

February 25, 1946

Dr. Rufus H. Moore,
Assistant Professor of Horticulture,
The University of Nebraska,
Lincoln 1, Nebraska.

Dear Dr. Moore:

I am very glad to reply to your letter of February 15 and to sketch briefly the information which is now available on the general subject in which you are interested. In addition I am sending you under separate cover a series of reprints which deal with our experimental work and give references to the work of others on this subject during more recent years. You will find that these reprints confirm the results obtained by us in previous years and extend the information on a broader basis.

The articles which appear in the September 1933 issue of the Journal of Industrial Hygiene are no longer available in reprint form. Otherwise I should send you marked copies calling your attention to specific matters of significance. In lieu of this I wish to refer to certain points in those articles which bear on questions which you raised.

1. Let me call your attention first to the article in this series which deals with lead absorption and excretion of a group of primitive people. This is the only article of its kind in medical literature, and it owes its importance to the fact that it demonstrates the natural lead content of vegetation and animal organisms, including man. Since the development of more precise analytical methods we have had an opportunity to recheck these results in certain critical respects. It is now fair to say that the results have been confirmed as entirely correct in principle but as being slightly low in quantitative sense. The differences between the later analytical results and those originally obtained are not very great.

2. Let me also call your attention to the article in this series on the sources of normal and incidental lead absorption in the general population. It is important to recognize that the natural lead content of food and beverages constitutes a very considerable proportion of that met with in the human dietary. Actually what we have established in recent years on the basis of some thousands of observations under carefully controlled conditions is that the mean daily intake of lead on the part of the average adult American is about $1/3$ milligram. You will see these figures recurring repeatedly in the observations of the later work. Let me call your attention particularly to the experiments we have carried out on the daily intake and output of lead by human subjects ^{under} carefully controlled

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conditions in the Laboratory, at various levels of daily dosage of soluble lead in addition to that which occurred incidentally in the diet. So far as I know these are the only observations that give a satisfactory answer to your question as to the rate of lead accumulation in the human body under various conditions of lead exposure.

3. The reference in your letter to the section appearing on page 306 to 339 is a little unfortunate in that if you will examine this section again, you will find that it refers to lead absorption and excretion of persons in various lead trades. This material is related to the problem of the ordinary citizen, but it is primarily concerned with lead exposures of a very different order of magnitude than that in which you are interested. Let me call your attention to a preceding article in the same series of "Lead Absorption and Lead Excretion in Modern American Life," for this is the part of the series which is of principal concern in connection with your problem. We have shown in this article in a very substantial way the pattern of the lead metabolism, the details of which have been confirmed conclusively by later investigation. In this article we have shown the order of magnitude of the daily lead ingestion and excretion of normal individuals, and to a limited degree the lead content of the body of normal individuals. I call your attention specifically to the last paragraph on page 280 and the discussion which follows under the heading of "Lead in the Tissues of Normal Persons." The reprints which I am sending you will show that the observations made herewith while somewhat fragmentary at that time, gave us a very good idea of the truth. Since that time we have studied the lead in the tissues of presumably normal individuals and have been able to show that there is little or no progressive accumulation of lead during the lifetime of individuals whose lead exposure is of average, normal or incidental character. In other words, we have been unable to establish that there is a progressive increase in the lead concentration in the tissues of normal individuals with advancing years of life. The tentative conclusions arrived at here on the basis of necessarily spotty information, have been confirmed beyond any reasonable doubt by systematic study of the lead intake and output of normal individuals over considerable periods of time. The lead metabolism under these conditions is so nearly balanced that the accumulation of lead within a lifetime appears to be quantitatively insignificant.

4. Despite the above statements, I wish to call your attention to the fact that every additional increment of lead ingested above the average normal level is accompanied by some accumulation of lead. We have on hand additional information now in preparation for publication which demonstrates conclusively that if we add so much as .3 milligrams of lead to that which is in the diet, and if we continue this additional increment daily over a period of months, there is a slow progressive accumulation of lead in the tissues. In two instances in which this has been done, the total accumulation has amounted to approximately 10 milligrams of lead per year. This might be regarded as coming within the limits of experimental error, but we consider that this is not so. On the other hand, there is

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good basis for taking the position that accumulation of lead at this rate will probably have very little significance in the course of a lifetime. The reason for this statement is that most of this lead will find its way into the skeleton, and that its release for excretion therefrom will be slow, so slow in fact that the lead in the circulating blood and in the urine will probably never be elevated measurably above the limits of normal values.

5. I would not want you to believe from these statements that we do not consider the contamination of food with lead compounds to be a matter of significance to the public health. On the contrary we have established beyond doubt that the ingestion of quantities of lead of the order of one milligram of lead per day, is capable of creating a significant hazard to the public health. It is necessary, therefore, that the lead contamination of food materials be controlled to such a degree that it is kept within the present reasonably satisfactory limits. This can only be done if great care is taken in the handling and processing of food materials in general. Present safety is based on the fact that most foods contain only minute traces of lead. Any general increase in the lead content of available food materials would result in a potentially hazardous situation.

I believe you will find that the examination of the articles which I am sending you will answer a number of questions and will raise certain others. Unfortunately we do not have information which would enable us to speak with any authority on the subject of arsenic. There are data available, and we have a considerable quantity ourselves. Such as they are, they suggest that this problem is of a different order of magnitude, because of the relative ease with which arsenic is excreted from the body. However, the problem has not been studied systematically to such a degree as to enable anyone to give conclusive answers to the problems that have been raised.

Cordially yours,

Robert A. Kehoe, M. D.

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Reprints under separate cover.

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February 15, 1946

Dr. Robert A. Kehoe
Kettering Laboratory of Applied Physiology
University of Cincinnati
Cincinnati, Ohio

My dear Dr. Kehoe:

In reviewing literature that might be applicable to a course in spray materials, I ran across a series of articles, published by you and two co-workers. These reports had the group title "On the normal absorption and excretion of lead", and appeared in the September 1933 issue of the Journal of Industrial Hygiene.

The section appearing on pages 306 - 339 was particularly interesting in that it gave data on the excretion of lead. If lead is commonly excreted as this report shows, it would seem that the presence of spray residues of lead arsenate on fruits are not the health hazard they were once thought to be. In scanning through the series of articles referred to above, I did not run across any statement on the accumulation of lead in the human system. Have your studies involved this phase of plumbism, and if so, where have the results been published? Certain references by other authors state that lead is deposited presumably in the epiphyses of the bones, but I have not run across any data supporting this statement.

I will greatly appreciate any information you might send me or any citations to which you might refer me that will clarify the question of what becomes of ingested lead which is not eliminated from the human system. I will also be interested in similar reports on arsenic if you can supply the citations.

Very truly yours,



Rufus H. Moore
Assistant Professor of Horticulture

RHM/s

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