Table 1. ROOT GROWTH IN TOXIC SOLUTION AS A PERCENTAGE OF NORMAL GROWTH

Concentration (micromoles/l.)		Population							
		1	2	3	4	5	6	7	8
Cu	5	72	4	83	66	7	4	34	4
	10	40	0	49	51	6	1	12	0
	15	20	0	32	29	1	0	4	0
Ni	5	27	12	50	103	43	60	50	30
	10	9	2	11	84	18	43	19	9
	15	4	0	3	70	4	14	10	0
Pb	75	26	18	37	27	16	22	80	28
	125	17	9	20	22	10	18	62	12
Zn	20	37	38	61	65	35	54	54	34
	40	21	17	33	42	19	38	48	21
	60	8	4	24	23	10	27	30	13

near the mine. 6, *A. tenuis* from a mine spoil-heap in North Wales, at first thought to contain lead, but now known to contain no significant amount of lead, but some zinc and possibly other metals. 7, *A. tenuis* from Goginan mine, Cardiganshire, previously described as resistant by Bradshaw[4]. The soil contains lead and zinc in toxic amounts. 8, *A. tenuis* from a meadow near Capel Bangor, Cardiganshire.

Each population except 2, 5 and 8, which were the controls, shows a marked degree of resistance to poisoning by the metals known to be present on the sites from which they were collected. The rather high degree of tolerance shown by the control 5 to nickel may be due to it having been grown in the same container as 4, which may have been removing a significant amount of nickel from the solution. However, without information as to how close to the mine the seed was taken, the possibility of some gene-flow from the nickel-resistant population cannot be eliminated.

A lesser degree of tolerance is also shown, in general, to other metals not known to be present. In the absence of detailed soil analyses, which are proceeding, the presence of other metals in the soil is possible, but it is suggested that the tolerance shown is due to an extension of the resistance mechanism operative against the main toxic agent. Population 6 is rather a special case, but seems to show its main resistance to nickel, although this is not so marked as in the Black Forest population.

On these sites the plant cover is generally very poor, especially where the calcium content is low, and very few species can cope with such an extreme environment. It is notable that two closely related species have proved capable of adapting themselves to meet these conditions with respect to a number of metals in several localities during the short time in which the sites have been available. The necessary genetic variation seems to be present in the genus *Agrostis* throughout a large part of its range.

The order of toxicity shown is copper > nickel > zinc > lead, which agrees with that given by Hewitt[5] and De Kock[6] for a range of plants, and also follows the Mellor–Malley series[7] for the order of stability of metallic-organic complexes. Furthermore, there are indications that the greater the degree of toxicity the more clear cut is the tolerance of it, excluding zinc, where no highly resistant population has yet been found. This lends support to the hypothesis that the resistance is due to the metal ions being bound internally by a process analogous to chelation; such a process would be most effective where the chelates are most stable. This would also explain the high concentrations of toxic metals in plants from poisonous sites noted by various authors[8,9].

However, unlike chelation the process is fairly specific for individual metals. Where activity is shown against lead, a lesser activity is shown against copper; not a higher as would be expected from the series quoted above. The advantage of this to the plant is apparent, in that it does not have micronutrient ions, which may not be abundant, made unavailable internally. If the plants have succeeded in elaborating a series of compounds capable of specific chelation, further study may be rewarding.

D. JOWETT

Department of Agricultural Botany,
University College of North Wales,
Bangor.
July 16.

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Fleas of the Rat in Tanganyika

THE flea records presented here have been based on a two-year study of *Rattus rattus* (L.), the commensal rodent of Tanganyika. No previous list of the flea fauna of *R. rattus* of Tanganyika is known. In all 1,788 specimens of *R. rattus* were obtained and their fleas collected.

The term *Rattus rattus* (L.) used here is one of convenience and embraces the very mixed, interbred population formed of strains of *R. r. rattus*, *R. r. frugivorus*, *R. r. alexandrinus* and *R. r. wroughtoni*, that is peculiar to Tanganyika and perhaps to other parts of East Africa.

Table 1

Fleas	No. collected	Percentage of collection
Xenopsylla brasiliensis (Baker)	723	71·72
Xenopsylla cheopis (Rothschild)	220	21·72
Leptopsylla aethiopicus (Rothschild)	18	1·77
Ctenocephalides felis strongylus Jordan	16	1·58
Echidnophaga gallinaceus (Westwood)	12	1·18
Dinopsyllus longifrons lypusus J. and R.	7	0·69
Pulex irritans Linnaeus	6	0·59
Ctenophthalmus cabirus Jordan	6	0·59
	1,008	

The dominant species, *X. brasiliensis*, was distributed and was dominant in urban and rural areas from sea-level to 6,000 ft., whereas *X. cheopis* was not found above 4,000 ft. *P. irritans* and *Ct. f. strongylus* were fleas of urban rats, but *D. l. lypusus*, *L. aethiopicus* and *Ct. cabirus* were confined to rats from the rural areas. The cosmopolitan *E. gallinaceus* was found in both urban and rural areas.

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J. G. HALCROW

Medical Department,
P.O. Box 110,
Morogoro, Tanganyika.
July 1.