DISCOVERY OF ICHNOGENUS *BELORHAPHE* FUCHS, FROM THE GARBYANG FORMATION, MALLA JOHAR AREA, UTTAR PRADESH

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THE Garbyang Formation is a well-defined lithostratigraphic horizon of the Tethys Himalaya which attains a huge thickness of *ca* 700 m in the Malla Johar area, Uttar Pradesh. It was been assigned to the Cambrian age and is represented by dolomite, limestone, sandstone and shale. The environment of deposition of the Garbyang Formatin has been considered as tidal flat to upper part of the shelf mud region of an open tidal sea[1]. The present note records well-preserved ichnogenus *Belorhaphe* Fuchs, 1895[2] from the uppermost lithologic member Garbyang G of Kumar *et al*[1]. (Figure 1a, b) exposed on the Malari-Sumna mule track. This is the first record of *Belorhaphe* from India and is the first record from the Cambrian rocks.

The ichnogenera are the trace fossils which throw light on the animal behaviour at the time of deposition. The ichnogenus *Belorhaphe* is in the form of sharply zig-zag shaped locomotion trails. The angle of the corners is always acute and is generally between 30 and 45°. The length of the trail (length between successive corners) is between 40 and 60 mm. In some corners small protrusion of about 10 mm is also recorded. Breadth of the trails is between 2–3 mm.

The present form resembles *Belorhaphe* Fuchs, 1895 in appearance but significantly the size of the present form is much bigger. Originally *Belorhaphe* Fuchs has been recorded from the Cretaceous to Lower Tertiary rocks, whereas the present record is from the upper Cambrian rocks (Garbyang G). Other ichnofauna known from the Garbyang Formation includes some trails and burrows from the same area[1].

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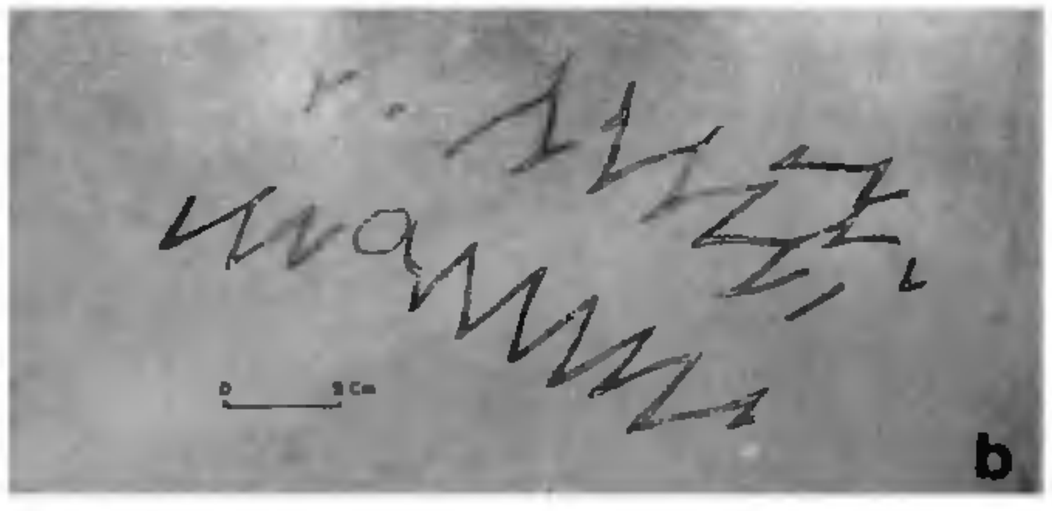

Figure 1a. Ichnogenus *Belorhaphe* Fuchs, the Garbyang Formation, Malla Johar area, Uttar Pradesh. **1b.** Line sketch of *Belorhaphe* Fuchs of figure 1a.

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CROSSABILITY STUDIES BETWEEN GREENGRAM AND BLACKGRAM

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GREENGRAM (*Vigna radiata* (L.) Wilczek) and blackgram (*Vigna mungo* (L.) Hepper) are the two tropical grain legumes having $2n=22$ chromosomes. Direct and reciprocal crosses involving six genotypes of greengram, LM 87, LM 24, MS 8909, LM 72, LM 15 and LM 449 and three of blackgram *viz* Gl, PLS 364/55 and 'Chockenpatti' were made in this investigation. Emasculation and cross-pollination were effected simultaneously in the evening (4–6 pm) and morning (6–8 am) hr. The crossability for different combinations is presented in table 1.

Cross-pollination succeeded when greengram was used as the female parent; the success in pod set varying from 0.7 to 11.5% thereby pointing the genotypic differences governing cross-compatibility. When blackgram varieties figured as female parents, the crossed flowers dropped within 24 hr following cross-pollinations.

To elucidate the probable reason for the one-way compatibility, crossed flowers were fixed after 8 to 24 hr of cross pollination in Carnoy's fluid (3 parts of absolute alcohol and 1 part of glacial acetic acid) for tracing the growth of pollen tubes within the pistil.

TABLE 1

Crossability percentage among different crosses of greengram × blackgram

Blackgram (as male)	Greengram (as female)					
	LM 87	LM 24	MS 8909	LM 72	LM 15	LM 449
G 1	100[a]	123	138	68	93	68
	6.0[b]	9	1	2	3	1
	6.0[c]	7.3	0.7	2.9	3.2	1.5
PLS 364/55	109	111	134	86	78	129
	12	9	4	3	2	5
	11.1	8.1	3.0	3.0	3.5	3.9
Chockenpatti	123	130	181	77	110	79
	9	15	4	3	5	1
	7.3	11.5	2.2	3.9	4.6	1.3

[a] = Number of flowers crossed
[b] = Number of crossed pods obtained
[c] = Crossability percentage

Staining techniques elaborated by other workers were followed[1-5]. Preparations with clarity and details were obtained following technique described below. After fixation of the cross-pollinated flowers for one hr in

Figure 1. Stigma of greengram pollinated with pollen grains of blackgram. Note the growth of pollen tubes (×3000).

Figure 2. Stigma of blackgram pollinated with pollens of greengram. There was no germination of pollen grains (×1500).

Carnoy's fluid, they were washed gently with distilled water. The styles were dissected and placed on a clean slide having 2 to 3 drops of safranin 0 fast green stain (Safranin 0-150 mg, fast green 250 mg, 45% hot acetic acid 25 ml). The styles were left in the stain for 20 hr and thereafter the excess stain was blotted and cleared in 45% acetic acid for 15 min. The styles were then placed on a drop of glycerine, covered with a cover slip and gently pressed before examination.

The bluish green pollen and pollen tubes could easily be traced in the light red-coloured stigmatic and stylar tissues of greengram (figure 1) whereas in the reciprocal with blackgram as ovule parent, there was no pollen germination and pollen tube growth (figure 2).

The stigmatic exudate provides a portion of the carbohydrate needed for wall biosynthesis by the developing pollen tube[6]. According to Martin[7] pollen germination failure after distant cross-pollinations is probably related to differences in the stigmatic environments such as the size, degree of branching and type of papillae and the composition of stigmatic exudate. Since there is no difference in the stigmatic and stylar morphology between blackgram and greengram plants, the failure of pollen germination may be due to the composition of the stigmatic exudate of the blackgram plant which reacts with substances from the pollen of greengram resulting in the failure of stimulation for germination. The chemicals present in the stigmatic exudate of greengram probably had inhibitory action on the germination of the blackgram pollen. Thus the barrier to successful hybridization between blackgram and greengram appears to exist at the pre-fertilization stage itself.

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NATURE OF SALT INJURY AT GERMINATION STAGE IN PADDY

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SEED germination in paddy under salt stress is limited due to the osmotic stress of the medium[1-5]. However, the mechanism of injury in paddy under salinity at seed germination stage has not been clearly studied so far. Hence the sequential changes were studied to establish the basis of salt injury at the initial stages of germination and early seedling growth

Seeds of two rice varieties *i.e.*, Basmati-370 and NC 1281 (fine and coarse grain respectively) were germinated in varying concentration of salt solution. Three levels of electrical conductivity (EC) *i.e.*, 1.3, 9.2 and 14.3 m mhos/cm were prepared using different dilutions of seawater from Mala river. Experiment was replicated sixteen times. Periodic observations on water absorption, amylase activity[6,7] total soluble protein[8], growth characters and sodium and potassium content in various parts of seed and seedlings from 6 hr to 8 days were recorded.

Water absorption rate was maximum upto 6 hr; there was then a sharp decrease at 24 hr at all salinity levels and at 48–72 hr there was an increase again but the increase was less at higher salinity levels in paddy seed. Delayed induction of seed germination, seed coat rupture and radicle emergence in paddy under salt stress have been reported[1]. This delayed germination was perhaps due to decreased water absorption under salt stress. Total soluble proteins increased with time at all salinity levels but salt and varietal differences were meagre at this stage. α-amylase activity increased with time but decreased with increase in salinity (table 1). Interaction effect was non-significant upto 72 hr but effects were significant at 96 hr and thereafter. At 120 hr Basmati-370 had higher enzymatic activity upto EC 9.2 but at EC 14.9, coarse variety NC 1281 had higher activity.

It was interesting to note that at germination stage, much of the sodium of the medium is retained in the seed coat as compared to rice grain (endosperm) at 2 days after sowing. At later stages upto 8 days, also husk contained more sodium while root had higher sodium than shoot and NC 1281 had lower sodium content than Bas-370. Potassium was more in the endosperm than in husk and shoot had more potassium than root and variety NC 1281 had higher potassium than Bas-370. At 8 days of sowing, the root and