Our clinical knowledge of deficiencies in the "Trace Elements" is abysmal. The authors do not substantiate a diagnosis of allergy in the cases reported. However, the observations and hypotheses presented are interesting. It is probable that "conditioned deficiencies" in certain enzyme systems may explain this well established fact that allergic diatheses have a strong familial tendency.

Trace Elements, Allergies, and Soil Deficiencies

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Trace elements represent those required by plants and animals in amounts too small to be accurately measured by the chemist. Consequently, he reports them present as a "trace". Iron, copper, manganese, zinc, boron, molybdenum, silicon and chlorine have been listed to date as essential *trace elements for plants.* If the boron, silicon, and molybdenum in that list are replaced by iodine and cobalt we have a fairly recent list of the trace elements essential for animals.[9]

One of the most prominent authorities on trace elements points out that "Plants apparently do not require iodine or colbalt, although these are invariably present in plant tissues, and animals have not so far been shown to require boron or silicon, although these trace elements are also normally present in animal tissues. The qualitative differences in the trace-element requirements of plants and animals, as well as the considerable quantitative differences which exist both within and between plants and animals, have great practical significance."[9]

Dr. Underwood, the pioneer of Australian discovery of the deficiencies of cobalt and copper responsible for "steely" wool in place of normally crimped fiber as the product of the sheep's skin, reminded us also that "nutritional disabilities of man are far more likely to be associated with poor choice of foods consumed than with their source. The effect of soil differences upon the trace element concentrations in plants is, in practice, easily the most important of the various influencing factors."[9]

Boron has not yet been considered an essential for animals and man. It is in connection with the baffling subject of allergies that we propose that boron be added to the list of trace elements essential for man and animals. This proposal is made because the administration of this element by mouth has recently shown

itself a decided help, if not a remedy, for irregularities in the health of the skin of warm-blooded bodies. Excesses of it, as is true for most of the other trace elements, have been serious disturbers of body physiology as shown by their prohibiting conception.[6] Recovered conception occurs, however, if the excesses are withdrawn. With these observations at hand, it seems to follow logically, that boron is an essential element in the nutrition of man and animals. Some discussion and evidence are accordingly presented.

PLANTS OF HIGHER FOOD VALUES ARE THE FIRST TO REFLECT SOIL DEFICIENCIES

Deficiencies of the trace elements in the nutrition of plants occur more often and more noticeably in the legumes. This is the group of plants which are high in their concentrations of proteins. They are also more commonly higher in their concentrations of the essential ash elements than are other plants. By virtue of that fact, they exhaust the soil of its store of the elements other than nitrogen most rapidly and severely. It follows that "they are harder to grow" yet they are commonly (erroneously) called "soil builders." It is the legume plant, alfalfa, that reflects the deficiency of boron in the soil by a chlorotic condition in its growing tips earlier and more clearly than does any other known field crop. (Figure I)

These facts suggest that alfalfa may be feeding our animals a higher concentration of boron in its forage than do other crops. Used, then, as a feed supplementary to other forages—for which purpose it is consumed so extensively—this crop may have fitted itself accidently into that unique place in practice by virtue of making up for the nutritional deficiency of boron for animals in those crops which it supplements. The question needs to be raised whether alfalfa has become so extensively used in supplements to animal foods,* not only because it renders excellent services in many broader phases of nutrition, but also because it has unwittingly been supplying the trace element, boron, which may have always been an essential element for animals and man but had not been discovered as so essential for that higher life group.** That the nutritional values of alfalfa have been the last curative hope for many animal troubles, commonly baffling for the veterinarians, is shown by the almost universal recommendation to "Try feeding some good, western alfalfa."

CHEMICAL PROPERTIES OF BORON CONNECT IT WITH BIOCHEMICAL POSSIBILITIES

Viewed in terms of its chemical properties, boron, which is classified as an inorganic element with an atomic number five, is in the periodic table next to carbon, which is commonly classified as an organic element with the atomic number six. This brings them together closely and lists them as similar in chemical properties and behaviors. By virtue of that fact, it is not strange that organic hydroxy-acids such as mannitol monoborate—a compound which con-

*Alfalfa in concentrated form now makes up a goodly portion of human food supplements. Might it not be serving unwittingly to provide boron as an essential element in human nutrition?

**A small percentage of clover plants (Trifolium subterraneum), a legume, in the pasture mixture with a grass (Phalaris tuberosa), a non-legume, feeds the Australian sheep enough cobalt to prevent the staggers syndrome, a symptom of the deficiency of this trace element. This legume delivers cobalt in beneficial amounts and/or compounds while the non-legume does not.[1]

FIGURE I. Boron deficiency has been shown most widely in the alfalfa crops by such symptoms as telescoped-like parts, bleached or chlorotic appearances and reduced growth.

tains both boron and carbon—should play an important role in the physiology of plants where it overcomes their excessive alkalinity[8]

Perhaps either the alkalinity of calcium hydroxide, neutralized by borogluconic acid, or the reaction of the boron with the sugar[7] was connected with the better intravenous relief for the cow's milkfever, which was observed, when someone in New England started using *calcium borogluconate* in place of the simpler compound, *calcium gluconate*, and found the former a more effective remedy. The soils of that area are reported to be deficient in boron for field, tree and vegetable crops (Figure II). This calcium borogluconate supposedly

serves better to deliver calcium for use in this metabolic emergency and dangerous physiological stress of the freshened cow. Yet the physiological role of the boron was not considered when it was first added to calcium gluconate to prevent its precipitation from concentrations as high as forty percent, if made up in a four percent aqueous solution of boric acid.[4] This leaves the boron to fit into the theory that it may be serving therapeutically and playing its own metabolic role in very refined details as is common for the other trace elements in both plants and animals. This suggests that our remedy for milkfever is a case of empiricism rather than an accurate diagnosis with boron a possibly essential trace element in animal nutrition, but in ways yet unknown.

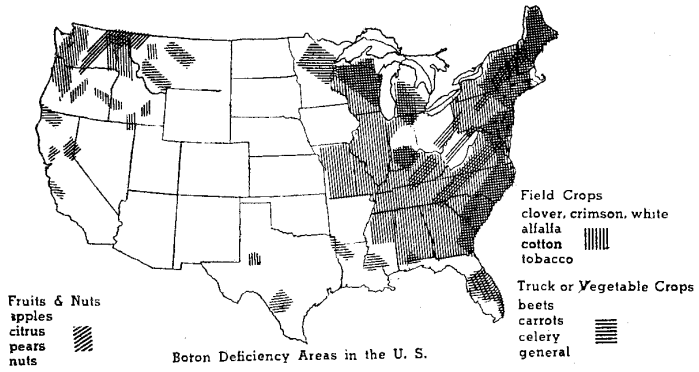

FIGURE II Boron Deficiency Areas in the United States. By courtesy of James A. Naftel's redraft of maps reported by K. C. Beeson. Soil Science 60:9-13, 1945.

ALLERGIES MAY BE DUE TO DEFICIENCY OF BORON

The observation in 1957 of the better health and growth of wheat plants in Alabama, fertilized by borax, prompted the use of this compound (sodium tetraborate decahydrate) in drinking water at the rate of about two grains (60 milligrams) per month. This is less than an equivalent monthly rate of seven milligrams of the element boron. Were one drinking water at the low rate of but two liters per day, that daily supply would need to carry the element boron at less than a quarter part per million* to be medication equivalent to that which gave decided improvement in nervous indigestion, excessive sneezing, and the common skin trouble of acne. Here we had the suggestion, by human demonstration, that the skin reactions—considered a symptom common to allergies—are removed by the introduction of the trace element boron into the warm-blooded system.

This observation concerning allergies prompts the theory that these ailments may be simply expressions, via the skin, of deficiencies of inorganic elements (soil origin via plants) operating through a long chain or series of biochemical reactions, not so readily traceable in the reverse from the skin irregularity to any in the food or in the digestive system and then still farther back to any shortages in the fertility of the soil. We are apt to be contented, then, in our

*Los Angeles water from Owens River aqueduct averages 0.43 ppm boron.

diagnosis by saying that allergies are *caused* by some food allergen introduced into the digestive system. Relief, then, is expected via exclusion from the diet of certain foods. The irregularies in the physiology of the body in its entireties are not even suspected, hence, much less diagnosed and prevented.

"It is becoming more evident that all types of eczema and dermatitis are expressions of food allergy. Intractable skin lesions refractory to dermatological treatment, beginning with infantile eczema or dermatitis and those occurring throughout life, are all amenable to allergic management.[2] Dermatitis was the principal complaint in one hundred cases observed in twenty-five years of private practice, but usually in such cases the complaints were multiple; cases of dermatitis or eczema from infancy to old age were included. Purpura, hives, and acne are included since they too are allergic diseases."[3]

PULSE DATA CLASSIFY ALLERGIES UNDER SYSTEMIC UPSETS

By means of the pulse-dietary technique, introduced by Arthur F. Coca, M.D.[2] as the method of choice in the diagnosis of nonreaginic allergy, the irregularities composing a long list have been clearly classified as allergies. The list includes health disturbances of the (a) central nervous system (migraine, epilepsy, speech defects, etc.); (b) ears (catarrhal deafness, vertigo, etc.); (c) eyes. (pollens, dusts, retinal detachment, etc.); (d) entire system (fever, toxemia, etc.); (e) nose (hay fever, excessive sneezing, frequent colds, etc.); (f) respiratory system (asthma, recurrent coughs, etc.); (g) gastrointestinal system (canker sores, ulcers, colitis, etc.); (h) cardiovascular system (hypertension, pseudo-angina, etc.); (i) genitourinary organs (renal colic, cystitis, multiple abortion, etc.); (j) skin (hives, eczema, acne, food and drug eruptions, etc.); (k) extremities (joint pains, child leg-ache, edema, arthritis, etc.). This list includes one hundred or more irregularities in health, all of which must be managed—and then only for relief—by abstaining from some kind of food or by exclusion from the mucous membrane of many substances in such finely divided states that they suggest their irritation of it by contact and by absorption. Such a long list of disturbances in health suggests that we must search for cause among a few of the essential elements at the outset of life in its less numerous requirements and simplest functions. Search there should be more fruitful in finding causes than search for them in later life with its multiplicities of functions involving myriads of compounds.

Relief, and only relief, for the large number of allergic individuals—amounting to 94 per cent of the population—by the elimination of items of food and other allergens from the environment, when others in the human species are not allergic and have been ingesting, digesting, absorbing, and metabolizing the so-called allergens with good results for health, makes one wonder about basic causes. It suggests that the life time of the allergic individual has not been a true epitome of the life history of the species. The allergic individual has seemingly lost out on some of the developmental stages during his growth when

the biochemical mechanism should have been set up for his digesting or metabolizing foods and other substances without disturbances in the entire system and without disruptions in so many body processes. He has apparently not developed in the evolutionary orderliness of the species for, or to the high degree of, using many substances as nourishment or as means of the self-preservation represented by the non-allergic individuals who are thereby considered healthy and normal in taking and metabolizing, with impunity, the many listed allergens.

BORON DEMONSTRATES ITS ESSENTIALITY FOR MAN AND ANIMALS AFFLICTED WITH DERMATITIS

With so many allergic manifestations and with no explicit knowledge of the failing body mechanisms which cause them, these ailments suggest that we ought to view them as possible deficiencies in nutrition. This seems a logical approach, when the trace element boron, administered to man as borax, decidedly modified an allergy, namely, acne, and cleared up a severe case of eczema affecting an animal when similarly administered by mouth. Such facts suggest that boron should be studied as an essential element for warm-blooded animals as well as for plants.

The successful treatment of the case of eczema of a mule suggests that the line of reasoning proposed is certainly not going far afield. This beast was tormented with dermatitis about the neck and shoulders for years. It was worse in summers when, with gnats and flies tormenting him, he was a very troublesome animal to work. Following the administration of borax (about one gram two or three times per week), beginning in April, this animal soon began to show improvement. He gnawed his skin less than formerly. There were fewer insects, and the secretions dried up. By midsummer hair had returned to most of the affected area, and the mule was so much quieter that he seemed like a different animal.

The reported results with this animal prompted a doctor of medicine to state his belief that Demodex mange (with the mite, Demodex folliculorum in the hair follicles and in the sebaceous glands) of dogs might be a form of acne (allergy). This theory prompted the feeding of borax to a couple of mangy dogs obtained from the pound in April, 1958. One of these, a pointer, was 6-8 years old. The other, a mixed terrier female, was about a year old and weighed approximately 25 pounds.

These two dogs were started on the borax treatment at the rate of only a few grains per day. There was some improvement noted by early August but the skins were far from healed when a veterinarian's examination of the female's oval-shaped, scabby areas with the Wood's lamp revealed ("Ringworm") a fungus present. Skin scrapings under the microscope showed Demodex mites on both dogs.

The dosage of borax was increased to about a gram per day per 15 pounds live body weight, with improvement showing soon thereafter. By October 23, an examination by still another veterinarian showed the pointer negative for

FIGURE III

Changes in the mangy condition of a terrier dog from the spring of 1958 (upper photo) to 1959 (lower photo) as the result of supplementing the food with borax. The center photo (enlargement of upper one) shows the fungus (ringworm) on the head.

the Demodex mites, while the terrier revealed two doubtful ones. A second test later was negative. The dogs were not infested with internal parasites and the blood picture was normal. By cold weather, both dogs had normal coats and had gained weight. One could not tell that they ever had mange. Both fungus and mange lesions had disappeared from the female. The improvement prompted cutting the feeding of borax to half the former rate, and planning to keep the dogs to note whether the mange would return in the summer of 1959. No other treatments for mange were used while feeding borax.

The pointer, kept through the winter, suffered a broken leg when hit by a car in the early spring. He was destroyed, since he had proven useless as a hunting dog. A few weeks before he was killed, a small area resembling mange appeared under his neck but his death prevented confirmation.

The female terrier, (Lucy) however, has never shown any sign suggesting the return of mange. She has given birth to two litters of pups. None of them has shown signs of mange. The condition of this dog at the beginning of treatment April, 1958, and again on October, 1959, just before the delivery of her last litter of pups, is shown in Figure III.

Another successful treatment of a very severe case of red mange was achieved in 1958, when a veterinarian suggested to his client that he give his bird dog a daily dose of one level teaspoonful of borax. This treatment was begun in the summer. Within six weeks new hair appeared. By hunting season, the dog was ready for service again. Tragedy struck, however, for this dog was bitten by a snake and died, according to the owner's report.

Dr. Hoerlin,[5] a veterinarian at the University of Alabama, reported as early as 1950 that borax given internally was relatively non-toxic to dogs. Borax in amounts needed for treating mange is readily consumed by dogs when mixed with their feeds.

Since no dogs were kept as controls in the preceeding treatment of red mange with borax, it was decided to repeat the tests in 1959. Four dogs with red mange, two males and two females, were obtained from the pound in Columbus, Georgia. They were taken to the veterinary clinic at Auburn, Ala., where all were declared to have Demodectic mange from observations of the skin and scrapings under the microscope. The two females were selected to receive the borax. One was of a tan color, weighing about 15 pounds (case No. 6395): The other was a blue hound weighing about 20 pounds (case No. 6396).

The two males were kept as controls. One was black and white, weighing about 30 pounds. (Case No. 6397). The other was a mixed tan and white terrier weighing 27 pounds. (Case No. 7072).

The treated dogs were placed in one pen and the controls in another. They were fed a dry dog ration with meat and bone scraps occasionaly. They were handled alike in every way possible, save that the treated dogs had about one gram of borax per 15 pounds of body weight added to their ration daily, while the control dogs were given none. The treated dogs were turned out to exercise in the evening and the controls in the morning. The test was begun April 27, 1959.

Within two months from the above date, new hair growth was appearing on the bare spots of the treated dogs. Some of the foul odor associated with the mange was subsiding. The control dogs continued with typical mange in appearance and odor.

Within four months the treated dogs were practically covered with hair, although close examination revealed irritated areas, and mange mites could be located by microscopic examination. The control dogs still had typical mange.

All dogs were taken to the veterinary clinic at Auburn, Ala., September 17, 1959. Dr. Hoerlein located mange mites near the toes of the treated dogs, but the hair coat was so good that he advised photographs of the dogs to note the improvement. The controls still had typical mange lesions and odor.

These dogs were taken to the clinic again on October 30, 1959. Dr. Hoerlein remarked that the treated dogs had made much improvement since the visit, September 17th. Only by repeated skin scrapings were two or three mites found on these dogs. The hair coat was practically normal in appearance. Mange mites were easily located on the controls which still had typical mange lesions

FIGURE IV

Changes in the appearance of a mangy dog from late April to early Octoger, 1959, as the result of feeding borax are shown in the upper two photographs. The appearances of another dog given no borax are shown for the same dates in the lower two photographs.

and odor. Figure IV includes photographs on April 27 and October 2, 1959, to note the contrast between the tan female given borax (Case No. 6395) and the black and white male control (Case No. 6397).

ARE ALLERGIES DUE TO DEFICIENCIES IN TRACE ELEMENTS?

In this report of several results from feeding boron, the dermatitis emphasized itself most prominently as one irregularity of the skin to suggest that allergies (expressing themselves by dermatitis as one very common symptom) may be

FIGURE V

This cow comes a long distance daily through the southern piney woods to graze the narrow strip of grass growing along the concrete pavement's edge on imported fertility. She risks her own life against the motorists who cannot always move over to mid-pavement on passing her. As a connoisseur of nutrition for her health she struggles hard to maintain that by natural means, or to demonstrate survival in spite of, more than because of, man.

premised on deficiencies of at least one of the trace elements, namly boron as a soil deficiency. Since dermatitis is only one of the many symptoms of allergy, and the others are all too often not of atopic or reaginic etiology, the time seems ripe to consider deficiencies in elements coming up from the soil via food as the possible cause of what is so widely but so loosely covered under the inclusive term " allergy".

When the mites of the Demodex mange and the fungi of the dogs disappeared, not because of epidermal applications of some powerful pesticide or fungicide of chlorinated hydrocarbon structure, but by the simple ingested supplement of the sodium salt of boric acid to cover the suspected deficiency of boron in the feeding of the animals, we have seemingly the simple duplication of what nature has always been doing in establishing any life form at its best in an ecological climate; namely, we have provided the required nutrition. (Figure V). The survival of the fittest, according to the Darwinian postulate, has always been brought about by that means in the natural patterns of life. Proper feeding undergirds all that is a healthy body, and all that is resistance to various onslaughts, in ways more devious than we yet credit to balanced and complete nutrition.

When the black wool fiber secreted by the white skin of the "black" sheep loses its black color to become gray; and when the fine wavy crimp of the white wool of the white sheep becomes nearly straight or "steely fiber, (Figure

VI) the question may well be raised as to the mechanism involved. The normal black color and the regular fine wave or crimp are brought back by feeding the sheep extremely small amounts of copper and cobalt salts.

Since the trace elements are biochemically effective when present in only "trace" amounts, they have not been quantitatively considered. Then too, since they are seemingly harbored or stored by some organs of the body, the lag in response to either depletion of the stored supply or to introduction by feeding, makes their effects less spectacular and thereby too little noticed to bring trace elements into the commonly considered causes of irregularities in health. But with boron required to prevent acne, eczema and mange; and with copper and cobalt essential for normal sheep wool and freedom from worms; such cases illustrating the essentiality of these elements for the prevention of skin irregularities give the trace elements a significance that bids fair to become more appreciated if tested farther.

ALLERGIES ARE NOT NECESSARILY INHERITED

The term "inheritance" has tranquilized our thinking about allergies in a more fundamental way, when those ailments have been considered "familial" and when hypersensitive states are listed as inherited. "Competent observers place the incidence of familial, nonreaginic allergy as high as 94 percent of our total population."[3] But when by the ingestion of borax in the drinking water in an area naturally low in boron, the excessive sneezing as a common affliction of both father and son disappeared, shall we say that the excessive sneezing was inherited? Shall we not more logically take to the belief that since both

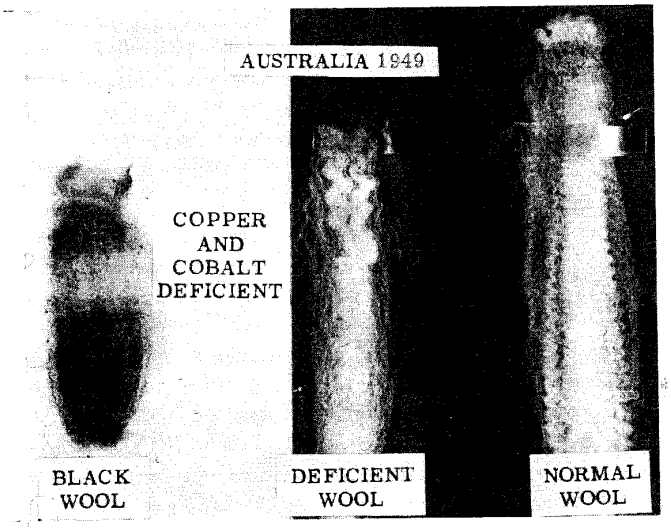

FIGURE VI

When but a short period of deficiencies of copper and cobalt changes the sheep's black wool to a gray and the fiber's fine crimp to a steel-like fiber, but both are restored to normal on feeding these trace elements, is this a case of dermatitis suggesting an allergy related to their deficiency?

men lived, and ate products grown in the same geographic area and in the same climatic soil setting, the correlation of the sneezing symptom between father and son was not proof that the former caused it in the latter (transmitted by inheritance)? Rather, isn't it far more logical to reason that both father and son had the same health irregularity from the same cause, namely, the deficiency of boron (a trace element or possibly others) in their food (or drink) and in the soil growing it, as revealed by improved wheat fertilized with borax?

This fallacy of saying that in the case of two closely correlated happenings the one *must* be the cause of the other, when they may be correlated because they have a common cause, is an error in logic that occurs widely. If you and a policeman in uniform are walking down the street together, does that fact prove that he is the cause of your going in that particular direction? He may or he may not be. Let's hope that it is the latter and that both of you happen to be going to the same supermarket as acquaintances meeting enroute by pure coincidence.

The liming of soils in the Eastern United States is a practice which has been extensively established and has persisted for many decades to the great benefit of agriculture, but unfortunately as the result of just such fallacious reasoning rather than through the fullest understanding of just how and why it serves. In that area of the United States where the soils are shown in Figure II to be seriously deficient in boron, there is increasing rainfall as one goes eastward. There are also increasing failures in growth of more nutritious legume crops as one proceeds in that direction. Hence the conclusion has commonly been drawn that the increasing degree of soil acidity caused by the increasing rainfall has caused the higher percentage of legume crop failures. When we say that the presence of the acid in the soil is the cause of the legume failure, we commit a fallacy in reasoning as a case parallel to that illustrated by the policeman and by the belief in allergic inheritance. We often miss the hidden and unknown common cause of two correlated happenings and then say erroneously "The one of the two must be the cause of the other."

Soil acidity and its correlated legume crop failures have a common cause in the higher rainfall, which caused growth of much vegetation to remove calcium and magnesium, and provided much water to leach these two essentials down and out in the form of carbonates, made soluble by the carbonic acid which roots use to make fertility elements available. These nutrients have been replaced by hydrogen or acidity, a non-nutrient. The soil is consequently infertile. Legume crop failures are due to starvation or to nutritional deficiencies, since legumes will grow in the presence of acid, or hydrogen, if the fertility is present with it. In such erroneous reasoning we miss the common, hidden cause, just as we do when we have common nutritional deficiencies as the basis for symptoms of father and son and then say the father transmitted the allergy to the son through inheritance.

Nature in the wild has always managed health (sometimes for better, sometimes for worse with survival in case of the former) of the many species of living forms by means of nutrition. Now that degeneration is rampant, would

it not be well to look for some hope in teaching and practicing nutrition for health rather than for any other purpose? Progress is often built on the facts some folks have observed. Trace elements and allergies revealed by the pulse-test may be somehow related. Clinical observations along this line of thought might be productive of interesting results.

Since trace elements from the soil are difficult to measure by chemical means and yet are decidedly significant factors in the life processes of plants, animals and man, shall we not observe our own bodies more closely for their assays of what elements are essential?

It is logical to expect better health and better foods from fertile soil.

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