EVOLUTIONARY SIGNIFICANCE OF POLLEN TO OVULE RATIO – A STUDY IN SOME PULSE CROPS

DURING the process of selection, under domestication many undirected but unavoidable changes have been occurring in plants widening the gap between the domesticates and their wild relatives. These domesticate-evolutionary trends may show up either in the vegetative parts of the plant or in the reproductive structures or very commonly in both[1]. However all these changes have been tuned towards a risk free or assured growth under domestication. As a consequence, the plants may have lost or tried to conserve their expendable energy in the process of bringing these changes[2].

Reproductive strategy provides an example where this phenomenon is found to operate. Through domestication, which is associated with the decrease in risks, there has also been a shifting tendency in the reproductive strategy of crop plants[3]. Increased number of pollen per ovule than what is actually needed may be one such process where wild types are expected to produce more than domesticate ones, to stand upto greater risks in their habitats.

This hypothesis was tested experimentally in various crops in four genera comprising of a few cultivated species of pulses and their related wild types or species. A particular species was designated wild, semidomesticated or highly domesticated following Smartt[1]. The number of pollen grains in an anther was counted by squashing individual anthers in 1% acetocarmine stain. A sample of 20 anthers was taken from flowers selected at random of healthy plants grown in pots. The pollen to ovule ratio (P/O) was then computed for each of the species/types using the formula—

P/O = Pollen number per Anther × Anther Number/Number of Ovules per flower

The number of anthers per flower was 10 in all the cases, and the number of ovules was ascertained by counting the number of ovule primordia in the pistil.

The four genera studied, all being autogamous, namely—*Macrotyloma*, *Phaseolus*, *Vigna* and *Glycine* showed similar and parallel trend in the pollen number/anther and pollen to ovule ratio from their wild to domesticated species (Table I). For instance, *Macrotyloma accilare*, a wild species of the highly domesticated *Macrotyloma uniflorus* had twice as high a pollen to ovule ratio as the latter. The latter, an ideal domesticate (as defined by Smartt) is a highly determinant crop with complete annual habit. The semi-domesticate type of *Macrotyloma uniflorus* possessed a P/O ratio in between its highly domesticate type and the wild species.

TABLE I

Pollen number per anther and Pollen to ovule ratio in a few wild and domesticated species of pulses

Sl. No.	Species		Pollen/Anther*	No. of ovules	Pollen : Ovule* ratio
1.	(i) *Macrotyloma uniflorus*				
	(*a*) Determinate	(D)	87·54	5	175·08
	(*b*) Indeterminate	(SD)	140·10	6	233·33
	(*c*) *Macrotyloma accilare*	(W)	248·00	7	354·28
2.	(i) *Vigna sesquipaedalis*	(D)	908·10	20	454·05
	(ii) *Vigna sinensis*	(D)	559·80	12	466·50
	(iii) *Vigna repens*	(W)	1308·75	11	1189·77
3.	(i) *Phaseolus radiatta*	(D)	505·00	10	505·00
	(ii) *Phaseolus mungo*	(D)	505·00	10	505·00
	(iii) *Phaseolus calcaratus*	(SD)	793·25	8	991·56
	(iv) *Phaseolus atropurpureus*	(W)	3377·50	15	2251·67
	(v) *Phaseolus trilobus*	(W)	3764·00	15	2509·33
	(vi) *Phaseolus panduratus*	(W)	1072·00	8	1340·00
4.	*Glycine max*				
	(*a*) Jupitore variety	(D)	225·00	3	750·00
	(*b*) Black Kulti	(SD)	377·00	3	1256·67

D = Domesticated; SD = Semi-domesticated; W = Wild.

* All the variations are significant at 1% level of significance (Analysis carried out for each genus separately).

These differences in P/O ratio were more pronounced between *Phaseolus mungo, Phaseolus radiatta* and their related wild species, namely, *Phaseolus otropurpureus, Phaselous trilobus* and *Phaseolus panduratus,* but, to a lesser extent with *Phaseolus calcaratus* a semi-domesticate species. The same trend exists between the domesticate and wild species of *Vigna.*

Soybean, *Glycine max,* where, recently introduced and highly domesticate varieties and land race material exist, again showed that the land race, Black Kulti, had a P/O ratio twice that of the variety, Jupitore.

The number of pollen grain per anther and the P/O ratio has so far drawn only passing references without any significance to the role it has played in shaping the reproductive strategy of a crop plant[4]. Though there may not, at present, be a strong evidence to assign risk continuums for the species based on their being wild or domesticated, it may be said that there does exists *prima facie* a strong correlation between the reproductive effort of species (measured by pollen number per anther) and P/O ratio.

The significance of the energy budgeting in a species between its vegetative and reproductive parts have been discussed in detail by Calow[4]. In an obvious step, which Maynard Smith[5] further attempts, the reproductive energy could be split into male and female gametes. The allocation of more energy in the wild types for a larger pollen production and hence a greater P/O ratio, needed essentially to cope with the risk factors in the process of pollination and fertilization, is cut down drastically in the domesticated types as evident from this study. Follow-up studies on the mechanisms of such evolutionary changes may have many interesting implications relevant to crop adaptive strategies.

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DEVELOPMENT OF INFECTION STRUCTURE BY UREDOSPORES OF *PUCCINIA RUELLIAE* (BERK. AND BR.) LAGERH.

Uredospores of *Puccinia ruelliae* (Berk. and Br.) Lagerh. were germinated in tap water by De and Roy[1]; but they did not observe differentiation of the germ tubes. The present study deals with the effects of some environmental factors on the development of infection structure by germinated uredospores of *P. ruelliae.*

The uredospores were scraped from the freshly collected infected leaves of *Ruellia prostrata* Lamk. and allowed to germinate in tap water on glass slides at 20° C following the method of De and Roy[1]. The germination occurred within 24 hours. The germinated uredospores were then transferred to tap water of different pH, varying from 2·5 to 7·5 (adjusted with normal NaOH or HCl at 0·5 unit increment) at 10° C, 14° C, 27° C and 30° C under 0, 6, 12, 18 and 24 hours of light (intensity 1,000 lux).

The uredospores are thick-walled, echinulate and yellowish brown in colour (Fig. 1). Only one germ tube was produced by a spore (Fig. 2). The germ tubes tolerated the entire pH range for their differentiation but temperature and photoperiod greatly affected it. Infection structure developed at 20° C and 27° C when the light period was followed by 12 to 18 hours of darkness. No infection structure occurred in complete darkness or in continuous illumination. Under these conditions, the germ tubes merely elongated into long (up to 5,000 μ), unbranched, aseptate hyphae which ultimately withered away. Optimal appresorial formation was induced by exposing the germinating spores to six hours of light at 20° C in water of pH 5·5 and in this optimal condition, 72% of the germinated spores formed infection structures.

Prior to differentiation, the germ tube extended into long, unbranched, aseptate hypha with rounded apical end, the protoplasm occupying a relatively constant volume at the tip of the germ tube, while the rest of the hypha remained almost vacuolated. After attaining a length of 3,000 μ, the germ tube ceased its forward growth and its apical end began to enlarge to form an appresorium. The protoplasm which moved into the developing appresorium was eventually isolated from the rest of the germ tube by a septum (Fig. 3). Then an infection peg began to develop from the appresorium (Fig. 4) within 4 5 hours and its tip started to swell to form the substomatal vesicle (Fig. 5). Soon the protoplasm migrated from the appresorium through the infection peg into the vesicle and shortly after the completion of this migration of protoplasm, a septum was formed between the vesicle and the infection peg. Subsequently, a single unbranched, aseptate infection hypha developed from