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INFLUENCE OF A CHLOR-ALKALI PLANT ON THE MERCURY CONTENTS OF FUNGI

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Significantly higher contents of mercury were found in fungi growing in the vicinity of a large Finnish chlor-alkali plant than in a control area. The highest concentrations (72-200 ppm dry wt) were found in Agaricus-species. The mercury contents in mycorrhizal fungi did not generally exceed the Finnish safety limit of 0.8 ppm.

Introduction

The high heavy metal concentrations in some edible fungi is a well known problem (1-5). The mercury content in certain fungi may be 100 times more than in green plants. A part (0-28 %) of the mercury is in the form of methyl-mercury (6-9). Lawn decomposing species of fungi (especially the Agaricus species) accumulate mercury very effectively from the substrate (10-11), while the heavy metal contents in wood decomposing and mycorrhizal fungi usually are very low. However, quite high concentrations have been noted in some Boletaceae species - especially in Boletus edulis (1, 3, 7).

Even in unpolluted areas the concentrations of heavy metals in fungi may exceed the safety limits approved for foodstuffs and in the Federal Republic of Germany and in Sweden the use of fungi has been restricted because of their heavy metal content.

The contents of mercury in fungi growing near mercury emitting industries may increase significantly. For example, RAUTER (12) found about 10 times more mercury in mushrooms collected in the vicinity of a chlor-alkali plant in Austria, KOSTA et al. (13) noted very high mercury concentrations in fungi growing near the Yugoslavian mercury mine at Idrija and LODENIUS & LAAKSOVIRTA (14) found high mercury contents in fungi growing around two Finnish chlor-alkali plants. The addition of municipal wastes to the substrate may increase the mercury content of Agaricus bisporus up to 900 % of the baseline concentrations (11).

Material & methods

The study area is situated in SW Finland (Fig. 1). Along the Kokemäenjoki river there are cultivated fields but most of the area consists of coniferous forests. The chlor-alkali plant at Äetsä is the largest one in Finland. It emitted 250 kg of mercury into the air in 1977 (according to information from the company). There is no other industry in this area.

94 samples of macrofungi, mostly edible mycorrhizal species, were collected in autumn 1979 along four transects 0.2, 1, 3 and 8 km from the plant (Fig. 1). From the point "North

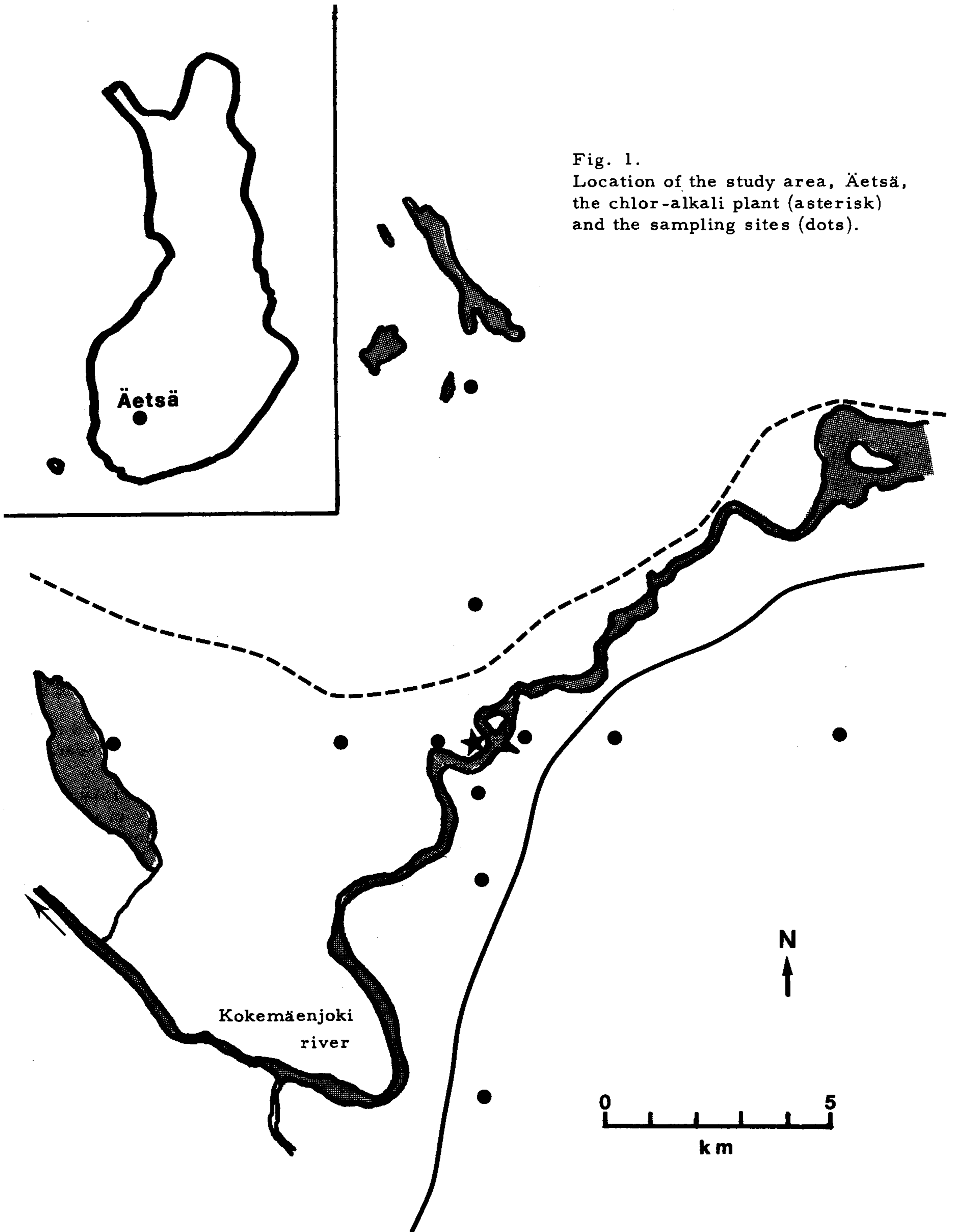


Fig. 1.
Location of the study area, Äetsä,
the chlor-alkali plant (asterisk)
and the sampling sites (dots).

1 km" no samples were obtained because the area is cultivated. From each locality we tried to get at least one sample of the following fungi: Lactarius necator, L. rufus, Russula emetica, R. paludosa, Amanita muscaria and some species of Boletaceae. From the lawns around the plant some lawn decomposing fungi were also collected. The mercury concentrations were compared to mercury contents in fungi collected in Mäntyharju, an unpolluted area 225 km E of Äetsä.

The samples were collected and analysed as described earlier (15) but 23 of the samples were divided into two portions, one of which was washed with tap water before drying in order to estimate the amount of washable mercury on the surface. The contents of mercury are given on a dry weight basis.

Results

The contents of mercury in fungi are given in Table 1. Fungi around Äetsä, even 8 km from the chlor-alkali plant, contained significantly more mercury than those from the control area. Lactarius rufus and L. necator contained 3.3 and 50 times more mercury at 8 and 0.2 km respectively from the chlor-alkali plant. In Russula emetica and R. paludosa the concentrations were 5.0 and 120 times higher respectively. There were no clear differences between Russula emetica and R. paludosa, while the concentrations seemed to be a bit higher in Lactarius necator than in L. rufus.

The increase of mercury content in Lactarius and Russula species towards the chlor-alkali plant was very clear. It seemed to increase exponentially (Fig. 2). There were no significant differences in mercury content between the four transects. The highest values were found 1 km south of the chlor-alkali plant, where there were almost no trees between the factory and the sampling site.

In the Boletaceae group and in Amanita muscaria and A. rubescens there was a considerable variation between the samples and no clear decrease in the mercury concentrations could be noticed. Some rather high mercury contents occurred in the mycorrhizal fungi Rhizites caperata (6.6 ppm), Hygrophorus camarophyllus (2.9 ppm) and Hydnum repandum (0.78 - 1.2 ppm). In Cantharellus cibarius, which is a very popular edible fungus in Finland, no mercury was found in the only sample collected 1 km from the factory. In the lawn decomposing Agaricus species the mercury contents were very high (mean 140 ppm) in the immediate vicinity of the chlor-alkali plant.

A 10-20 % loss of mercury was detected in the water washed samples collected 0.2 or 1 km from the plant, while no effect of washing could be noted at distances of 3 or 8 km from the plant.

Discussion

The results of this investigation confirm the comprehension about the spread of air-borne mercury from chlor-alkali plants which has resulted from analysis of snow (16), moss (17) and lichens (18); the highest concentrations are in the immediate vicinity of the factory and they decline first rapidly then slowly with increasing distance from the plant. A considerable part of the mercury spreads far from the pollution sources (19).

The mercury concentrations found at Äetsä were somewhat lower than in corresponding species collected near an Austrian chlor-alkali plant (12) but the increase in mercury content is in the same order of magnitude. The concentrations at Äetsä were at the same level as those observed in 1978 when some preliminary measurements were made (14).

According to the Finnish Board of Trade and Consumers Interest (20) the highest allowable mercury content of fungi is 0.8 ppm of fresh weight which corresponds to 9.1 ppm of dry weight if the dry weight of fungi is assumed to be 8.8 %. In our material from Äetsä only one sample of mycorrhizal fungi exceeded this limit and in most samples the mercury content was considerably lower. In Agaricus samples collected near the chlor-alkali plant the mercury contents exceeded the safety limit 15-fold. As the washing of fungi does not significantly lower the concentrations, fungi growing on lawns around chlor-alkali plants should not be used for human consumption.

Table 1. Mercury contents (ppm dry wt) in fungi growing at increasing distances from the chlor-alkali plant at Äetsä and in the control area.

Species	0.1 km			1 km			3 km			8 km			Control area		n
	W	S	E	S	W	E	S	W	E	N	Mean ± s.d.	Range			
<i>Lactarius necator</i> (Fr.) Karst.	2.0	1.0	0.22	0.91	0.10	0.35	0.14	0.06	0.16	0.24	0.09	0.074	0.02 - 0.20	5	
<i>L. rufus</i> (Fr.) Fr.		0.13	0.12	0.03	0.13	0.08	0.09	0.08	0.16	0.16	0.06	0.020	<0.01 - 0.09	6	
<i>Russula emetica</i> (Fr.) S.F. Gray	2.7		0.65	0.05	0.44	0.04	0.10	0.05	0.05	0.05	0.46	0.008	<0.01 - 0.02	6	
<i>R. paludosa</i> Britz.		4.1	0.03	0.05	0.09	0.12	0.07	0.07	<0.01	0.04	0.18	0.044	0.02 - 0.07	5	
<i>Russula</i> sp.	2.1	3.7	0.49	0.24	0.38	0.12	0.07	0.07							
<i>Leccinum</i> sp.		0.82	0.75	0.76	1.9	0.57	0.75	0.28				0.225	0.14 - 0.34	11	
<i>Boletus edulis</i> Fr.		0.23	1.1	1.1		1.4						0.613	0.41 - 0.73	4	
<i>Tylophilus felleus</i> (Fr.) Karst.		2.4		0.59		0.46	0.88				1.4				
<i>Suillus luteus</i> (Fr.) S.F. Gray												0.08		1	
<i>S. variegatus</i> (Fr.) O. Kuntze												0.096	0.07 - 0.15	5	
<i>Amanita muscaria</i> (Fr.) Hook		1.8		1.7	1.2	1.3	3.0	0.50	0.49	1.2	0.41	0.260	0.19 - 0.32	8	
<i>A. rubescens</i> (Fr.) S.F. Gray						2.0	1.1		1.7	1.2	1.2	0.12		1	
<i>Albatrellus ovinus</i> (Fr.) Kotl. & Pouz.						0.08	0.17		0.06		0.18	0.067	0.04 - 0.09	3*	
<i>Hydnum repandum</i> (Fr.) Fr.						0.78	1.2				0.06	0.463	0.29 - 0.62	4	
<i>Inocybe</i> sp.	0.22														
<i>Rhizites caeperata</i> (Fr.) Karst.						6.6						0.73		1	
<i>Cantharellus cibarius</i> Fr.												0.015	0.01 - 0.02	2	
<i>Paxillus involutus</i> (Fr.) Fr.	4.2														
<i>Hygrophorus camarophyllus</i> (Fr.) Duméeé, Grandj. & Maire									2.9						
<i>Marasmius oreades</i> (Fr.) Fr.								1.7	3.6			1.74	0.26 - 6.4	7	
<i>Psathyrella candolleana</i> (Fr.) Maire		0.37										0.04		1	
<i>Agaricus</i> sp.	200							5.7*				4.20	1.6 - 6.8	2	
	72														
	150														

* these samples were collected 30 km NW of Helsinki

* Agaricus arvensis 5 km S of the factory

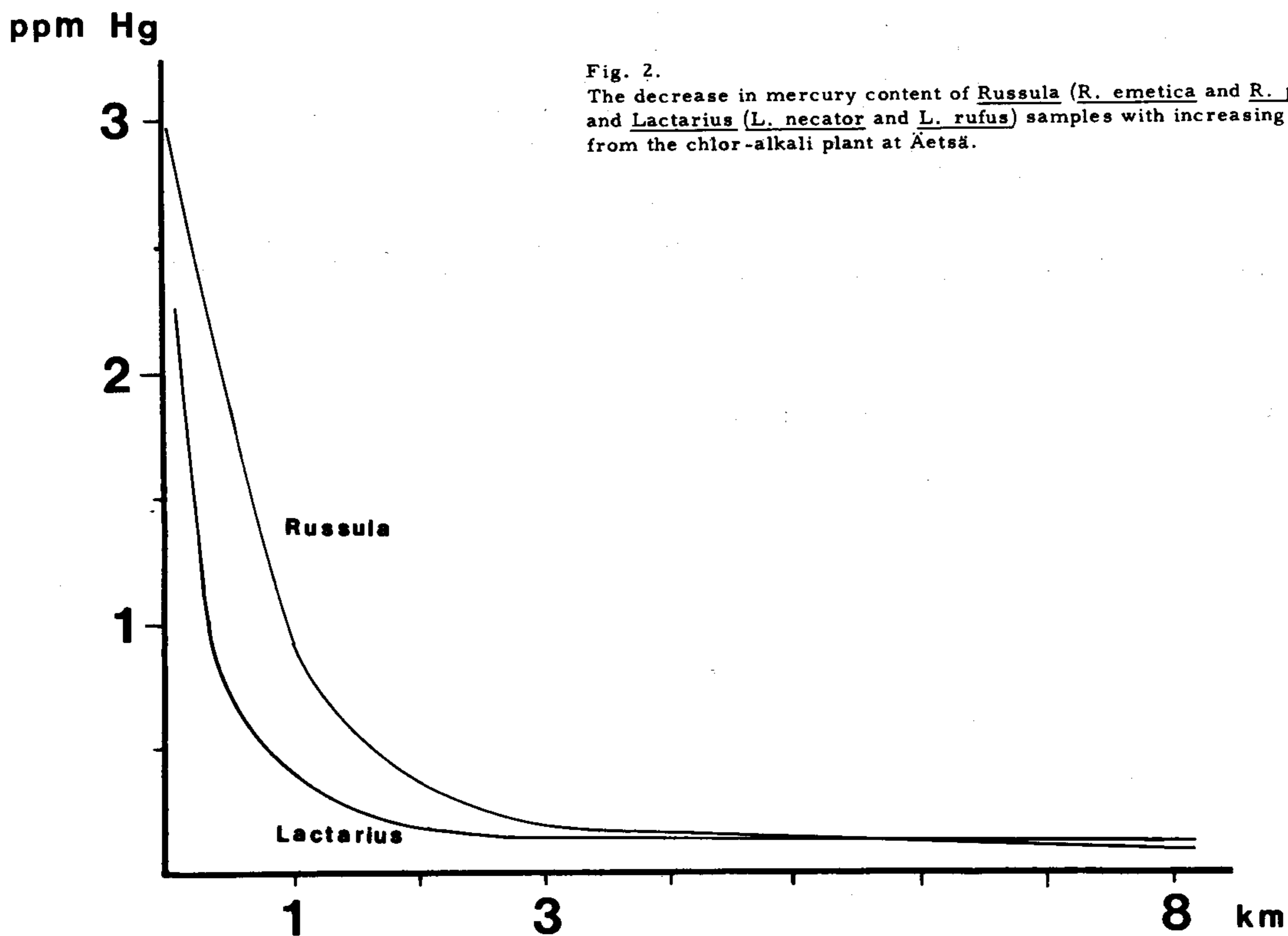


Fig. 2.

The decrease in mercury content of *Russula* (*R. emetica* and *R. paludosa*) and *Lactarius* (*L. necator* and *L. rufus*) samples with increasing distance from the chlor-alkali plant at Äetsä.

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