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Antagonism Between Molybdenum and Certain Heavy Metals in Plant Nutrition

IT has been recognized in the literature that an excess of either manganese, zinc, copper, cobalt or nickel will induce iron-deficiency chlorosis in plants. Other toxic effects such as stunting and lower leaf necrosis may also occur. These effects have been confirmed in water-culture experiments with flax, conducted at the Plant Research Laboratory, Department of Agriculture, Burnley, Victoria.

In these experiments, it has been further shown that it is possible to reduce the severity of iron-deficiency symptoms, caused by an excess of any one of the above elements, by increasing the supply of molybdenum to the solution. Various concentrations of added molybdenum up to 20 parts per million have been used.

In the case of excess manganese (5–100 p.p.m.), which has been the heavy metal treatment most intensively studied, the added molybdenum reduced the severity of lower leaf necrosis, which is a characteristic manganese-toxicity symptom. A preliminary paper on this subject will be published in a forthcoming issue of the *Journal of the Australian Institute of Agricultural Science*. This describes experiments with flax. Manganese/molybdenum antagonism has since been demonstrated in water-culture experiments with peas, cabbages and tomatoes.

In Victoria, on highly acid soils, a previously undescribed disease of flax occurs which has been called 'lower leaf scorch'. Previous to the water-culture work outlined above, it was found that lower leaf scorch could be prevented by liming, and aggravated by sulphur, steam sterilization, or manganese sulphate. Affected plants were found to contain a higher manganese concentration than normal. In the past two seasons the disease has been prevented, in both pot and field experiments, by applying small amounts of ammonium molybdate (1–2 lb. per acre). In further pot experiments with highly acid soils (pH 4·8), heavy dressings of manganese sulphate (up to 10 cwt. per acre) caused severe lower leaf scorch. However, where ammonium molybdate (2 lb. per acre) was added with the heavy dressings of manganese sulphate, the severity of manganese-induced lower leaf scorch was much reduced. Applications of some samples of superphosphate have been effective in preventing lower-leaf scorch of flax. Such samples have been found to contain significant amounts of molybdenum impurity.

In a preliminary experiment, I have found that flax grown in water-cultures without molybdenum, but with a normal supply of manganese and iron, has shown a slight general chlorosis, and a necrosis of the lower leaves commencing at the edges. These symptoms appeared to be similar, if not identical, with those of lower leaf scorch or manganese toxicity.

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Synonymy of the Nudibranch Genera *Pellibranchus* and *Okadaia*

SINCE the publication of a paper[1] describing *Pellibranchus cinnabareus* as a new genus and species of non-pelagic nudibranch mollusc, Dr. Nils H. J. Odhner, of the Riksmuseet, Stockholm, has pointed out to me that *Pellibranchus* is a synonym of *Okadaia* Baba[2]. *Okadaia* contains small nudibranchs less than 5 mm. in length, limaciform, head and foot not carinate; rhinophores simple, contractile, without sheaths; mouth slit-like; gills absent; anus and nephroproct opening slightly to the right of the mid-dorsal line, about a third of the way back from the head; genital orifices obliquely in front of the anus on the right side of the body; jaw plates absent; radula formula, 3, 0, 3; liver divided into three or four lobes; true heart not enclosed in a pericardium; gonads consisting of two or three testes and five or six ovaries; development is direct. These are the characters of the nudibranch described in my paper, and *Pellibranchus* is clearly a synonym of *Okadaia* which now contains *Okadaia elegans* Baba, 1930, the type from Japan, and *Okadaia* (= *Pellibranchus*) *cinnabareus* (Ralph, 1944) from New Zealand.

Both *O. elegans* and *O. cinnabareus* frequent the intertidal zone. Towards the beginning of October, *O. elegans* begins to lay eggs underneath stones. Adult animals and eggs of *O. cinnabareus* can be found under the surface of stones at all seasons of the year. *O. elegans* is most abundant from January to April. Specimens of *O. elegans* are known to occur along the Pacific Ocean side of Japan from Tomoika (Amakusa) to as far north as Akkeshi (Hokkaidô). At present *O. cinnabareus* is known only from tidal runnels along the shore at Island Bay, Wellington.

O. cinnabareus is distinguished from *O. elegans* principally on the structure of the teeth comprising the radula. The first lateral of *O. elegans* has one denticle outside the cusp and two inside, whereas in *O. cinnabareus* the first lateral has only one denticle, which is situated inside the cusp. The third lateral of *O. elegans* takes the form of a squarish plate; but in *O. cinnabareus* it is more conical. Baba[3] gives the colour of *O. elegans* as light orange-yellow. *O. cinnabareus* is bright red. Baba counted 27–54 heart-beats per minute through the transparent integument of *O. elegans*. It is not possible to count the heart-beats in *O. cinnabareus* as the integument is heavily pigmented and non-transparent. Full accounts of the two species have appeared in the *Japanese Journal of Zoology*[2] and the *Transactions of the Royal Society of New Zealand*[1].

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