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EFFECT OF SULPHUR ON BACTERIAL NODULATION OF GROUNDNUT ROOTS

THE fixation of elemental nitrogen by the symbiotic nodule bacteria needs no emphasis. It has long been recognized that certain crops such as clovers, alfalfa, peas and other legumes improve the soil in some way, making it possible to get higher yields of cereals after these crops. Lyon and Bizzell[1] in a ten-year experiment at Ithaka, New York, found that the amounts of nitrogen fixed in pounds per acre per year were 251, 168 and 105 by nodule bacteria of alfalfa, sweet clover and soyabean, respectively.

The nodulation in legumes was stimulated by fertilizing the soil with sulphur and its compounds as was observed by several workers.[2-8] Tacheuchi[9] reported that higher dose of sulphur and its compounds gave a decreasing effect upon the number of nodules.

Groundnut plants (*Arachis hypogæa* L.) T, 32 were raised in washed silica sand in pots. The plants were supplied with complete nutrient solution, the formula for nutrient solution is given in Table I (Tisdale *et al.*[10]) and distilled water for irrigation. All the pots received 5 ppm iron tartarate, 2 ppm manganese chloride, 3 ppm boric acid and 1·4 ppm molybdic acid. pH of the final solution was adjusted to 6·5 by adding N/10 NaOH. Nutrient solution was added at the rate of 250 c.c. per pot on alternate days. At periodical intervals, the whole plant was pulled off with the help of distilled water running through rubber tube in the root zone, taking precaution not to injure the root nodules. The nodules were then separated and counted.

TABLE I

Composition of nutrient solution and compound of sulphur used

Treatment	Doses of S ppm	Gm. of salt per litre of water					
		KNO_3	KCl	K_2SO_4	$CaCl_2$	$MgCl_2$	$Ca(HPO_4)_2 . H_2O$
S_0	0	0·505	0·220	0 0000	0·33	0·19	0·125
S_1	3	0·505	0·215	0·0054	0·33	0·19	0·125
S_2	9	0·505	0·204	0·0163	0·33	0·19	0·125
S_3	27	0·505	0·171	0·0489	0·33	0·19	0·125
S_4	81	0·505	0·073	0·1468	0·33	0·19	0·125

An observation of the data in Table II reveals that number of nodules per plant at the time of harvest increased from 9·3 to 121·3 with the enhancement of sulphur concentration from 0 to 9 ppm in the nutrient solution. Further increase in sulphur concentration upto 81 ppm showed a corresponding decrease in the number of nodules per plant. The treatments showed significant difference and treatments S_3 and S_4 were of equal effect.

TABLE II

Effect of sulphur concentrations on the number of nodules per plant of groundnut

S. No.	Treatment	Doses of S ppm	Age of crop in days							Mean	Index	Weight of root at 160 days per plant
			20	40	60	80	100	120	140			
1	S_0	0	0·4	1·8	3·3	4·7	6·3	8·0	9·3	4·8	100	0·467
2	S_1	3	0·5	5·0	25·0	29·3	35·3	40·0	51·0	26·6	548	0·467
3	S_2	9	5·6	23·7	60·6	78·3	108·3	118·7	121·3	73·1	1304	1·050
4	S_3	27	2·9	20·0	51·3	67·3	73·3	93·3	103·3	58·8	1111	1·167
5	S_4	81	2·4	11·3	33·7	47·0	60·0	78·3	85·3	45·4	917	1·133
	Mean		2·4	12·4	34·8	45·3	55·6	67·7	74·0	..	..	0·857
	C.D.		..	..	..	..	..	..	..	18·60	..	..

The reduction in nodulation due to sulphur deficiency corroborates with the findings of Gaw and Soong,[7] Ivanoff[8] and Bledsoe and Harris.[6] This decrease may be attributed to the deficiency of sulphur, which is a nutrient element, and restricted supply of sulphur-containing plant proteins which are essential for the multiplication and growth of symbiotic bacteria. The decrease in root size may be a factor for the reduction in nodulation, but the effect of deficiency appears to be more marked on nodulation as compared to size (weight) of roots.

The decrease in number of nodules in treatments with 27 and 81 ppm of S may be due to inhibitory effect of sulphate at higher concentrations. A similar effect was also observed by Tacheuchi.[9]

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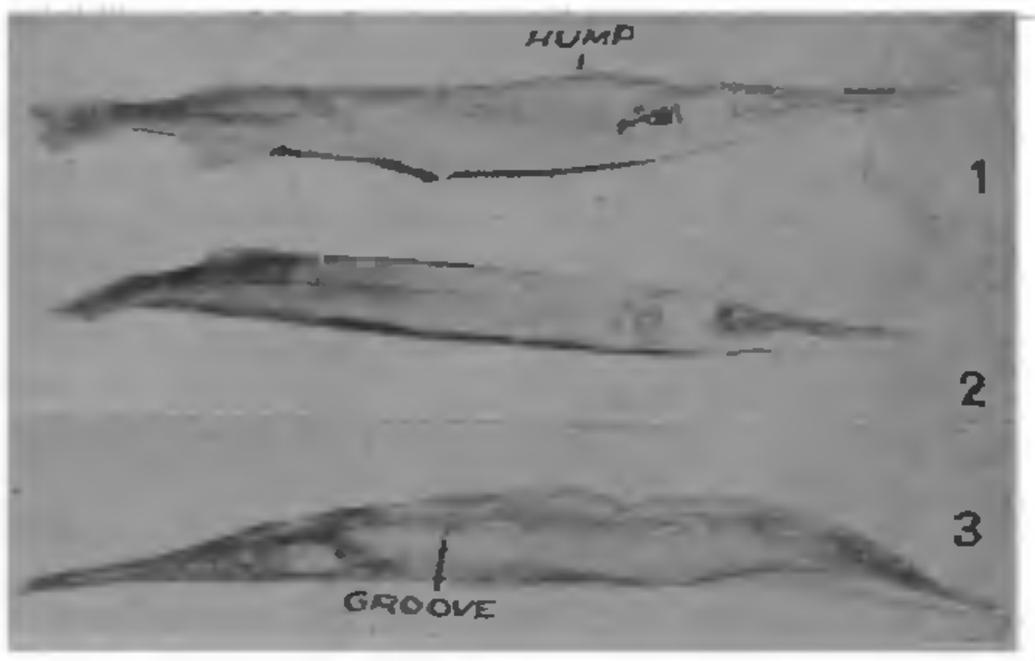
SEXUAL DIMORPHISM IN THE GAR FISH, *XENENTODON CANCILA*

DAY[1] describing *Belone cancila* (*Xenentodon cancila*) states, "There is a variety at Hardwar and in Central Provinces, having a hump along the first part of its back, sometimes continued as an elevated ridge as far as the origin of the dorsal fin". In the present study, several hundred specimens were examined from the collections made at Bhopal, Jabalpur, Shivpuri, Gwalior, Dehradun, Muzaffarnagar, Allahabad and the local lakes (Ramgarh and Mahesra) and the rivers (Rapti and Rohin). A good percentage of them was with humped back (Fig. 1) as mentioned above. The hump is darker in colour than the adjoining body surface and its ratio with the head-length determined from random sampling is 1·0 : 2·1. The examination of gonads reveals that the hump-backed specimens are males. On the contrary, females have flat surface with a shallow groove in the corresponding region (Figs. 2 and 3) without any colour differentiation. Thus it is clear that *Xenentodon cancila*



FIGS. 1–3. Fig. 1. *Xenentodon cancila*, male with hump. Fig. 2 *Xenentodon cancila*, female without hump Fig. 3 *Xenentodon cancila*, female showing groove.

exhibits sexual dimorphism and the humn is not a characteristic feature of a different variety as suggested by Day but a male character like that of a pink salmon, *Oncorhynchus gorbuscha* (Norman and Greenwood[2]). The male and female ratio is approximately 1 : 2. Further, certain male specimens show more prominent pink colour on the ventral surface of the lower jaw than those of the females. Whether the factors responsible for such a colouration are ecological or due to hormonal activity is under investigation.

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FOLIAR SCLEREIDS IN SOME SPECIES OF *LIMONIUM* (PLUMBAGINACEAE)

RECENT studies have stressed the importance of sclereid pattern in anatomical taxonomy in many seed plants. During the studies on the comparative morphology of foliar sclereids in several genera, a unique pattern of foliar sclereid distribution in certain species of *Limonium* of significant morphological interest was observed.