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The 5th Annual Conference of the I. S. F. R. will be held on March 19 to 22, 1973 in Oxford, England. Details will appear in the July issue. Abstracts of 250 words in English in triplicate should be mailed prior to October 15, 1972, to the Secretary, International Society for Fluoride Research, Box 692, Warren, Michigan 48090.

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FLUORIDE is listed in
Current Contents Agricultural
Food and Veterinary Sciences

EDITORIAL

SEA SALT AND SKELETAL FLUOROSIS

In 1940 Pandit et al. (1) observed an incidence of 23% fluorosis in a group of over one thousand persons in South India whose drinking water contained 2.5 to 5.0 ppm fluoride.

In commenting on this report, Nikiforuk and Grainger (2) suggested that fluoride contained in sea salt might be a significant factor in causation of the disease. This theory had been proposed previously by Shaw et al. (3). When confronted with an excessively high fluoride content in teeth (0.030% in enamel and 0.071% in dentin) in certain individuals in Delhi, India, they estimated that only 1/3 of the fluoride could have been ingested through the water because of its low fluoride content, namely 0.25 ppm. On the assumption that sea salt contained 40 ppm fluoride and that sea salt is an important contributor of fluoride in the diet, they calculated that the per capita consumption of salt by the natives might range between 42 to 58 grams per day. In 1962, Hadjimarkos (4) estimated that sea salt in children's diet could provide daily between 0.4 and 1 milligram of fluoride.

The concept that sea salt contains approximately 40 ppm of fluoride is based on the 1933 studies by Thompson and Taylor (5). However, they were not aware that the bulk of fluoride together with gypsum is precipitated as relatively insoluble fluoride during the early stages of evaporation of sea water (6), thus causing the fluoride concentration of sea salt to be lower than that found in the sea water's total dissolved solids.

In contrast to the 40 ppm value, Venkatarayachari (7) found only 13.5 to 15.5 ppm of fluoride in sea salt locally available at Tirupati in South India. In 1971 Rao (8) reported even lower values from 7 localities in India, namely 4 to 17 ppm as determined by the National Institute of Nutrition in Hyderabad. According to a 1966 Special Report by the Indian Council of Medical Research (9) ten grams per day was the average per capita consumption of sea salt by an adult in India. Another 1966 report (10) raised this figure to between 12 to 20 grams.

From the available information, Rao (8) concluded that sea salt contributed fluoride in the amount of 0.05 to 0.34 mg per day. On the basis of individual consumption of six pints of water per day in India (1), the maximum amount of fluoride that can be obtained from sea salt is equal to an average daily fluoride uptake through drinking water whose fluoride content is 0.1 ppm.

Thus, the widely accepted concept that sea salt contributes materially to skeletal fluorosis in India is not substantiated. Rao concludes that provision of defluoridated sea salt to Indian people would not greatly benefit them in prevention of dental and skeletal fluorosis.

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FLUOROSIS OF SHEEP CAUSED BY THE HEKLA ERUPTION IN 1970

by

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SUMMARY: For centuries, eruptions of the volcano Hekla in Iceland have caused serious damage to domestic animals.

This study is concerned with the effect of the May 5, 1970 eruption. On that day, samples of ash contained up to 2,000 ppm of fluoride. The values decreased to 10% within two weeks and to 2% within three weeks. During the first week stagnant surface water contained up to 70 ppm fluoride, running water up to 10 ppm.

Where the layers of ash on the ground were about 10 mm thick, grass analyzed for fluoride showed 4,300 ppm on the second day after the eruption. This level fell to less than 30 ppm after 35 to 40 days, partly due to heavy rainfall.

Acute fluorosis accounted for a mortality of approximately 3% of the sheep and 8 to 9% of lambs in the affected area during the first few weeks. Convulsive seizures, pulmonary edema, kidney and liver changes accounted for the deaths.

Subsequently, no evidence of skeletal fluorosis was noted except for slight periosteal thickening in less than 0.25% of 400 animals which were x-rayed. In the bones of lambs, fluoride concentrations increased about 4 fold of normal, but in adult sheep only about 50%.

In spite of the relatively short time exposure to fluoride, dental fluorosis occurred in 25.3% of the third incisors which erupted 4 to 9 months later and in 8.6% of the second incisors which erupted 9 to 13 months after the volcanic eruption.

1. Historical Background

Diseases of domestic animals following volcanic eruptions have been known for centuries in Iceland. The earliest descriptions of toxic symptoms due to ash from a volcanic eruption were written in 1694, one by farmer Oddur Eiriksson, the other by clergyman Benedikt Pétursson. They describe dental lesions; stained and

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Presented at the Fourth Annual Conference of I.S.F.R., The Hague, 10/24-27/1971.

defective incisors with excessive wear, which were called "ashteeth" (1); in young sheep, cattle and horses following the Hekla eruption of 1693. These constituted the first record of the dental lesions in Iceland which are now recognized to be caused by fluorine in the volcanic ash.

To the comprehensive accounts of dental lesions in domestic animals following the eruption of Lakagigir in 1783 by Magnus Stephensen and Hannes Finnsson (1) the latter added affections of molars leading to the condition known in Iceland as "gaddur" meaning spike. He observed that affected animals were sensitive to cold water and that "gaddur" makes a delayed appearance after young animals have been exposed to volcanic ash.

The Danish botanist Schyte (2) and the Icelandic farmer Oddur Erlendsson added other features to the toxic symptoms caused by volcanic ash in their description of diseases of animals following the eruption of Hekla in 1845. For example, the latter's detailed account of dental lesions is supplemented by an exact description of bone changes. About 90 years later Roholm (3) analyzed the fluorine content of bones from this eruption and thus proved that these bone changes were caused by fluorine. He also produced similar lesions in sheep which were fed hay to which NaF had been added.

During the 1947 eruption of Hekla, volcanic ash fell on farmland in the adjoining districts. Now for the first time, it was possible to analyze the fluorine content of ash as well as water and vegetation contaminated by it. The ash contained 70 to 110 ppm water-soluble fluorine compounds (4). Sigurdsson and Palsson (5) found symptoms of chronic fluorosis in sheep on farms in the neighborhood of Hekla. They also produced fluorosis in sheep experimentally by mixing volcanic ash collected from this eruption with drinking water and hay.

The main purpose of this short historical survey is to emphasize that diseases of domestic animals caused by volcanic eruption have been known in Iceland for a long time.

2. Current Observations

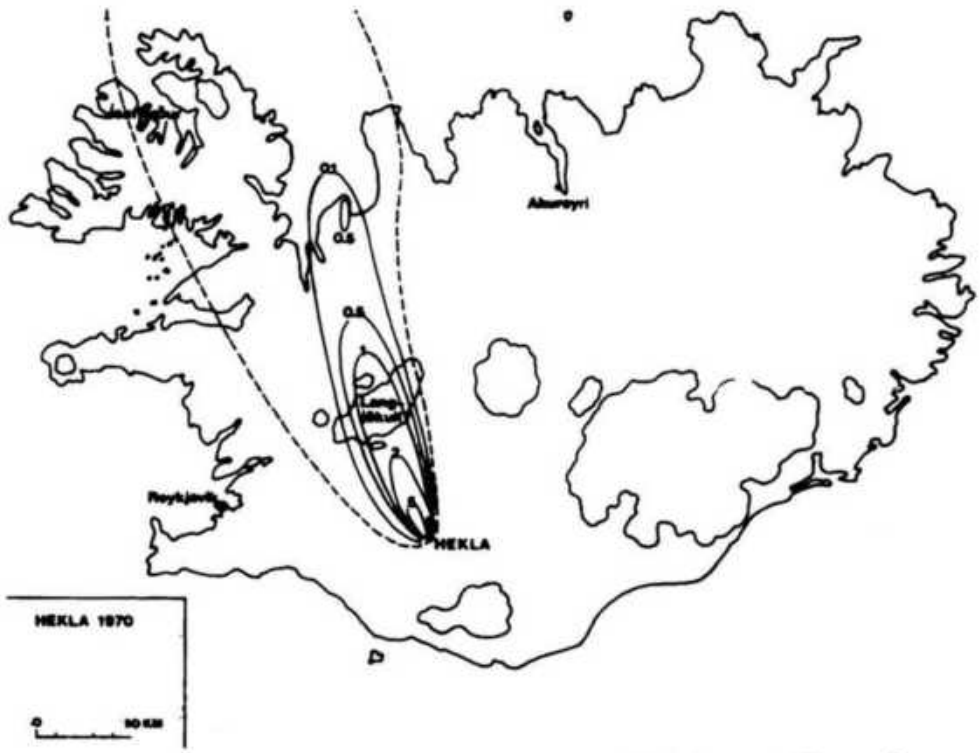
The most recent eruption of Hekla began on May 5, 1970. During the first hours of the eruption volcanic ash fell over a wide area.

As shown in Fig. 1 a great sector of the western part of the country was covered with ash, including farmland in the south and north as well as grazing areas in the interior. It should be pointed out that signs of chronic fluorosis were found only within the area covered with a layer of ash 0.1 cm of more, but acute sickness occurred likewise where only a trace of ash fell.

Analysis of the ash of samples taken on the first days after the eruption showed up to 2000 ppm of water-soluble fluoride in the south and as high as 1400 ppm in the north. The fluoride content of the ash had decreased within 2 weeks to 10% of the original value, and within 3 weeks to between 1 and 2%.

Fig. 1

Distribution of Ash



----------Limits of ash covered area ——————Thickness of layer in cm

There was a distinct increase of fluoride in water. Values in the first week ranged from 4 to 70 ppm in stagnant surface water, after two weeks, they ranged between 0.30 and 14 ppm. In running surface water, the highest values were 10 ppm on the first day but they declined rapidly. After two weeks, values ranged from 0.25 to 0.50 ppm. In deep artesian wells, the corresponding values were always less than 0.70 ppm.

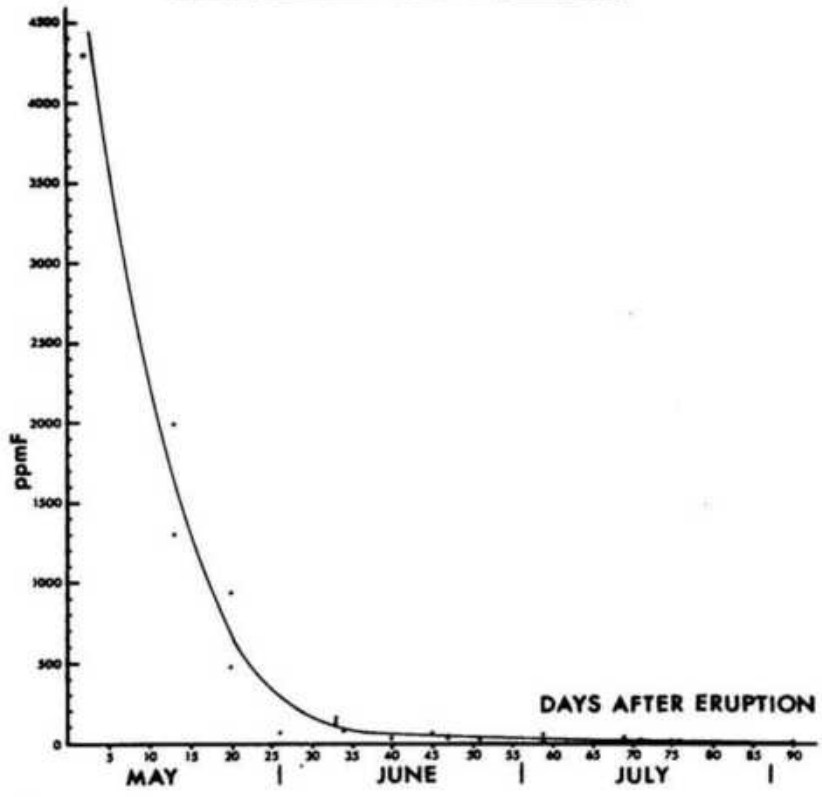
On the first days after eruption, samples of vegetation were taken for fluoride analyses. Figure 2 shows the results of fluoride analysis of grass on the farm Haukholt, where the layer of ash was about 10 mm thick. The initial value on the second day after the eruption was 4,300 ppm, one of the highest values recorded. The fluorine content of the grass fell rapidly, partly due to heavy rainfall during this time. Thirty-five to 40 days after the beginning of the eruption it was less than 30 ppm, a fluoride content generally accepted as innocuous even in long term experiments. Fluoride analyses from other farms in the ash-covered area conformed in general to this same pattern.

It should be emphasized that exposure to high levels of fluoride endured for a maximum of 5 to 6 weeks. It must, however, be stressed that the period of exposure of sheep to fluoride varied in the ash-covered area due to difference in sheep management. This difference was reflected in a varying frequency of both acute and chronic fluorosis. Many farmers kept the sheep away from con-

taminated pasture for the first 3 weeks. Nevertheless, the estimated daily fluoride uptake by sheep on these farms was approximately 2.5 mg per kg body weight.

Fig. 2

Fluorine in Grass Following the Eruption of Hekla 1970
(ppm F^- in Dry Matter) Haukholt



Acute Fluorosis

Sheep grazing outdoors as the volcanic ash was falling were frightened, restless and nervous. The major acute symptoms were loss of appetite, especially for concentrates, drowsiness, general prostration. Lameness, often intermittent, was observed. Gastro-intestinal symptoms with blood-stained diarrhea were frequent. In some cases respiratory symptoms with cough and dyspnea were noted. Loss of wool was often observed in sheep recovering from the acute symptoms. Blood samples showed low serum calcium levels in many cases, with the lowest values recorded at 5.30 mg%. The fluoride content of the urine was greatly increased; often values ranged from 30 to 60 ppm. The highest value of fluoride in urine was 93 ppm. With good care, by keeping sheep away from contaminated grass and water, by adding aluminum sulphate to the mineral supplements to reduce the resorption of fluorine and by giving calcium injections to prostrate sheep, many

recovered. Nevertheless there was a substantial mortality from the first days onwards throughout the first few weeks. Approximately 3% of sheep and 8 to 9% of lambs in this area died. Some sheep which died during the first hours or days showed convulsive seizures and blood-stained froth in mouth and nose terminally. At autopsy blood-stained froth was found in the trachea and bronchi. The lungs were heavy, blood-filled and edematous. The mucosa of the air passages was hyperemic with diffuse bleeding. The heart was dilated with a passive congestion of the internal organs. In the liver and in the cortex of the kidneys, yellowish areas were seen. The intestinal mucosa was often reddened; the contents were thin and blood-stained.

Microscopic examinations showed hemorrhagic tracheo-bronchitis; edema, congestion and bleeding in the lungs. In the kidneys degeneration and necrosis of the proximal convoluted tubules and protein casts were observed. The liver showed congestion and slight fatty degeneration in a few cases. Fluoride analyses of the rumen contents yielded values of several hundred ppm. The only sign in sheep which died a few weeks after the eruption was progressive wasting.

The clinical signs, pathological and biochemical changes found during the first days are consistent with acute fluoride intoxication. According to the high fluoride content in stagnant ponds and in grass it appears likely that on the first days the sheep could have ingested as much as 100 mg fluoride per kg, which is in the range of an acute lethal dose for man and for some laboratory animals.

Chronic Fluorosis

Bone Lesions: Several hundred sheep were examined clinically for fluorotic bone lesions. Bones from sheep and lambs in the area where ash fell, were collected and examined grossly and radiologically, and several bones were submitted for fluoride analysis. Mainly metacarpals and metatarsals but in some cases also mandibular bones were examined. Among the bones of approximately 600 lambs and 100 adult sheep, none showed fluorotic bone lesions macroscopically. X-rays from about 400 cases revealed slight periosteal thickening in less than 10 of them.

A distinct increase in fluoride content of bones in lambs and yearlings was noted, the former showing about 4 fold mean increase and the latter about 3 fold normal values. In adult sheep, the mean increase was only about 50% of the normal value. This tendency to decreasing accumulation of fluoride with age is a well established fact. The fluoride values differed widely, partly because samples were analyzed from the whole area and the degree of contamination varied in different regions, partly because of different management of the sheep. In the area covered with a layer of ash of 0.1 cm thickness or more, the mean fluoride value in lambs was 791 ppm whereas, in the marginal region, the mean value was only 352 ppm.

It is generally accepted that there is a correlation between the accumulation of fluoride in bones and the occurrence of fluorotic bone lesions. In our material, a mean increase of 3 to 4 fold normal values in lambs and yearlings was, as

a general rule, not accompanied by macroscopic or radiologic bone changes. The few cases showing slight periosteal thickening in radiographs had approximately a 6 to 8 fold increase of fluoride in bones. This conforms with most observations on sheep and cattle (6, 7, 8). However, admittedly it is difficult to compare observations by different investigators because of varying criteria used in evaluation of fluorotic bone lesions.

The results of fluoride analysis of bones is summarized in Table 1.

TABLE 1

Results of Fluoride Analysis of Bones
(ppm fluoride in ash)

	Number	Mean	S. D.	Lowest value	Highest value	Normal
Lambs	43	699	345	165	1570	180
Yearlings	21	1781	966	710	3900	560
Adult Sheep	11	1211	294	850	1660	830

Fluorotic Dental Lesions

We began looking for signs of dental fluorosis at sheep gatherings in the autumn 1970 and continued by visiting 10 farms in the north and 10 in the south during winter and spring of 1971. The last examination was made at sheep gatherings late in September of this year. Altogether, about 550 sheep three years and younger have been examined. When we started this study we did not know what to expect. The estimated daily dose of 2.5 mg/kg is in the range reported as toxic in experiments on cattle, whereas a daily dose as low as 0.9 mg/kg causes dental fluorosis (9) in long-term experiments. The question arose whether or not the very short period of exposure to fluoride would produce lesions in the developing permanent teeth. The results of our examination is summarized in Table 2.

The first incisor in sheep, one year old at the time of exposure, which erupted 1 to 5 months later, was always normal, whereas the second incisor of this sheep, erupting 9 to 13 months after exposure, was damaged in 8.6% of observed cases. The third incisor in sheep two years old at the time of exposure which erupted 4 to 9 months later, was most frequently affected i.e. in 25.3% of the observed cases. On the other hand, the first incisor of lambs born at the time of exposure and emerging 13 to 17 months later escaped damage.

TABLE 2

Dental Fluorosis of Sheep Following the Eruption of Hekla in 1970

Incisors	Eruption of teeth in months after exposure to high fluorine	Total number of teeth observed	Normal	Questionable effect	Fluorotic lesions
I_1	1- 5	291	287	4	0
I_3	4- 9	154	109	6	39 (25.3%)
I_2	9-13	186	165	5	16 (8.6%)
I_1	13-17	104	99	5	0

According to our results, the developing permanent incisors of sheep are sensitive to high fluoride levels of very short duration if the exposure takes place approximately 6 to 12 months prior to eruption. We are not aware of any study on the chronology of formation of the teeth of sheep but it is safe to assume that within this period the crown of the incisors is formed. Recently Suttie and Faltin (10), who reported the results of a short term experiment on cattle, produced severe fluorotic lesions of the incisors in heifers by feeding 2.5 mg/kg/daily to one group 13 to 15 months of age and the other 16 to 18 months old. They correlated the time of exposure with the chronology of development of the incisors of cattle as studied by Brown et al. (11) and came to the conclusion that developing incisors are not only sensitive to fluoride during the formation of the crown but also about 1 to 3 months before and after the completion of the crown. By measuring the fluoride content of enamel in sections from the top downwards, they found an indication of a regular pattern of enamel apposition.

In this connection an observation made by us may be of interest: In a 2 year old sheep the second incisors, which were partly erupted, showed severe fluorosis. The first incisors were normal. Five months later, the second incisors were fully erupted and the lower 2/3 of the crown was perfectly normal, but the uppermost 1/3 of the crown was damaged to the extent that it was totally worn away. This sheep had, according to reliable information, only been exposed to fluoride the first two days after the ash had fallen.

The dental lesions in the majority of our cases were severe, falling in grade 4 or 5 according to Dean's classification as modified by Greenwood et al. (12).

This report must be regarded as preliminary because we are certain that not all of the long-term effects have appeared to date, 1 1/2 years after the eruption. A follow up is planned for the next few years.

Acknowledgements: Research on the biological effects of the eruption was carried out in collaboration with the Institute for Agricultural Research and the Industrial Research and Development Institute, Reykjavík. We are indebted to H. Thormar for carrying out fluorine analyses, to S. Thórarinsson for Fig. 1, to F. Pálmason for Fig. 2 and to P.A. Pálsson for much advice and help.

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Discussion

Dr. G. Scholl: Did you find fluoride damage and changes in the teeth of sheep within one year after the eruption?

Dr. Georgsson: Yes, we did. We are still following them in our study.

Dr. A. H. Mohamed: What breed of sheep did you use in your study and analysis? Results and reactions could vary according to the different breeds.

Dr. Georgsson: Our studies were concerned only with the regular Icelandic breed of sheep. Yes, it is possible that different breed of sheep may manifest different reactions.

Dr. G. L. Waldbott: Were analyses made for pollutants other than fluorides which could have been responsible for damage? In acute poisoning did you encounter damage to the central nervous system?

Dr. Georgsson: We found traces of thalium, chlorine and others. Many of the sheep were very sensitive to pain, hyperexcitable and irritable. These symptoms and signs could be due to hypocalcemia or to damage to the central nervous system.

Dr. G. Rosenberger: Was any cattle adversely affected?

Dr. Georgsson: No, because the ruption occurred in March 1970, and cattle had not been put out to pasture as yet. Usually they are not let out until much later. In 1970 they were not released before July.

Dr. S. P. S. Teotia: Experiments in dogs and sheep given sodium fluoride did not show signs of bone lesions even after 1 year on a high fluoride diet. We too, found evidence of hypocalcemia in pregnant ewes.

Dr. Georgsson: High fluoride exposure for only 4 to 6 weeks caused these changes after the eruption. No changes were found in the joints, but some were noted in the bones. Hypocalcemia was noted in both pregnant and nonpregnant sheep; most of the ewes were pregnant at that time of the year.

Dr. H. A. Cooke: Were there complaints from humans living in the affected area?

Dr. Georgsson: Only during the first few days following the eruption - due to irritation of the respiratory tract and the eyes by the dust.

EFFECT OF HF ON THE FINE STRUCTURE OF MESOPHYLL CELLS FROM GLYCINE MAX, MERR

by

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SUMMARY: A series of ultrastructural changes were observed in soybean leaves fumigated with 40 to 50 ppb of hydrogen fluoride. In the cytoplasm the presence of small vacuoles was the first noticeable initial change. The fragmentation of the vacuolar membrane occurred either simultaneously or followed immediately. Lipid-droplet-like globules and numerous vesicles occurred subsequently in the cytoplasm and increased as the injury became more severe.

There was a decrease in polysomes and a detachment of ribosomes from the rough endoplasmic reticulum. Free ribosome concentration also decreased as the injury became severe.

Mitochondrial modifications involving dilation of outer and cristae membranes followed by reduction of both cristae number and matrix electron density and the disappearance of mitochondrial granules were observed in the chlorotic leaves. Electron dense inclusions accumulated in some mitochondria as well.

The first noticeable change observed in the chloroplast was the presence of clusters of phytoferritin granules within the stroma after only 2 days of fumigation. Alterations in nuclear structures were observed in later stages of injury.

Numerous small electron dense particles were found on various types of membranes in cells of severely chlorotic leaves. They were distributed on outer mitochondrial membranes, endoplasmic reticula, dictyosomes, tonoplasts, plasmalemma, nuclear envelopes, and disintegrating organelles and vesicles, but were never observed on membranes of chloroplasts and microbodies.

The presence of fluoride has attracted the attention of many workers primarily in certain industrial areas where the emitted atmospheric fluoride concentrates and is accumulated by plants initiating injury.

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Presented at the Fourth Annual Conference of I. S. F. R., The Hague, 10/24-27/71.

Fluoride compounds have a wide range of harmful effects on plants, ranging from non-visible disorders to the death of certain plant species. The mechanisms involved, however, are little understood. Nevertheless, it is known that many physiological and biochemical processes are markedly affected by fluorides (1). Reduction of plant growth (2, 3), induction of leaf chlorosis and eventually necrosis, effects on photosynthesis, on respiration, and effects of cellular metabolites on certain enzyme reactions are well documented phenomena (3, 5, 6).

Limited studies have been made concerning the effect of HF on the fine structure of plant cells. This study was undertaken to establish the fine structural changes in soybean leaf cells induced by HF fumigation.

Method

Soybean (Glycine max Merr. variety Corsoy) seeds were germinated and grown for about a week and transferred to half-strength Hoagland nutrient solution in a growth chamber equipped with both fluorescent and incandescent lights. When the third trifoliate leaves of soybean plants were formed (average of 3 weeks from seed germination), the plants were fumigated with 40 to 50 ppb of HF in a polyvinyl plastic fumigation chamber for periods of 1 to 6 days.

The first trifoliate leaves were mature and fully expanded at the time of fluoride fumigation. The initial visible symptoms developing on these first trifoliates were generally manifested as slight chlorosis in the marginal regions of the leaves. This usually developed at the end of the second fumigation day. No visible injury was observed on the first day. As the fumigation continued, the marginal chlorosis became more and more severe and the chlorotic areas extended from the margins inwardly and interveinally toward the entire leaf. Finally, at the end of six days of fumigation, necrosis developed along the margins of the leaves.

Leaf discs of about 1 mm in diameter were sampled from marginal areas of those first trifoliate leaves, from the control as well as the fumigated plants, fixed according to Karnovsky's method (7), dehydrated (8), thin sections cut and analyzed with a Zeiss EM9A.

The effect of two concentrations of HF, i.e. 40 to 50 ppb and 100 to 150 ppb, on the macroscopic, microscopic and fine structures of one-month-old soybean trifoliate leaves was studied.

Results

Initial visible symptoms that developed on mature trifoliates were generally manifested as slight chlorosis in the marginal regions. As fumigation continued, the chlorosis became more severe and the chlorotic areas extended interveinally from the margins throughout the entire leaf. Finally, the chlorotic areas became necrotic. The younger trifoliates which were expanding or emerging at the time of fumigation, however, developed general chlorosis. Leaf blade malformation and the death of terminal buds resulted with prolonged fumigation. Stems and roots revealed no visible injury symptoms even when the leaves were severely injured.

Control soybean leaves revealed a dorsiventral dicotyledonous leaf anatomy. The first sign of disorder observed under the light microscope was cellular disorganization in a few spongy mesophyll cells which occurred 3 days after initiation of fumigation with 40 to 50 ppb HF. Various degrees of obvious cellular deterioration occurred in all cell types studied. Dispersion of chloroplasts, clumping of cell contents into dark masses, and collapse of cell walls was observed later. The order of injury was first on the spongy mesophylls followed by the lower epidermis and then the palisade mesophylls. Upper epidermal cells and xylem vessels were the last to be affected by HF. Although the number of chloroplasts in both mesophyll layers was not significantly changed, the leaf blade thickness decreased greatly as fluoride injury developed.

Karnovsky's fixative, glutaraldehyde followed by osmium tetraoxide, mixture of glutaraldehyde and osmium textraoxide, and potassium permanganate, were used in preparation of control soybean leaf samples. Karnovsky's fixative seemed to give the best results. Chloroplast ribosomes, chromatin materials and other cell structures were excellently preserved. The structural details of most cellular components were similarly rather well-preserved by fixation with glutaraldehyde followed by osmium tetraoxide. The chloroplast ribosomes, however, were not clearly evident within the stroma by the use of this method. Fixation using a mixture of glutaraldehyde and osmium was not satisfactory. With the exception of vascular tissues, preservation of chloroplast ribosomes, nuclear chromatins, and mitochondrial granules was poor. Also the proteinaceous matrix of both chloroplasts and mitochondria was not properly fixed. Fixation with potassium permanganate gave poor results with all proteinaceous structures except for membranes.

A progressive series of changes occurred in the mesophyll cells of soybean trifoliate leaves after fumigation with 40 to 50 ppb of hydrogen fluoride for 1 to 6 days. The first change seemed to occur after 24 hours of HF fumigation before any visible injury could be detected on the leaves. It involved an increase in the amount of endoplasmic reticula (ER) and their aggregation. Subsequently the amount of ER was reduced and small vacuoles were formed in the cytoplasm after 2 days of HF fumigation. Orderly crystalline arrays of an iron-protein complex granules -- phytoferritin, accumulated within the stroma of some chloroplasts.

On the third day of injury, accumulation of lipid-droplet-like globules in the cytoplasm was evident. Partial dilatation and detachment of ribosomes from rough ER was often observed and some ER as well as dictyosome cisternae were fragmented (vesiculated). Mitochondrial membranes showed a slight swelling and a few mitochondria showed loss of their matrix electron density. Tonoplasts in many cells began to break up into vesicles, and many multivesicular bodies appeared in the cytoplasm.

As the injury became more severe after 4 days of fumigation, the deterioration of mitochondria was more evident. The electron density of the matrix was reduced further and most of the mitochondrial granules disappeared from the mitochondrial matrix. Small vacuoles, lipid-globules, and multivesicular bodies were

still present in the cytoplasm. Tonoplasts continued to break up but the cell content retained its peripheral location. Most ER and dictyosomes were partially dilated and detachment of ribosomes from ER surfaces was also evident. Free ribosomes in the cytoplasm were also greatly reduced in number.

Chloroplasts became more or less rounded in shape but contained most normal components. Many, however, contained reduced grana-lamellae membrane systems and more and larger osmiophilic globules (plastoglobuli). Some chloroplasts showed a loss of their stroma materials, especially those in the spongy mesophyll cells. Chloroplast ribosomes were not evident in most chloroplasts. Electron dense vacuolar inclusions were observed in many cells. Their appearance, however, did not follow a strict pattern.

Many nuclei were enlarged and lobulated and contained morphologically different types of nuclear inclusions. A volume increase in some nucleoli was also observed at this stage of HF injury.

After 5 days of fumigation severe chlorosis developed on the first trifoliate leaves. The cell content started to disperse throughout the cell and disintegration of cytoplasm and organelles was severe. The plasmalemma, however, still appeared intact, although the permeability might have been altered. Deterioration of mitochondria continued, the matrix electron density and the number of cristae was greatly reduced, and no mitochondrial granules were evident within the matrix. In some mitochondria, various electron-dense mitochondrial inclusions formed. ER and dictyosomes degenerated in the more severely injured cells and the ribosomes in these cells were very difficult to detect.

Microbodies were the last organelles to be affected by HF fumigation. Only at this late stage of injury was reduction of matrix electron density and homogeneity observed. The crystalline inclusions, however, were still retained.

Chloroplasts were swollen and their envelope was partially or completely disrupted. Release of the matrix materials and their osmiophilic globules into the cytoplasm subsequently occurred.

Several changes were also observed and the presence of nuclear inclusions, of numerous interchromatin granules and a few fibrils, and clumping of chromatin materials into dark masses was evident. Segregation of nucleolar fibrillar and granular components also occurred in a few nucleoli.

The most remarkable changes observed in this stage of HF injury was the accumulation of numerous electron dense particles on various types of membranes in the cells. They were deposited on plasmalemma, tonoplasts, ER, dictyosomes, and other mitochondrial membranes, but not normally on internal cristae membranes, vesicles, or nuclear envelopes. These particles were never found on chloroplast envelopes, the inner grana-lamellae membranes, or microbodies.

Finally, the deteriorated organelles and the disintegrated cytoplasm clumped together and formed electron-dense dark masses. Subsequently they were more or

less plasmolyzed from the cell wall and clumped in the center of the cells. Only aggregates of chloroplasts, mainly grana stacks and starch grains could be recognized. Collapse of the cell wall and cell turgidity also followed. This then, presumably, led to the death of cells and the leaf area became necrotic.

When soybean plants were subjected to higher HF concentrations (100 to 150 ppb), the same types of visible injuries, i.e. marginal chlorosis and necrosis, as well as the same types of microscopic disorders, i.e. disorganization of cell contents, derangement of chloroplasts and finally clumping of cell contents were observed. Although most ultrastructural changes induced by 100 to 150 ppb of HF were similar to those induced by 40 to 50 ppb HF, there were some differences. Neither lipid-globules nor multivesicular bodies were formed in the cytoplasm and the small electron dense particles were never found on any types of membranes at any stage of injury. Although the chloroplast envelopes were found to break up at later stages of HF injury, the stroma materials seemed normal throughout the study. Microbodies appeared to be intact and functional even in severely injured cells. The dissociation of the middle lamellae of cell walls was evident in many cells.

In general, the concentration of HF did not alter the type of injury that developed but it did influence the rate of development. Regardless of the concentration applied, HF induced internal structural changes correlated with the external visible injury symptoms that developed on the leaves.

An initial site of hydrogen fluoride injury was on the tonoplast membrane. The disruption of the tonoplasts with the subsequent release of the vacuolar substances including the accumulated fluorides into the cytoplasm may have caused the further disintegration of cytoplasm and organelles in the cells. Accumulation of fluoride by other organelles such as mitochondria may also explain their sensitivity to fluoride.

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Discussion

Dr. A. H. Mohamed: 1. Do you assume that fluoride attacks the vacuolar space and the membrane, or could it be the endoplasm or the mitochondria? 2. Did you study the DNA?

Dr. Miller: When soybean plants were fumigated with HF early injury symptoms included the formation of small vacuoles. The dilation of the endoplasmic reticulum has been suggested as the principal cause of pathological cell vacuolation. In our experiments the vacuolation preceded dilation of the endoplasmic reticulum and dictyosomes. Vesiculation of the tonoplast (vacuolar membrane) occurred very early which could have resulted in the observed formation of small vacuoles.

Modification of the mitochondria occurred at early stages of injury. Both the outer and internal cristal membranes were swollen. Our evidence supports an early effect on the vacuolar membrane. This could change the osmotic environment of the cytoplasm, triggering other organelle changes and deterioration.

We did not study the DNA but observed numerous changes in the nuclei including formation of various inclusions.

J. R. Marier: May the mitochondria then lose their intracellular ions or cell membrane permeability?

Dr. Miller: Many of the effects observed in the cell may be secondary as a result of changed cellular permeability. Initial effects of fluoride on the membranes would change the cell permeability, resulting in a new cellular environment. Rupturing of the tonoplast would allow various ions, salts and metabolites to permeate into the cytoplasm. The storage of fluoride in the vacuole could affect many organelles if a release into the cytoplasm occurred. Mitochondria could of course, together with other components, be directly affected by fluoride. The effect of fluoride on available calcium and magnesium would affect the integrity of the membranes. Actual removal of these ions from the membrane may be an initial fluoride effect.

Under the conditions of our experiments the chloroplasts were not injured in the first stages of fluoride damage. Chlorophyll disappearance is associated with fluoride damage. This may be a result of destruction of chloroplast integrity. In addition, fluoride may affect chlorophyll biosynthesis. We show in laboratory experiments an effect of fluoride on the incorporation of S-amino levulinic acid into total porphyrins and specifically into chlorophyll (a). The inhibition occurs with fluoride levels less than 10^{-3}M.

Dr. C.W. Chang: Which are the areas most sensitive to fluoride?

Dr. Miller: Our evidence would indicate that the vacuolar membrane is most sensitive to fluoride damage, followed by various and varied effects on other organelles such as the mitochondria, endoplasmic reticulum, nuclei, etc.

Dr. Mohamed: I think the gaseous HF will penetrate the membrane readily, especially with high fluoride dosage, but with low fluoride dosage the damage is not as great, the clumping does not occur, but the nuclei of the chromosomes could be affected.

Dr. Miller: Yes, I agree.

Dr. G.L. Waldbott: How can the inclusions reported in various organelles be isolated?

Dr. Miller: Various techniques involving differential centrifugation and micromanipulation could be employed.

PREVENTION OR REDUCTION OF FLUORIDE EFFECTS IN CATTLE

by

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SUMMARY: Damage to cattle by fluoride in the vicinity of industries is not likely to be completely eliminated within the near future by limiting fluoride emission. With 1 microgram per m^3 as the maximum emission concentration (MIK) additional measures must be instituted, namely: 1) reduction in the daily fluoride uptake by animals from feed below the tolerance limit, 2) limiting the duration of fluoride emission, 3) inhibition of the rate of fluoride absorption.

In order to carry out these objectives, measures concerning the production, maintenance and feeding technique are suggested which are based on studies in two emission areas. A supplementary feeding regime with a low fluoride forage (below 20 ppm) will reduce the daily fluoride uptake per kilogram of dry food substance on an average by 8%. During a two year experiment on 24 milk cows in a polluted area near an aluminum factory, administration of a low fluoride food mixture containing 3% aluminum sulfate and chloride in equal parts reduced fluoride uptake and absorption per kilogram dry substance by about 15%.

Introduction

Fluoride uptake in plants, animals and humans is determined by the sum total of fluoride in the soil, water and air due to both natural and emission sources. When excessive fluoride absorption takes place for months or years, fluoride accumulates in increasing amounts in hard tissues where it alters their structure as well as their metabolism. Disturbances of postnatal tooth formation in cattle which are particularly sensitive to fluoride uptake, can be precipitated by an increase of as little as 3 to 5 times in the daily natural fluoride uptake. Daily fluoride uptake of 5 to 10 times the normal amount leads to structural changes of hard tissues associated with painful gait and difficulties in chewing. Most importantly dental and skeletal fluorosis is accompanied by limitation of food uptake which leads to a reduction in productivity of the respective cattle and to economic loss. Prevention and reduction of adverse effects of fluoride emissions on cattle in contaminated areas constitutes an important task of the veterinary physician who should also serve as an arbiter between the divergent interests of industry and agriculture. Any satisfactory solution of the various practical problems must

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Presented at the Fourth Annual Conference of I. S. F. R., The Hague, 10/24-27/71.

TABLE 1

Daily Fluoride Uptake of a Cow Weighing 500 kg and Producing 10 kg Milk

	Maintenance and Feeding	Air mg F⁻	%	Water mg F⁻	%	Dry Food mg F⁻	%	Beet Leaves mg F⁻	%	Hay mg F⁻	%	Straw mg F⁻	%	Daily total uptake mg F⁻	mg F⁻ pro kg KGW
Industrial /Rural area	In Barn	0.1	0.17	8	5.9	35	25.9	53	39.3	29	41.5	10	7.3	135	0.27
	On Pasture	0.1	0.08	7	5.7	26	21.5	-		88	72.7	-		121	0.24
	In Barn	0.1	0.03	10	3.0	74	21.8	106	31.2	120	35.3	30	8.6	340	0.68
	On Pasture	0.1	0.05	8.8	4.3	55	26.6	-		143	69.0	-		207	0.41
Emission area Seelze Lthen	In Barn	1.5	0.2	6	0.9	62.5	9.9	250	39.6	250	39.6	61	9.8	631	1.26
	On Pasture	5.0	0.6	5.3	0.6	84	9.4	-		800	89.4			894	1.79
	In Barn	5.4	0.4	5.2	0.4	34	2.7	295	23.1	902	70.5	37	2.9	1279	2.56
	On Pasture	5.4	0.3	18	0.9	34	1.7	-		2000	97.1	-		2057	4.11

be based upon an adequate appraisal of the origin and development of airborne fluoride.

Suggested Procedures

In order to prevent or mitigate the adverse effects of fluoride emissions three basic measures should be instituted:

1. Reduction of the daily uptake,
2. Shortening of the emission period and
3. Inhibition of fluoride absorption by the animals.

Once fluorides are absorbed by the body of the animal their toxic effects as well as fluoride accumulation and excretion cannot be influenced. Similarly dental and skeletal changes induced by fluorides are little amenable to therapy.

1. Reduction of Daily Fluoride Uptake

Among the three above-named measures, the reduction of the daily fluoride uptake in animals warrants foremost consideration.

Limitation of fluoride emission is the focal point of our considerations. This measure, however, involves certain technical and particularly, financial problems in the Bundesrepublik Germany which have only an indirect bearing on veterinary medicine: During the past years the German aluminum industry has made considerable progress in reducing fluoride emission through installation of filter and scrubbing equipment. However, in order, with certainty, to lessen damage to cattle, according to our present knowledge (1, 2) the MIK for fluoride must be limited to 1 $\mu g/m^3$ of air.

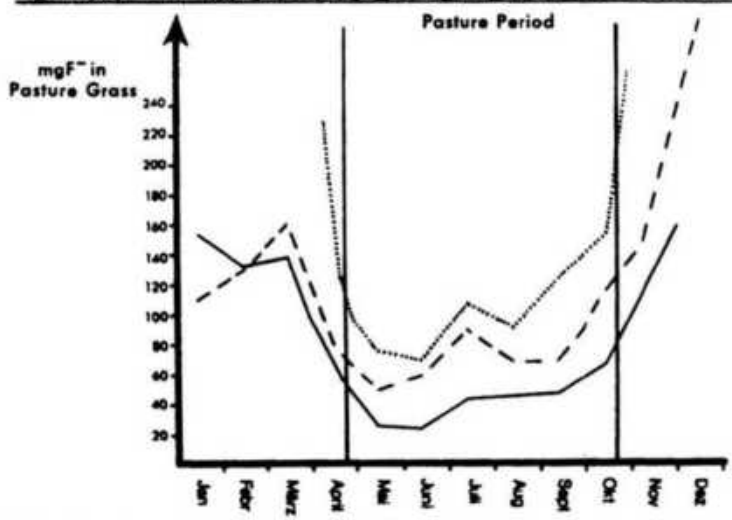
Since the occurrence and extent of fluoride damage in cattle depends primarily upon the magnitude and duration of fluoride uptake, measures concerned with production, maintenance and feeding technology must be undertaken in order to avoid or minimize such damage.

In evaluating the program of maintaining animals in fluoride-polluted areas, the mean fluoride levels of forage plants during the growing season and pasture periods must first be determined. The fluoride content of pasture forage can be lowered by intensive agricultural soil practices such as cultivating and reseeding of permanent pasture, adequate fertilization, utilization of chopped hay and early harvesting for preparation of hay and grass silage. The duration of fluoride accumulation on the surface and inside of leafy portions of a plant is determined mainly by the rate of a plant's growth (Fig. 1).

Another important prophylactic measure consists of the computation of the total daily fluoride ration which the cattle can tolerate. Under practical feeding conditions during the summer months, careful attention must be given to the fluoride content of green forage and/or of pasture grass, whereas during the winter months the content of roughage and silage, through which the animals take up more than 90% of fluoride (Fig. 2), must be considered. With the knowledge of the ap-

Fig. 1

Fluoride Content of Pasture Grass Related to Season



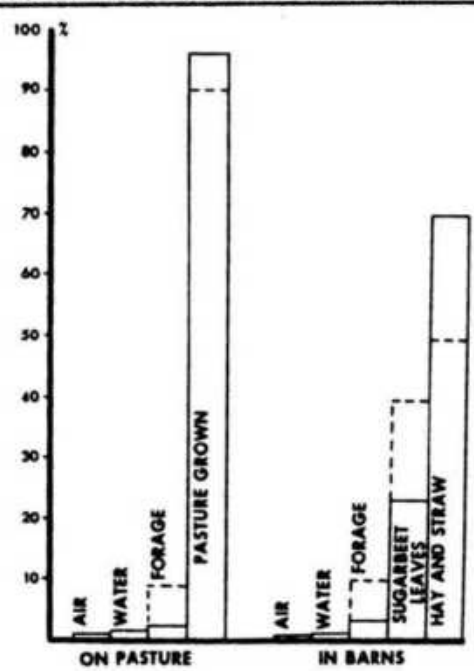
Monthly averages covering 3 to 4 years.

_____ mgF⁻ in 100 grams dry substance in pasture near factory.

- - - - - - - - - -
. . . . . mgF⁻ in 1000 grams dry substance from unexposed pasture.

Fig. 2

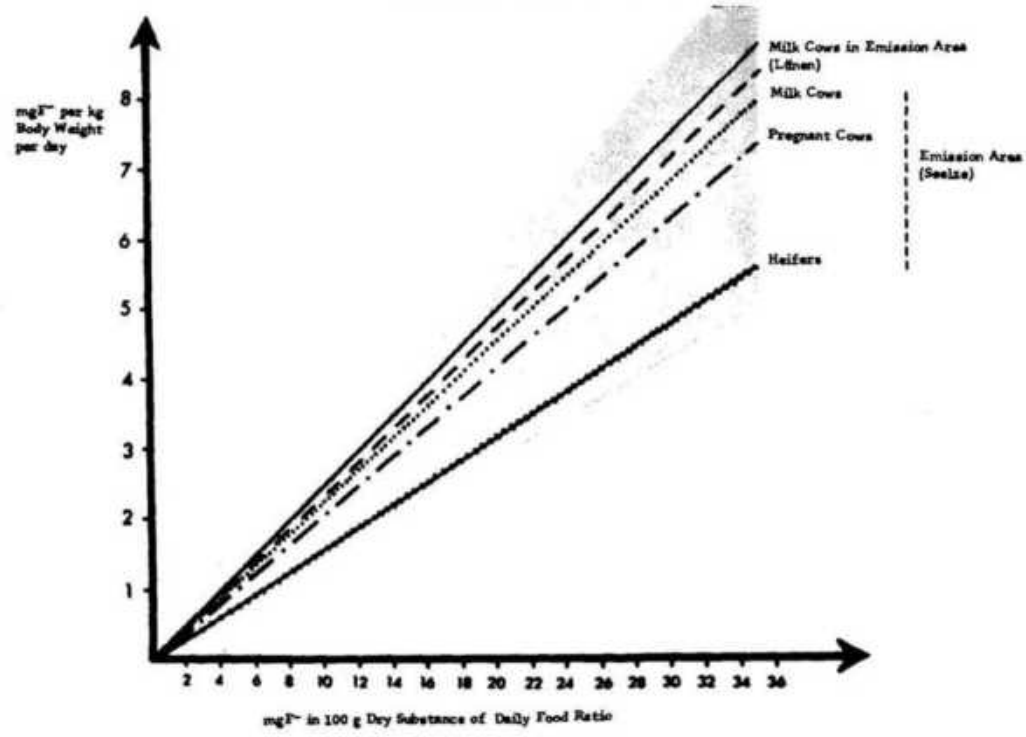
Mean Percentage of Fluoride Uptake of a Milk Cow from Air, Water and Food in Two Fluoride-Contaminated Areas



proximate fluoride content of the locally available nutritional components, the daily fluoride uptake of cattle can be calculated on the basis of the dry substance content of their ration. There is a fairly consistent relationship of approximately 1 to 4 between the daily fluoride uptake per kilogram of body weight and the fluoride content of the fodder (Fig. 3).

Fig. 3

Relationship of Fluoride Uptake and Fluoride Content of Dry Feed in 2 Emission Areas

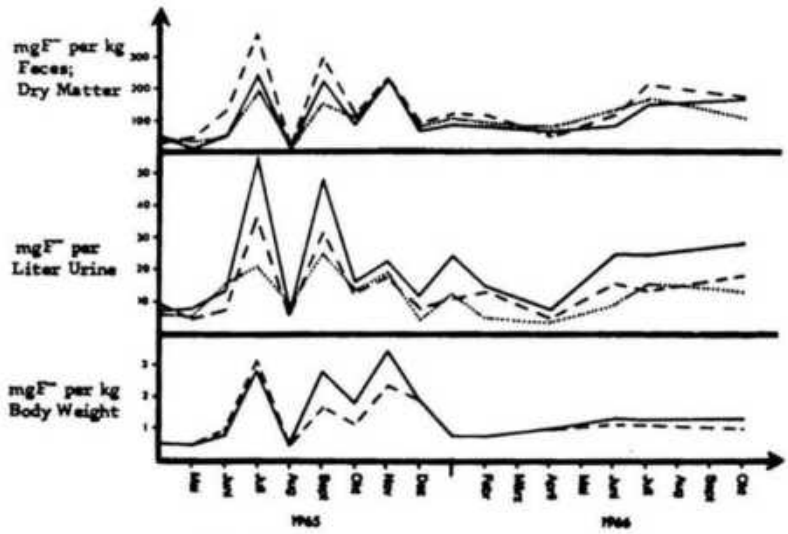


Should there be an excess above this tolerance limit by 1 to 2 mg F^-/kg of body weight per day, the fluoride uptake must be diminished by supplementary low fluoride feed which is preferred by the animals. Each kilogram of dry substance of a supplementary low fluoride feed decreases the daily fluoride uptake by 5 to 10% depending upon the magnitude of the total daily ration. As supplementary feeding all rations with less than 20 ppm fluoride, particularly all kinds of feed grain, commercial mixed feed and industrial by-products such as bran, chopped sugar beets, molasses, husks of grapes or brewer's grain can be considered. In an emission area, a careful adjustment of the length of time that cattle is kept on pasture is mandatory. Should the content of pasture grass be excessively high (above 100 ppm) pasturing of cattle should be abandoned in favor of exclusive barn management or temporary outdoor care by utilizing chopped green fodder. For pasturing cattle, particularly young animals, green acreage which is least exposed to emissions should be utilized whereas the more severely affected pastures should be employed for hay and grass silage.

Another means of diminishing fluoride uptake is the artificial defluoridation of fluoride-polluted forage. In Norway, Flatla and Ender (3) added various mineral acids to silage through which its fluoride content was lowered to 1/10 of its original value.

Fig. 4

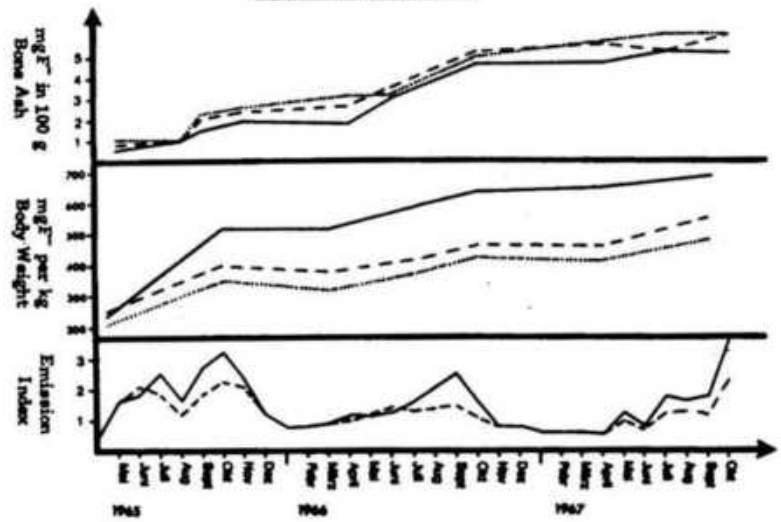
Mean Fluoride Content of Dry Fecal Substance, Urine and Average Daily Fluoride Uptake of a Group of 8 Cows



_____ Control
---------- Receiving aluminum salt mixture in food
..... Aluminum mixture in drinking water

Fig. 5

Mean Incisor Index (according to Dean scale) and Mean Fluoride Content of Bone Ash (tail vertebrae) Related to Monthly Mean Fluoride Uptake



_____ 8 control cows
----------8 cows receiving aluminum salt mixture
..... 8 cows receiving aluminum solution with drinking water

2. Reduction of Fluoride Emission

The second means for preventing or minimizing fluoride damage to cattle consists in reduction of the duration of the emission. This can be accomplished by a change-over from milk cows to feeder cattle, by discontinuing milking or by fattening steers, particularly in the barn. With such practices, the duration of residence of cattle in an emission region can be reduced to 1 to 3 years, thus avoiding the threat of long-term cumulative effects.

3. Decrease of Fluoride Absorption

The third measure to avoid fluoride toxicity by polluted forage consists in reducing the absorption of fluoride. As early as the thirties, Sharpless and others noted in feeding experiments in rats that sodium fluoride is less poisonous and less of it accumulates in the skeleton when certain calcium and aluminum salts are administered simultaneously with it. Subsequently these results were partially confirmed in cattle. Calcium and phosphorus compounds in amounts exceeding those present in mineral supplements afforded no protection against fluoride damage in cattle. On the other hand, feeding experiments in ruminants by Hobbs et al. (4), Tesink (5) and Ender et al. (3) in Norway showed that the toxicity of sodium fluoride is decreased by 30 to 40% by administration of aluminum salts in doses of 10 to 30 milligram per kilogram of body weight per day. According to our present knowledge, the mechanism of these substances consists in the formation of less dissociated and therefore less absorbable aluminum fluoride complexes in the digestive tract.

During 1965 to 1967 we carried out studies (6) pertaining to this problem on 24 milk cows in a fluoride emission area. We obtained comparative data on a mixture of aluminum sulfate, aluminum chloride and aluminum oxide as well as on a 0.3% aluminum salt solution used as a beverage. During the 33 months of the experiment, the mean fluoride uptake of 1.43mg per kilogram body weight per day of the aluminum mixture and 1.17 mg of the aluminum salt solution decreased fluoride absorption by about 20%. Differences were noted not only in the mean fluoride excretion through the urine and feces but also in the fluoride content of the tail vertebrae (Fig. 4 and 5). Fluorosis of the incisor teeth, however, did not improve through the administration of the aluminum salts. In a fluoride-polluted area, addition of aluminum salts in the form of a low fluoride pellet mixed with 3% aluminum salts is especially useful when the total daily fluoride uptake remains at or below the tolerance limit.

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Discussion

Prof. S.S. Jolly: In relation to human fluorosis when both calcium and magnesium levels are low, the effects appear to be more pronounced. Therefore, to reduce adverse fluoride effects the dietary minerals as well as vitamins should be increased.

Dr. Gründer: We have not carried out experiments with fluoridated water. Fluorosis in cattle may differ from fluorosis in humans. We have not added extra calcium.

Dr. S.P.S. Teotia: In experiments carried out on 3 groups of monkeys, one of which received high calcium plus vitamins, the other low calcium plus vitamins, a third control group was given a normal diet. Both experimental groups were fed the same amount of NaF. When examined after 1 year, bone ash in monkeys on the high calcium and vitamin diet showed a minimal amount of fluorosis; the group on the low calcium and vitamin diet showed evidence of more pronounced fluorosis and their bones contained more fluoride.

Dr. Gründer: We believe that aluminum and calcium act similarly in preventing fluoride damage to cattle in a fluoride-polluted area.

CONTENT OF FLUORINE IN SOME FOODS AND BEVERAGES CONSUMED IN CHILE

by

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A. Jimenez, E. Torres and M. Lopez
Santiago, Chile and Paris, France

SUMMARY: The authors assayed levels of the fluoride centent of some Chilean foods and beverages. In beverages fluoride averaged from 0.4 to 1.15 ppm, in shellfish from 1.46 to 3.4 ppm, in fish from 1.75 to 5.17 ppm and in fruit from 0.3 to 1.0 ppm. Separation of fluoride from food was made by distillation and by a special microdiffusion technique. The quantitative determination was based on the zircone-alizarine complex method.

The purpose of this paper is to evaluate fluoride levels in some Chilean foods and beverages since studies have indicated a reduction in dental decay when adequate fluoride during dental development is provided.

The separation of fluoride from food was done by distillation (for tea) and by a special microdifusion technique as fluorhydric acid (for marine foods, fruits and wine). The quantitative determination was made by colorimetric reaction based on the specific decoloration of a zircone-alizarine complex. The details of the analytical procedures have been published (1).

The following table shows the content of moisture and fluoride (average and range) of drinking water, tea infusion, wines, various kinds of shellfish, fresh and canned fish as well as some fruits.

The average amount of fluoride obtained from drinking water consumed by the population of the city of Santiago (Chile) approximates the concentration of fluoride added by the water company for fluoridation purposes (1 ppm).

There is a wide range of fluoride levels in tea which is due to such factors as the plant's botanical variety, the area in which it is grown, and the procedure by which the infusion is prepared.

Table 1 shows varying results in the fluoride content of a shellfish (cholgas) and of a fish (pejegallo) according to the month in which it is caught. In May up to August, the values were a great deal lower than in August. This demonstrates the

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From the Dept. of Food Chemistry, Faculty of Chemistry and Pharmacy, University of Chile* and from the Chair of Toxicology, Faculté de Pharmacie, Paris, France **.

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TABLE 1

Fluoride Content in Chilean Foods and Beverages

Samples	No. of Samples	Moisture g/100 g	Range mg/l F^-	Average mg/l F^-	Month
BEVERAGES					
Water for drinking	8	----	0.84 - 1.17	1.03	
Tea (infusion)	21	----	0.81 - 1.94	1.15	
White Wines	13	----	0.20 - 1.70	0.63	
Red Wines	17	----	0.084-0.94	0.44	
CHILEAN SHELLFISH			mg F^-/kg Fresh Material		
Almejas-Venus sp.	4	85.0	1.73 - 1.85	1.78	
Choritos-Mytilus edulis	5	84.5	1.34 - 1.57	1.46	
Machas - Mesodesma donacium	3			3.15	
Langostinos - Cervimunida johni	3	78.8	1.99 - 2.18	2.06	
Gambas-Heterocarpus reedi	5	82.0	2.27 - 2.53	2.44	
Erizos-Loxechinus albus	3		2.87 - 3.20	3.03	
Cholgas - Aulacomya ater	5	77.1	3.27 - 3.52	3.38	(May)
Cholgas ID	4	83.1	1.99 - 2.15	2.08	(August)
Chilean Fish					
Merluza (Hake) -Merluccius gayi	7	81.8	3.73 - 4.34	4.02	
Sierra (Sawfish)-Thyrsites atun	7	67.5	3.19 - 3.89	3.48	
Corvina (Corvine) Cilus montii	6	77.5	2.09 - 2.85	2.42	
Lenguado (Sole) Paralichthys microps	6	80.3	1.45 - 2.21	1.75	
Congrio colorado-Genipterus (Red Conger) Chilensis	5	81.3	2.10 - 2.74	2.26	
Congrio negro-Genipterus (Black Conger) maculatus	5	83.0	1.77 - 2.74	2.26	
Pejegallo-Callorhynchus	8	79.8	4.11 - 4.97	4.62	(May)
Pejegallo-Id.	5	80.2	2.19 - 2.47	2.38	(August)
Pejerrey-Odetesthes regia (var. mackerel)	6	77.2	4.74 - 5.81	5.17	
Canned Fish					
Atun (Tunny) - Thunnus in oil	6	56.7	3.52 - 4.00	3.73	
Anchovy, fillets -Engraulis ringens	6	45.4	2.83 - 3.18	3.02	
Sardines in oil Clupea fugensis	6	58.1	4.12 - 4.20	4.27	
Fruits					
Apples - Pyrus malus	3	83.9	0.61 - 0.64	0.63	
Pears - Pyrus communis	3	85.5	1.07 - 1.11	1.09	
Oranges - Citrus aurantium	3	87.8	0.31 - 0.41	0.35	

influence of the biological cycle upon the quantity of fluoride which accumulates. Other factors are the kind of fish and their physical conditions when they were caught.

The variations in the fluoride content of the analyzed fruits can be explained on the basis of the wide fluctuations of fluoride concentration in water and soils in which they are grown, which affect their fluoride levels.

The final conclusion is that tea infusion is rich in fluoride, one cup containing approximately 0.5 mg. Of the various food analyzed, marine foods (fish and shellfish) contained the highest fluoride content, namely 1.3 to 5.8 mg/kg of fresh material.

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MEASURING INSTRUMENTS FOR DETERMINATION OF FLUORIDE IMMISSIONS

by

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SUMMARY: Damage from gaseous fluorides (HF) differs from that due to particulate fluoride. In evaluating fluoride damage in plants, the fluoride content of dust is relatively insignificant. In animals, fluoride absorption depends largely upon the solubility of the compound. The author describes equipment which permits the separation of particulates from gaseous fluoride.

The tolerance level of atmospheric fluorides has been widely discussed and, in certain countries, air quality standards have already been established. In many instances these standards are not scientifically founded: No systematic comparative measurements of the simultaneous fluoride content of air and the fluoride uptake by plants have been performed over a prolonged period, e.g. during the period of growth and development. Whereas extensive tests have been made on plants exposed to HF in greenhouses the results of which indicate relative differences in fluoride sensitivity, they do not permit comparisons to airborne fluoride.

From Aluminium-Hütte, Rheinfelden GmbH, 7888 Rheinfelden (W. Germany).

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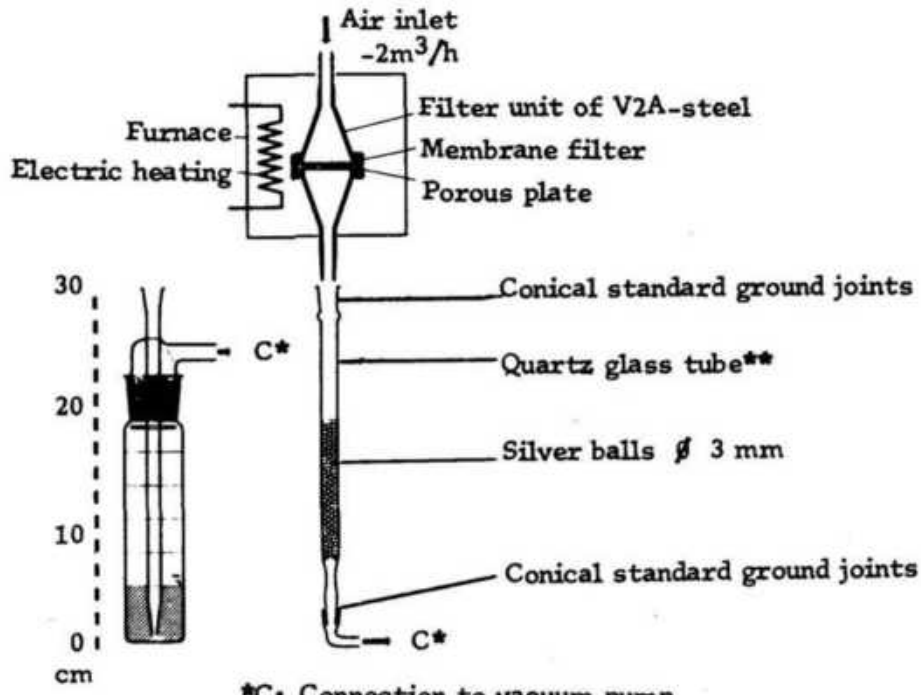
Presented at the Fourth Annual Conference of I.S.F.R., The Hague, 10/24-27/71.

Fig. 1

Instrument for Determination of Fluoride in Air with a Membrane Filter for Collecting Dust



*C: Connection to vacuum pump
**Model: Landesanstalt NRW

It is clear that a distinction must be made between the injury caused by gaseous fluorides (HF) and that by particulate fluoride. Concerning fluoride damage to plants, the fluoride content of dust is of minor importance; in animals fluoride compounds are partially absorbed according to their solubility. HF is definitely noxious. Therefore gaseous fluoride and fluoride in dust must be determined separately.

For measuring the atmospheric fluorides an apparatus presented in Fig. 1 consists of a heated membrane filter with a minute diameter of 1 to 2 μ. The sample must be heated in order to avoid condensation of HF. HF is absorbed either by the impinger or the absorption tube with NaOH-loaded silver balls or bead spheres recently developed by the "Landesanstalt" in Essen (West-Germany). The tested volume of air is about 2 m^3/h. By this method, reproducible results can be obtained. Using the former methods, without previous dust separation, the sampling of dust in the impinger or the absorption tube depends on particle size, wetability and solubility.

The method used in certain countries, which employs a sodium formate impregnated filter, must be rejected because it does not permit atmospheric fluorides to be separated from particles.

CALCIFICATION OF THE VAS DEFERENS IN A PATIENT WITH ENDEMIC FLUOROSIS

(CASE REPORT)

by

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Meerut, India

SUMMARY: A case of endemic skeletal fluorosis with probable secondary hyperparathyroidism is presented in which bilateral calcification of the vas deferens occurred. No symptoms were associated with calcifications of the vas deferens. They were the incidental findings on X-rays of the pelvis taken for other reasons.

Calcification of the vas deferens and of the seminal vesicles, though rare, has been recognized since 1893 when Orth (1) observed calcified vas deferens at autopsy. In the U. S. literature in 1906 George (2) presented the first description of calcification of both the vas deferens and the seminal vesicles. Bianchini (3) recognized the condition radiographically in 1930. Wilson and Marks (4) in 1951, considered calcification of the vas deferens a pathognomonic sign of diabetes mellitus.

We wish to present a unique case of non-inflammatory calcification of the vas deferens in a non-diabetic patient associated with endemic skeletal fluorosis.

Case Report

In April, 1970, a 50 year old male appeared in our out-patient department complaining of pains in bones and joints, back pains, stiffness, immobility of the neck and spine, and inability to walk for the past four years. He had spent his entire life in an endemic fluorosis area. He had been treated for ankylosing spondylitis elsewhere for several months but without benefit.

On examination, the blood pressure was 130/85, pulse 82. The patient had yellowish black mottling of the teeth, a fixed spine with generalized forward flexion, flexion deformities at the hips, knees and elbow joints, inability to close the fist and marked tenderness over his entire body.

An early tuberculin skin test was negative. His plasma calcium was 10.8 mg/100 ml, plasma phosphorus 3.0 mg/100 ml, alkaline phosphatase 88 K.A. Units, blood urea nitrogen 26 mg%, fasting blood sugar values were 98, 88, 90 and 103 mg/100 ml on different days. Twenty-four hour urinary calcium was 41 mg

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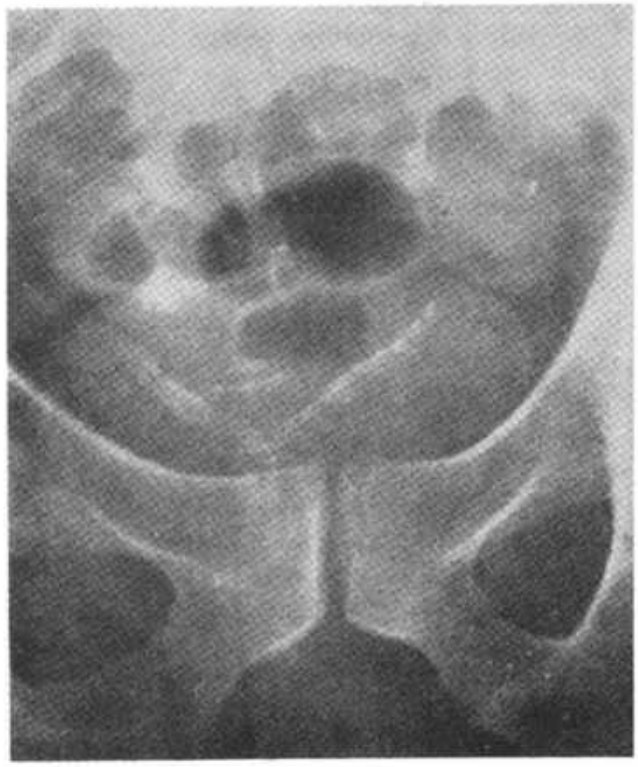
Presented at the Fourth Annual Conference of I. S. F. R., The Hague, 10/24-27/71.

(normal 500), phosphate clearances as 139 and 46 ml/min/1.73 m^2 respectively. The renal tubular reabsorption of phosphate was 75% and urine analysis and culture showed no abnormality. Drinking water, collected from the wells of the endemic area contained 8 to 10.5 ppm of fluoride.

X-rays showed chalky white ground glass appearance of the entire vertebral column, irregular osteophytes, calcification of the vertebral ligaments and of the interosseous membranes of the forearms and legs as the characteristic radiological features. The chest film revealed a generalized osteosclerosis, but no sign of pulmonary tuberculosis. Radiograph of the pelvis disclosed linear areas of calcification in the walls of vas deferens as well as a diffuse increase in bone density (Fig. 1). Loss of lamina dura in dental radiograph and sub-periosteal resorption in the fingers of the hands suggested hyperparathyroidism.

Fig. 1

Xray of Pelvis



Note: General osteosclerosis associated with calcification of the vas deferens.

Histology of the iliac crest bone biopsy showed poorly formed Haversion systems, disordered lamellar orientation of the compact bone, areas of osteoid tissue among the trabeculae; the latter were thick and appeared to contain excess calcium.

Discussion

The investigations performed in this case confirmed the diagnosis of skeletal fluorosis. The patient had no history or evidence of tuberculosis, diabetes mellitus, urogenital infections or uremia which are the recognized causes of calcification of vas deferens.

Laboratory investigations and the skeletal radiographs of the hand suggested parathyroid hyperfunction which has developed, probably, as a compensatory phenomenon secondary to the decreased solubility of the bone salt in skeletal fluorosis. Calcifications of vertebral ligaments, capsules, muscular attachments, tendons and of interosseous membranes are the well established features of skeletal fluorosis, (5).

The secondary hyperparathyroidism by elevating the serum calcium levels in our case has further increased the tendency for calcifications and of the vas deferens. Circumstantial evidence suggests that vas deferens calcification has been caused by fluorosis rather than old age. Calcification of vas deferens in skeletal fluorosis is rare and has not been reported in the literature.

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FLUORIDE INTAKE FROM FOOD

by

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SUMMARY: In order to evaluate the safety of food grown near a Czechoslovakian aluminum smelter, grain and vegetables were assayed for their fluoride content at varying distances from the smelter during a 10 year period.

At a distance of 100 meters downwind, the fluoride levels in grain varied between 6.34 and 19.64 mg/kg. At a 500 meter distance, the average values were 35%, and at one kilometer, 15% of the above values.

The fluoride content of green parsley leaves was 11.57 ppm (control 0.66), of the roots 0.08 (control 0.03) and of the outer surface of root 0.12 ppm (control 0.03 ppm).

The major sources of fluoride for humans are food, water and, in certain cases, fluoride compounds emitted from industries. Under normal conditions, fluoride uptake from the air is insignificant. Fluoride gains entrance into the human organism of persons residing in the vicinity of a fluoride emitting factory either directly through eating contaminated vegetables grown in the area or indirectly via consumption of domestic animals which have ingested contaminated forage.

By determining the fluoride content of agricultural plants grown in the vicinity of the aluminum smelter, we ascertained the extent of the hazard of intoxication through consumption of vegetation. Since agricultural plants are subjected to unremitting long-term exposure, they serve as a suitable indicator of the contamination of the environment by industrial emissions.

In fruit and to some extent in vegetables grown near an aluminum plant, fluoride accumulates mainly below the surface of the fruit (1).

In order to determine which part of the plant contains the highest values of absorbed fluoride, we determined the fluoride uptake in the individual parts of parsley. Table 1 demonstrates that the largest amount of fluoride gathers in leaves and in the parts of the plant which are above ground and less in the root. Relatively little fluoride is found in potatoes.

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Presented at the Fourth Annual Conference of I.S.F.R., The Hague, 10/24-27/71.

TABLE 1

Distribution of Fluoride Content in Parsley
(mg F^-/kg of fresh weight)

	Dust on green leaves	Edible part: Green	Edible part: Peeled	Whole root	Outer surface of root
Control	0.01	0.66	0.01	0.03	0.04
Area with maximum exposure	0.14	11.57	0.02	0.08	0.12
Increase compared with the control	12.3	17.3	2.0	2.8	3.0

The fact that relatively large amounts of grain were grown near the aluminum smelter enabled us to survey the extent of the air contamination by fluoride. During the course of 10 years various kinds of grain were collected. At a distance of 80 to 130 meters in the area of the prevailing winds the fluoride content of the grain varied between 6.34 and 19.64 mg/kilogram. Upon adopting the average values obtained as 100% we found that at a distance of 500 meters the fluoride levels of grain were reduced to about 35% and at 1 kilometer another 15%. These values correlate in general with the occurrence of fluoride in fly dust present on the fruit of the grain and also on the grain kernels following thrashing. The averages of fluoride values in dust on wheat were 0.013 and on rye 0.018 mg F/km dry weight. Grain cultivated in a circular area with a diameter of two kilometers from the source of emission should not be consumed locally but can be exported for use in uncontaminated areas.

TABLE 2

Average Yearly Fluoride Content of Cereals at a 100 Meter Distance from the Aluminum Smelter

	Oats	Control	Barley	Control	Rye	Control	Wheat	Control
1956	6.50	1.50						
1957					12.40	1.45		
1958			16.40	1.79				
1959							19.64	2.36
1960							11.36	1.96
1961					8.53	1.48		
1962							6.98	2.06
1963					8.24	1.63		
1964							8.22	1.85
1965							6.35	-----

Based on long-term assays for fluoride in agricultural products, certain measures were instituted in the aluminum plant. In order to alter the yield of agricultural products, it was proposed to establish two protective zones near the plant at a distance of 1 and 2 kilometers. It was held desirable not to grow edibles intended for human nutrition within 1 km circle. This measure pertains mainly to vegetables with large leaf surfaces such as lettuce (2). Food and vegetables which are grown at a greater distance from the factory should not only be thoroughly washed but peeled as well (1). Furthermore, domestic cattle should not graze within the 2 km circle and the source and content of fluoride in forage should be carefully monitored. Poultry can be raised in coops as close as 1 km from the factory since chicken eggs do not accumulate much fluoride. Because fluoride intake through food is increasing throughout the world, fluoride should not be added to drinking water in the vicinity of a fluoride-emitting factory.

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SPECIAL REPORT

THE ECOLOGICAL ASPECT OF FLUORIDE

by

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It is a great honor to be asked to present the Opening Address at this, the 4th meeting of the International Society for Fluoride Research. I chose "The Ecological Aspect of Fluoride", because I believe that such an appraisal is mandatory.

Ecology can be defined as "the influence of the environment on living things". Thus, there are two considerations: the environment and living things. During the journey of an all-pervasive pollutant (such as fluoride) from its source to its eventual targets, the word "environment" can mean many things. For instance, air, soil, and water can all serve as environments for fluoride. However, they also serve as modes of transport for fluoride's entry into vegetation. Similarly, vegetation can be an environment for fluoride, but it also serves as one of the modes of transport for fluoride uptake by other forms of life. In this manner, biological transfers occur, and food chains are built up, increasing in diversity all along a pollutant's journey. As if this were not complicated enough, man can complicate it further by recourse to fluoride-containing fertilizers, insecticides and mineral supplements for livestock.

As concerns his own environment, man can increase the fluoride burden from sources such as food and beverage processing, and widespread use of fluoride-containing aerosols and pharmaceuticals. Such sources include exposure to organic forms of fluoride, some of which are subject to biotransformation with consequent formation of toxic metabolites. And so, the assessment of the total environmental impact of fluoride is a complicated procedure, especially if one is trying to keep track of the multiple factors involved in cause-and-effect relationships.

Today, whether one is talking about fluoride or some other pollutant, it does not suffice to limit the discussion to the presence of a given substance in air, or water, or vegetation, or whatever. On the contrary, what is required is an integrated "tracking down" of a pollutant where ever it may exist in the ecosystem or in man's own environment. Also there is the consideration that fluoride is only one of many pollutants attempting to co-exist in our technological environment.

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Presented at the 4th Annual Conference of I. S. F. R., The Hague, 10/24-27/71.

In view of the foregoing, it is obvious that a multidisciplinary approach is needed for a comprehensive evaluation, in which inputs from all the scientific specialties contribute to the total mosaic of knowledge. This is why I have always looked forward to the meetings of the ISFR, because this Society brings together the geologist, meteorologist, the industrial researcher, analytical chemist, botanist, veterinarian, toxicologist, clinician. In other words, it creates an opportunity for dialogue between the various scientific specialties.

My purpose is not to dwell on things already familiar to everyone, but to present an insight into things I have wondered about during the preparation of a soon-to-be published article devoted to the topic "Environmental Fluoride". Everyone is familiar with the types of fluoric materials utilized in many industrial processes, how they give rise to fluoride emissions, the various forms of these fluoride emissions, as well as the problems they can create. In what follows, I will give examples of something that, in my opinion, will assume increasing importance in studies of man's environment. I refer to synergisms.

In the past many researchers, who have conducted field studies on polluted vegetation, have shown that fluoride tends to be the major atmospheric pollutant involved in a situation that also involves sulfur dioxide. This is true even though the concentration of airborne sulfur dioxide may greatly exceed that of fluoride. It emphasizes the fact that fluoride is much more phytotoxic. However, some researchers have wondered about a possible synergism involving both fluoride and sulfur dioxide. Thus, in 1952, Adams et al. had stated:

> "...the possible synergistic effects of subdamage concentrations of sulfur dioxide in admixture with gaseous fluorine compounds must be thoroughly investigated..." (1).

Much later, in 1968, Van Raay reported:

> "...it is not unreasonable to presume that, for instance, apple trees may be more sensitive to SO_2 contamination if HF pollution is also present"(2).

Then, in January 1971, the International Joint Commission of the United States and Canada (charged with the study of ecological parameters in the Great Lakes basin) issued a report in which atmospheric fluoride measurements were included in the survey. The report contains the following statement:

> "Continuous exposure to a combination of pollutants in low concentrations... may cause an increase in the damage that a (particular) pollutant can inflict" (3).

Thus, it can be appreciated that such a consideration is not only of long standing, but remains uncertain. The only criterion I have found concerning the simultaneous presence of both HF and SO_2 in the same atmosphere is that proposed in 1968 by Lindberg in the Soviet Union (4). In this approach, the level of HF and SO_2 is expressed as an arithmetic fraction of whatever "maximum permissible" concen-

trations are selected for a given exposure-time; and, when the sum of these two fractions exceeds a total of 1, an undesirable situation is deemed to exist. Thus, if the air contains 3/4 of the permissible level for HF and also for SO_2, the sum is 1.5 - and therefore - unacceptable. However, this calculation implies a simple additive effect of airborne HF and SO_2, and would underestimate the condition if a synergism magnifies the combined effect of these two pollutants.

The "co-existence" of airborne fluoride and sulfur dioxide is a very realistic consideration. Even the activities that entail considerable atmospheric fluoride emission utilize fossil fuels as an energy source. A recent Canadian study has demonstrated (5) that there is a close parallel between the concentration of atmospheric fluoride and sulfur dioxide originating from coal-burning. One can only wonder about the effects of any inherent synertgism on all forms of biological targets.

Another example of a synergism involves the magnitude of fluoride uptake in vegetation, arising from the use of fluoride-containing phosphate fertilizers. In 1969, Bovay (6) described how phosphate fertilizers containing 1.1% of potassium fluoroborate greatly enhanced uptake of fluoride, with consequent damage to vegetation. Hydrophonic studies by Collet et al (7) revealed that the cause was not the fluoroborate as such, but rather the simultaneous presence of unbound borate. It was shown that mildly acidic conditions (pH 5.6) favored hydrolytic cleavage of fluoroborate, and that the presence of only 10^{-5}M of available boron (i.e. 0.11 mg/l) would double the uptake of fluoride via the root-system of vegetation. Collet et al. attributed this phenomenon to a synergistic effect of unbound boron on fluoride uptake.

Such findings may have implications regarding the use of fluoride-containing fertilizers, even when such fertilizers do not contain boron. Certain soils, as attested to by a recent survey in California (8), are known as "high boron soils", and can contain as much as 64 ppm of boron. Remembering that only 0.11 ppm of available boron were required to double fluoride uptake by vegetation, and that mildly acidic conditions increased the availability of boron, one wonders about the use of fluoride-containing fertilizers, particularly in acidic high-boron soils.

I have now given two examples of synergisms: one in air, and one in soil. Next, I want to deal with a condition in the 3rd major component of the ecosystem: water. This too, will be related to the topic of synergism. It revolves around man's propensity to utilize the world's waterways as a "catch all" for unwanted materials. Today, all over the civilized world, one can see (and often, smell) the consequences of such a practice. Also, I realize that - in the field of "pollution control" - abatement of airborne emissions is often achieved by resorting to spray towers and scrubbing devices; in this way, the problem can be transferred from air to water. On Canada's East coast, we recently had a situation in which 22,800 pounds of fluoride per day was discharged into a relatively small harbor inlet (approximately 13 square miles) for more than 4 months (9). As a result of this incident, I became interested in uptake of fluoride by aquatic vegetation, although I have found only one report on this topic. A study at the French Atomic Energy Centre in Pierrelatte has shown (10) that exposure of aquatic vege-

tation to 100 ppm of waterborne fluoride for 5 days increased the vegetation's fluoride content 50 fold, whereas exposure to 20 ppm for 14 days increased it 38 fold. Unfortunately, the report does not provide information concerning exposure to lower levels of waterborne fluoride for longer periods of time.

This is of interest, not only because it relates to the aquatic food chain, but also because of another possibility that deserves serious consideration. Within the past few years, Miller and his co-workers have awakened world to the possiblity that vegetation exposed to fluoric air-pollution possesses the ability to convert inorganic fluoride to the much more toxic fluoroacetate and fluorocitrate forms (11). This is a finding of a great importance. All past surveys of fluoride pollution have used inorganic fluoride as a "guideline" for mammalian symptomatology and toxicity. However, if vegetation-borne compounds such as fluoroacetate contribute to the symptomological pattern, this would require some serious reappraisals. While there is no information on the topic, one cannot help but wonder about such an inorganic-to-organic mechanism in aquatic vegetation. After all, it is in an aquatic environment that mercury was found to convert to more toxic organic forms.

Another consideration about water: As is the case with air, it can abound with a multitude of pollutants. Recently, I have examined documents relating to water quality parameters, and was surprised to find that there are at least 75 of these. Permissible levels can be found for such elements as arsenic, barium, boron, cadmium, chromium, lead, manganese, mercury, selenium, as well as compounds such a cyanide, pesticides, weed-killers, sulfonates, phenols, and detergents. Although relatively low levels have been set for these, one wonders about the sum total of their cumulative effect and also about the possibility of synergisms, not only among the above-mentioned group, but including fluoride. Based on such considerations, a recent Canadian article advocates that "Water should be considered a food and brought under the control of the Federal Food and Drug Directorate...water would then have to be tested and approved in the same manner as food additives"(12). Some people in our Food & Drug Directorate would not welcome this proposal, primarily because they are already overworked in their attempt to keep up with the proliferation of additives, adulterants, and outright toxic substances in the galaxy of foods and drugs.

So far, I have given examples of potential synergisms as they apply to air, soil, and water. However, consideration of today's environment requires inclusion of the biological targets of pollutants. In this area, I have been interested in something that must be considered akin to a synergism, namely the intake of a pollutant in a biological organism beset by nutritional inadequacy. In many reports the "toxicity" of fluoride was assessed in mammalian species that, otherwise, were receiving an optimal diet. This is quire acceptable if the species in question is normally maintained on such a high dietary regime. But extrapolation of such findings to human populations is unwarranted, because the nutritional status of the human being seems to leave much to be desired. United States surveys indicate that more than half of the population have inadequate intakes of dietary components such as calcium and vitamin C (13) and a similar trend seems to prevail in

regional surveys done in Canada (14). Recent reports by Reddy and co-workers (15) have described how dietary insufficiencies of either calcium, vitamin C, or protein, aggravate the toxic effects of fluoride in rhesus monkeys.

In all such situations, the things that worry me about fluoride, and about other pollutants, are not the things we know, but the things we do not know, or the things we have neglected.

I will now present a few final impressions. It is often stated that fluoride is only a "local" problem and yet, at a 1968 symposium in Wageningen, it was reported that fluoride-induced injury to coniferous forests could occur at a distance of 32 km from the emitting source, and the destruction of some species at a 13 km distance (16). It all depends on how one defines the word "local". Of course, it is possible to establish a low level baseline for fluoride in ambient air by avoiding all sectors likely to be contaminated by industrial emissions. And yet, the fact remains that many districts have more than their share of industrial activity, plus the emissions that such activities entail. The Wageningen symposium included a presentation in which it was estimated that 400,000 hectars of European forests had been destroyed by the action of atmospheric fluoride and sulfur dioxide (17). A recent report attests to the situation in the Montana region of the United States, and summarizes it as follows:

> "Gaseous and particulate fluoride effluents...have caused considerable environmental damage over a large geographical area. Herbaceous plants, shrubs, and trees showed foliar burn correlated with excessive fluoride accumulations... The occurrence of elevated fluorides in insects indicates accumulation through the food chain of the ecosystem. Foliar necrosis due to fluorides was found in Glacier National Park, representing an unwarranted intrusion by technology of man into one of the few remaining truly pristine habitats of the world" (18).

But, in spite of such occurrences, the question is often asked: "What does it matter if some vegetation is destroyed?" To me, this represents the attitude that propelled mankind into what I call The Age of Pollution, and is tantamount to someone asking: "How much of Lake Erie (or Lake Balaton, or Lake Constance) can we destroy?" The ecosystem is an integrated and interactive organism, and, like it or not, we are part of that system.

Concerning fluoride emissions of various forms, wisdom dictates that every effort should be made to contain fluorides within the confines of the factory. There are now economic incentives for pursuing such a policy, because compounds such as cryolite and hydrofluoric acid can be synthesized from waste fluoric gases and particulates (19, 20, 21). Such recycling can benefit all industries involved in the utilization or emission of fluoric products. One thing is certain: It will undoubtedly benefit the ecosystem.

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FLUORIDE-INDUCED DIURESIS: PLASMA CONCENTRATIONS IN THE RAT

by

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(Abstracted from Proceedings of the Society for Experimental Biology and Med. 137:458-460, 1971)

The authors quote observations by Bond and Murray (1), Gottlieb and Grant (2) and Goldemberg (3) in which the administration of fluoride to laboratory animals and to man has caused polyuria. However no data on the corresponding plasma fluoride concentrations in these experiments were recorded. In a previous publication Taves et al. (4) considered the possibility that excessive fluoride concentrations in plasma following administration of methoxyflurane anesthesia could be the cause of polyuria and toxicity to the kidneys. Therefore, they investigated the levels of fluoride both in urine and in plasma of rats.

Method

Four rats were anesthetized at the same time by intravenous infusion. Each received fluoride at a different rate namely, 0, 100, 500 and 1000 nmoles (0, 1.9, 9.5 and 19 ppm) per minute respectively. All solutions contained 150 mM sodium, but the concentrations of chloride and fluoride varied. The solutions were infused continuously at 20 µl per minute into the left iliac vein. The rats, all females weighing approximately 200 g, were anesthetized with 40 mg per kilogram sodium pentobarbital.

Urine collection began 10 minutes after the start of the infusion and continued for seven 30-minute periods. Blood samples were collected for fluoride analysis at about the midpoint of the second and fourth through the seventh collection periods. The urine was drawn through indwelling intraurethral PE-50 polyethylene catheters and collected in capillary tubes of known volume and constant inside diameter (Drummond Microcaps). The measured length of the urine columns in the capillary tubes, provided the estimate of the urinary volumes.

Blood was drawn from the severed tail tips of the rats into heparinized capillary tubes and centrifuged. At the cell-plasma interface the capillary tubes were scored and the plasma expressed into containers to await analysis. The fluoride was measured by the Orion fluoride electrode.

All fluoride-infused groups manifested a significant increase in urinary flow

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rate by the third 30-minute period with little change thereafter compared with the control groups.

The plasma fluoride concentrations in those receiving 500 to 1000 nmoles per minute rose gradually from the second to the final period by 70 to 90%. Infusion of 500 nmoles of fluoride per minute produced a maximum diuresis which was 3 times the mean control urinary flow rate and a plasma fluoride concentration of 272 μM. The hundred nmoles per minute fluoride infusion rate produced an 80% increase in urinary flow rate with a plasma fluoride concentration of 56 μM.

The authors conclude that their findings indicate that the nephrotoxicity following methoxyflurane anesthesia is due, at least in part, to the breaking down of methoxyflurane to inorganic fluoride.

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HYDROFLUORIC ACID BURNS OF THE HAND

by

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(Abstracted from the Journal of Bone and Joint Surgery, 52:931-936, 1970)

Reviewing the activities with which hydrofluoric acid burns may be associated, Dibbell et al. list the production of plastics, germicides, dyes, tanning agents, stable solvents, fire-proofing materials, and semiconductors, as well as etching and frosting of glass, removal of defects in the glazing of pottery, removal of sand from castings in foundries and removal of rust.

The fluoride ion readily penetrates the skin to deep tissue layers causing liquefaction necrosis of soft tissues, decalcification and corrosion of bone, as well as the type of dehydration and corrosion of tissues which other mineral acids produce. Ionized calcium and magnesium is trapped and forms relatively insoluble calcium and magnesium fluoride associated with excruciating pain. White areas of coagulation and blistering appear at the site of injury surrounded by erythema. Areas underneath the finger nails which are inaccessable to local applications constitute predilective sites. The intensity and rapidity of onset of symptoms vary with the concentration of the acid, the duration of contact, the total amount of acid and the penetrability and resistance of the tissue exposed.

Among 45 hydrofluoric acid burns on the hands, 16 were treated by injections with a 10% calcium gluconate solution. Thirteen of the 16 patients experienced immediate relief of pain. They had neither tissue loss nor other complications. In the remaining three who received the calcium injections, late debridement of the burned tissue under regional block anesthesia was required. Of those who were treated with Zephiran (benzalikonium chloride) seven of fifteen (44%) showed tissue loss ranging from blister formation of the skin to partial loss of a digit.

When too much of the calcium gluconate solution is injected, especially into the fingers, pressure necrosis and sloughing may result. Regional block anesthesia is usually employed prior to local injection of calcium gluconate. Soaking the burned area with cold Hyamine No. 1622 (a high molecular weight quarternary ammonium compound) and iced aqueous or alcoholic Hyamine solution for 1 to 4 hours combined with analgesic for relief of pain has been recommended. Zephiran can be used equally well if Hyamine is not available.

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A CASE OF ACUTE SODIUM FLUORIDE INTOXICATION

by

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(Abstracted from Journ. of Association of Physicians of India 17:373-4, June 1969)

A 16 year old girl developed acute fluoride intoxication after accidental consumption of one tablespoon of sodium fluoride which had been kept in the home as a dusting powder for poultry. When she was admitted to the hospital, three hours after taking the poison, she was fully conscious and coherent but somewhat irritable. Shortly thereafter, the pulse rate increased to 130 per minute, the blood pressure became unrecordable and the patient became comatose. Respiration was shallow with a rate of 40 per minute. Treatment was instituted with 5% glucose, 30 mg Mephentine and 8 mg Decadron intravenously and 20 mg of Lasix intramuscularly but the patient failed to rally.

When she developed carpopedal spasm, a sign of low serum calcium, she was given 10 cc calcium gluconate intravenously. A dramatic improvement ensued with a rise in blood pressure to 160/90 and a drop in the respiration rate. Additional doses of calcium gluconate were given along with Decadron and Mephentine.

The only abnormal laboratory finding recorded was a low radioactive iodine uptake (19% of normal) on the third day following admission.

The authors pointed to the fact that chronic poisoning is common in many parts of India but that this was the first case of acute fluoride poisoning observed during the past 10 years.

In reviewing the literature, they noted that the disease is frequently mistaken for botulism, ptomain poisoning or "intestinal flu". The usual manifestations of acute intoxication are diarrhea, vomiting, salivation, hyperemia of the pharynx, shallow respiratory movements, ronchi in lungs as well as tenderness in the abdomen. Among laboratory tests, etching of glass by the aspirated stomach content, low serum calcium levels, hyperglycemia and a decrease in serum amylase are usually found in acute fluoride intoxication.

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THE FLUORINE CONTENT IN FAVORITE FOODS OF JAPANESE

by

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(Abstracted from Japan J. Public Health 14: 41-47, Jan. 15, 1967)

The authors determined the fluoride content of a wide variety of foods obtained from numerous local Japanese markets during the years 1958 to 1965. The foods were analyzed immediately after they were received, ashed with lime suspension at 500 to 600°C according to the method of the Association of Official Agricultural Chemists, and distilled according to Willard and Winter. The fluoride was assayed by zirconium eriochrome cyanin R method. Some specimens were measured by trium nitrate volumetric and aluminum hematoxilin method.

Rice, the staple food in Japan showed 9.67 parts per million (ppm) fluoride in the polished and 19.96 ppm in the unpolished state. The fluoride levels in cereal and vegetables increased during the years of 1958 to 1965. In 1965, cucumbers contained 5.04 ppm as compared with 0.34 in 1958 (7 samples in 1965 and 10 samples in 1958). The authors attributed the rise to the increased use of phosphate fertilizer, the fluoride content of which ranges from 0.01 to 9.88%.

One hundred nine samples of city water from Japanese cities ranged from 0.02 to 0.54 ppm.

The daily fluoride intake by individuals residing in rural areas were computed by the authors: In Shippo-mura Village, where drinking water contained slightly above 2 ppm, the daily fluoride intake during winter 1958 was calculated to be 4.38 mg; in Yatomi-cho, with 0.9 ppm fluoride water, 3.10 mg daily. However in 1965, the average daily intake of fluoride from the same diet reached 11.13 mg. Moreover, fluorides as impurities were found in hundreds ppm in eutrophics and other medical supplies.

The authors correlated their findings with the rate of human mortality from gastric cancer in Japan and found coefficients of +0.615 for the male death rate and +0.554 for the female death rate at the level of significance of 0.1%. They also reported a parallel relationship between mortality from gastric cancer and the amount of phosphate fertilizers applied to patty fields with a correlation coefficient of +0.998.

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