps 7-8, glabrous-glabrescent, indehiscent, 2 awned. Seeds somewhat reniform, brown-dark brown.

Two periods of peak flowering were recorded in all the three taxa: in *S. ovata* from December-February and June-September, in *S. tiagii* from January-March and July-September, whereas in hybrid from January-March and July-September.

An initiated bud took about 15-16 days in *S. ovata*, 13-15 days in hybrid and 16-18 days in *S. tiagii* to become a flower. The opening and closing times of flowers varied depending on temperature and light. At 25-35°C anthesis took place at 11.30 am. -12.30 pm in *S. ovata* between 1.20-2.00 pm in hybrid and at 1.20-2.15 pm in *S. tiagii* while flowers remained open for about 1½-2¼hours in all the three taxa, and shedding of petals and filaments took place after 1-1½,1 day and 1-3 days of flowering in *S. ovata*, hybrid and *S. tiagii*, respectively.

Insects (Visitors and Pollinators): Different types of insects including Hymenoptera, Lepidoptera and Hemiptera were observed on flowers of all the three taxa of this complex (Table 1). The nectar and pollen seem to be the main rewards.

Hymenoptera were the main pollinators and can be divided into two groups on the basis of their foraging behaviour.

Group A: This group includes *Apis sp., Bembix* sp., and *Chrysis* sp., all of which share same foraging behaviour. Insects directly land on the staminal column of the flower and grasp it with the legs. From there, insert their proboscides in the slit present at the base of the staminal column between the two petals that leads to the nectary situated at the base of the sepals. Insects usually explore all the five nectaries of a flower by revolving or twisting on the staminal column. During nectar sucking, insects also collect pollen with their forelegs and store them in the corbiculae. Pollen also get deposited on the ventral side of thorax and abdomen along with the legs (Fig.2,A-D).

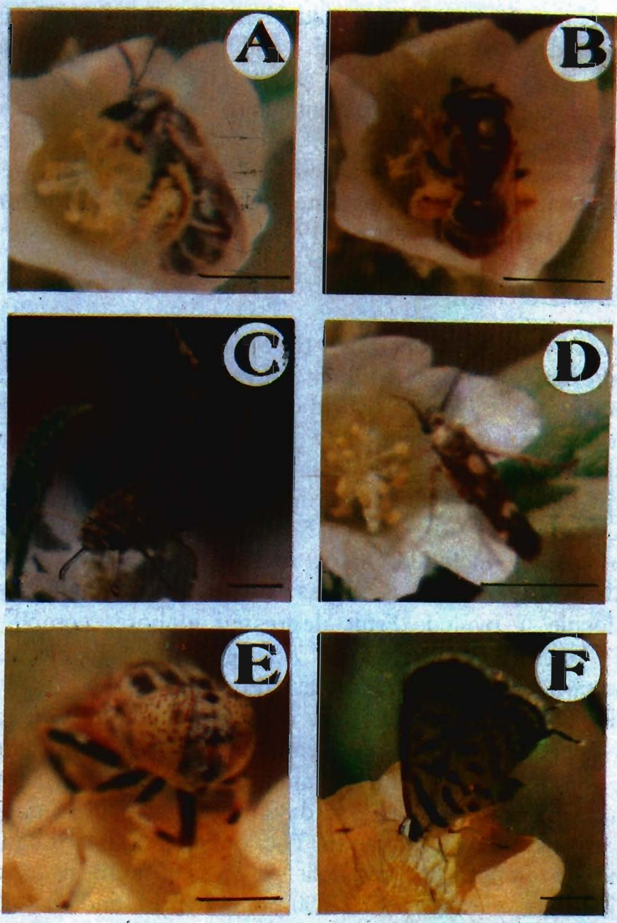

Fig. 1. Insects foraging behaviours. A & B *Bembix* sp., collecting pollen and nectar from the flower of *Sida ovata*. C, *Cosmophila* sp., sucking the nectar from the flower of *S. ovata*. D, *Liorhyssus* sp., alighted on petals of *S. ovata*. E, *Vespa* sp., collecting the pollen from the flower of *S. tiagii*. F, *Sylepta deurogata* sucking the nectar from the flower of *S. tiagii*.(Scale bar = 5mm).

Apis sp., and *Bembix* sp., (Fig.1, A & B) are restricted to *S. tiagii* and *S. ovata*, respectively (Table 1). Both the insects visit all the flowers (i.e. 4-5 flowers open/plant) of one plant and then divert their attention towards the other plant. However, the case of *Chrysis* sp., is different. It is less frequent than the other insects and visits *S. ovata and S. tiagii* both (Table 1). First it visits flowers of the *S. tiagii* and then the flowers of *S.ovata*. It usually visits 1-2 plants of a species and then turns its attention towards the other species, resulting the intertransfer of pollen grains of both the species.

Group B: It includes *Bombus* sp., *Vespa* sp., and *Ponera* sp., All these insects usually land on the petals instead of staminal column. All the three insects species seem to be monotropic. *Bombus* sp., visits the flowers of *S. ovata* only (Table 1). It lands on the petals and sucks the nectar by inserting its proboscis in the nectaries. During

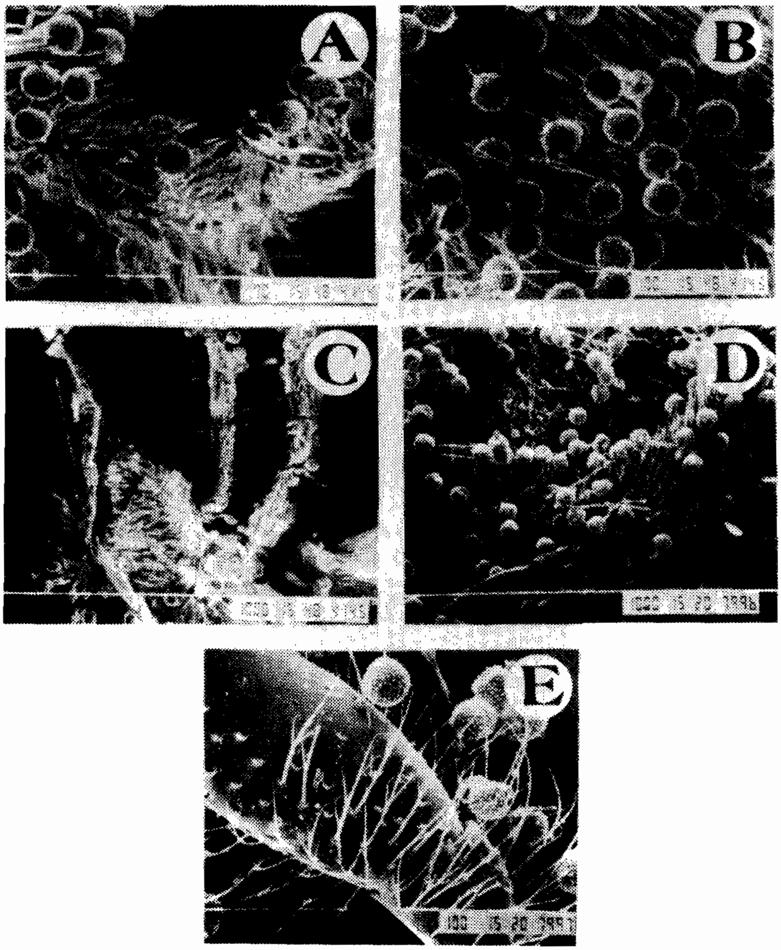

Fig.2. Scanning micrographs showing pollen grains. A & B, on the leg and abdomen of *Bembix* sp. (*Sida ovata*). C, on the abdomen and legs of *Apis* sp., (*S. tiagii*). D, on the leg and abdomen of *Chrysis* sp. (*S. ovata* & *S. tiagii*). E, on the leg of *Ponera* sp. (Hybrid). Scale bar (A, B & E) = 100μm; (C & D) = 1000μm.

nectar sucking, pollen grains get deposited on legs, ventral side of thorax and abdomen. *Vespa* sp., is confined to the flowers of *S. tiagii* only (Table 1). It visits the flowers only for pollen grains (Fig.1,E) and while resting on the petals, collects pollen with the help of forelegs and stores them in the corbiculae. *Ponera* sp., is restricted to hybrid flowers only (Table 1). Its behaviour is some what different than the other insects, it first hovers around the flower and during hovering it collects the pollen with the forelegs (Fig.2,E) and then lands on the petals and sucks the nectar by inserting the proboscis in the nectaries. Inter and intraplant behaviour. of these three insects is similar to that of *Apis* sp.

Certain Lepidopteruns were the common visitors (without pollen load) in this complex, namely *Coletis* sp., and *Pieris rapea* L. (Table 1), while *Sylepta deurogata* visits the flowers of hybrid and *S. tiagii* only (Fig. 1,F, Table 1), whereas

Table 2. Pollen-ovule ratio in *Sida ovata* complex.

Taxa	Average No. of anthers/ flowers	Average No. of Pollen/ anther	Average No. of Pollen/ flower	Average No. of ovaries/ flower	Average No. of ovules/ ovary	Pollen-ovule ratio
S. ovata Forssk.	20.75 ± 0.289	62.4 ± 0.853	1289.2 ± 20.5	1	7.75 ± 0.09	166.35
Hybrid	23.46 ± 0.97	51.66 ± 1.21	1209.82 ± 22.54	1	7.66 ± 0.34	157.94
S. tiagii Bhandari	20.85 ± 0.20	61.6 ± 1.48	1279.9 ± 22.09	1	7.8 ± 0.22	164.09

Cosmophila sp., (Fig. 1,C) and *Pieris* sp., visit the flowers of *S. ovata* and *S. tiagii*, respectively (Table 1). All Lepidopteruns behaved in same manner i.e., they alight on petals, insert their proboscides in nectaries (at the base of sepals) and suck the nectar without coming into contact with sexual parts. The activity of all the Lepidopteruns started just after the opening and continued till before the closing of flowers.

Certain other rare insects (Table 1) such as *Liorhyssus* sp., (Hemiptera) (Fig.1,D), *Halictus* sp., (Hymenoptera) on *S. ovata* and *Specius* sp., (Hymenoptera) on *S. tiagii* were also observed. All these insects may be regarded as opportunist that merely utilize the floral rewards without performing pollination.

Pollen - Ovule Ratio (p/o): Pollen - ovule ratios in *S. ovata, S. tiagii* and hybrid were 166.35, 164.09 and 157.94 respectively (Table 2). According to Cruden (1977), with these values of p/o all the three taxa are facultative autogamous.

Breeding System: In all the treatments fruits were formed with the exception of apomixis and back crosses. The difference in percentage of fruit sets among the different pollination treatments in all the three taxa was statistically significant (Table 3). Direct autogamy significantly resulted in highest fruit set in all the three taxa while hybridization (reciprocal crosses between both the parental species) showed significantly lowest fruit set. The differences between control and indirect autogamy were not significant in *S.ovata* and hybrid while significant in *S.tiagii* (Table 3).

Seed set per fruit among the different pollination treatments differed significantly in *S. ovata* and *S. tiagii* while non-significantly in hybrid (Table 4). In both the parental species seed set was significantly reduced in hybridization whereas more or less similar seed set was observed in all the other treatments with the exception of xenogamy in *S. tiagii*, which significantly increased from hybridization and declined significantly from rest of the treatments (Table 4).

The seed weight per fruit among the different pollination treatments were significantly different in all the three taxa (Table 5). In *S. ovata*, seed weight was significantly maximum in direct autogamy and minimum in hybridization. However, it did not differ significantly between control and indirect autogamy and between geitonogamy and xenogamy. In hybrids seed weight was significantly maximum in both direct and indirect autogamy and minimum in xenogamy. However, seed weight was more or less similar (non-significant difference) between direct and indirect autogamy and between control and geitonogamy. In *S. tiagii* seed weight was minimum in hybridization and xenogamy while more or less similar in rest of the treatments (Table 5).

Among all the three taxa, control significantly differed in fruit set, seed set and seed weight (Table 6-8) but DMRT of all the three parameters showed significant differences between hybrid and both parental species while non-significant between parental species (Table 6-8).

In the direct autogamy the difference in fruit set was non-significant while significant in seed set and weight among all the three taxa (Table 6-8) and DMRT of seed set and weight showed non-significant differences between both the parental species and significant differences between hybrid and parental species (Table 7 & 8). Indirect autogamy significantly differed among all three taxa in fruit set, seed set and weight (Table 6-8) . DMRT showed that fruit set and seed weight did not dif-

Table 3. Effect of different pollination treatments on fruit set in *Sida ovata* complex.

	ONE-WAY ANOVA					DUNCAN'S MULTIPLE RANGE TEST (DMRT)		
Taxa	Sv	Df	Ss	Ms	F-value	Treatments	Rank	Mean
S. ovata	Treat-ments	5	14884	2976	41.54**	Control	2	62 b
						Direct autogamy	1	76 a
	Error	24	17200	71.00		Indirect autogamy	3	62 b
						Geitonogamy	4	36 c
	Total	29	16604			Xenogamy	5	25 d
						Hybridization	6	14 e
Hybrid	Treat-ments	4	7270	1817	14.94**	Control	2	43 b
						Direct autogamy	1	65 a
	Error	15	1825	121		Indirect autogamy	3	38 b
						Geitonogamy	4	25 c
	Total	19	9095			Xenogamy	5	8.0 d
S. tiagii	Treat-ments	5	14720	2944	25.23**	Control	2	57 b
						Direct autogamy	1	74 a
	Error	24	2800	116		Indirect autogamy	3	51 c
						Geitonogamy	4	34 d
	Total	29	17520			Xenogamy	5	22 e
						Hybridization	6	8 f

n.s = not significant; * = $P<0.05$; ** = $P<0.01$; *** = $P<0.001$. Means sharing the same letter do not differ significantly $P>0.05$.

Table 4. Effect of different pollination treatments on seed set in *Sida ovata* complex.

	ONE-WAY ANOVA					DUNCAN'S MULTIPLE RANGE TEST (DMRT)		
Taxa	Sv	Df	Ss	Ms	F-value	Treatments	Rank	Mean
S. ovata	Treat-	5	20	4	4.0*	Control	2	6.7 ab
	ments					Direct autogamy	1	7.1 a
						Indirect autogamy	3	6.6 ab
	Error	24	32	1		Geitonogamy	4	6.5 b
						Xenogamy	5	6.3 b
						Hybridization	6	4.5 c
	Total	29	52					
Hybrid	Treat-	4	170	4262	2.51 n.s	Control	-	-
	ments					Direct autogamy	-	-
						Indirect autogamy	-	-
	Error	15	255	1700		Geitonogamy	-	-
						Xenogamy	-	-
	Total	19	425					
S. tiagii	Treat-	5	104	20	6.66**	Control	3	6.9 ab
	ments					Direct autogamy	1	7.7 a
						Indirect autogamy	2	7.3 ab
	Error	24	73	3		Geitonogamy	4	6.8 b
						Xenogamy	5	4.9 c
	Total	29	177			Hybridization	6	2.3 d

Abbreviations and probability levels as in Table 3.

Table 5. Effect of different pollination treatments on seed weight per fruit (gms) in *Sida ovata* complex.

	ONE-WAY ANOVA					DUNCAN'S MULTIPLE RANGE TEST (DMRT)		
Taxa	Sv	Df	Ss	Ms	F-value	Treatments	Rank	Mean
S. ovata	Treat-ments	5	0.00826	0.00172	6.95**	Control	3	0.0283 b
						Direct autogamy	1	0.0325 a
	Error	24	0.00596	0.000248		Indirect autogamy	2	0.0289 b
	Total	29	0.0145			Geitonogamy	4	0.0234 c
						Xenogamy	5	0.0219 c
						Hybridization	6	0.0162 d
Hybrid	Treat-ments	4	0.00304	0.000761	6.98**	Control	3	0.0141 b
						Direct autogamy	1	0.0163 a
	Error	15	0.00164	0.000109		Indirect autogamy	2	0.0158 a
	Total	19	0.00469			Geitonogamy	4	0.0125 b
						Xenogamy	5	0.0055 c
S. tiagii	Treat-ments	5	0.025	0.0050	9.09**	Control	3	0.0292 bc
						Direct autogamy	1	0.0352 a
	Error	24	0.013	0.00055		Indirect autogamy	2	0.0320 ab
	Total	29	0.038			Geitonogamy	4	0.0264 c
						Xenogamy	5	0.0174 d
						Hybridization	6	0.0085 e

Abbreviations and probability levels as in Table 3.

fer significantly between both the parental species but differed significantly between hybrid and both parental species (Table 6 & 8), while seed set differed significantly in all the three taxa (Table 7).

Geitonogamy showed significant differences in seed set and weight and non-significant in fruit set among all the three taxa (Table 6-8). DMRT showed that seed set and weight differed significantly between hybrid and parental species but was non significant between both the parental species (Table 7 & 8).

Xenogamy showed significant differences in fruit set, seed set and weight among all the three taxa (Table 6-8). DMRT showed that fruit set and seed weight differed significantly between hybrid and parental species but was non-significant between both the parental species (Table 6 & 8). However, the difference in seed set was non-significant between hybrid and *S.tiagii* and between the parental species but significant between hybrid and *S.ovata* (Table 7). Hybridization (reciprocal crosses between both the parental species) did not differ significantly in all the three parameters (Table 6-8).

Discussion

All the three taxa of *S. ovata* complex flower simultaneously throughout the year with two peak flowering periods, one in the summer and the other in winter. The duration of flower anthesis seems to be regulated by temperature and light. At high temperature and light, flowers remain open for relatively short period as compared to the low temperature. Flowers were protandrous and this condition seems to be wide spread in the members of family Malvaceae (Faegri & van der Pijl, 1971).

Chrysis sp., (Hymenoptera) seems to be responsible for the hybridization between *S. ovata* and *S. tiagii* as it visits both the species . However, transfer of pollen may be restricted as few individuals of *Chrysis* sp., were active in the population. Besides, certain specific insects (pollinators) such as *Bembix* sp., and *Bombus* sp., were confined to *S. ovata* flowers, *Apis* sp., and *Vespa* sp., to *S. tiagii* while *Ponera* sp., to hybrid flowers only. Even the visits of other insects regarded as non-pollinators including butterflies and other insects were species specific (Table 1).

Although all the three taxa occur sympatrically and apparently offer similar rewards i.e., nectar and pollen to the insects, but the specificity of the insects may be due to the differences in flower colours or in quantity and quality of chemicals present in nectar and pollen.

All the hand-pollination treatments resulted in normal fruit and seed set with the exception of apomixis and back crosses. In all the three taxa highest fruit and seed set were produced in self pollination i.e., in both direct and indirect autogamy as compared to the other treatments. Thus as indicated by pollen-ovule ratios, all the three taxa are facultative autogamous and irrespective of protandry capable of both direct and indirect i.e., insect mediated type of self pollination. Similarly, heavy seeds were formed in self pollination as compared to other treatments. Harper (1966) and Grant (1967) have also observed that heavier seeds are produced in self pollinated taxa. However, Salisbury (1942) reported heavier seeds in cross pollination as compared to selfed ones.

Table 6. Effect of various pollination treatments on fruit set among all the three taxa.

ONE-WAY ANOVA					DUNCAN'S MULTIPLE RANGE TEST (DMRT)		
Source	Ss	Df	Ms	F-value	Treatments	Rank	Mean
Control	1014.533	2	507.266	5.88*	*S. ovata*	1	62 a
Error	1035.2	12	86.266		*S. tiagii*	2	57 a
Total	2049.733	14			*Hybrid*	3	42.6 b
Direct-	343.33	2	171.666	1.80 n.s	*S. ovata*	-	-
autogamy					*S. tiagii*	-	-
Error	1140	12	95		*Hybrid*	-	-
Total	1483.33	14					
Indirect-	1493.2	2	746.6	9.18**	*S. ovata*	1	62 a
autogamy					*S. tiagii*	2	51 a
Error	975.2	12	81.266		*Hybrid*	3	37.6 b
Total	2468.4	14					
Geitonogamy	343.33	2	171.666	1.66 n.s	*S. ovata*	-	-
Error	1240	12	103.333		*S. tiagii*	-	-
Total	1583.33	14			*Hybrid*	-	-
Xenogamy	865.2	2	432.6	4.91*	*S. ovata*	1	25 a
Error	1055.2	12	87.933		*S. tiagii*	2	22 a
Total	1920.4	14			*Hybrid*	3	7.6 b
Hybridization	90	1	90	0.8 n.s	*S. ovata*	-	-
Error	900	8	112.5		*S.tiagii*	-	-
Total	990	9			*Hybrid*	-	-

Abbreviations and probability levels as in Table 3.

Table 7. Effect of various pollination treatments on seed set among all the three taxa.

ONE-WAY ANOVA					DUNCAN'S MULTIPLE RANGE TEST (DMRT)		
Source	Ss	Df	Ms	F-value	Treatments	Rank	Mean
Control	21.6053	2	10.8026	30.48***	*S. ovata*	2	6.7 a
Error	4.252	12	0.3543		*S. tiagii*	1	6.9 a
Total	25.8573	14			*Hybrid*	3	4.26 b
Direct-autogamy	22.068	2	11.034	35.90***	*S.ovata*	2	7.1 a
					S. tiagii	1	7.7 a
Error	3.688	12	0.3073		*Hybrid*	3	4.88 b
Total	25.756	14					
Indirect-autogamy	27.9213	2	13.9606	62.32***	*S. ovata*	2	6.6 a
					S. tiagii	1	7.3 b
Error	2.688	12	0.224		*Hybrid*	3	4.12 c
Total	30.6093	14					
Geitonogamy	25.8013	2	12.9006	38.81***	*S.ovata*	2	6.5 a
Error	3.988	12	0.3323		*S.tiagii*	1	6.8 a
Total	29.7893	14			*Hybrid*	3	3.88 b
Xenogamy	45.268	2	22.634	5.30*	*S. ovata*	1	6.3 a
Error	51.188	12	4.2656		*S. tiagii*	2	4.9 ab
Total	96.456	14			*Hybrid*	3	2.12 b
Hybridization	12.1	1	12.1	1.47 n.s	*S. ovata*	-	-
Error	65.8	8	8.225		*S. tiagii*	-	-
Total	77.9	9			*Hybrid*	-	-

Abbreviations and probability levels as in Table 3.

Table 8. Effect of various pollination treatments on seed weight per fruit (gms) among all the three taxa.

ONE-WAY ANOVA					DUNCAN'S MULTIPLE RANGE TEST (DMRT)		
Source	Ss	Df	Ms	F-value	Treatments	Rank	Mean
Control	7.22064E-04	2	3.61032E-04	24.24***	*S. ovata*	2	0.0283 a
Error	1.78692E-04	12	1.4891E-05		*S. tiagii*	1	0.0291 a
Total	9.00756E-04	14			*Hybrid*	3	0.0140 b
Direct-	0.0010504893	2	5.252447E-04	35.62***	*S. ovata*	2	0.0325 a
autogamy					*S. tiagii*	1	0.0352 a
Error	1.76908E-04	12	1.474233E-05		*Hybrid*	3	0.0162 b
Total	0.0012273973	14					
Indirect-	7.44016E-04	2	3.72008E-04	49.26***	*S. ovata*	2	0.028 a
autogamy					*S. tiagii*	1	0.032 a
Error	9.062E-05	12	7.551667E-06		*Hybrid*	3	0.015 b
Total	8.34636E-04	14					
Geitonogamy	3.968493E-04	2	1.984247E-04	12.62**	*S. ovata*	2	0.0234 a
Error	1.88588E-04	12	1.571567E-05		*S. tiagii*	1	0.0263 a
Total	5.854373E-04	14			*Hybrid*	3	0.0142 b
Xenogamy	7.171373E-04	2	3.585687E-04	6.68*	*S. ovata*	1	0.0218 a
Error	6.435E-04	12	5.3625E-05		*S. tiagii*	2	0.0174 a
Total	0.0013606373	14			*Hybrid*	3	0.0054 b
Hybridization	1.48996E-04	1	1.48996E-04	1.36 n.s	*S. ovata*	-	-
Error	8.76188E-04	8	1.095235E-04		*S. tiagii*	-	-
Total	0.001025184	9			*Hybrid*	-	-

Abbreviations and probability levels as in Table 3.

Hybridization (reciprocal crosses) between *S. ovata* and *S. tiagii* resulted in fruit and seed set. But hybridization seems to be restricted as very few fruits and seeds/fruit were formed due to some genetic barriers between both the species. Both the parental species produced relatively greater amount of fruits and seeds as compared to hybrid. The reduction in fruit and seed set in hybrid may be due to low pollen fertility and meiotic irregularities as discussed earlier (Dawar *et al*., in press).

The results of the present study suggest that all the three taxa are facultative autogamous and hybridization between *S. ovata* and *S. tiagii* takes place in the natural population through insect (*Chrysis* sp.,). However, hybridization is limited due to the scarcity and limitation of the pollinators and also due to some genetic barriers in both the *Sida* species. This may also explain the failure of back crosses and survival of hybrid seedlings.

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