ANKLE KERATOSIS

AN INVESTIGATION INTO THE ETIOLOGY AND SIGNIFICANCE OF THIS LESION

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I N D E X

Page

CHAPTER IV (Contd.)

Page

A P P E N D I X

CHAPTER I

I N T R O D U C T I O N

The part played by nutrition in the maintenance of health and in the prevention and cure of disease is universally accepted as one of great importance. Optimal health depends on optimal nutrition and the body's resistance to infections is believed to be considerably influenced by the nutritional state.

In ordinary times the choice of diet varies with custom, with the housewife's knowledge of food values, and with the amount of money available for food. In wartime, this responsibility is to a large extent transferred to the central administration of the country, because of the need for a system of rationing which will ensure a fair distribution of restricted food supplies. In the last war 1939 to 1945, the scheme was successful in supplying basic needs and in preventing the development of any widespread nutritional disorder. This success was largely the result of the application of the newer knowledge of nutrition to the selection of the types of food for import, to the control of home produce, and to the manner of distribution among the different age groups. The continuance of the war and of strict rationing over a period of years made it probable

that chronic malnutrition might become prevalent. This condition is less easily detected than are the severe acute deficiency diseases, and it was feared that such a state would inevitably be reflected in the output of work in factories, and on the powers of resistance to infection and other disease. Constant vigilance of the position was maintained by surveys of the nutritional condition of children, factory workers, pregnant women, and of men and women in the forces. Furthermore it was realised that the assessment of health, and particularly the detection of minor degrees of malnutrition, were subjects requiring more investigation. For this reason, in many wartime surveys, the incidence of certain signs was recorded while at the same time their nutritional significance was being investigated. Various forms of keratosis of the skin were studied in this way, and it was thought that Ankle Keratosis, a condition which has received only the barest mention in the literature, was also worthy of special investigation. It seemed important in view of food rationing and of the prevalence of the lesion to decide whether or not it was due to a food deficiency, and if so, which factor was responsible.

Before entering into a detailed description of the study of Ankle Keratosis which was made during the war, it is proposed to discuss briefly the present position of our

knowledge of nutrition with particular reference to pre-clinical deficiency states and to the methods used in the assessment of nutrition.

Malnutrition, when it is termed primary, is the result of dietary deficiencies, but a secondary type of malnutrition may develop in spite of an adequate diet if there is some abnormality of digestion, absorption or assimilation of foodstuffs. The discussion which follows refers only to the primary type of malnutrition.

DEGREES OF MALNUTRITION.

The discovery of vitamins has resulted in a great advance in the understanding of the science of nutrition, and the application of this knowledge has caused the virtual disappearance, in this country at least, of gross deficiency diseases. Emphasis is now being placed on lesser degrees of deficiency which are believed to be particularly prevalent among children.

(1) MALNUTRITION IN ANIMALS.

It is customary to subdivide the nutritional state into four classes, optimal, good or satisfactory, minor or pre-clinical deficiency (subnutrition, hypovitaminosis, presymptomatic or subclinical deficiency) and frank deficiency disease. This classification arose in the first place from the study

of induced deficiencies in animals. Feeding experiments give the opportunity of determining a test animal's requirements for various essential nutriments with a considerable degree of accuracy. There have been many investigations of this type using a great variety of deficient diets. These can be arranged in such a way that the supply of any one nutriment is optimal, adequate, minimal, inadequate, or absent, while all other nutritional factors are present in optimal amounts. The severity of the state of malnutrition which develops in an animal on a restricted diet is found to vary with the extent and duration of the deprivation. Complete absence of an essential substance causes failure to thrive and specific signs of deficiency. A 'minimal' amount of an essential nutriment is defined as that amount which is just sufficient to prevent the development of frank deficiency disease. An amount intermediate between minimal and optimal is termed 'adequate' and is thought to maintain a satisfactory state of nutrition. The relationship between nutritional states and dietary intakes can best be illustrated as follows.

Intake	Nutritional State
Optimal	Optimal
Adequate	Satisfactory
Minimal)	Preclinical Deficiency
Inadequate)	Frank Deficiency Disease
Absent)	

(2) MALNUTRITION IN HUMAN SUBJECTS.

The same relationship between the nutritional state and the dietary intake probably exists in human subjects, although no sharp distinction between the various classes can be recognised. One grade of deficiency passes gradually into the next and it is usual to find that more than one factor is responsible for the deficiency state. Kruse (1943) regards malnutrition as a condition which may be either acute or chronic in its development, and mild or severe in its degree. In the following discussion the terms described under animal nutrition will be retained as they are more generally accepted.

(a) Frank Deficiency Disease:

Gross deficiency diseases such as beri-beri, pellagra, and scurvy occur in patients whose diet has for some time been very deficient in foods containing thiamin, niacin, and

ascorbic acid respectively.

(b) Preclinical Deficiency:

Many workers believe that minor deficiencies of the vitamins and of some of the minerals lead to a state of sub-nutrition which is insidious in its onset, requires special tests for its detection, and which materially influences the state of health.

Latent scurvy was described by Hess in 1917, but most of the work on minor deficiencies has been done in recent years. Spies et al. (1939a) have described in detail the prodromal symptoms of pellagra which they believe to represent a state of pre-clinical deficiency, and the following authors are agreed that a minor deficiency state commonly occurs. McLester (1939), Harris (1940), Konstam & Sinclair (1940), Sebrell (1941), Orr (1941), Bean et al. (1942), and Jolliffe et al. (1942).

The influence of such factors as age, rate of growth, activity, infection, diarrhoea, pregnancy and the like, on the requirements of the different vitamins has been determined both in animals and in human subjects, and is found to be considerable. (Ellison & Moore, 1937; Minot, 1938; Teel et al., 1938; Dann & Cowgill, 1938; Davidson & Scarborough, 1941; Popper & Steigman, 1943). As a result, it is difficult to define the minimal quantity of any one nutriment necessary

to maintain health. A minimal diet would not allow for storage, with the result that extra supplies required for times of physiological stress or in the presence of an infection would not be met. It is reasonable to suggest that a person taking a diet which allows no margin of safety for the essential nutriments, might suffer from a state of preclinical deficiency, and it is obviously advisable that the diet should contain all essential factors in amounts greater than the minimum. In other words the intake should be at least 'adequate'.

(c) Optimal Nutrition:

More recently the effect on health of supplies of vitamins in excess of so-called 'adequate' amounts has been investigated, and it is claimed by some that they cause a definite improvement in the general condition and in the output of work. (Borsook, 1945). Yudkin (1944a) found a reduced incidence of minor ailments in school children, following a course of supplementary vitamins. On the other hand, Bransby et al. (1944; 1946) failed to demonstrate any consistent improvement in the health of children who were given vitamin pellets every school day for a year. When additional vitamins cause no appreciable improvement in the state of health, the diet is believed to be already 'optimal' in this respect.

EVIDENCE OF THE EXISTENCE OF PRECLINICAL DEFICIENCY STATES.

Although there remain many problems to be solved in human deficiency diseases, no one would now deny that diseases such as scurvy, beri-beri, rickets and pellagra can be prevented by providing a diet which contains adequate amounts of food rich in the specific vitamins concerned. The existence or otherwise of an 'optimal' as compared with an 'adequate' dietary is not a matter of great concern, but it is of the greatest importance to determine the validity of the claim that preclinical deficiencies exist and that they impair health.

A study of the literature has been made and the following experiments and observations have been selected as evidence of the reality of minor deficiency states. The investigations fall into four main categories. I. Animal experiments, II. Supplementary feeding experiments, III. Comparison of nutritional states in different social classes, IV. Detection of signs of deficiency in apparently healthy children.

I. ANIMAL EXPERIMENTS.

Experiments on animals have many advantages over those conducted on human subjects, and have elucidated many problems concerned with deficiency diseases. Objections are sometimes raised that the conclusions drawn from such experiments are applied to human nutrition without adequate

proof that the metabolic and pathological processes are sufficiently closely related. Animal experiments, however, have played a very important part in our knowledge of food values and it has been shown that while their individual requirements undoubtedly do vary, the underlying principles of nutrition are similar in all species. The following examples are quoted from a great variety of animal experiments which demonstrate the principle that preclinical deficiency states are a reality.

(1) Preclinical Vitamin A Deficiency.

Mouriquand (1939) demonstrated three degrees of corneal lesion in the rat corresponding to three stages of vitamin A deficiency. In the early stage biochemical changes occurred; in the middle stage microscopic, and in the late stage macroscopic lesions developed. Several rats were placed on a diet deficient in vitamin A. Others were given a full diet and acted as the control group. After a few days of deficient diet the rats remained apparently well, but exposure of their eyes to ultra-violet light revealed histological evidence of vitamin A deficiency. It was postulated that in this stage a biochemical change had occurred in the cornea, since ultra-violet light had no effect on the cornea of healthy control rats. A longer period of vitamin A deficiency caused the spontaneous

development of histological changes in the cornea, although clinically the eyes appeared to be normal. Finally the typical picture of xerophthalmia occurred.

(2) Preclinical Vitamin C Deficiency and Wound Healing.

The influence of vitamin C on the healing of wounds in guinea pigs was demonstrated by Hunt (1941). An absolute deficiency of the vitamin produces frank scurvy in the guinea pig, but in the following experiments sufficient ascorbic acid was given to prevent the onset of clinical scurvy. Gastrotomy wounds were made in a group of animals on deficient diet and in others receiving full diet. The rate of healing of the wounds in the two groups was then compared. In those guinea pigs on deficient diet there was obvious delay in the healing process, and histological examination showed that the normal collagen was replaced by precollagen fibres. It would therefore appear that a state of pre-clinical vitamin C deficiency causes delay in the healing of guinea pig's wounds.

(3) Preclinical Vitamin C. Deficiency and Resistance to Infection.

The resistance of guinea pigs to tuberculous ulceration of the bowel when fed infected sputum was shown by McConkey and Smith (1933) to be influenced by the degree of vitamin C deficiency. Of thirty-seven guinea pigs which

were fed infected sputum and which received inadequate amounts of vitamin C, twenty-eight developed ulceration of the bowel. In thirty-five control animals receiving a full diet only two cases of tuberculous enteritis followed the feeding of infected sputum.

Finkelstein (1932), McClung and Winters (1932) and many other investigators have come to similar conclusions, using various types of vitamin deficiency, different host animals, and infective organisms. Schneider (1946) by means of an improved technique has confirmed the fact that the susceptibility to infection of lower animals is influenced by the state of nutrition.

From the results of these experiments it can be said that a state of subnutrition or of preclinical deficiency may occur in animals and that special tests are required for its detection.

II. SUPPLEMENTARY FEEDING EXPERIMENTS.

(1) Milk Supplements.

One of the earliest experiments of this nature was carried out over a period of four years by Corry Mann (1926). A group of boys living in an institution and receiving the ordinary diet were then given an extra pint of milk daily. A remarkable improvement occurred in their general condition and in their average increase in height and weight when

compared with boys not receiving the supplement. This result was shown to be due not only to the increased caloric value of the diet, but also to the special properties of milk. A supplement of New Zealand butter of equivalent caloric value produced similar but less marked improvement in another group of boys.

Orr (1928) and Leighton & McKinlay (1930) confirmed the fact that when the average diet of British children is supplemented with milk, an improvement in their nutritional state can soon be detected. The practice of supplying milk to school children free or at a low cost has been responsible for a general improvement in health. In Glasgow schools for instance, in 1944 the average weight of thirteen year old boys was 6.82 pounds heavier than the average for boys of the same age in 1935, and their height was 1.67 inches taller in spite of various adverse wartime conditions and a restricted diet. Similar increases are reported for the girls. The incidence of dental caries in these children has also been greatly reduced. (Young, 1944). Improvement in the nutrition of children in other parts of the country during wartime is of the same order. Bransby (1944) and Magee (1946).

(2) Supplements of Foods rich in Vitamins and Minerals.

Milk is not the only food which when added to the average diet has caused striking improvements in the nutritional

condition. Ross & Summerfeldt (1935) and Morgan & Barry (1938) have reported good results for additional cereals rich in thiamin. Borland (1940) confirmed the results obtained by Schiötz (1931) who gave a supplementary meal called the Oslo breakfast to school children with marked beneficial effect on their heights, weights, and general health. The breakfast consisted of milk, butter, vitamin-rich cereals, fruit and other foods served cold. In London children, this type of meal was shown by Borland to have more influence on the nutritional state than the ordinary cooked school dinner, even when extra milk was given.

(3) Dietary Supplements to Pregnant Women.

It has been shown that additional vitamins and improved diet during pregnancy have a beneficial effect on mothers and their babies. (Mellanby, 1933; Theobald, 1937; McCance et al., 1938; Ebbs et al., 1941; Burke et al., 1943). Ebbs and his co-workers claim that not only did the extra nourishment result in a general improvement in the mothers' health, but also in fewer complications of pregnancy and in a reduced morbidity rate among the infants.

It must be concluded that the average diet of children and of pregnant women is at least not optimal, and probably in many cases is so inadequate that it causes pre-clinical deficiencies.

III. COMPARISON OF THE STATES OF NUTRITION OF DIFFERENT SOCIAL CLASSES.

The kind of food which people choose to eat is influenced by financial considerations, by a knowledge of food values, and by food fashions and habits. In poor households with young children, the larger the family the less money per head there is to spend on food, and the more likely it is that cheaper and filling foods such as bread and cereals will be bought. Dietary surveys by Orr and Clark (1930), and by Orr (1936) have shown that on the average, the diet of working class people, though adequate in caloric value, is frequently unsatisfactory in respect of animal proteins, fats, minerals and vitamins, since these substances are to be found in the more expensive foods such as butter, milk, meat, eggs and fruit. It should be remembered that the health of an individual is affected by a great many factors such as overcrowding, infection and poor hygiene as well as by an inadequate diet. A comparative study of the health of higher and lower income groups must therefore be interpreted with caution. For this reason no great emphasis can be placed on the influence of nutrition on the general health of the people except in so far as specific deficiencies can be demonstrated.

Wiehl & Kruse (1941) investigated the nutritional state of school boys from different levels of society. They found a significant increase in signs of specific nutritional

deficiency, particularly of vitamin A and of riboflavin, among boys from the lower income level. Davidson et al. (1943) comparing groups of municipal and private school chidren found that 39 per cent of the former and only 5 per cent of the latter had a mild anaemia. A more favourable state of nutrition among children from families of the higher income groups has also been found by Spence & Charles (1934); Orr, (1936); Schiötz, (1936); McCance et al., (1938); and Yudkin, (1944a.)

IV. DETECTION OF SIGNS OF DEFICIENCY IN APPARENTLY HEALTHY CHILDREN.

Of the four methods available for demonstrating minor degrees of malnutrition, the detection of the earliest signs of deficiency is the most important from the practical aspect, but it is also the most difficult. In recent years many workers have recorded observations which they claim as evidence of minor deficiencies. The interpretation of their findings has led to a great deal of controversy, and as a result of further study many tests have had to be discarded. Some of these will be referred to later. The early signs of rickets and of nutritional anaemia which are described below are, however, generally accepted as reliable evidence of subnormal nutrition.

(1) Early signs of rickets.

The first effects of an inadequate diet are believed

to be biochemical and functional alterations in the tissues concerned. This is followed by anatomical changes which at first may be reversible, but which later result in permanent damage. Thus, investigations which detect biochemical or functional alterations or which reveal early histological lesions are most likely to be useful as tests of deficiency.

Rickets can be cited as an example of a disease in which the sequence of events described above occurs. The earliest symptoms are said to be irritability, sweating and flabbiness of the muscles, none of which is specific for the disease. At the same time certain biochemical changes may occur, which in the absence of any other bony disease, are almost diagnostic of rickets. The plasma phosphorus is reduced and the plasma phophatase rises above the normal limits. (Mackay, 1926; Smith & Maizels, 1932; Morris et al., 1937.) When the deficiency has been present for some time, X-ray films demonstrate typical changes in the epiphyseal ends of the long bones. Mild bony lesions are difficult to detect clinically and different observers do not always agree about the diagnosis — facts which emerged when the British Paediatric Association made surveys of the incidence of rickets in this country (1944). Biochemical tests and changes in the X-ray appearances of the long bones are useful adjuncts to the diagnosis of rickets in the early stages before permanent damage to the skeleton has occurred.

When these examinations were carried out on a large scale it became apparent that while florid rickets was relatively uncommon, the early signs of Vitamin D deficiency were present in a large proportion of the population. Using X-ray evidence for the diagnosis, Atkinson and his collaborators (1926) found the incidence of rickets in London children under two years of age to be 8 per cent, while Maddox (1932) found that 12.4 per cent of children under two years in Sydney, and Graham (1942) found 23.6 per cent of children under eighteen months in Glasgow suffered from rickets. When biochemical changes are taken as the main evidence, the incidence of the disease is found to be still higher. Thus Morris (1938) found evidence of rickets in 49.8 per cent of Glasgow children under three years of age, and Corner (1944) found it in 41.4 per cent of Bristol children under eighteen months.

It may therefore be inferred that many infants suffer from pre-clinical rickets. Krestin (1945) has demonstrated by repeated X-rays the prophylactic effects of adequate doses of cod liver oil, and it is believed that the virtual disappearance of florid rickets in this country is the result of action taken by the Child Welfare Authorities.

(2) Nutritional Anaemia.

Nutritional anaemia occurs when diets deficient in iron

are taken for any length of time. It is well recognised that a low iron intake is only one of a variety of factors which may cause a hypochromic anaemia, but in the absence of any other obvious cause it is presumed that the anaemia is nutritional in origin. Dietary surveys carried out in Aberdeen by Davidson and his co-workers (1935) support this view. They found that while the recommended optimal intake of iron is 15 to 20 mgms. per day, the daily intake of iron averaged only 10 mgms. and it was not uncommon to find intakes of 5 to 8 mgms. Similar results were obtained by McCance et al. (1938). Administration of iron in these cases produced a significant rise in the level of haemoglobin and a recognisable improvement in their general health. Davidson et al. (1933), (1944), Yudkin (1944 b.).

When the intake of iron in the diet is inadequate, the haemoglobin content of the blood is reduced to an extent which varies with the physiological demands for iron and with the severity of the deficiency. Administration of iron to a case of nutritional anaemia results in an increase of haemoglobin until a saturation point is reached, after which no amount of iron can raise the haemoglobin further. The level below which an adult may be said to be anaemic has been arbitrarily fixed at 80 per cent by Davidson et al. (1943). Between this point and 100 per cent the person is stated to have a subnormal haemoglobin which will respond to iron therapy either

by improved diet or by inorganic salts.

The frequency of iron deficiency anaemia in infants has been fully demonstrated by Mackay who claims that it lowers their resistance to infection. (Mackay, 1931; 1933). Many other workers have confirmed the presence of iron deficiency anaemia in infancy (Parsons & Hawksley, 1933; Josephs, 1936; Hutchison, 1938; Medical Research Council Report, 1945.) This type of nutritional deficiency occurs also in school children, in adolescent girls, and in adult women especially if parous or pregnant. The prevalence of minor degrees of iron deficiency has thus been amply demonstrated.

STANDARDISATION OF MINIMAL AND OPTIMAL DAILY REQUIREMENTS.

Many other experiments and investigations could be added in support of the existence of a preclinical deficiency state, but those described above have been selected because they appear to provide reliable evidence of a sufficiently varied character. Prevention of minor degrees of malnutrition with their consequent detrimental effect on health requires accurate knowledge of optimal daily requirements. Committees of experts have been set up in different countries to make recommendations of minimal and optimal requirements of the vitamins and essential minerals. (Technical Commission on Nutrition (1938); National Research

Council, Committee on Food and Nutrition (1941).) By comparing the results of dietary surveys with the recommended daily intakes of the various food substances, dietary defects can be readily detected and appropriate measures taken for their correction. Agreement has been reached on the daily requirement of some minerals and vitamins, but for others there is a difference of opinion, and in several instances the figures quoted are only tentative. This uncertainty results from the limitations of the experimental approach to dietary studies in human subjects, and from difficulties experienced in the assessment of the nutritional state. If reliable early signs of specific deficiencies could be found, the amount of the appropriate food substance sufficient to prevent their development could be calculated, and in this way estimates of optimal requirements could be given.

ASSESSMENT OF NUTRITION.

With the recognition that minor deficiencies occur in large numbers of apparently healthy children, the evaluation of nutritional states has become a problem of increasing importance. Two outstanding difficulties prevent a ready solution to the problem:

(a) The inexactness of the definition of the term 'Nutrition'.

(b) The lack of specific signs of early malnutrition.

(a) The Inexactness of the Definition of 'Nutrition'.

In 1926 there was an attempt to limit the interpretation of the term 'nutrition' to the weight of an individual. The following is a quotation from a special report to the Medical Research Council by Paton & Findlay (1926). "Nutrition does not refer to the height of the child, to the state of his health, or to his muscular activity..... Nor has nutrition anything to do with growth..... Nutrition simply refers to the manner in which an individual absorbs and assimilates his food, in short, increases his bulk." In the same year Corry Mann (1926) carried out experiments which proved that the nutrition of school children affects their height as well as their weight, an observation which has been confirmed many times. (Drummond, 1934; Medical Correspondent in Berlin, 1936; Orr, 1940.) This relatively simple conception of the influence of nutrition on the body, namely on the height and weight, has now given way to a more complex one. Bigwood (1937), Wiseman (1938), Harris (1940), Mackie (1940) and many other observers have demonstrated that the skin, hair, nails, teeth, gums, subcutaneous fat, and muscle are all influenced by nutrition. That nutrition should affect so many tissues is not surprising, nor is it to be wondered at that this has led to a loose interpretation of the term nutritional state. Capon (1945) has drawn

attention to the confusion which is apparent in some of the recent literature between the nutritional state and the state of health. The lack of precise knowledge on the subject is typified by such a statement as that made by the Ministry of Health's Advisory Committee on Nutrition (1937). "We have interpreted the state of nutrition as applying to the physical and functional bodily condition, only in so far as it is dependent on food."

(b) The Lack of Specific Signs of Early Malnutrition.

It has been found possible to correlate certain clinical signs with the lack of individual nutriments in the diet. Diets known to be deficient in only one essential have been given to human subjects who were kept under close observation. Different deficiencies produce separate syndromes, and it is now possible on certain restricted diets, to predict the signs which are likely to develop and the probable time of their appearance. It is, however, incorrect to assume that the discovery of any one of these signs in an otherwise healthy individual is necessarily a sign of nutritional deficiency. The greater the number of 'nutritional' signs which are present, the more likely it is that faulty diet is responsible. Many signs are not specific, and others which were previously thought to be so can be produced by several agents.

METHODS OF ASSESSING THE NUTRITIONAL STATE.

There are at present three main methods of assessing nutritional states:-

(A) Height and weight measurements.
(B) Clinical examination.
(C) Detection of specific signs of deficiency.

(A) HEIGHT AND WEIGHT MEASUREMENTS.

So long as the nutrition of children was thought to affect only their heights and weights these measurements were used in varying combinations and the figures obtained were compared with accepted standards for different ages and sexes. Many complicated formulae based on these measurements have been evolved, but have mostly been given up because they have not overcome the defects inherent in the simple height and weight estimations. (Bigwood, 1937; Wiseman, 1938; Cluver, 1940.). Orr (1940) believes that the ratio of height to weight gives some indication of the state of nutrition, but only in relation to past feeding.

The main defects of height and weight measurements used as indices of nutrition are:-

(a) The difficulty in deciding the range of normality,
(b) The influence of heredity,
(c) The acknowledged fact that severe deficiencies may co-exist with normal values.

(a) The Range of Normal Values.

The inability to determine exactly the range of normality is the main drawback to the use of all tests which set out

to assess nutritional states. Certain deductions can be made by observing under different conditions or over a period of years, the behaviour of the mean heights and weights in large groups of children at different ages. Lesser factors which may affect these measurements tend to cancel each other out, and the influence of nutrition can then be calculated by statistical methods. Heights and weights of large groups of children have proved very useful as an objective measurement of the trend of nutrition, as for instance, in the supplementary feeding experiments described above, in surveys of the nutrition of Belgian children in the last war (Ellis, 1945) and of French children under the German occupation (Debré, 1945). It is of course important not to interpret the average as the normal, and the smaller the group of cases the more important does this become.

(b) The Influence of Heredity.

The influence of heredity on physique is obviously very important. It has been explained in the following terms by Orr (1940).

"There is no doubt about the overwhelming importance of heredity which sets the pattern and sets limits to stature. But it depends on nutrition and other environmental factors whether the body will attain the stature and degree of perfection made possible by inheritance."

(c) Malnutrition associated with Normal Height and Weight Values.

The occurrence of definite deficiency diseases in children of average height and weight measurements is a clear demonstration of the inadequacy of assessing nutrition by this method alone. Spence (1931) has reported cases of xerophthalmia in children of average weight and apparently good general nutrition. Average weights have been noted in children suffering from scurvy (Barlow, 1894; Hess, 1917; Wiltshire, 1919), from rickets (Freudenberg, 1935), and from beri-beri (Kerley & Lorenze, 1941.).

In spite of their limitations, height and weight measurements give useful information and are still widely used. They have the advantage of being entirely objective.

(B) CLINICAL EXAMINATION.

Isolated height and weight measurements are of little value as indices of nutrition in the individual case. It is not possible without a clinical examination to distinguish the heavy child who is simply very well-nourished from one who is suffering from endocrine deficiency. Clinical examination is of course necessary to determine the condition of the skin, hair, nails, teeth, gums, subcutaneous fat and muscle tone. Variations in the condition of these tissues cannot be readily measured, and Jones (1938) has given statistical evidence of the unreliability of attempts to subdivide

nutritional states by clinical examination alone. Clinical assessments vary from one observer to the other, and also from day to day with the same observer. Yet School Medical Officers are expected to grade the children they examine into three categories, and conclusions are drawn from such classifications. Nevertheless clinical examination is important and should never be omitted particularly in individual assessments. It is only by its use that disease and conditions other than nutrition which influence health can be detected.

(c) TESTS FOR SPECIFIC DEFICIENCY.

Ever since it has been recognised that the most frequent defect of modern diets is the lack of minerals and vitamins, people have been searching for the earliest signs of deficiency in the hope that minor degrees of malnutrition would thus be more readily detected. Deficiency diseases have been studied from two main aspects, the experimental and the clinical. On the one hand, a diet in which the nutriment to be tested is either absent or is present in inadequate amounts, is given to a test animal and the effect of this deprivation on its health is observed. Induced deficiency experiments have also been carried out on human subjects, and in this way certain symptoms and signs have come to be associated with specific deficiencies. On the other hand, the physician is presented with a variety of symptoms and signs from which a diagnosis has to be made. Gross deficiency

diseases rarely present any diagnostic problems but the symptoms of early nutritional disorders are usually vague and non-specific, and the early signs may be difficult to interpret.

(1) Experimental Approach.

It is necessary to distinguish clearly between animal and human experiments. The latter are more difficult to carry out but yield much more valuable information which can be directly applied to nutritional problems. Human experiments are limited in number and have been undertaken only in recent years. The result of much of the work on animals is still used, but should always be interpreted with caution. For instance, thiamin deficiency in animals causes an increase in the blood pyruvic acid (Thompson & Johnson, 1935; Kato & Li, 1941) and a similar increase is found in cases of wet beri-beri. (Platt & Lu, 1936.) However, Williams et al. (1940) and Jolliffe et al. (1939) who induced a thiamin deficiency in human subjects failed to demonstrate a rise of pyruvic acid in the blood. About the interpretation of the test there is still considerable difference of opinion.

Feeding experiments in human subjects have been made in which thiamin, riboflavine, biotin, vitamin A or ascorbic acid have been either totally or partially lacking in the diet. (Williams et al. 1940; Sebrell et al., 1941; Keys

et al., 1944; Sydenstricker et al., 1942; Jeans et al., 1941; Lund & Crandon, 1941.) In the course of these investigations many tests have been carried out and some interesting facts have emerged. The etiology of diseases such as beri-beri and scurvy is less simple than was formerly believed, since deprivation of the pure substance thiamin and ascorbic acid has not produced the whole picture of beri-beri or scurvy. Yet these diseases are believed to result from the continued use of a diet deficient in vitamin B_1 and C respectively, and in the early stages are cured by their administration. It would appear that multiple deficiencies are commoner than was formerly supposed, and in pellagra as many as four vitamin deficiencies have been reported. (Spies et al., 1939b). The use of a diet in which a single vitamin is deficient is of course highly artificial, but has helped to clarify the relationship between vitamins and clinical signs. Mellanby (1921) in his early experiments with dogs, emphasised the dependence of one nutritional factor on another, and most recent studies on the subject endorse this view.

The most important result of induced deficiency experiments is the recognition that the lack of a single vitamin may be related to the development of one or more specific signs. For instance, riboflavin deficiency causes vascularisation of the cornea, cheilosis, angular stomatitis, and specific

tongue and skin changes. Deprivation of vitamin A may cause prolongation of the dark-adaptation time and night blindness. A diet deficient in ascorbic acid causes this substance to disappear from the plasma and from the blood cells; follicular keratosis develops; there is delay in the healing of wounds; and eventually peri-follicular haemorrhages develop. These and other signs are to be found in naturally occurring deficiency diseases.

(2) Clinical Approach.

In contrast to the development of specific signs in induced deficiency experiments, there is considerable difficulty in proving the specific nature of signs in the early stages of the natural disease. Whereas a deficient diet may in time lead to the development of certain characteristic signs, these can often be produced by conditions unrelated to the diet.

1. Difficulties in the Interpretation of 'Nutritional' Signs.

Many examples could be given of difficulties in the interpretation of 'nutritional' signs. Three of these will be discussed briefly.

(a) Follicular Keratosis.
(b) Dark-Adaptation Time.
(c) Capillary Resistance Test.

(a) Follicular Keratosis.

Wiltshire (1919) described follicular keratosis as one of the early signs of scurvy, and this appeared to be

confirmed recently by its development in experimental vitamin C deficiency. (Lund & Crandon, 1941.) On the other hand, Frazier & Hu (1931), Goodwin (1934), Lehman & Rapaport (1940), Stannus (1941), Sydenstricker (1941) and others have related follicular keratosis to a deficiency of vitamin A. Contradictory results of treatment of follicular keratosis with vitamin A have been reported, but recent critical work has failed to show any improvement in the lesion following the injection of large doses of vitamin A. (Hawes, 1945.). Jolliffe & Stern (1940) and Peck et al. (1941) believe that Darier's disease is a more severe form of follicular keratosis and that it is also caused by hypovitaminosis A. Eight cases of the disease which were examined by Sinclair (1945), however, showed no evidence of vitamin A deficiency. Induced deficiency of this vitamin in human subjects has not so far produced a follicular keratosis. (Stannus, 1945.)

Pemberton (1940) interpreted the occurrence of follicular keratosis as a sign of vitamin A deficiency, and found that five per cent of school children suffered from this type of malnutrition. Stannus (1945) found the incidence of follicular keratosis to vary from 15 to 30 per cent or higher in school children, but states that contrary to his previous opinion (1941), the condition appears to be unrelated to a nutritional deficiency. Hawes (1945) while recognising

that vitamins A and C and nicotinamide are not related to follicular keratosis, believes that it may be caused by some nutritional disorder such as a relative deficiency of fats.

(b) Dark-Adaptation Time.

Attempts have been made to discover the incidence of vitamin A deficiency by measurements of the dark-adaptation time. Jeghers (1937), Hecht & Mandelbaum (1940) and Jeans et al. (1941) found a delay in the dark-adaptation time when vitamin A deficiency was induced in human subjects. They suggest that this measurement be used in nutritional surveys as a sign of deficiency. Platt & Lu (1936), Youmans & Patton (1940), Spector et al. (1943), and Yudkin (1945) also recommend this test.

Jeans et al. (1937) found the incidence of delayed dark-adaptation times to be 19 per cent in school children, and in an orphanage the incidence was as high as 35 per cent. Maitra & Harris (1937) by means of this test, found that 22 to 36 per cent of elementary school children showed evidence of vitamin A deficiency.

Other observers have pointed out defects in the test. Wittkower et al. (1941) state that a prolonged dark-adaptation time is seen in abnormalities of the eye, such as myopia, retino-choroiditis, and glaucoma; in toxaemias; and in various forms of psychosis. Pollak (1945) believes that

several other nutritional factors may be responsible for the presence of the sign. In the examination of apparently healthy school children, Jeans et al. (1941) have demonstrated a seasonal incidence which they relate to minor illnesses during the winter, rather than to a seasonal variation in the supply of vitamin A. Snelling (1938) and Baum & McCoord (1940) found that adaptation to the dark improves with practice, especially in children, a fact which seriously reduces the value of the test.

(c) Capillary Resistance Test.

Dalldorf (1933) using this test as a sign of preclinical scurvy stated that 66 per cent of children from poor homes suffered from this condition. Göthlin (1937), Braestrup (1937), Bell et al. (1940) and others have used the capillary resistance test as an indication of the state of vitamin C nutrition, but later work has discounted this. (Ralli & Sherry, 1941; Davidson & Scarborough, 1941; McNee & Reid, 1942).

2. Other Methods of Confirming the Presence of Nutritional Deficiency.

(a) The Therapeutic Test.

The response to treatment may at times be so dramatic that its specific nature cannot be doubted. In the therapeutic test, attempts are made to control the effect of treatment by repeated investigations of deficiency signs.

In vitamin A deficiency the dark-adaptation time may be tested at intervals of two to three days, in beri-beri the level of pyruvic acid in the blood may be determined, in rickets the level of plasma phosphorus and phosphatase may be estimated, and so on. The advantages of treating the patient and at the same time of proving the nature of the deficiency have made this a popular test.

(b) Nutritional Surveys.

Investigation into the nature of a patient's previous diet is often helpful. A satisfactory dietary survey, however, is very laborious and may fail to give a true picture of the past diet.

CONCLUSION.

A consideration of these facts leads to the conclusion that, despite a remarkable advance in the knowledge of nutrition and of vitamins in particular, the ability to assess nutrition remains largely a matter of personal judgment. In order that in the future minor degrees of deficiency may be diagnosed with confidence, it is important that all possible 'nutritional' signs should be fully investigated, and that unless they prove to be both reliable and specific they should be discarded. With this in mind it was decided to obtain more precise information about Ankle Keratosis and to determine its etiology.

Thickening of the skin about the ankle has been described in association with pellagra (Snyder, 1923; Stannus, 1934 and 1941) and in vitamin A deficiency (Stannus, 1941). It therefore seemed justifiable to postulate a nutritional basis for this condition. Ankle Keratosis is a simple sign which requires only careful observation for its detection, although measurement of the degree of skin thickening presents some difficulties. If it were shown to be a reliable test of deficiency, its value in the assessment of nutrition would be considerable.

CHAPTER II

GENERAL REVIEW OF KERATOSIS

DEFINITION OF KERATOSIS.

Ankle Keratosis is the name given to a rough, dry, raised thickening of the skin about the ankle. Roxburgh (1944) defines Keratosis as a "localised area of hyperkeratosis", and this is the interpretation given to it in this thesis.

The terminology of skin diseases is very confusing, two or more names having been given to the same condition by different observers. The various interpretations of the term 'keratosis' in the text-books on diseases of the skin demonstrate well this lack of uniformity. Walker and Percival (1939) and Gardiner (1945) in their text-books, label one or more conditions Keratosis without defining the term, and lesions such as corns and callosities which, in other text-books are listed as examples of the Keratoses, are called benign tumours. Cranston Low (1934) defines keratosis as the normal process of keratinisation, while in the text-book by Becker and Obermayer (1943) keratosis is defined as a "lesion produced by a peculiar hyperplastic change in the epidermis of the skin or of the epithelium of the muco-cutaneous junction". In the latter text-book

the conditions included under this heading are all pre-malignant in character, whereas those lesions which are characterised by hyperkeratosis and which are benign in nature are grouped together under the title Hyperkeratoses and Dyskeratoses. When naming the individual lesions, however, Becker and Obermayer often use the terms hyperkeratosis and keratosis synonymously, despite the serious prognosis implied in their definition of the Keratoses. Thus, Follicular Keratosis and Follicular Hyperkeratosis are apparently interchangeable terms, and plaques of keratosis are said to occur in Keratodermia Palmare et Plantare, a congenital condition with no tendency to malignant degeneration. The latter condition is also called Keratosis Palmare et Plantare and Hyperkeratosis Palmare et Plantare by other authors. In Dorland's Medical Dictionary (1936) Keratosis, Hyperkeratosis, and Keratodermia are defined as follows. Keratosis is "Any horny growth, such as a wart or callosity; any disease attended by horny growths". Hyperkeratosis is "Hypertrophy of the corneous layer of the skin or any disease characterised by it". Keratodermia is "Hypertrophy of the horny layer of the skin".

In most text-books on dermatology the three terms hyperkeratosis, keratosis, and keratodermia are used synonymously.

HYPERKERATOSIS ASSOCIATED WITH OTHER DISEASES.

When a lesion is entitled Hyperkeratosis or Keratosis it is understood that hypertrophy of the horny layer of the epidermis, the stratum corneum, is its main histological feature. Hyperkeratosis may and frequently does occur, as part of the general pathology in other skin diseases. Examples of the latter are Eczema Sclerosum, Eczema Tylosum, Eczema Verrucosum, and Lichen Planus Verrucosum, (Steelwagon, 1902); Lichen Simplex Chronicus, or Neurodermatitis (Hartzell, 1917; Haxthausen, 1934; Smith, 1942); and Keratosis Blenorrhagica (Coombes et al., 1940). Keratosis in the sense in which it is used in this thesis does not include any of these conditions.

CLASSIFICATION OF THE KERATOSES.

The clearest description of the Hyperkeratoses is given in a Practical Handbook of the Pathology of the Skin by MacLeod and Muende (1940). In this text-book the hyperkeratoses are classified as follows:-

I. DIFFUSE:

1. Congenital (a) Harlequin foetus
   (b) Congenital ichthyosis.
2. Acquired Pityriasis rubra pilaris.

II. CIRCUMSCRIBED:

1. Simple traumatic. Corns and callosities.
2. Hyperkeratosis with dilatation of the blood vessels of the corium. Angiokeratomata. (Erythema keratodes of Brooke.)

3. Circumscribed hyperkeratosis affecting hair follicles and sweat ducts.
   (a) Comedo plug.
   (b) Keratosis follicularis contagiosa.
   (c) Keratosis follicularis (Lichen pilaris etc.)
   (d) Mibelli's porokeratosis (Hyperkeratosis eccentrica)
   (e) Keratosis punctata.

4. Localised hyperkeratosis associated with excess sweating.

5. Localised hyperkeratosis associated with elimination of poisons by skin.

6. Precancerous hyperkeratosis.
   (a) Keratoma senilis.
   (b) Labial keratosis.
   (c) Tar "
   (d) Soot "

7. Cutaneous horn.

(Keratosis Palmare et Plantare is classified with regional hard naevi.)

The following conditions will be discussed briefly, Congenital Ichthyosis, Follicular Keratosis, and several types of Localised Circumscribed Keratoses.

CONGENITAL ICHTHYOSIS.

The generalised type of ichthyosis occurs not infrequently, and most observers report an exaggeration of the keratotic process on the extensor surfaces of the elbows and knees. In addition, keratosis follicularis or pilaris is often present. Every case of ichthyosis examined in the present series showed a localised thickening of the skin at the ankle, indistinguishable from Ankle Keratosis.

KERATOSIS FOLLICULARIS.

Of the circumscribed types of hyperkeratosis, attention has been focussed in recent years on follicular keratosis, or keratosis pilaris as it is sometimes called. The condition is classified as an ichthyosis by Cranston Low (1934) and is described briefly in the following terms.

"There is also a follicular form of the condition which is seen on the backs of the upper arms and fronts of the thighs. Little horny masses accumulate at the mouths of the hair follicles. These prevent the hairs growing out properly and the hair lies coiled up under the scale. This causes irritation as the hair grows and tries to push its way out, so that there is often some redness from inflammation round the mouths of the hair follicles. This condition is called Lichen Pilaris."

The distribution of the lesion and its follicular character serve to differentiate it readily from Ankle Keratosis. It is interesting to note, however, that Stannus (1945) in his description of follicular keratosis states that "There is often some general dryness and roughness with scaliness and exaggeration of the skin creases giving rise to a wrinkled appearance, associated with hyperkeratosis..... The follicular keratosis is often associated with hyperkeratosis of the skin about the elbows and knees and in some cases, of the skin in front of the ankle joints." This

localised type of keratosis receives no further mention in the article.

LOCALISED CIRCUMSCRIBED KERATOSES.

Practically all types of circumscribed keratosis other than those affecting the hair follicles and sweat ducts can be described as localised. In some cases the keratosis is located in the palms and soles such as occurs in Callosities and in the condition called Keratodermia Palmare et Plantare. Corns are usually found on the toes or soles of the feet, and other types of keratosis may be found on the face, the lips, the scrotum, the hand or other part of the body.

In Keratodermia Palmare et Plantare, the keratosis does not spread on to the dorsum of the foot or ankle and is not likely to be confused with Ankle Keratosis.

The pre-cancerous keratoses which occur in old age have been found to follow exposure to tars, mineral oils, sunlight, X-rays, radium. They may develop after prolonged administration of arsenic. Their serious nature may be suspected from the history, and can be confirmed by biopsy.

Ankle Keratosis.

It must be acknowledged that keratosis limited to the skin of the ankle has not yet been fully described. Brief reference to plaques of hyperkeratosis about the ankle are

made by Stannus (1941) in association with chronic vitamin A deficiency and in connection with chronic pellagra. Snyder (1923) also noted hyperkeratosis of the ankle skin in pellagra. Smith (1942) mentions plaques of keratosis about the ankle in neurodermatitis, and Becker and Obermayer (1943) in elephantiasis.

Ankle Keratosis can be differentiated from neurodermatitis by the site of the lesion, and the absence of severe itching; and from elephantiasis by the normal appearance of the legs.

Lesions Associated with Ankle Keratosis.

Ankle Keratosis may be associated with localised hyperkeratosis of the elbows or knees, with follicular keratosis, and with asteatosis or 'weathering'. Its relationship to the latter condition may be fairly close and will be described in detail later. All cases of congenital ichthyosis, show Ankle Keratosis as a part of the general keratotic process.

Apart from these conditions Ankle Keratosis is usually the sole manifestation of a skin abnormality.

TREATMENT OF KERATOSIS.

The treatment recommended for most types of keratosis consists of softening of the keratotic skin with 5 to 10 per cent salicylic acid and the application of oils to keep the skin supple. Treatment of the pre-cancerous types of keratosis consists of fulguration, or excision and skin-

grafting.

Those types of keratosis which are thought to be related to vitamin deficiencies are said to respond slowly to massive vitamin therapy. It is characteristic that skin lesions are the last of all the deficiency signs to disappear and sometimes after weeks of treatment may only be slightly improved. Lehman & Rapaport (1940).

CHAPTER III

THE INCIDENCE OF ANKLE KERATOSIS

In the absence of a full description of Ankle Keratosis in the text books of Diseases of the Skin, and in the recent dermatological literature, the following short account of its clinical features is given prior to an account of its incidence. Further details of its appearance and the histological picture will be described later.

DESCRIPTION OF ANKLE KERATOSIS.

In the North East of England, where the condition was studied, Ankle Keratosis is referred to colloquially as 'boot-scruff'. It manifests itself by a varying degree of roughening and thickening of the skin, the exact position of which depends on the type of footwear worn. In children wearing sandals it is found on the dorsum of the foot on the skin adjacent to but not covered by the leather; (Plate No. 1.) in those wearing shoes, the skin below and at the bend of the ankle is affected; (Plates No. 2, 3, 4, 5 and 6) and when boots are worn, the keratosis is found over an area corresponding roughly to the tongue of the boot, and also round the leg at, and immediately above, the upper edge of the boot. (Plates No. 7, 8, 9, 10 and 11). In

contrast to Follicular Keratosis where the pathological changes are confined to the hair follicles, the keratotic process appears to affect the skin generally, producing patches of varying sizes and shapes. Small patches of keratosis may be only 0.5 cm. in diameter, while the larger ones may cover the ankle from one malleolus to the other and extend downwards 6 to 8 cms. on to the dorsum of the foot, and upwards to cover the lower fourth of the leg. In some cases the keratotic skin merges gradually into the normal, but in others the edge of the keratosis is quite sharply defined. The degree of skin thickening may vary in different children, and in the same child on different parts of the ankle or at different seasons, from a barely perceptible alteration from the normal to a hard rough dirty-looking patch 3 to 4 mm. thick.

As the lesion is situated at the ankle, it is less noticeable than if it occurred on the face or the arms. This fact coupled with the absence of itching, pain or other complaint, probably explains why the condition has not been fully described before. Those mothers who object to its dirty appearance will explain how they have applied various ointments with indifferent success, or have tried to remove it with pumistone. Unless this kind of treatment is carried out regularly, the keratosis usually recurs.

Degrees of Keratosis.

For the purposes of description, three degrees of keratosis are recognised. The first degree consists of a thickening and roughening of the skin revealed by close observation and palpation; the second consists of a dirty gray, obviously thickened skin, not requiring palpation to confirm its presence; the third degree is a thick horny yellowish gray patch visible at a distance of several feet. On closer inspection of the latter type, the skin is seen to be hard and greatly thickened, quadrilateral and rectangular areas being clearly demarcated by deep grooves, corresponding to a gross exaggeration of the normal skin markings. The underlying skin, seen at the bases of the grooves, is slightly engorged, but in spite of this, the lesion has a dirty gray appearance, due partly to the dust and dirt particles which collect in the grooves between the keratotic plaques, and partly to the yellowish colour of the hyperkeratotic skin. When more than one degree of keratosis is present in any one case, the most marked abnormality is usually to be found in the skin nearest to the free edge of the boot or shoe leather. The typical distribution of third degree keratosis is within 2 cm. of the edge of the footwear. See Plates No. 1, 3, 4, 5, 6, 8, 9, 10 and 11.

By inspection alone, it may be difficult to distinguish a first degree keratosis from a normal dirty skin, but

palpation reveals the presence of skin thickening and the dirty colour remains after washing. Whenever there is any doubt that alterations in the skin at the ankle are in fact due to keratosis, the condition is labelled 'doubtful keratosis', and in the analysis of the results of the investigations, all doubtful cases have been coupled with those in which keratosis is absent.

METHODS OF EXAMINING AND RECORDING ANKLE KERATOSIS.

Method of Examination.

A good source of light and a strong hand lens giving a magnification of two to four diameters, are essential for the proper study of a lesion like Ankle Keratosis. In order to examine the surface markings of the skin, it has been found useful to smear into the skin a charcoal ointment, and to rub off the excess with cotton wool. The ointment which was used for this purpose consisted of 10 per cent charcoal in two parts of lanoline and one part of liquid paraffin. The healthy skin treated in this way retains very little of the Charcoal Ointment in the skin furrows, but the ointment may fill the mouths of the hair follicles which will then stand out as black dots. Various alterations of the normal pattern which are seen in keratosis, 'weathering', and other related abnormalities, will be described later. This method of examination was carried

Fig.2

Diagram to show lines and areas about the ankle

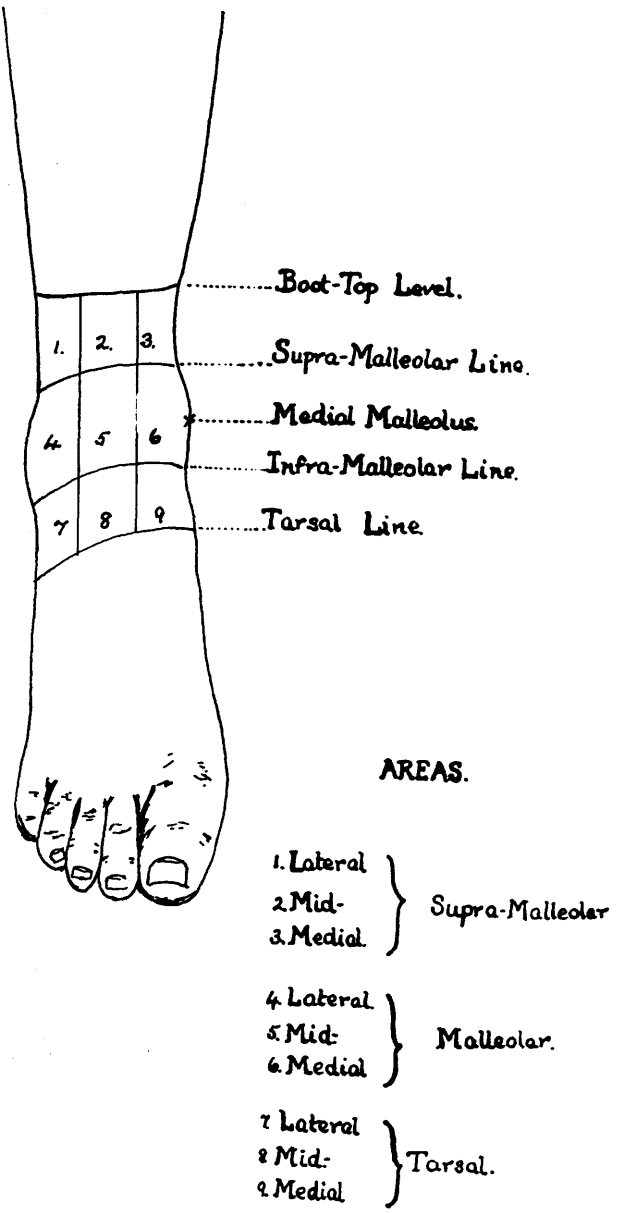


Fig.2

out in a few cases prior to photographing the skin in order to obtain a clearer picture of the site of the keratosis, and in the case of the macrophotographs, to record the details of the skin markings.

Division of the Ankle Region into Areas.

The skin about the ankle has been divided into nine regions or areas for the convenience of description. See Fig. 2. On close inspection of the ankle, particularly in infants and young children, two or three transverse furrows or flexure lines can be seen in the skin. The most constant one runs slightly obliquely from the tip of one malleolus to the tip of the other and will be referred to as the infra-malleolar line. This line as it occurred in an infant of four months is clearly demonstrated in Plate No. 12. A similar transverse furrow crosses the lower leg at the upper level of the malleolar processes of the tibia and fibula, to which the name of supra-malleolar line has been given. A third furrow crosses the dorsum of the foot near the ankle and has been named the tarsal line. In children wearing boots, a fourth line can usually be demarcated 2 to 3 cms. above the supra-malleolar line, its position being dependent on the height of the boot. In children wearing ankle-socks a similar line can often be made out. This line will be referred to as the boot-top

level. Longitudinal lines such as are shown in Fig. 2 divide the ankle into three regions, medial, mid-, and lateral. The following nomenclature can thus be given to the nine areas described by these lines; medial, mid-, and lateral tarsal areas between the tarsal and infra-malleolar lines; medial, mid-, and lateral malleolar areas between the supra- and infra-malleolar lines; and medial, mid-, and lateral supra-malleolar areas above the supra-malleolar line and below the boot-top level.

Method of Recording the Incidence of Ankle Keratosis.

In the surveys of school children, the percentage of children showing all degrees of Ankle Keratosis has been used for comparative purposes. Simple statements about the incidence of Ankle Keratosis, however, give no indication of the extent or severity of the lesion and may in fact be misleading. An indication of the severity of the condition can be obtained by recording separately the incidence of the three degrees of keratosis described above, and this method has also been used in the large surveys which were made. When more than one grade of keratosis was present in any one child, the case was labelled according to the most severe degree present. The extent of skin involvement may in some cases be minimal, while in others there may be two, three, or more of the skin areas at the

ankle affected. Hence a true picture of the severity of the keratotic lesion can only be obtained if the area of keratotic skin is also taken into account. In certain observations and experiments requiring a particularly accurate picture of Ankle Keratosis, points have been given to each child according to the extent and severity of the keratosis. One point is given for a first degree keratosis, two for a second degree, three for a third degree, and a half for a doubtful keratosis. These points are multiplied by the number of skin areas involved. For example, if one boy had a second degree keratosis on the mid-malleolar and mid-supramalleolar areas of one foot and a third degree keratosis in the same position on the other foot, he would be given four points for the one and six points for the other, giving him a total of ten points. Similar methods have been adopted to record the severity of 'weathering' - a condition frequently associated with keratosis. Three points each are given for mild, moderate and severe 'weathering'. In this way, diagrammatical expression can be given to the detailed observations which were recorded in each case, and closer comparisons of different groups of children under varying conditions of diet and management are possible.

Methods of sampling employed.

In an attempt to obtain a true picture of the incidence of Ankle Keratosis, the feet and ankles of one hundred and thirty-eight adults and two thousand eight hundred and fifty-three children were examined. Many of the latter were examined on two or more occasions. Efforts were made to obtain samples of the population as free from selection as possible. If the school or institution to be investigated were small, all children were seen, otherwise special age groups were selected. For instance, in large schools all boys and girls of six, nine and twelve years might be taken while in others the first half of the class on the roll book might be examined irrespective of the children's ages. In the same way when hospital cases were examined, selected observations made at intervals are not included in the results, but only those observations which were made when the whole ward had been examined specially for that purpose, and irrespective of the patient's complaint or the duration of the illness.

RESULTS OF THE SURVEYS.

Total Incidence.

Out of two thousand nine hundred and ninety-one individuals examined, two thousand and seventy-seven (69.44 per cent) showed no keratosis or such a slight alteration from

Table 1

AGE INCIDENCE

AGE in Years	AGE GROUP	NUMBER EXAMINED	ANKLE KERATOSIS									
			ALL DEGREES		FIRST DEGREE		SECOND DEGREE		THIRD DEGREE		ABSENT OR DOUBTFUL	
			No.	%	No.	%	No.	%	No.	%	No.	%
2-5	1	81	8	9.88	5	6.17	3	3.71	0	-	73	90.12
5-8	11	1,041	322	30.93	219	21.04	80	7.68	23	2.21	719	69.07
8-11	111	912	302	33.11	223	24.45	67	7.35	12	1.31	610	66.89
11-14	1V	766	238	31.07	164	21.41	62	8.09	12	1.57	528	68.93
14-17	V	53	24	45.28	17	32.08	5	9.43	2	3.77	29	54.72
Adults	V1	138	20	14.49	18	13.04	2	1.45	0	-	118	85.51
Total	-	2,991	914	30.56	646	21.59	219	7.33	49	1.64	2,077	69.44

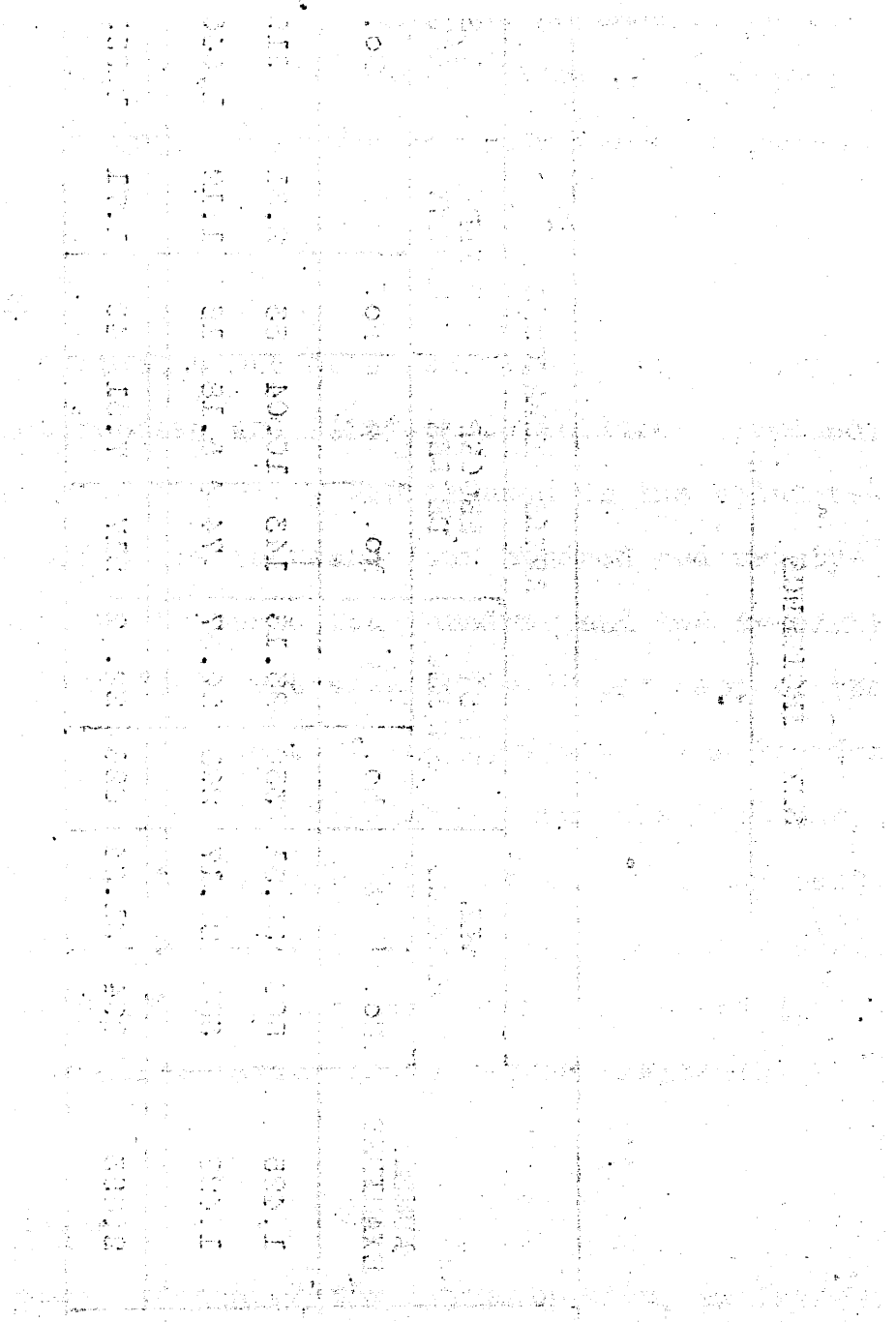
Table 1

the normal that the condition was labelled 'doubtful keratosis'. Of the remainder, nine hundred and fourteen persons (30.56 per cent) showed varying degrees of thickened skin; six hundred and forty-six (21.59 per cent) had a first degree keratosis, two hundred and nineteen (7.33 per cent) had a second degree keratosis, and forty-nine (1.64 per cent) showed keratosis of the third degree.

Age Incidence.

A hundred and thirty-eight adults and two thousand eight hundred and fifty-three children aged from two to seventeen years were examined. No case of Ankle Keratosis has been encountered in the first two years of life. The percentage distribution of keratosis among the different age groups is shown in Table I. For convenience of description the age group two to five years will be referred to as age group I, five to eight years as age group II, eight to eleven years as age group III, eleven to fourteen years as age group IV, fourteen to seventeen years as age group V, and adults as age group VI. It is seen that the incidence of keratosis in age groups II, III, and IV, varies from 30.93 per cent to 33.11 per cent, figures very similar to the total incidence of 30.56 per cent, while in age group V the incidence is much higher - 45.28 per cent - and in age groups I and VI it is much lower - 9.88 per cent and 14.49 per cent respectively. In addition to the low

Table 11



SEX INCIDENCE

SEX	NUMBER EXAMINED	ANKLE KERATOSIS									
		ALL DEGREES		FIRST DEGREE		SECOND DEGREE		THIRD DEGREE		ABSENT OR DOUBTFUL	
		No.	%	No.	%	No.	%	No.	%	No.	%
Male	1,425	506	35.51	330	23.16	143	10.04	33	2.31	919	64.49
Female	1,428	388	27.17	298	20.87	74	5.18	16	1.12	1,040	72.83
Total	2,853	894	31.34	628	22.02	217	7.61	49	1.71	1,959	68.66

Table 11

incidence of all grades of keratosis in age groups I and VI, it is interesting to note the complete absence of third degree keratosis and the very small incidence of second degree keratosis (3.71 per cent and 1.45 per cent respectively).

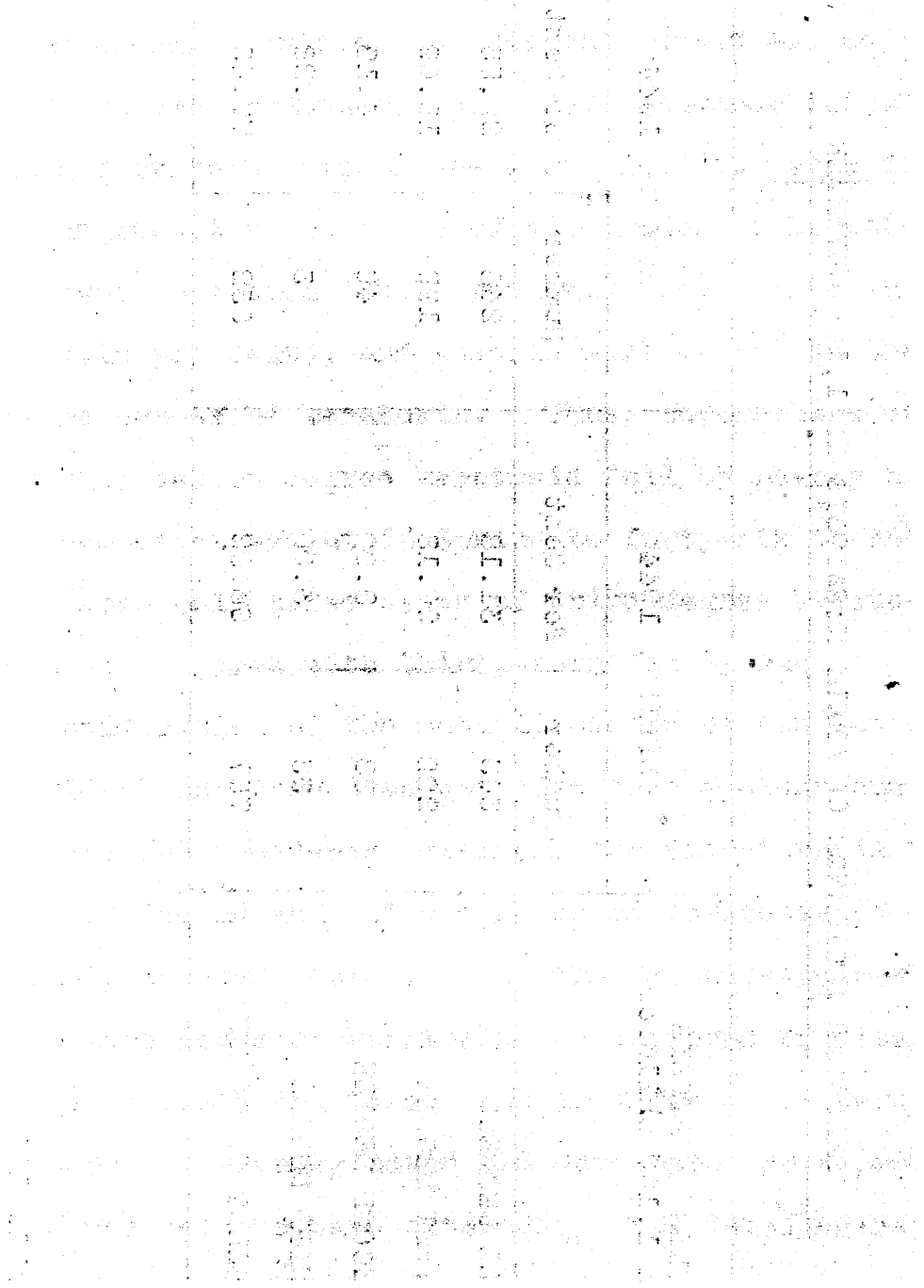
Sex Incidence.

The sex incidence has been calculated for the two thousand eight hundred and fifty-three children examined. The sexes are almost equally represented in the total results, there being one thousand four hundred and twenty-five males and one thousand four hundred and twenty-eight females. No keratosis was seen in 64.49 per cent of the males and in 72.83 per cent of the females. The incidence of second and third degree keratosis among the boys was twice as great as it was among the girls, 10.04 per cent of the boys and 5.18 per cent of the girls having second degree keratosis and 2.31 per cent of the boys and 1.12 per cent of the girls having third degree keratosis. See Table II.

Seasonal Incidence.

In the early stages of the investigation, an impression was gained that Ankle Keratosis occurred more frequently during the winter and spring months than at other times of the year. It was therefore decided to make two examinations

Table 111



SEASONAL INCIDENCE OF ANKLE KERATOSIS IN 1,100 CHILDREN

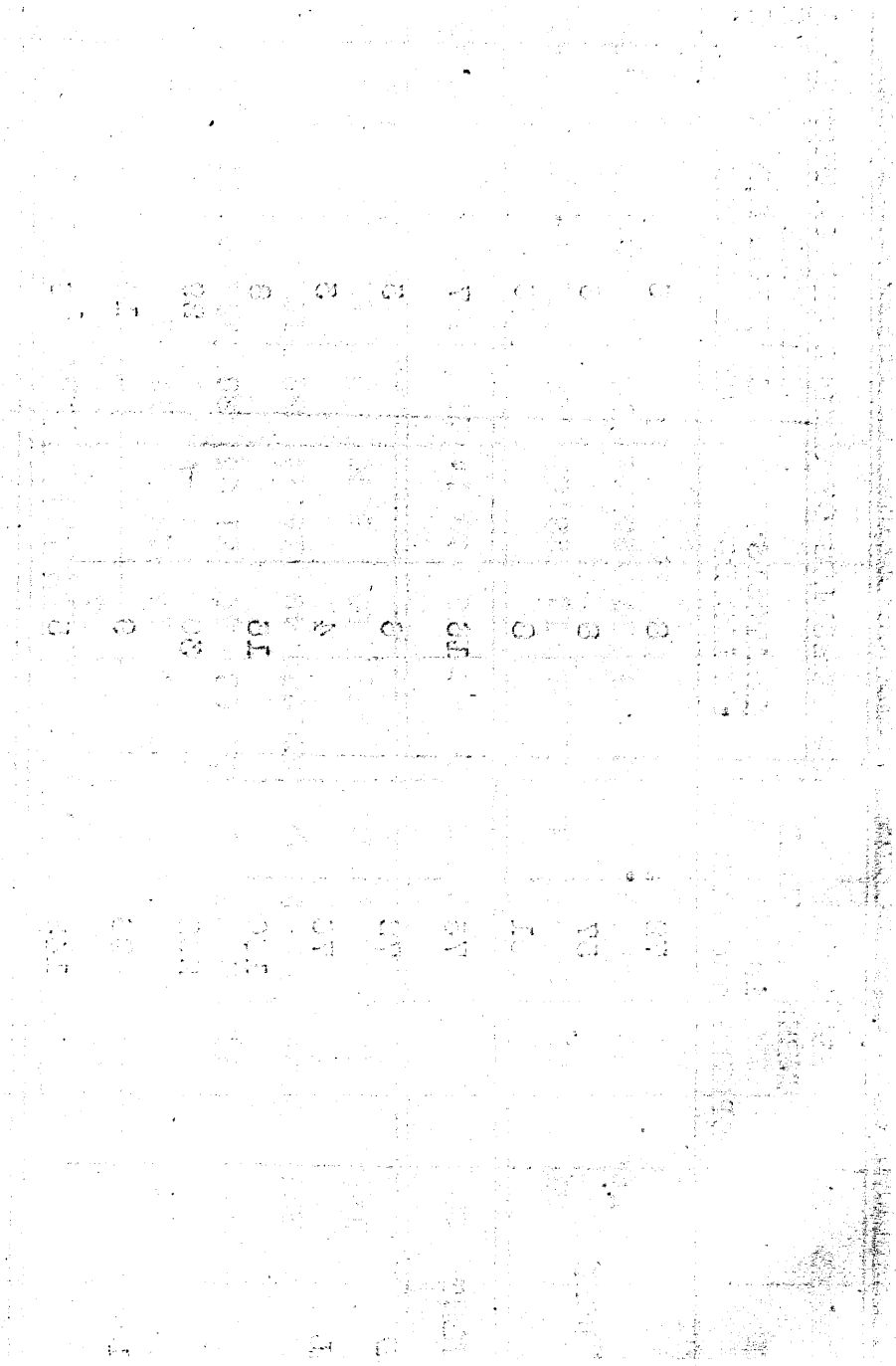
ANKLE KERATOSIS in 1,100 Children	SPRING, 1944		AUTUMN, 1944	
	Number	Per Cent	Number	Per Cent
ALL DEGREES	343	31.18	248	22.55
FIRST DEGREE	222	20.18	199	18.09
SECOND DEGREE	88	8.00	46	4.18
THIRD DEGREE	33	3.00	3	0.28
ABSENT OR DOUBTFUL	757	68.82	852	77.45

Table 111

of the same children, one in the Spring and the other in the Autumn, when it was believed that the influence of winter and summer conditions on the skin would become most evident. Eleven hundred children were examined twice and the findings at both seasons are summarised in Table III. It is clear that the incidence of all grades of keratosis is much lower in Autumn (22.55 per cent) than it is in Spring (31.18 per cent), and this is more marked in the more severe grades of keratosis. Thus, the numbers of children with second degree keratosis fell by nearly half, that is from eighty-eight in Spring to forty-six in Autumn, and there were only three cases of third degree keratosis in Autumn as compared with thirty-three in Spring.

A consideration of the natural course of the lesion in the individual children does not give such a clear-cut picture of seasonal incidence, although the reduction in the incidence of second and third degrees of keratosis occurred consistently in every school. At the second examination in Autumn many cases of keratosis had improved or disappeared but others remained unaltered, and in a few cases keratosis which was not previously noted had developed, or a previous keratosis was seen to have extended. The detailed results are given in Table IV, where it is seen that in 10 per cent of individuals, or in 26.44 per cent of children with keratosis, there was no alteration in the degree of keratosis,

Table 1V



SEASONAL VARIATION IN THE DEGREE AND EXTENT OF ANKLE KERATOSIS

SCHOOL	NUMBER EXAMINED in SPRING and AUTUMN	RESULTS OF SECOND EXAMINATION IN AUTUMN		
		KERATOSIS UNALTERED	KERATOSIS DETERIORATED OR DEVELOPED	KERATOSIS IMPROVED OR CURED
PENDOWER	72	8	6	19
WESTMORELAND ROAD	57	8	6	18
ELSWICK ROAD	61	8	6	7
CAMBRIDGE STREET	73	16	7	12
WINGROVE ROAD	72	6	3	17
WESTGATE HILL	76	4	3	39
MORPETH	160	16	8	54
DUDLEY	298	30	29	33
EAST HARTFORD	86	9	10	12
MONKSEATON	145	5	6	11
TOTAL NUMBER EXAMINED	1,100	110 (10.00%)	84 (7.64%)	222 (20.18%)
TOTAL SHOWING ANKLE KERATOSIS	416	110 (26.44%)	84 (20.19%)	222 (53.37%)

Table 1V

Table V

SEASONAL INCIDENCE OF ANKLE KERATOSIS IN THE INDIVIDUAL SCHOOLS

	SCHOOL	Number of Children Examined Twice	ANKLE KERATOSIS											
			ALL DEGREES				FIRST DEGREE				SECOND & THIRD DEGREE			
			SPRING		AUTUMN		SPRING		AUTUMN		SPRING		AUTUMN	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
NORTHUMBERLAND	EAST HARTFORD	86	24	27.91	22	25.58	16	18.60	17	19.77	8	9.31	5	5.81
	MORPETH	160	71	44.38	35	21.88	50	31.25	28	17.50	21	13.13	7	4.38
	DUDLEY	298	66	22.15	68	22.82	49	16.44	58	19.46	17	5.71	10	3.36
	MONKSEATON	145	16	11.04	12	8.28	10	6.90	9	6.21	6	4.14	3	2.07
	Total in NORTHUMBERLAND	689	177	25.69	137	19.88	125	18.14	112	16.26	52	7.55	25	3.62
NEWCASTLE	WESTMORELAND ROAD	57	28	49.12	18	31.58	13	22.81	10	17.54	15	26.31	8	14.04
	PENDOWER	72	28	33.89	20	27.78	17	23.61	18	25.00	11	15.28	2	2.78
	WINGROVE ROAD	72	24	33.33	15	20.83	16	22.22	13	18.05	8	11.11	2	2.78
	ELSWICK ROAD	61	15	24.59	17	27.87	7	11.48	12	19.67	8	13.11	5	8.20
	CAMBRIDGE STREET	73	29	39.73	26	35.62	18	24.66	20	27.40	11	15.07	6	8.22
	WESTGATE HILL	76	44	57.90	16	21.05	27	35.53	13	17.11	17	22.37	3	3.94
	Total in NEWCASTLE	411	168	40.87	112	27.25	98	23.84	86	20.92	70	17.03	26	6.33

Table V

and in 7.64 per cent of the total number, or in 20.19 per cent of cases with Ankle Keratosis, the lesion had increased from the time of the first examination.

These individual results altered the general trend towards improvement during the Summer in two out of ten schools, at Dudley, (Northumberland), and at Elswick Road (Newcastle). See Table V. In these schools the incidence of all grades of keratosis, and in particular of the first degree, increased slightly in spite of a reduction in the percentage of second and third degree changes. In three other schools, East Hartford (Northumberland), Pendower and Cambridge Street (Newcastle), the number of children with first degree keratosis increased, while those with a more severe degree of keratosis decreased, the net result being a reduction in the incidence of all grades of keratosis.

Since all the surveys were made in either Spring or Autumn the seasonal incidence can also be expressed by dividing the results into these two groups, even although they include many cases and some districts which were examined only once. The total incidence of all degrees of keratosis in these districts fell from 31.17 per cent in Spring to 23.80 per cent in Autumn. All the different grades of keratosis showed improvement in the Autumn. This is shown overleaf and also in Table VI.

Table V1

SEASONAL INCIDENCE OF ANKLE KERATOSIS IN ALL CHILDREN EXAMINED

SEASON	DISTRICT	NUMBER EXAMINED	ANKLE KERATOSIS							
			ALL DEGREES		FIRST DEGREE		SECOND DEGREE		THIRD DEGREE	
			No.	%	No.	%	No.	%	No.	%
SPRING	NORTHUMBERLAND	907	243	26.79	182	20.07	53	5.84	8	0.88
	NEWCASTLE	599	219	36.56	133	22.20	62	10.35	24	4.01
	GLASGOW	405	137	33.83	97	23.95	39	9.63	1	0.25
	DARLINGTON	34	17	50.00	12	35.30	4	11.76	1	2.94
	CORNWALL	140	34	24.29	30	21.43	4	2.86	0	-
	WARWICKSHIRE	244	76	31.15	65	26.64	11	4.51	0	-
	TOTAL	2,329	726	31.17	519	22.28	173	7.43	34	1.46
AUTUMN	NORTHUMBERLAND	703	132	18.78	108	15.36	22	3.13	2	0.29
	NEWCASTLE	411	112	27.25	86	20.92	24	5.84	2	0.49
	GLASGOW	279	34	12.19	34	12.19	0	-	0	-
	PONTELAND	156	98	62.82	53	33.97	37	23.72	8	5.13
	HOSPITAL PATIENTS	102	17	16.67	15	14.71	2	1.96	0	-
	TOTAL	1,651	393	23.80	296	17.93	85	5.15	12	0.72

Table V1

	SPRING	AUTUMN
First degree Keratosis	22.28 per cent	17.93 per cent
Second " "	7.43 "	5.15 "
Third " "	1.46 "	0.72 "

Children in Northumberland, Newcastle, and Glasgow were examined at both seasons and in each case the incidence was higher and the grade of keratosis was more severe in Spring than in Autumn. Thus in Northumberland and Newcastle, the incidence of first degree keratosis fell from 20.07 per cent and 22.20 per cent in Spring to 15.36 per cent and 20.92 per cent in Autumn. In these districts also the incidence of second degree keratosis fell from 5.84 per cent and 10.35 per cent in Spring to 3.13 per cent and 5.84 per cent in Autumn, and the incidence of third degree keratosis from 0.88 per cent and 4.01 per cent to 0.29 per cent and 0.49 per cent respectively. Similarly in Glasgow the figures for first degree keratosis fell from 23.95 per cent in Spring to 12.19 per cent in Autumn, and while there was 9.63 per cent of second degree and 0.25 per cent third degree keratosis in Spring, no cases of either degree were found in Autumn.

Geographical Incidence.

A comparison was made of the incidence of Ankle Keratosis in a few representative areas of Scotland and England. Since it has been shown that there is a definite seasonal

Table V11

GEOGRAPHICAL INCIDENCE OF ANKLE KERATOSIS IN HEALTHY CHILDREN
(SPRING SURVEY)

DISTRICT	Number of Children Examined	ANKLE KERATOSIS									
		ALL DEGREES		FIRST DEGREE		SECOND DEGREE		THIRD DEGREE		ABSENT OR DOUBTFUL	
		No.	%	No.	%	No.	%	No.	%	No.	%
WEST SCOTLAND	465	137	33.83	97	23.95	39	9.63	1	0.25	268	66.17
NORTH-EAST ENGLAND	1,540	479	31.10	327	21.23	119	7.73	33	2.14	1,061	68.90
MIDLANDS OF ENGLAND	244	76	31.15	65	26.64	11	4.51	0	-	168	68.85
SOUTH OF ENGLAND	140	34	24.29	30	21.43	4	2.86	0	-	106	75.71
Total	2,329	726	31.17	519	22.28	173	7.43	34	1.46	1,603	68.83

Table V11

variation in the frequency and severity of Ankle Keratosis, a comparison of its incidence in different districts must be made at the same season of the year. In the West of Scotland at Glasgow four hundred and five children were examined; in the North East of England at Newcastle and Darlington and in villages and towns of Northumberland one thousand five hundred and forty children were examined; in the Midlands of England at Nuneaton and at Barford in Warwickshire two hundred and forty-four children were examined; and in the South of England at St. Austell in Cornwall one hundred and forty children were examined, giving a total of two thousand three hundred and twenty-nine children. All children compared in these groups were examined in Spring; they were apparently healthy, living in their own homes or in institutions and attending day schools. The results are shown in Table VII. Out of two thousand three hundred and twenty-nine children, seven hundred and twenty-six (31.17 per cent) showed all degrees of keratosis, five hundred and nineteen (22.28 per cent) had a first degree keratosis, one hundred and seventy-three (7.43 per cent) had a second degree keratosis, and thirty-four (1.46 per cent) showed keratosis of the third degree. The incidence of Ankle Keratosis in the different districts varies from 33.83 per cent in the West of Scotland to 24.29 per cent in the South of England. In the West of Scotland,

in the Midlands, and in the North East of England, the variation in the incidence of all degrees of keratosis is only slight, that is from 31.10 per cent in the North East of England to 33.83 per cent in the West of Scotland. When the incidence of the different degrees of keratosis is examined it is seen that in the West of Scotland and in the North East of England, second and third degrees of keratosis are more frequently seen than in the other areas. Thus, in the West of Scotland second degree keratosis occurs in 9.63 per cent of children and third degree keratosis in 0.25 per cent, and in the North East of England the figures are 7.73 per cent and 2.14 per cent respectively. No case of third degree keratosis occurred in either the Midlands or the South of England and the incidence of second degree changes was 4.51 per cent in the Midlands and 2.86 per cent in the South of England.

Regional Incidence.

Further examination of the results obtained in the North East of England shows a considerable difference in the incidence of keratosis in Northumberland and in Newcastle. Examinations were made on one thousand five hundred and six children in Spring. Nine hundred and seven children came from Northumberland and five hundred and ninety-nine from Newcastle. The incidence of all degrees

of keratosis in Northumberland children was 26.79 per cent as compared with 36.56 per cent in those living in Newcastle. Similarly the different degrees of keratosis showed a lower incidence in Northumberland as compared with that in Newcastle; the figures being 20.07 per cent first degree, 5.84 per cent second degree and 0.88 per cent third degree for Northumberland; and 22.20 per cent first degree, 10.35 per cent second degree and 4.01 per cent third degree for Newcastle. The Autumn figures for the incidence of keratosis in Newcastle also show a consistently higher incidence for all grades than those in Northumberland. These results are given in detail in Table VI. (Opposite page 55).

Social Status.

The type of child covered by the surveys came for the most part from working class families. At Glasgow three types of school were selected in the Autumn survey: a part fee-paying school 'X', a board school of better working class type 'Y', and a very poor school serving a slum area 'Z'. In each school between eighty-five and one hundred children were examined. The total incidence of keratosis was low and the degree of keratosis was mild in all the schools. In no case did second or third degree keratosis occur. The incidence of keratosis was as follows:-

'X'	school	(better class)	16.6 per cent keratosis
'Y'	"	(good working class)	11.7 " "
'Z'	"	(poor slum class)	11.9 " "

Table V111

INCIDENCE OF ANKLE KERATOSIS IN DIFFERENT TYPES OF NEWCASTLE SCHOOLS

(SPRING SURVEY)

TYPE OF SCHOOL	NUMBERS EXAMINED	ANKLE KERATOSIS									
		ALL DEGREES		FIRST DEGREE		SECOND DEGREE		THIRD DEGREE		ABSENT OR DOUBTFUL	
		No.	%	No.	%	No.	%	No.	%	No.	%
Better Working Class	294	85	28.91	53	18.03	25	8.50	7	2.38	209	71.09
Poor Working Class	305	134	43.93	80	26.23	37	12.13	17	5.57	171	56.07
Total	599	219	36.56	133	22.20	62	10.35	24	4.01	380	63.44

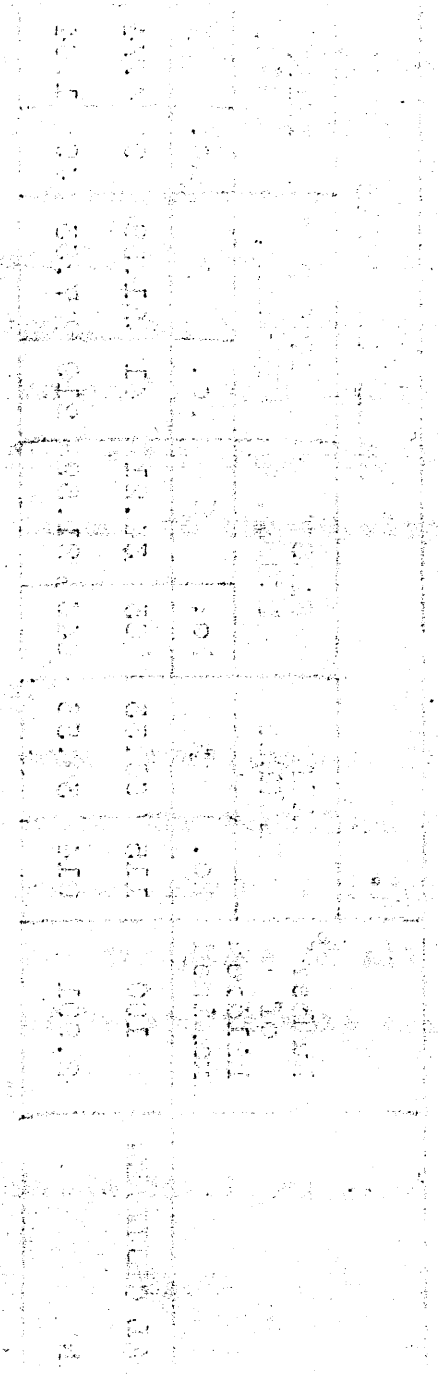
Table V111

Similarly the Newcastle schools which were investigated could be placed into two groups, three schools serving a better working class and three serving a poor working class area in the city. The Newcastle schools were examined both in Spring and Autumn but the figures quoted here are the results of the Spring survey where there was a much higher incidence and a severer grade of keratosis than was found in the Autumn survey at Glasgow. In contrast to the even distribution of keratosis among the three types of Glasgow schools, the better class schools in Newcastle showed a less severe and less frequent keratosis than the poorer schools. Details of these results are shown in Table VIII. It is seen that 71.09 per cent of the better working class children remain free from keratotic changes, as compared with 56.07 per cent of the poor working class children and with the total incidence for the area of 63.44 per cent. Further, in children from better working class homes there is less second and third degree keratosis (8.50 per cent and 2.38 per cent respectively) than occurs in children from poor working class homes (12.13 per cent and 5.57 per cent respectively).

In Northumberland and Warwickshire, the fathers of the majority of the children were either miners or agricultural labourers, although at Morpeth and Monkseaton and in one of the Warwickshire schools some children of the professional

classes were included. Of these three districts, Monkseaton had the highest percentage of children from the professional and middle classes. The incidence of keratosis at this school was only 12.43 per cent at the first examination in Spring. Twenty-one out of a total of one hundred and sixty-nine children showed keratosis, five cases (2.96 per cent) were of the second degree and two cases (1.18 per cent) of the third degree. Both cases with third degree keratosis and one with second degree came from a Public Assistance Institution in the village. As there were only eight institutional children attending the school, (constituting 2.06 per cent of all children on the roll) the incidence of keratosis in the remainder is reduced still further if these cases are omitted. In order to exclude a regional factor as the cause of the low incidence at Monkseaton, children in Blyth were examined at the same season. Blyth is a town in the same district but of a lower social grade, the occupation of the men consisting mainly of mining and shipbuilding. Eighty-two children were seen and the incidence of keratosis was 35.61 per cent, of which 31.91 per cent had first degree changes and 3.7 per cent second degree changes. No cases of third degree keratosis were seen. Compared with the total incidence — 30.56 per cent for all grades of keratosis, 21.59 per cent for first degree, 7.33 per cent for second degree and 1.64 per cent for third degree keratosis,— it can be seen that while the

Table lX



A COMPARISON OF THE TOTAL INCIDENCE OF ANKLE KERATOSIS WITH THE INCIDENCE IN INSTITUTIONAL CHILDREN

	Number of Children Examined	ANKLE KERATOSIS									
		ALL DEGREES		FIRST DEGREE		SECOND DEGREE		THIRD DEGREE		ABSENT OR DOUBTFUL	
		No.	%	No.	%	No.	%	No.	%	No.	%
INSTITUTIONAL CHILDREN	190	115	60.53	65	34.21	41	21.58	9	4.74	75	39.47
ALL CHILDREN	2,991	914	30.56	646	21.59	219	7.33	49	1.64	2,077	69.44

Table 1X

incidence of all grades of keratosis at Blyth was rather higher than the average, the number of cases with severe keratosis was much less. Comparing this school's results with those of Monkseaton, the incidence of first and second degree keratosis was considerably higher in the Blyth school.

Although exact details of the occupation of all the parents were not obtained, instances of first and second degree keratosis were noted in eight children of the professional classes, a fact which suggests that this social class is at least not immune to the development of Ankle Keratosis.

Institutional Children.

Two institutions were investigated, St. Joseph's Orphanage at Darlington and the Ponteland Cottage Homes in Northumberland. The remarkably high figure of 60.53 per cent was obtained for the incidence of all grades of keratosis. All degrees of keratosis were commoner, the figures being as follows:-

First degree keratosis	34.21 per cent	(total incidence	21.59 per cent)
Second " "	21.58 "	(total incidence	7.33 per cent)
Third " "	4.74 "	(total incidence	1.64 per cent)

See Table IX.

Among the children examined at the Ponteland Homes, the length of residence of one hundred and forty-six of them is known. Seventy-seven had lived in the Homes for more than two years, forty-four had been there for more than six months but less than two years, and twenty-five had lived there for six months or less. There was very little difference in the incidence of keratosis in those children who were admitted to the Homes from two years to six months before examination, as compared with the incidence in those admitted to the Homes more than two years before examination. Taken together, however, there was nearly twice as much keratosis and the degree present was much more severe in this group than in those who had resided in the Homes for less than six months. Thus, 60 per cent of those less than six months resident in the Homes were unaffected by keratosis as compared with only 34.7 per cent of all children who were in the Homes for longer. Of the 40 per cent of recent admissions who had keratosis, six (24 per cent) had a first degree keratosis, four (16 per cent) had a second degree keratosis and none had a third degree keratosis as compared with 25.6 per cent first degree, 24.8 per cent second degree, and 6.6 per cent third degree keratosis in the remainder.

Familial Incidence of Ankle Keratosis.

The village of East Hartford was selected for study of the social background and the familial incidence of Ankle Keratosis, because it was thought to be representative of a poor mining community. The housing conditions in this village are shocking, each house consisting of two or three apartments without any modern conveniences. There is not even running water in the houses. The adjacent streets are in poor condition, their surface is broken, wet and muddy and the gutters are used for the discharge of soiled water in preference to the kitchen drain pipes. The children's boots were nearly always sodden and in poor repair.

Twenty families were visited and examined. The School Nurse made a preliminary visit to the houses to warn the parents and obtain their co-operation. The parents were mostly very interested and anxious to help. Only two adults refused to be examined. The families were selected in the following way. Eighty-eight children had been examined at the school in Spring and Autumn of the same year. Ten of the children in whom no keratosis was found and ten children in whom a second or third degree keratosis was found at one or both examinations were selected, and their families were made the subject of this study. These two groups of

families will be referred to as the 'Keratotic' and 'Normal' family groups respectively. The investigations were carried out in early Spring. Twenty-seven adults and fifty-eight children were included in this household investigation, the size of the families ranging from one to eight. Most of the adults were mothers or grandparents, the fathers in ten households being out at work or away from home. None of the adults examined showed a definite keratosis. Of the seven fathers examined, four volunteered the information that they had suffered from 'boot scruff' when they were boys, but as they grew older their skin had become smooth again. Two of them associated the disappearance of the keratosis with the wearing of long trousers.

The following comparison of the two family groups refers only to school children, since Ankle Keratosis is infrequently seen in children under five years of age.

In the 'Keratotic' family group, twenty-five school children were examined of whom nine had normal skins or minor changes marked as doubtful keratosis. The remainder showed a varying extent of first or second degree keratosis. On the point system, eighty-six points were accorded to these children, giving a mean of 3.44 points per child. In the 'Normal' family group, twenty children of school age were examined and only one child showed a mild keratosis. He was given three points, making the mean for this group 0.15

Table X

INCIDENCE OF ANKLE KERATOSIS IN SICK AND HEALTHY CHILDREN

	Number of Children Examined	ANKLE KERATOSIS									
		ALL DEGREES		FIRST DEGREE		SECOND DEGREE		THIRD DEGREE		ABSENT OR DOUBTFUL	
		No.	%	No.	%	No.	%	No.	%	No.	%
SICK	102	17	16.67	15	14.71	2	1.96	0	-	85	83.33
HEALTHY	2,751	877	31.88	613	22.28	215	7.82	49	1.78	1,874	68.12

Table X

points per child. In spite of the small numbers, the results of this investigation seem to show a definite familial tendency towards the development of Ankle Keratosis. It was also noticeable that the standard of living in the 'Normal' family group was on a higher level than in the 'Keratotic' families.

Incidence of Ankle Keratosis in Sick Children.

One hundred and two children in the wards of the Royal Victoria Infirmary, Newcastle, were examined with a view to obtaining the incidence of Ankle Keratosis among sick children. The results show that 14.71 per cent had a first degree keratosis, and 1.96 per cent had a second degree keratosis while no cases of third degree keratosis occurred. See Table X.

These children suffered from a variety of complaints such as injuries to hands, legs, or head; burns; osteomyelitis; appendicitis; tuberculous adenitis; erythema nodosum; pleurisy with effusion; and acute rheumatism.

Relationship between Ankle Keratosis and the Incidence of Past Disease.

The incidence of past diseases among apparently healthy children examined at Morpeth, Dudley, and East Hartford was investigated. Those school records in which the last examination had taken place not more than two years previously were used as evidence of the past history of the children,

Table XI

RELATIONSHIP OF ANKLE KERATOSIS TO THE INCIDENCE OF PAST DISEASE

IN 427 APPARENTLY HEALTHY CHILDREN

ANKLE KERATOSIS	NUMBER OF CHILDREN	MEASLES		CHICKEN POX		WHOOPING COUGH		SCARLET FEVER		DIPHTHERIA		MUMPS		DISEASE OF THE EARS		DISEASE OF THE NOSE AND THROAT		CARIOUS TEETH		OTHER DISEASES	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
ABSENT OR DOUBTFUL	263	181	68.82	86	32.70	124	47.15	11	4.18	13	4.94	45	17.11	14	5.32	63	23.95	144	54.75	170	64.64
FIRST DEGREE	123	105	85.37	42	34.15	45	36.59	10	8.13	3	2.44	20	16.26	3	2.44	29	23.58	54	43.90	70	56.91
SECOND AND THIRD DEGREE	41	33	80.51	13	31.71	18	43.90	1	2.44	5	12.20	7	17.08	1	2.44	10	24.39	19	46.34	26	63.41
TOTAL	427	319	74.71	141	33.02	187	43.79	22	5.15	21	4.92	72	16.86	18	4.22	102	23.89	217	50.82	266	62.30

Table XI

supplemented by questions addressed to the children themselves. In this way four hundred and twenty-seven sufficiently complete records were obtained. The children were divided into three groups. All those in whom no evidence of keratosis or only doubtful changes were found were collected together and their past history compared with those showing first degree keratosis, and with those showing second or third degree keratosis. Because of the small numbers of children with second and third degree keratosis, their results have been combined for comparative purposes. The occurrence in each child's past history of the various infectious diseases, disorders of the ear, nose, throat, or teeth, and of any other disease was noted. It is seen in Table XI that with the exception of measles and of scarlet fever, other disorders and illnesses have a similar incidence in all groups or a higher incidence in the 'Normal' than in the 'Keratotic' groups.

ASSOCIATION OF ANKLE KERATOSIS WITH OTHER CONDITIONS.

I. Ichthyosis.

In the course of these investigations, seven cases of congenital ichthyosis of mild and moderate degrees were seen. Every case seen, showed an excessive thickening of the skin in the region of the ankle, the exact position of

which varied with the type of footwear. When Ankle Keratosis occurs in children with otherwise normal skins, a similar relationship exists between the site of the lesion and the footwear.

II. Minor Abnormalities of the Skin.

(a) Asteatosis or Weathering. According to Becker and Obermayer (1943) asteatosis denotes drying of the skin, often due to exposure to alkalies or to cold air. The condition is commonly known as 'chapping'. The skin appears dry, slightly scaly, and erythematous in isolated plaques or over large areas, the surfaces of which have the appearance of superficial fissuring called 'chaps' or 'keens'.

The detailed study of institutional children demonstrated how frequently they suffer from asteatosis or 'weathering' of the hands and legs. The occurrence of much 'weathering' of the legs and feet drew attention to the possible relationship between this condition and Ankle Keratosis.

In the town of Glasgow, and in the counties of Cornwall, Warwickshire and Northumberland, one thousand one hundred and sixty-two children were made the subject of a particular study to determine the possible relationship between 'weathering' and Ankle Keratosis. The incidence of keratosis in this group was 28.2 per cent (three hundred and

twenty-eight cases); one hundred and twenty-two children (10.5 per cent) showed 'weathering' and in fifty-two cases (4.4 per cent) the 'chaps' seemed to be definitely related to the keratosis. Thus, of three hundred and twenty-eight children with Ankle Keratosis, the latter was closely associated with the presence of 'chaps' in fifty-two (15.9 per cent).

(b) Follicular Keratosis. At East Hartford the incidence of Follicular Keratosis in one hundred and sixty children was found to be 34.4 per cent. In the same children the incidence of Ankle Keratosis was 29.4 per cent. Twenty children (12.5 per cent) had both Ankle Keratosis and Follicular Keratosis, thirty-five children (21.9 per cent) had Follicular Keratosis only, and twenty-seven (15.6 per cent) had Ankle Keratosis only.

III. Signs of Nutritional Deficiency.

One hundred and sixty children at East Hartford were fully examined for clinical signs of nutritional deficiency, such as pallor of the mucous membranes, cheilosis, hypertrophic or spongy gums and prominent or atrophic tongue papillae. None of these signs occurred with any frequency and there was no apparent correlation between them and the occurrence of Ankle Keratosis.

The nutritional state as determined by the School

Medical Officer is recorded in two hundred and sixty-one of the children whose past histories were analysed above. Observations on the nutritional state of children are known to have a personal bias and to be unreliable, but it was considered a point of interest to note what state of nutrition was accorded to the 'Keratotic' and 'Normal' groups of children by the two school doctors who had recently examined them.

School doctors are required to divide the children into three groups (A), (B), and (C), according to their nutritional state. This assessment is based partly on the weight of the child and partly on the general clinical findings. (A) signifies a good or satisfactory state of nutrition, (B) slight undernutrition, and (C) definite malnutrition.

Of the two hundred and sixty-one children, one hundred and thirty-one had absent or doubtful keratosis and one hundred and thirty had a variable degree of keratosis. The nutritional state of these two groups was assessed as follows:-

No keratosis	A - 23 children	17.6 per cent
" "	B - 86 "	65.6 "
" "	C - 22 "	16.8 "
Keratosis present	A - 33 "	25.4 "
" "	B - 69 "	53.1 "
" "	C - 28 "	21.5 "

CHAPTER IV

A. ETIOLOGICAL FACTORS.

In the preceding chapter the results of the surveys on Ankle Keratosis are given. They were carried out with a view to establishing the incidence of the lesion under different conditions. Nearly three thousand individuals are included in the surveys, and of these, eleven hundred were examined twice. It is now proposed to analyse these results in an attempt to discover the etiology of the condition. Several experiments were carried out with the same object, and these along with other observations not included in the surveys will also be described here.

In view of the relatively minor skin changes which are referred to as first degree keratosis, much more weight is given to the presence and behaviour of second and third degrees of keratosis in the following analysis. The grades of keratosis are not clearly-cut and cannot be accurately measured. One degree may change gradually into another, and as a result, reference is occasionally made to a child having 'almost a second degree', or 'almost a third degree' keratosis.

In this section the following factors will be considered: (1) age, (2) sex, (3) season, (4) district, (5) disease,

(6) social status, (7) type of footwear, (8) shoe leather, (9) friction, (10) 'weathering', (11) general care, (12) state of nutrition, (13) care of the skin.

(1) Age.

No child under two years of age showed any evidence of Ankle Keratosis. Of the eighty-one children aged from two to five years, only eight (9.88 per cent) showed keratosis, and the three cases in which second degree changes were found, were all between four and four and a half years old. This low incidence in early childhood is definitely significant being more than six times the Standard Error. Between the ages of five and fourteen years the incidence of keratosis varied slightly, from 30.93 per cent to 33.11 per cent, but in adolescents, that is from fourteen to seventeen years of age, the incidence rose to 45.28 per cent. This last result was obtained from the examination of only fifty-three children, but statistical analysis shows that it is just more than twice the Standard Error. It cannot be concluded, however, that there is a greater tendency for Ankle Keratosis to occur at this age, since the group of adolescents unfortunately does not represent a fair sample of the population. More than half of these children came from institutions where there was a high incidence of keratosis. With advancing years the keratosis tends to disappear and the incidence in adults is significantly lower than the total

for all ages. Of one hundred and thirty-eight adults examined only two had a second degree keratosis, while no case of third degree keratosis occurred. See Table I, opposite page 51.

Thus, Ankle Keratosis can be regarded as a condition which occurs in approximately one third of school children, and in about 9 per cent of children a second or third degree keratosis is found. No cases have been reported under two years of age; it is very uncommon under five years and is only occasionally seen in adults, where it occurs in a mild form.

The relationship between the age incidence and other factors will be discussed later.

(2) Sex.

A higher incidence of all grades of keratosis, particularly of the severer grades, occurred in boys. This result is statistically significant in that it is more than two and a half times the Standard Error. See Table II opposite page 52. It has also been noted that the site of the keratosis in the two sexes is different, a difference which is related to the type of footwear. Boys wear boots more frequently than girls, and they therefore tend to develop the boot type of keratosis. In girls, keratosis is more commonly found in the shoe and sandal position.

(3) Season.

It is found that the Spring figures give a significantly higher incidence of all degrees of keratosis as well as a significantly higher incidence of second and third degrees of keratosis than do the Autumn figures. See Tables III, IV, and V, opposite pages 53 and 54. Examinations of the same children in Spring and Autumn showed that in every school there was a consistent reduction in the percentage of second and third degrees of keratosis in Autumn.

In Table IV it is seen that at the second examination in Autumn, 53.37 per cent of children with keratosis showed improvement or cure of the lesion. On the other hand, some children who had no signs of keratosis in Spring had since developed it, and in some others the keratosis was seen to have increased. This progression of the lesion occurred in eighty-four children, 20.19 per cent of all those with keratosis, but since eighty-four children constitute only 7.64 per cent of the total number examined, it does not cause a significant alteration in the general trend towards improvement of the lesion in Autumn.

The behaviour of Ankle Keratosis in individual cases has been more closely studied by repeated examinations of twenty-nine children at the Ponteland Homes. The frequency and severity of keratosis and also of 'weathering' in these children was very great, and with two exceptions the seasonal

Fig.4

Chart to show the Relationship between Ankle Keratosis and 'Weathering'.

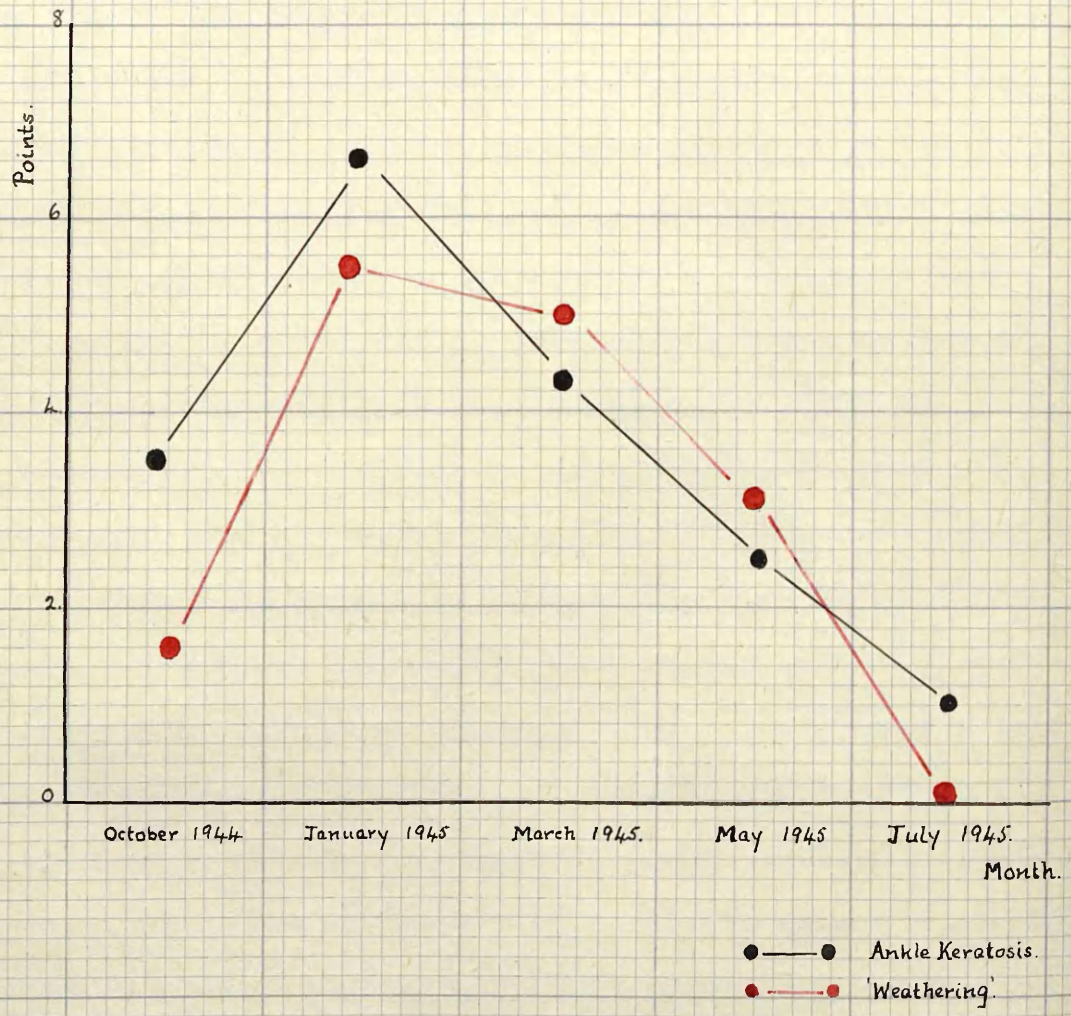


Fig. 4

variation of keratosis was clearly seen in all. Points have been accorded to each child in the manner already described, (page 49), and the average results have been plotted in Fig. 4. In this way the general course of keratosis and of 'weathering' has been expressed graphically. The presence of 'weathering' was most marked in January and March, less so in October and May, and practically absent in July.

A lesion which is more prevalent in Winter and Spring than in Summer or Autumn may possibly be due to (a) environmental conditions, (b) seasonal variations in the diet such as has been shown to occur with Vitamins C and D (Harris & Olliver, 1943; Bicknell & Prescott, 1942), or (c) the prevalence in Winter of infections and other illnesses, which may lower the resistance or predispose in some way to its development. The influence of these factors in the development of Ankle Keratosis will be discussed below.

(4) District.

(a) Geographical Distribution. Four representative areas of England and Scotland were examined with a view to determining the geographical distribution of Ankle Keratosis. In Fig. 5 the incidence of Ankle Keratosis in these districts has been compared in two ways. In the upper chart the total incidence of the condition in the different districts is shown

Fig.5

TOTAL INCIDENCE OF ANKLE KERATOSIS
IN DIFFERENT DISTRICTS

GEOGRAPHICAL DISTRIBUTION OF ANKLE KERATOSIS
(SPRING SURVEY)

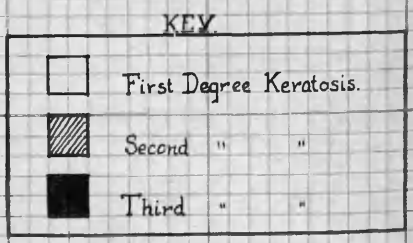


Fig.5

irrespective of the season of the year. From this chart it would seem that Ankle Keratosis occurs more frequently in the North East of England than elsewhere. Further, the degree of keratosis there,would appear to be much more severe. The Midlands and South of England, however, were visited only in Spring, and the lower chart in Fig. 5 shows the incidence of Ankle Keratosis in the four districts at this season. When the comparison of results is limited to those surveys which were made in Spring, it is seen that the incidence of all grades of keratosis is similar in the West of Scotland, in the North East and in the Midlands of England. The incidence of third degree keratosis remains highest in the North East, and this is statistically significant in that it is more than three times the Standard Error. These results are shown in detail in Table VII (opposite page 56). The low incidence of severe degrees of keratosis in the Midlands and South of England is striking. In the Midlands, second degree keratosis occurred in 4.51 per cent of children, and in the South of England in 2.86 per cent. These figures are statistically significant being more than twice and three times the Standard Error respectively. When the absence of third degree changes in these two districts is also taken into account the low incidence of severe degrees of keratosis becomes still more

significant.

A condition which shows a variable incidence in different districts may be due to selection of cases, to the season in which the survey was made, to differences in diet, and to local conditions such as the weather, among other factors.

(i) Selection of Cases. It is believed that the children examined in the four districts form a fair sample of the scholars at council schools, although it should be remembered that at Glasgow the schools examined in the Spring survey all served a poor working class district. (ii) Seasonal Variation. Attempts have been made to exclude the seasonal factor by considering the results of only those surveys which were made in the Spring. It was not possible, however, to examine all districts at exactly the same time, and it so happened that Glasgow was examined in the early Spring, Newcastle and Northumberland in mid Spring, and the Midlands and South of England were examined in the late Spring. It is therefore not possible to state that the seasonal factor was entirely excluded. (iii) Differences in Diet. The fact that, at the time of the survey, rationing of food was universal throughout the country simplifies the analysis of the regional figures. It is known that certain types of non-rationed foods and even some rationed foods, such as milk and eggs, were more easily

obtained in the country than in the towns. Similarly in certain districts such as the South and Midlands of England, fruit and vegetables were more abundant than in the North. However, basic foods such as meat, fish, cheese, sugar, and fats were fairly evenly distributed in all areas.

When these considerations are applied to the results obtained in the regional surveys, certain facts emerge. A comparison of the two areas where fruit and vegetables were more abundant with the other two districts, gives the percentage of children without keratosis as 75.71 per cent and 68.85 per cent respectively. The difference between these figures and the total incidence is not significant, but it has been shown above that the low incidence of second and third degrees of keratosis in the Midlands and South of England is statistically significant. Thus, these figures do not exclude the possibility that dietary factors may be related to the lower incidence of severe keratosis in the Midlands and South of England. (iv) Local Conditions. In the four regions of England and Scotland under consideration, climatic conditions differ somewhat. In the West of Scotland the weather is generally wetter and milder than in the North East of England where the prevailing wind from the East is very cold, while in the Midlands of England extremes of temperature are more likely to occur. The climate in Cornwall is more temperate than in the Midlands

or the North East of England, although there is a relatively high rainfall and strong winds blow off the sea. (Curnow, 1945). In the North East and in the Midlands of England the water is hard, in Cornwall it is soft, and in the West of Scotland it is very soft. The possible effect of hard water and cold East winds on the skin will be considered later.

(b) Ankle Keratosis in Northumberland and in Newcastle. There is a considerable difference between the incidence of keratosis in the towns and villages of Northumberland and the incidence in Newcastle. (See Table VI (opposite p. 55).) In the latter all grades of keratosis occurred with greater frequency; 36.56 per cent of the children there showed keratosis as compared with 26.79 per cent in children from Northumberland.

The incidence of second and third degrees of keratosis in Newcastle was 10.35 per cent and 4.01 per cent as compared with 5.84 and 0.88 per cent respectively in Northumberland. A consideration of the types of schools examined in Northumberland is necessary before coming to any conclusion as to the cause of this difference. Dudley and East Hartford are typical mining villages with rows of miserably poor houses without gardens. Monkseaton and Blyth are situated on the coast, but as explained in Chapter III, the type of child at the Monkseaton school comes from a higher social

class with better housing conditions and with gardens. It is very probable that the Monkseaton children consume a better diet with, among other things, a higher proportion of garden produce, than do those attending the Blyth school. In Morpeth the schools examined probably represent country conditions more nearly than do the other villages in Northumberland. Morpeth is a country town and the pupils examined include children of mixed social status, living in and outside the town. Table V (opposite p. 54) shows that in Spring the incidence of all grades of keratosis in Morpeth school children was 44.38 per cent as compared with 40.87 per cent in Newcastle. In Autumn the incidence of keratosis was 21.88 per cent in Morpeth as compared with 27.25 per cent in Newcastle. It may therefore be concluded that the difference in the incidence of keratosis in these two districts is only partially, if at all, related to the difference between town and country conditions of life.

(5) Disease.

A study of the influence of past and present disease on the frequency of Ankle Keratosis is possible from the figures collected in Tables X and XI (opposite pages 65 and 66). (a) Present illness. The low incidence of keratosis in children who were hospital patients at the time of their examination suggests that present illness is not a predisposing factor. On the contrary it was noted that confinement

to bed caused an improvement and sometimes a cure of the keratosis. In spite of the small numbers of children in the hospital group, the low incidence there is statistically significant. To what extent this was due to better diet in hospital, greater cleanliness and care of the skin, or lack of exposure to the cold winds and weather is not apparent from these results alone.

(b) Past Diseases. Satisfactory records of the past history of 427 apparently healthy school children were obtained. The children were divided into three groups. (1) Absent or Doubtful Keratosis, (2) Mild Keratosis, and (3) Severe Keratosis. All children with first degree changes formed the mild keratotic group, and those with second and third degrees of keratosis were combined, because of the small numbers, to form the severe keratotic group.

The frequency of a past history of chickenpox, mumps, and of diseases of the nose and throat was found to be similar in all groups. When the mild and severe keratotic groups are combined, the previous occurrence of whooping cough, diphtheria, diseases of the ears, carious teeth and other diseases is found to be similar or higher in the Absent than in the Keratotic groups. Measles and scarlet fever are the only diseases which show a significantly higher incidence in the Keratotic than in the Absent groups.

Using the χ^2 test for significance, P = 0.01 or less in both cases. If a close relationship existed between the development of Ankle Keratosis on the one hand, and a previous history of measles and scarlet fever on the other hand, one would have expected a higher incidence of these diseases in the severe as compared with the mild keratotic groups. This however does not occur. It can therefore be concluded that the frequency of past illnesses does not contribute to the development of Ankle Keratosis.

(6) The Social Status.

Ankle Keratosis has been seen in children from all levels of society, but a comparison of schools from poor and better working class districts both in Newcastle and on the Northumbrian coast suggests that a high incidence of severe grades of keratosis may be correlated with a poor social background. A very high incidence of Ankle Keratosis was found in all institutional children, the result being statistically significant. A significantly low incidence of the lesion was found at Monkseaton where, in general, the children came from families of the higher income group.

Several factors may play a part in this relationship. It is well known that the average diet of the poorer working classes is often unbalanced, in particular lacking adequate

quantities of first class proteins, animal fats, and other vitamin-rich foods. There has been a tendency for war-time rationing to level out these differences, and in the opinion of many experts an improvement has been seen in the average dietary of the working classes since rationing commenced. Because of the expense, however, many of the poorer people did not make use of all their rations. This was true especially of foods such as meat, tinned meat, fish, and dried fruit. Another possible causal factor is the state of the housing conditions of the working classes, where overcrowding and lack of proper facilities are all too common.

In contrast to the figures in the North East of England, the Glasgow figures for the three schools of different social status examined in Autumn do not support the contention that keratosis is more common among children from the lower income groups. In 'X' the better class school, the incidence of keratosis was 16.6 per cent as compared with 11.7 per cent in 'Y' the better working class school and with 11.9 per cent in 'Z' the poor working class school. The total incidence for Glasgow at that time was extremely low (12.19 per cent) and no case of second or third degree keratosis was observed. The slightly higher incidence of keratosis in the better class school is not statistically

significant. A further survey in Spring of four hundred and five Glasgow children from poor working class families demonstrated, not only that second and third degrees of keratosis do occur, but that they may be seen quite frequently. When the Spring and Autumn findings at Glasgow are combined, however, the incidence of all grades of keratosis, and particularly of the severer grades, is significantly low. The housing conditions in Glasgow are probably worse than in any of the other areas, and it is unlikely that the diet of the Glasgow children was any better than that of the average Newcastle child at the same season.

A closer study of the incidence of the lesion among children of the same social class and living under similar conditions, was made in East Hartford. In this village, the main occupation of the fathers is mining and the housing conditions are very bad. The incidence of keratosis appeared to be much higher in certain families than in others. Those showing keratosis had on the whole a larger number of children, and a somewhat lower standard of living. The latter was judged by the nature and cleanliness of the personal clothing and household furnishings, as well as by what could be deduced from a discussion on diet and general management.

Poverty, bad housing conditions and the relatively larger families of the poorer classes result in the

individual child receiving less attention than does the average better class child. This lack of individual attention reaches its peak in institutions where by far the highest incidence of keratosis was found. Children who were resident in the Ponteland Homes for less than six months showed a lower incidence and a milder degree of Ankle Keratosis than those who had lived there for longer. This suggests that conditions at the Institution, rather than the poor conditions of the homes from which these children originally came, are related to the high incidence of keratosis there.

(7) Footwear.

In Chapter III the main features of Ankle Keratosis have been described, and it was noted that the site of keratosis appears to bear a close relationship to the type of footwear. When sandals or ankle-strap shoes are worn, keratosis if it occurs, develops on the dorsum of the foot on the skin adjacent to but not covered by the leather. See Plate No. 1. Frequently, additional keratotic changes are seen over the instep in relation to the strap of the shoe. In some cases the affected skin appears to lie directly under the strap, while in other cases this definitely does not occur. With ordinary lacing shoes the tarsal and malleolar areas are mainly affected and the lesion

here is often diffuse in character. It extends down to the upper edge of the shoe leather where an abrupt or a more gradual change to normal skin is seen. Plates No. 2, 3, 4, 5 and 6. The characteristic boot keratosis occurs in the mid-malleolar and mid-supramalleolar areas, frequently with an extension round the boot-top level especially on the lateral aspect of the leg. Plates No. 7, 8, 9, 10 and 11. Keratosis may occur over the Tendo Achilles at the boot-top level and from there to the calcaneus. Minor changes are often seen over the prominence caused by the head of the talus. From the boot-top level upwards over the lower third or more of the leg, associated 'weathering' may be seen, particularly in Winter and Spring. It was frequently noted that the tongue of the boot was tucked down over the dorsum of the foot, or after wearing the boots for a little the tongue slipped to one or other side. As a result, the underlying skin was less protected and in closer contact with the boot laces than usual. In a proportion of cases the keratosis occurred above the boot-top level in children not wearing boots, and in some of these cases the keratosis appeared to be related to the ankle-sock level. A few children wore boots or shoes without stockings. Several children with the boot type of keratosis declared that they had never possessed boots of any kind. In 1912-1913 at Cardiff, Shaw (1946) observed Ankle Keratosis

in children who ran about in bare feet. In these cases the keratosis occurred in the boot position.

The close relationship between footwear and the site of keratosis is so common that it is often possible, by examining the skin of the ankle, to tell the type of footwear in use. A change from boots to shoes or vice versa, results in an alteration of the site of keratosis and in an improvement or disappearance of the keratosis from its original position. This alteration was noted on many occasions in children at Ponteland and elsewhere when repeated examinations were carried out. It occurred two to three weeks after the change of footwear.

Further observations were made on the condition of the footwear at East Hartford village and at the Ponteland Homes. In the latter Institution, where the general condition of the footwear was good, it was surprising to find so many instances of badly fitting shoes, causing blisters, corns and sores on the heels and bony prominences. Two pairs of boots or shoes were kept and they were dry and in good repair. At East Hartford the boots were often found to be in bad repair, thoroughly sodden and sometimes one or two sizes too big, being held on to the feet by very tight laces. As a rule only one pair was available whilst the second pair was in the process of being repaired. There is a possibility that tight lacing may interfere with the

circulation of blood to the skin resulting in an area of relative ischaemia.

(8) Shoe Leather.

The close relationship between footwear and Ankle Keratosis draws attention to a possible etiological factor in the boots or shoes themselves. The frequency of keratosis and the fact that all types of shoes, boots, and sandals seem to be involved make it unlikely that sensitisation to the shoe leather is a probable cause, but it was considered wise to exclude the possibility. In the ordinary type of leather dermatitis the affected parts of the skin are closely related to and usually directly covered by the leather. Sometimes socks or stockings intervene between the leather and the skin. The reaction is acute with erythema, itching, exudation and scaling. (Henly, 1939). In no way does Ankle Keratosis resemble this kind of lesion.

Patch Tests. At the Ponteland Homes, patch tests were carried out on ten children, six of whom had Ankle Keratosis, and four of whom had normal skins. Since the boots at this institution were not lined during the war, only the leather was used for testing. A circular patch of leather was moistened in water, covered by a square patch of cellophane and fixed to the forearm with adhesive tape. In this way false reactions due to the adhesive tape were

avoided. The patch was removed forty-eight hours later and the arms observed up to ten days thereafter. One boy without keratosis developed a very slight diffuse erythema which disappeared within twenty-four hours. No other reaction occurred in the skin of any of the children and the test was considered negative.

(9) Friction.

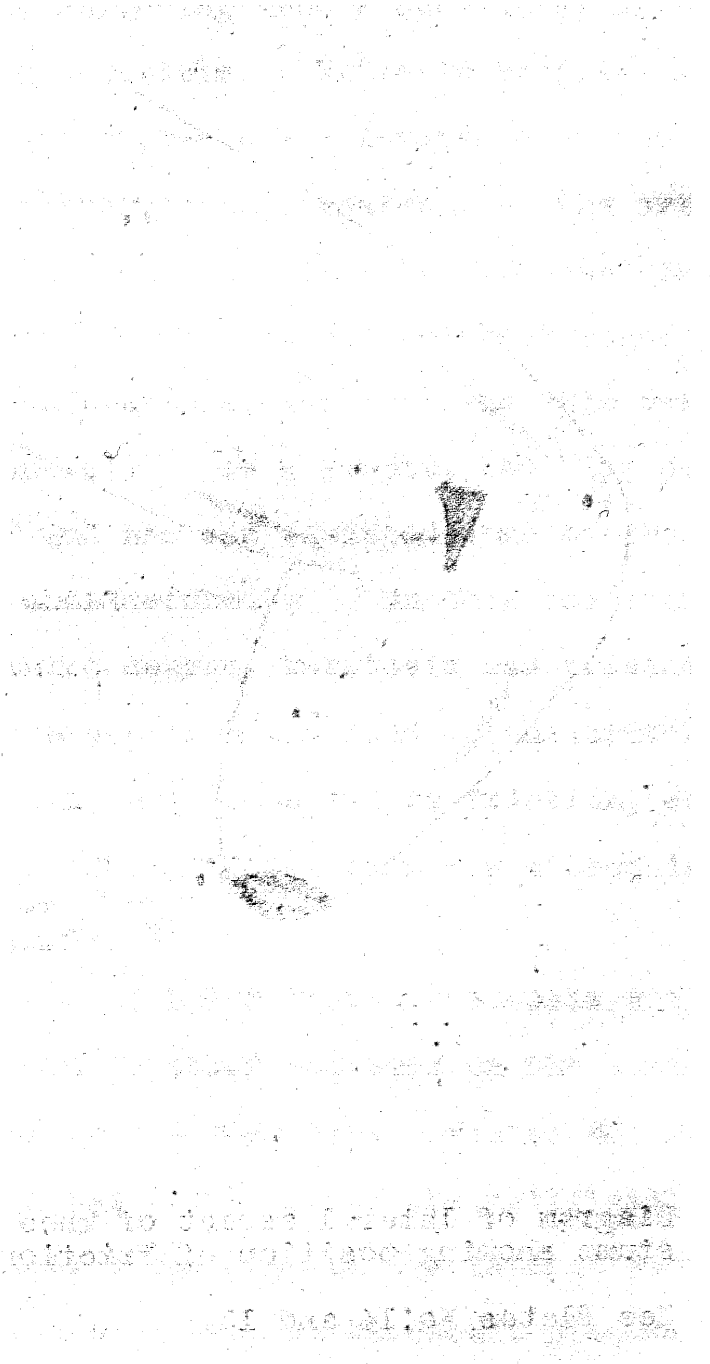
The possibility that friction of the boot or shoe on the skin might be the primary cause of keratosis was next investigated. The most characteristic type of boot keratosis occurs over the mid-malleolar and mid-supra-malleolar areas, along the boot-top level, and occasionally down the Tendo Achilles. In all these positions friction of the leather on the skin probably takes place. This is most likely to occur in active boys, running about all day, and often wearing boots a size too big for them. The boys attributed the 'boot scruff' to new boots and tight lacing, particularly with leather laces. Often one foot was more affected than the other, frequently the right foot, and the boys would say "Oh! that is the foot that I use to kick the ball with." It is possible that one foot may be subjected to more friction than the other by such activities. In Boot Keratosis the skin covering the head of the talus is also often affected. This is a bony prominence covered by and receiving constant friction from the leather. On

the other hand the extent and site of Shoe Keratosis does not appear to be so closely related to friction. How, for instance, could friction from shoes, even if they are one or two sizes too big, cause keratosis all over the lateral malleolus, and up on to the mid-malleolar position and higher? These are common sites for keratosis in children wearing shoes and there is no possible contact there with the shoe leather over the greater part of the affected skin. Furthermore, friction can be excluded as an etiological factor when Ankle Keratosis develops in the boot position in children who have never worn boots.

There are, however, instances of keratosis where it appears that friction is the main etiological factor, and in them the macroscopic findings are identical with those of Ankle Keratosis. The following cases are examples of this type of keratosis which shall be called Friction Keratosis.

Friction Keratosis. (a) Keratosis which is commonly believed to be related to friction is seen on the elbows and knees, due to pressure of kneeling and of leaning one's weight on bent elbows. It has been noted that keratosis of elbows and knees is sometimes associated with Ankle Keratosis. Such a keratosis frequently shows a follicular element especially immediately below the olecranon processes and the patellae.

Fig.7



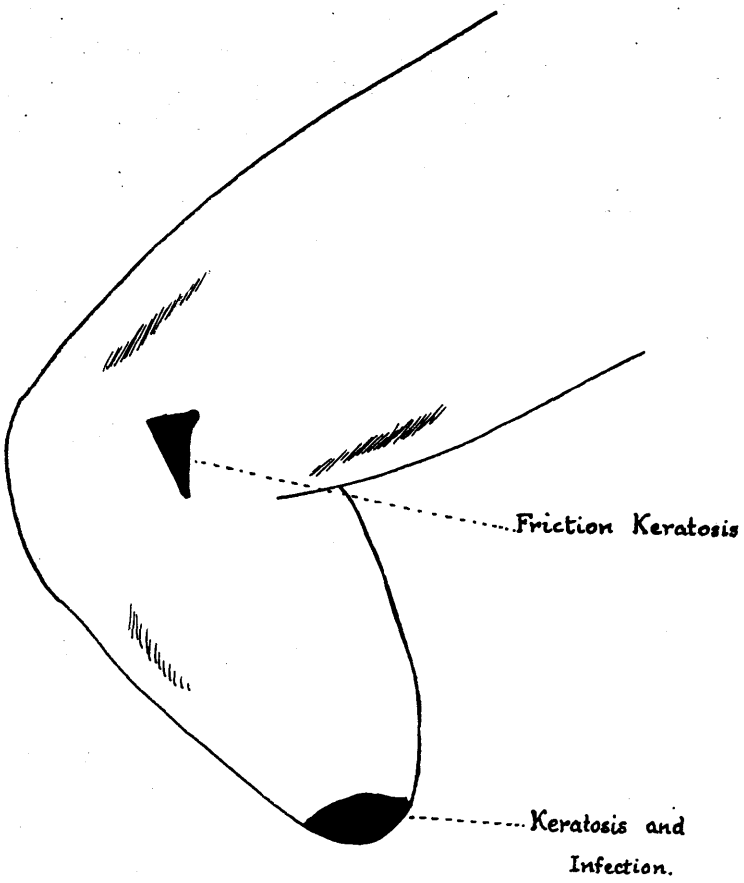


Diagram of lateral aspect of knee and amputation stump showing position of Friction Keratosis.

See Plates No.14 and 15.

Fig.7

(b) Crutch Keratosis. A girl of thirteen years was admitted to the Children's Wards of the Royal Victoria Infirmary, Newcastle, suffering from a chronic arthritis resembling rheumatoid arthritis. While in hospital she was noted to have a first degree Ankle Keratosis in the shoe position. After three months' treatment of the arthritis, she was able to walk slowly and stiffly, and was discharged home. She soon discovered that her quickest means of getting about was on crutches, and she used this means of progression continuously. As a result, her hips became fixed at about 70° and she was admitted some months later for correction of this deformity. On this occasion a marked second, almost a third degree, keratosis was present in the axillary skin in contact with the head of the crutch. Folds of skin in the axilla, not subjected to friction, escaped keratotic changes. The affected skin was a brownish yellow colour. See Plate No. 13.

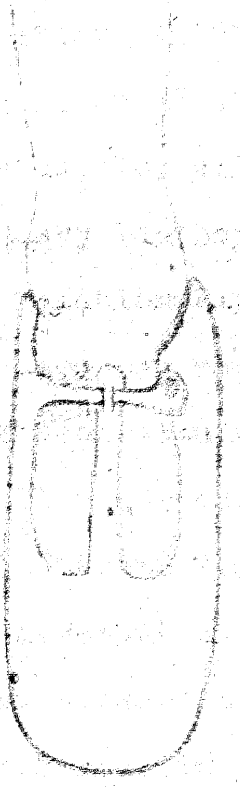
(c) Another case of third degree keratosis which was definitely related to friction occurred on the amputation stump of a boy wearing a wooden leg. Plates No. 14 and 15 and Fig. 7. The metal framework of the artificial leg was too narrow and friction occurred on the lateral aspect of the knee joint, producing typical keratotic plaques. When this defect was remedied the keratosis disappeared in four to six weeks. Keratosis was also present on the skin

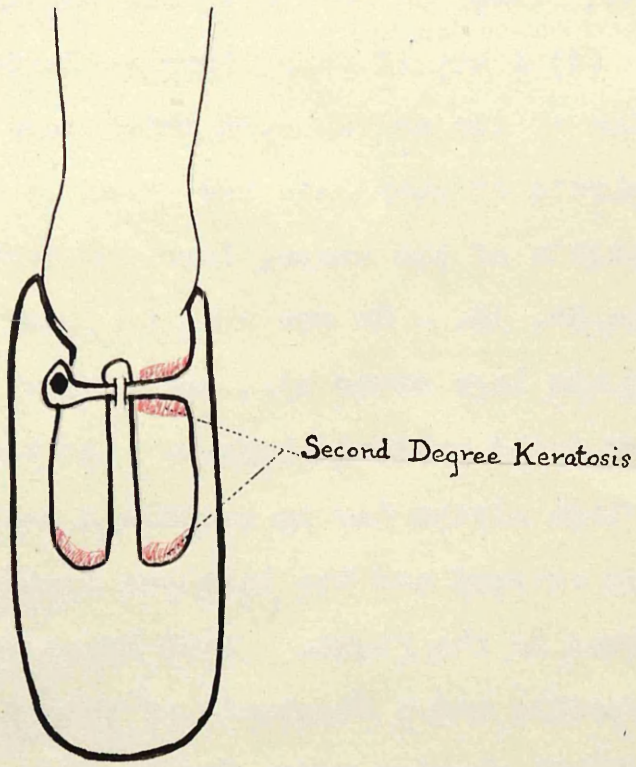
covering the bony stump over the weight-bearing area, but as this skin occasionally broke down and discharged purulent material, it is not included in the present discussion. The latter type of keratosis resembles a case described by Forman (1945) as 'Verrucose Dermatitis of Amputation Stump'.

(d) A boy of four years suffering from a congenital lesion of the spinal cord which gave rise to a flaccid paralysis of both legs was found to have an extensive keratosis of the knees, legs and feet caused by friction. Plate No. 16. He was able to crawl about the floor dragging his legs after him, and by movements of his arms and trunk could pull his legs up into the knee-elbow position. The legs always lay in a certain position, the right one being everted and the left one inverted, so that both feet pointed to the right. Both knees showed well-marked thickening and a keratosis of the first and second degrees. Keratotic changes were also present on the right internal malleolus and medial aspect of the foot, and on the left external malleolus and lateral aspect of the foot; that is on those parts of the lower limbs exposed to friction on the floor. A trophic ulcer was present on the upper third of the lateral aspect of the left leg.

(e) Another example of friction keratosis of second or third degree can frequently be seen on the internal malleoli of children who are constantly kicking their ankles. In the

Fig.8





B.D. May 1945

Diagram to show the relationship between sandals and the site of Ankle Keratosis.

Fig.8.

Glasgow, Warwickshire and Cornwall schools particular note was kept of this point. It was present in 2 to 4 per cent of children in these districts.

It has already been mentioned that, if friction is the main etiological factor, it is difficult to understand the distribution of Ankle Keratosis in those children wearing shoes. In the following cases it is unlikely that friction played a part in the development of Ankle Keratosis. (i) One child wearing a heavy leather strap shoe demonstrated very clearly the relationship between the Keratosis and the shoe. When the shoe was removed, two narrow linear patches of keratosis were seen with a strip of normal skin running between. The latter corresponded exactly to the strap of her shoe, which buttoned firmly on to the foot and which did not allow free movement of the strap on the skin beneath. Similar patches of keratosis occurred at the bases of the toes on either side in relation to the edge of the shoe leather. See Fig. 8. (ii) One of the two adults with second degree keratosis was a policeman. He did very little walking as he had for years been on point duty, but because of his occupation he was exposed daily for many hours in all weathers. The keratosis was limited to the mid-malleolar area. These facts and the occasional development of Ankle Keratosis on the boot position in the absence of wearing of boots do not favour the friction hypothesis.

In some instances at least, a factor other than friction must be responsible for the development of Ankle Keratosis.

Area of Skin Affected by Friction.

In view of the importance of friction as a possible cause of keratosis in some cases, it was decided to determine more exactly the area of skin which could reasonably be expected to be affected by friction of the footwear. The edges of the shoes and the tongues and edges of the boots of four children were coated liberally with the Charcoal Ointment and then put on to the bare feet. The children were told to run about for five to six minutes and the foot was then re-examined with the shoe or boot still in position. In this manner the skin affected by friction was blackened and its extent could be easily determined. This was greatest when the shoe or boot was too big for the child. In the case of the shoe, a small border of skin above the upper level of the shoe, not more than 0.5 cm. broad, came into contact with the blackened leather. This was broadest on the lateral aspect of the dorsum of the foot. The experiment with boots showed that a considerable margin of skin above the boot-top level, varying from 0.5 to 1.5 cm. broad, was affected by contact with the boot leather. The area of skin affected by third degree keratosis in most cases corresponds with the area shown to be affected by friction with the shoe leather.

The ankle region has been divided into three horizontal areas, the supra-malleolar, malleolar, and tarsal areas by supra-malleolar, infra-malleolar and tarsal lines. Support for this division, details of which are given in the preceding chapter, is obtained by the distribution of keratosis at the ankle.

It is frequently observed that the skin of the supra- and infra-malleolar lines escapes keratotic changes. See Plates No. 2, 3, 4, 17, 18, and 19. These lines are examples of flexure lines or furrows which are formed by the attachment of the skin over joints to the underlying structures. A folding-in of the skin along these lines may result in their protection from friction. Similar folds of axillary skin escaped keratotic changes in the case of Crutch Keratosis described above.

(10) Asteatosis or 'Weathering'.

In its mildest form, 'weathering' is the name given to a reddening of the skin, the surface of which is covered with fine white powdery scales. With a hand lens, tufts of dilated capillaries are readily visible. In a more severe case the skin is definitely swollen, and very dry; the red colour is deeper and is sometimes combined with blotchy purple, although the skin may feel warm to the touch. In such a case, 'chaps' or 'keens' may be seen in the acute

or healing stages. Plate No. 20. An acute 'chap' appears as a deep crack along the line of the surface markings of the skin (Simon's lines), its base is a deep red colour and it often gapes considerably. It may bleed or presumably may exude serum without actually bleeding, since the process of healing is nearly always accompanied by the formation of linear scabs. When the 'chaps' are healed, the skin is often left dry and powdery.

'Weathering' was studied most closely at Ponteland, where it was observed in all its stages. It was noted to occur frequently on the legs in boys of school age.

The area of skin involved by this process of 'weathering' varies enormously. In a child wearing boots, the whole leg from the boot-top level to the middle of the thigh may be affected, or it may be confined to a band, 2 to 5 cms. in depth, around the boot-top level. This band is very often deeper in front and has a semi-circular outline. 'Weathering' occurs in spite of the fact that the boys wear thick stockings which reach up to the knee.

In many cases keratosis occurs in the boot position with 'weathering' above the boot-top level, but it is often difficult to say where one process begins and the other ends. Plates No. 21 and 22. In those cases of second or third degree keratosis, where there is a tendency for the keratotic skin to be lifted up at the borders of the rectangular areas,

'weathering' probably plays an important part in the etiology. In an extreme case of 'weathering' and keratosis, typical 'chaps' occur in the keratotic area. When both these lesions occur in the same child, the most characteristic keratotic changes are to be found nearest to the edge of the leather, and changes typical of 'weathering' are usually found farthest away from it. In children wearing shoes, 'weathering' may be seen in the exact position occupied by keratosis in other children, that is on the tarsal and malleolar areas. Similarly when either type of lesion occurs alone in children wearing sandals, the same site is affected.

The position of keratosis on the leg or foot and its relation to the footwear suggest that 'weathering' may be an etiological factor of importance. Skin which is covered by the shoe leather is protected, while that immediately adjacent to it is exposed to damp from wet socks or stockings, and to the cold winds and frost. This unprotected skin adjacent to the edge of the shoe leather may be affected by keratosis or by 'weathering'. The failure of the malleolar lines to show keratotic changes may, by reason of their position, be due to protection from either friction or 'weathering'. Keratosis often occurs without 'weathering', and the latter may be present in the absence of typical keratosis. In many instances both changes are seen in the

same child and it is sometimes difficult to know whether roughening is due solely to 'weathering' or whether a keratotic change is also present.

An attempt has been made to chart the frequency and severity of keratosis and 'weathering'. See Fig. 4 (opposite page 74). From the results of the repeated examinations of children at Ponteland, curves of the incidence of these two conditions at different seasons have been drawn. It is seen that both keratosis and 'weathering' are more common in Winter and Spring and they follow a similar course, but the keratosis curve falls before that of 'weathering'. With simple protection, 'chaps' can be cured in about a week, whereas keratosis usually takes three to four weeks unless other treatment is given. In Glasgow, Cornwall, Warwickshire, and Northumberland the incidence of 'weathering' was noted when the surveys of school children were carried out. 'Weathering' occurred in 10.5 per cent of these children, while keratosis was seen in 28.2 per cent. In 4.6 per cent of the children, keratosis and 'weathering' occurred together and seemed to be definitely related, but 5.9 per cent of the children showed evidence of 'weathering' without any keratosis. The incidence of these two conditions is therefore much lower in healthy school children than it is in the Ponteland children.

'Weathering' is known to be caused more easily in certain

individuals. It is believed that fair-skinned people are more susceptible to this condition, their skins reacting more rapidly to immersion in water and to exposure to alkalies and other chemicals. The frequency of such minor trauma on the skin varies with occupation, being particularly common in housewives in whom it produces 'chapping' of the hands and forearms. Frequent washings of the legs and the use of much soap followed by exposure to cold winds may produce similar changes in children.

(11) General Care.

In the preceding paragraphs some of the predisposing factors and some possible local causes of Ankle Keratosis have been considered. The high incidence of this condition among institutional children has already been emphasised. This was so striking a fact that it was decided to carry out further investigations at Ponteland Cottage Homes. In the course of these special investigations certain facts emerged about the general management and care of the skin of which brief mention will now be made.

At the Cottage Homes the children are for the most part arranged in family groupings. In a 'family house' there are twelve to fifteen children. The ages of the girls range from three to sixteen years, and the boys from three to nine or ten years. They are under the care of the foster

mother as regards diet and general management, and one of the older girls, the house girl, assists and deputises for her when she is away. After the age of nine or ten years the boys are placed in Boys' Houses under the control of a foster mother and father. There are thus two main types of houses, the Family House and the Boys' House. There are sixteen houses in all, arranged in a semi-circle around a large playing field which is very exposed. The numerous examinations, which were carried out during the course of experiments to be described later, gave excellent opportunities for observing the details of the management in the individual homes. Some mothers were clearly more interested in the welfare of their children than others, and it became obvious that washing of the feet and legs was carried out more frequently than is usual with children of the same social class. In addition to the weekly bath, the feet and legs were washed every night and sometimes twice a day, thick lathers of soap being applied. In addition, ordinary household soap such as is used for scrubbing floors was provided for the children. The older girls aged nine to fourteen years assisted in bathing the young ones, and each child was inspected for cleanliness afterwards. No one observed whether or not the skin was properly dried.

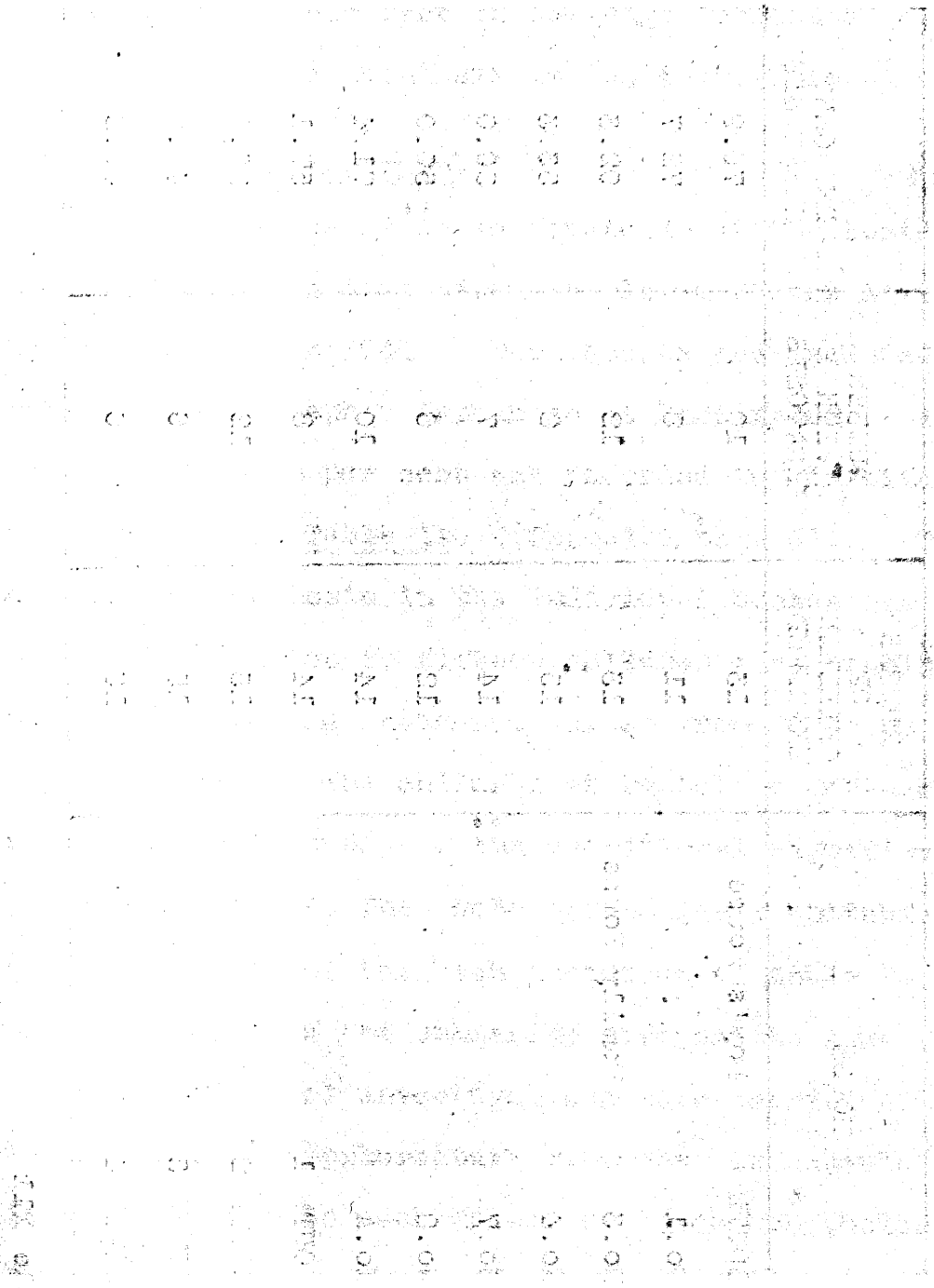
In the light of these observations it is of interest to refer back to the age and sex incidence of keratosis for

which at least a partial explanation is suggested. Infants and young children are normally looked after by adults who take care not only to keep them clean, but to dry the skin after washing. Special superfatted soap is usually purchased. When the child approaches school age he is more often left to look after himself which he does with a varying degree of skill. In families of the higher income group more time and assistants are usually available for close supervision of bathing until the child is much older. In institutions young girls are often left in charge, and they or their foster mothers may be too busy to give sufficient attention to details. The children who assist with the bathing of the younger ones have been observed to lather the skin thickly with soap, and only partially remove it with water. The skin may also be insufficiently dried. As they become older and more responsible they take care to wash and dry themselves adequately, girls being more careful than boys.

Excess of soap is known to have a detrimental effect on the condition of the skin. (White, 1920; Jordan et al. 1940; Harry, 1942; McCutchan, 1945). It removes the natural protective coating, and alters the hydrogen-ion concentration of the surface of the skin. This is normally acid. (Cowdry, 1928).

Exposure to weather, hard water, household soap, and

Table XII



INCIDENCE OF ANKLE KERATOSIS IN INDIVIDUAL HOUSES AT PONTELAND COTTAGE HOMES

HOUSE		NUMBER OF CHILDREN EXAMINED	NUMBER WITH KERATOSIS	PER CENT KERATOSIS
SOUTH	Boy's House	13	10	76.9
No.1	" "	11	8	72.7
No.3	Family House	13	12	92.3
No.4	" "	15	8	53.3
No.7	" "	14	7	50.0
No.8	" "	12	6	50.0
No.A	" "	14	10	71.4
SOUTH 1	" "	14	8	57.1
SOUTH 2	" "	15	12	80.0
SOUTH 3	" "	15	6	40.0
SOUTH 4	" "	13	6	46.2

Table XII

lack of individual attention are local factors which probably all play their part in the high incidence of 'weathering' and of Ankle Keratosis in the institutional child.

(12) State of Nutrition.

The incidence of Ankle Keratosis at the Ponteland Cottage Homes was determined in eleven of the sixteen houses in October 1944. The results are included with those of St. Joseph's Orphanage at Darlington. An incidence of 60.53 per cent was recorded for institutional children. See Table IX. (Opposite page 61). The incidence of keratosis in the individual houses was also determined. Eleven to fifteen children were examined in each house and the incidence varied from 40 to 92 per cent. See Table XII. The children at Ponteland Cottage Homes were chosen for study of the nutritional significance of Ankle Keratosis. They were particularly suitable for this purpose because of the high incidence of Ankle Keratosis, and the nature of the community life at the Homes.

Two principal investigations were carried out. In the first one, supplementary vitamins in capsule or tablet form were given to each member of three households for a period of twelve weeks. In the second investigation, extra milk, eggs, butter, and fruit were supplied to one household in addition to the ordinary institutional diet.

The following is an outline of the plan of nutritional experiments:-

A. Supplementary Vitamin Experiments.

1. Supplements of Vitamin A and D as Haliverol.
   House No. 7.

2. Supplements of Vitamin B complex as Beminal.
   House South 2.

3. Supplements of Vitamin C as Redoxon.
   House South 3.

4. No supplements. Control House.
   House A.

B. Supplementary Food Experiments.

1. Extra rations supplied. South House
2. Control House House No. 1

The nature of the institutional diet provided for these children will now be considered.

Average Weekly Diet.

The foster mothers are allowed considerable scope for individuality in the choice of menu within the limits of the rations. Food is ordered from a central store and is cooked by the foster mother for her own family. Rationed foods such as meat, bacon, fats, cheese, sugar etc., were identical with those obtained all over the country. It is interesting to note that this resulted in the butter consumption being increased by 100 per cent, since the pre-war

Table XIII

Average weekly Consumption of Foodstuffs included in the Dietary, for each child.

Bacon	4 ozs.		
Butter	2 "		
Margarine	4 "		
Lard	2 "		
Cheese	3 "		
Meat	18.2 "	12 ozs.	Beef, Mutton or Pork
		2 "	Tripe
		0.9 "	Liver
		3 "	Sausage
		0.3 "	Brawn
Suet	0.6 ozs.		
Fish cakes	1.		
Milk	7.7 pints		
Tea	1 oz.		
Cocoa	0.46 oz.		
Coffee	0.4 "		
Sugar	8 "		
Syrup	1.2 "		
Jam	2.4 "		
Marmalade	1.2 "		
Rice	2.07 "		
Semolina	1.25 "		
Soyolk	0.5 "		
Oatmeal	1.5 "		
Split Peas)			
Lentils)	2.55 "		
Beans)			
Barley)			
Bread	4.55 lbs.		
Flour	11.4 ozs.		
Potatoes	3.75 lbs.		
Vegetables	3.75 "		
Fresh fruit			
Apples	2.7 ozs.		
Oranges	2.0 "		
Dried Fruit			
Raisins)			
Sultanas)	0.5 oz.		
Prunes)			
Dates)			
Apricots)	1.2 "		
Eggs dried	0.75 oz.		
shell	0.5 "		
Custard pwd.	1.2 "		
Yeast	0.5 "		

allowance was 1 oz. per child per week. As far as non-rationed foods such as sausage, liver, brawn, etc. are concerned, the Homes appeared to receive a fair share. Fish was very scarce as were shell eggs, and fresh and dried fruit. The average weekly diet sheet is reproduced in Table XIII.

A. Supplementary Vitamin Experiments.

Since it was thought that Ankle Keratosis might be an index of a minor food deficiency, it was decided to supplement with vitamin tablets or capsules, the ordinary diet in three houses for a period of twelve weeks. Twelve to thirteen children living in each house received the vitamin supplements. A fourth house was observed concurrently as a control. It was realised that improvements which might occur in the Ankle Keratosis during this experiment would not necessarily be of statistical significance, owing to the small numbers. It was hoped, however, that a clue to a deficient factor might be found, when the experiment could have been repeated on a larger scale. The experiments were planned to take place during the winter season when there is a natural tendency for Ankle Keratosis to become more severe. Any improvement which might occur would then be contrary to the natural course of the condition, and could probably be related to factors directly connected with the experiment.

After consideration of the incidence of keratosis in the individual houses and in consultation with the Matron, four of the Family Houses were selected. It was decided to give supplementary vitamins to House No. 7 in which 50 per cent of the children had keratosis, to House South 2 in which 80 per cent of the children had keratosis, and to House South 3 where the incidence was 40 per cent. House A where the incidence was 71.4 per cent was to be used as the control. The foster mother in every house selected, could be relied upon to co-operate in the regular administration of tablets or capsules.

1. Supplements of vitamin A and D as Haliverol.

Twelve children in House No. 7 completed the experiment in which a supplement of 21,600 units of vitamin A and 12,750 units of vitamin D was given daily. The foster mother in this house explained that six children were already receiving cod liver oil regularly and that calcium tablets were being given to the children with chilblains. In all other respects the diet was average for the Homes. The incidence of keratosis (50 per cent) was the same in December as it had been in October. The degree of keratosis at the ankle was mild, six cases being of the first degree, and one other case being doubtful. In March, at the completion of the experiment, one boy who had shown a first degree keratosis in December had a second degree keratosis

on one foot; the other foot, on which there was a very persistent blister and which had been kept wrapped up for weeks, was without keratosis. Of the other five cases of first degree keratosis at the beginning of the experiment, one was cured, one almost cured, and three remained the same. Two children in whom there was no keratosis in December were labelled doubtful cases in March. Thus at the completion of the experiment only five children (41.7 per cent) had keratosis, but one showed it in the second degree, and there were two new doubtful cases. It can be concluded that in this house containing twelve children from four to fourteen years old, supplements of vitamins A and D did not make any significant difference in the amount or degree of keratosis.

2. Supplements of Vitamin B complex as Beminal Tablets.

Thirteen children in House South 2 received three Beminal tablets daily. This gives a daily supplement of:

Thiamin	9.9 mgm.
Nicotinamide	24.9 "
Riboflavin	3.0 "
Vitamin B6	0.45 "
Pantothenic Acid	1.5 "

Before the experiment was started, twelve children showed Ankle Keratosis giving an incidence of 92.5 per cent. In addition to the large number of cases of keratosis in this house many of them were of the severe type. In two children the keratosis was labelled almost third degree, in five it was second degree, and in five it was of the first

degree. After three months of this additional vitamin B complex only one first degree keratosis was cured. There were now three children with definite third degree changes, four with second degree, one almost a second degree, and three children with first degree keratosis. Thus an improvement of 7.9 per cent occurred in the incidence of keratosis in March as compared with December, but the degree of keratosis had become more severe, and no benefit could be said to have resulted from this treatment.

3. Supplements of Vitamin C as Redoxon.

In House South 3, twelve children completed the experiment in which an addition of 100 mgms. of ascorbic acid was given daily for twelve weeks. Five children showed keratosis in December, one a second degree and the other four, first degree keratosis. There were also four doubtful cases. In March there was a slight general improvement, five cases having no keratosis and three being doubtful as compared with three and four respectively in December. Of the four cases with keratosis at the end of the experiment there were two children showing changes of the second degree and two cases of first degree keratosis. There was thus an improvement of 8.4 per cent in the total incidence and the area of skin affected was considerably reduced in many cases.

4. The Control House.

In December eleven of thirteen children in this house had keratosis, and in March this number was reduced to eight, giving an incidence of 61 per cent as compared with 84.6 per cent in December. At the beginning of the experiment there were three children with second degree keratosis, one almost a third degree, seven with first degree and two with no keratosis. After twelve weeks the number of children with second degree keratosis remained the same but there were only five cases of first degree, one doubtful, and three in whom there was no keratosis. Of all the houses showing improvement the greatest occurred in the Control House, not only in the total incidence but also in the area of skin involved.

The children taking part in the vitamin experiment were re-examined in July 1945, six and a half months after the commencement of the experiment. In all four groups there was a further improvement in the condition. The house which had received supplements of Beminal showed the least improvement. The greatest improvement was seen in the controls and in those receiving Redoxon tablets. Of the latter, three of the four cases who had shown keratosis in March were now cured or almost cured and no new cases had developed. In the control group the eight cases of keratosis in March were reduced in July to three (23 per cent), all of minor degree. Considering the initial high

Fig.9

Chart to show the effect of Supplementary Vitamins on the course of Ankle Keratosis

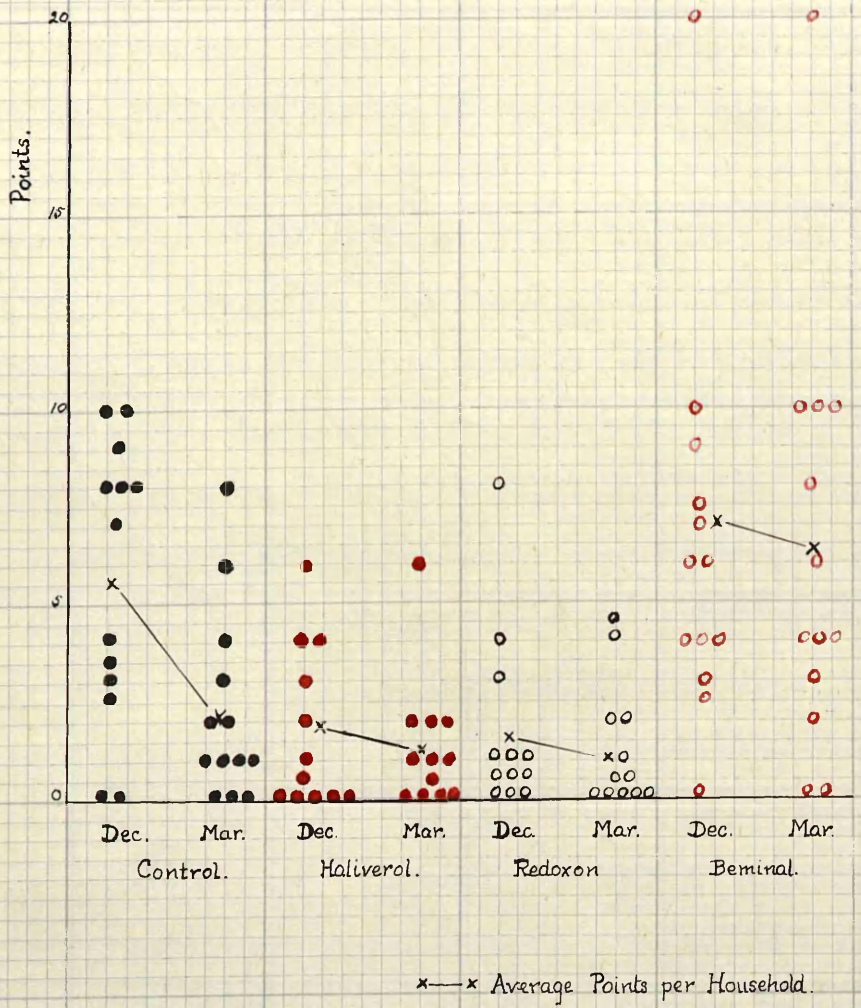


Fig. 9

incidence of keratosis in the control group (84.6 per cent) this indicates an improvement of 61 per cent in the incidence. The reduction of keratosis from 41.7 per cent to 8.3 per cent in the twelve children who received ascorbic acid was considered not to be due to a specific influence of the vitamin on the course of the keratosis but rather to its spontaneous cure in Summer. These results have been charted in Fig. 9 by giving points to each child according to the degree and extent of keratosis.

In conclusion it can be said that supplements of vitamins given to small groups of children over a period of three months did not appear materially to influence the course of Ankle Keratosis.

B. Supplementary Food Experiments.

In the event of the deficiency being due to some factor other than the vitamins selected for the experiments described above, supplements of food in the form of butter, milk, eggs and oranges were given for twelve weeks to children in one of the Boys' Houses. The other Boys' House acted as the control.

These Houses were chosen for this experiment in preference to the Family House where the greater difference in the children's ages would have resulted in an unequal distribution of the additional food. House No. 1 contained

sixteen boys, and South House fifteen boys. The supplementary food was given to the latter, as their foster mother was particularly intelligent and co-operative and could be relied upon to ensure a fair distribution of the supplements which were extra to the normal diet. Each child received twelve weekly rations consisting of 5.3 oz. butter, 3½ pints of milk, half a bottle of concentrated orange juice (approximately 180 mgms. of vitamin C) and 5½ reconstituted dried eggs. This represents a considerable addition of protein, fat, and several important vitamins and minerals.

(a) South House. In February 1945 before supplementing the diet, the incidence of Ankle Keratosis was 80 per cent, twelve boys presenting a varying degree of the condition. One boy showed a third degree keratosis, three boys a second degree, one almost a second degree and six boys a first degree keratosis. Two boys had doubtful changes, and only one was without any evidence of keratosis. There was a steady improvement in nearly every case during the course of the experiment so that twelve weeks later the keratosis had disappeared in five cases, improved slightly in four, and considerably improved in three. In two boys the condition was stationary and in one there was a slight deterioration. Thus in May, there was a total of five cases showing keratosis which gives an incidence of 33.3 per cent and four cases with doubtful changes. Fourteen of

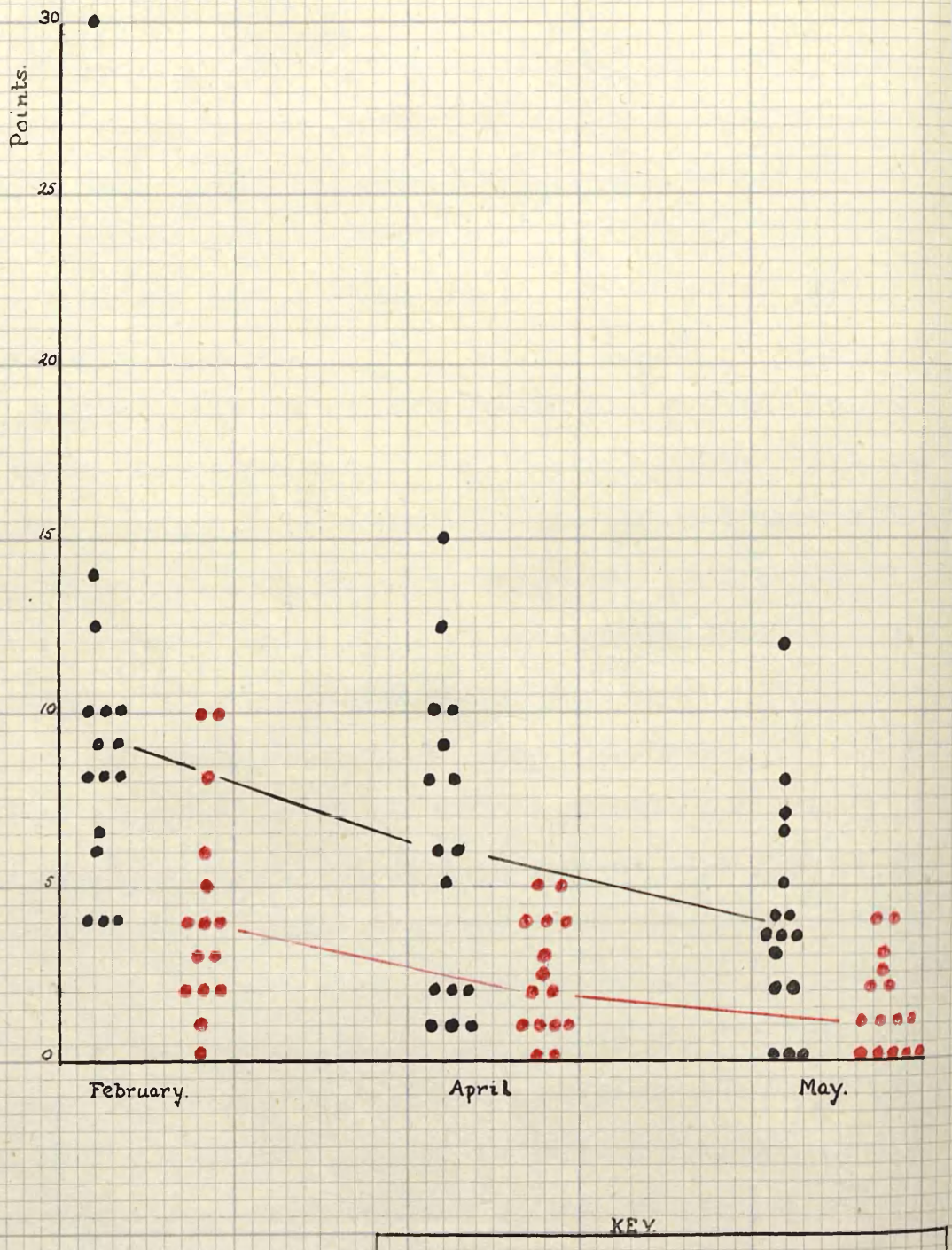
the boys were re-examined in July, eighteen weeks after the commencement of the experiment, and there was then a further slight improvement in the keratosis — not in the number of cases, but in the extent of skin involvement.

(b) House No. 1. It was obvious that the degree of keratosis in this house was much greater than in South House. None of the boys had normal skin in the ankle region. There was only one boy with a first degree keratosis, eight boys had a second degree and six boys a third degree keratosis. A steady improvement was seen in the next twelve weeks. The keratosis disappeared in three cases, three boys showed slight improvement, and seven considerable improvement. In two, the condition remained stationary and one case deteriorated slightly. Thus the total incidence in May was 75 per cent as compared with 100 per cent at the commencement, but the improvement in degree was much greater than is indicated by these figures. In July two of the boys had left the Homes, and of the fourteen boys examined only three showed keratosis which was all of the first degree, and very limited in extent. There was thus a spontaneous improvement in the incidence of keratosis from 100 per cent in February to 75 per cent in May and to 25 per cent in July.

In Fig. 10 the results of these experiments are charted

Fig.10

Chart to show the effect of Supplementary Diet on the course of Ankle Keratosis.



KEY

- Points per child in Control House
- Average points in Control House.
- Points per child in House receiving Extra Diet
- Average points in House receiving Extra Diet.

Fig. 10

diagrammatically, points having been given to each child according to the degree and extent of the keratosis, as described above. In this way the trend of Ankle Keratosis can be traced during the course of the supplementary feeding experiment. It is clear from this chart that throughout the experiment the extent of keratosis in the Control House was much greater than in the South House. Further, its rate of improvement towards the Summer was as great as that which occurred in South House, that is the house given extra diet. The average improvement in the number of points in the Control House from February to May was 4.35 as compared with 3.3 in South House. Taking into account the spontaneous improvement which occurs in the summer months, there is no clear evidence that the supplementary diet materially influenced the incidence or severity of Ankle Keratosis.

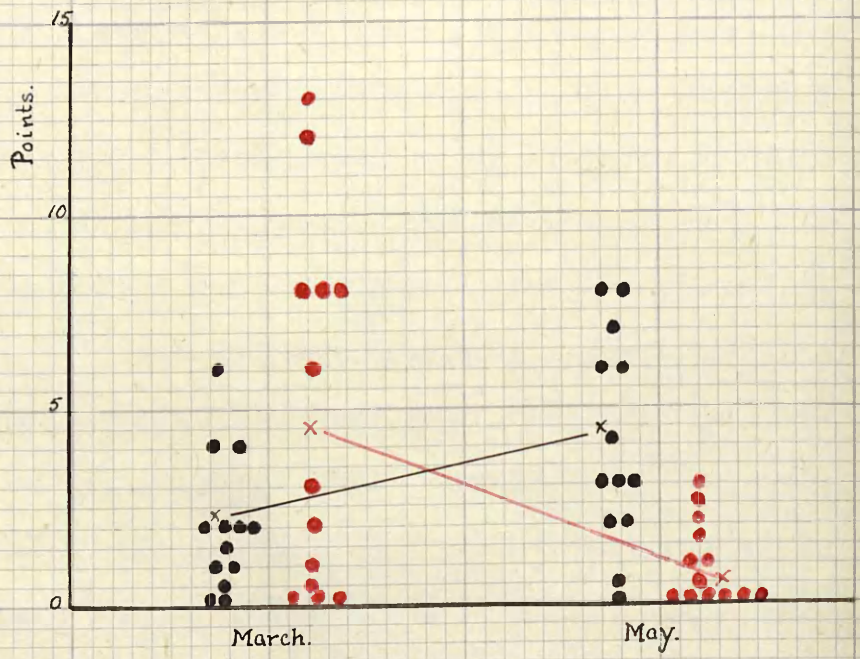
(13) Care of the Skin.

An impression had been gained that to some extent the degree of keratosis was related to the interest shown by the foster mothers. Where more individual care was given to each child, there was a tendency for that house to show a lesser degree of keratosis. In some instances it appeared that improvements which occurred in the Control or the Experimental Houses were largely due to the interest aroused

by the proposed investigations. It was therefore decided to try the effect of local treatment of the ankles in all children in one of the Houses, whether or not they showed any keratosis. A Family House, House No. 4, containing thirteen children was chosen for this experiment, and the results obtained were compared with the natural course of the lesion in a Control House. The local treatment begun in March, consisted of the use of toilet soap in place of household soap, adequate rinsing and thorough drying of the legs and feet, and the daily application of an emollient ointment (Unguentum Eucerin Hydras). The three oldest girls confessed that they had not applied the ointment as instructed, and it is significant that they alone showed no improvement in the keratosis. One of these three girls had a doubtful keratosis throughout the six weeks of the experiment. The other two had a normal smooth skin in March, and after six weeks, one developed a doubtful and the other a first degree keratosis. Excluding these, six children showed second degree keratosis, two a first degree keratosis, in one the changes were doubtful in nature and one other showed no evidence of keratosis, giving an incidence of 80 per cent. After treatment five cases were cured, two cases had considerably improved and one other had slightly improved. There was no change in the child who had doubtful keratosis, nor in the one with normal skin

Fig.11

Chart to show the effect of care of the skin on the course of Ankle Keratosis.



KEY.

- Points per child in Control House.
- x — x Average points in Control House.
- Points per child in Experimental House.
- x — x Average points in Experimental House.

Fig. 11

at the ankle. The incidence was therefore reduced in six weeks from 80 per cent to 20 per cent. These results have been expressed diagrammatically in Fig. 11. It is seen that the average number of points per child fell from 4.5 in March to 0.8 in May. House A, which had acted as the Control House in the supplementary vitamin experiments, served again as a control. At the commencement, ten of the thirteen children in this house showed keratosis of varying degree giving an incidence of 77 per cent: (in 23.1 per cent second degree changes were seen as compared with 60 per cent in House No. 4.) At the end of the experiment the incidence was reduced to 61.5 per cent. The details of the cases are as follows: none was cured, one was considerably improved, three slightly improved, and one case with and one case without keratosis remained stationary. In five children the keratosis had either extended or increased in degree. In these six weeks the average points per child rose from two to four, indicating an increase in degree and extent of keratosis despite the reduction in the total incidence. The results obtained in this experiment suggest that foot care is an important factor in the prevention and cure of Ankle Keratosis. This statement is supported by the fact that in House No. 4, slight deterioration in the condition of the skin occurred in three of the children who were re-examined six weeks after local treatment

had ceased. The number of children taking part in the experiment is unfortunately too small to allow of statistical analysis of the results.

B. PATHOLOGY.

(1) Morbid Anatomy.

The main features of Ankle Keratosis have been described at the beginning of Chapter III, the general appearance, the variable size and shape of the lesion, and its relation to the footwear. There remains to be described here the details obtained on closer examination.

It has been found necessary to make a study of the normal skin at different ages and in different parts of the body in order to appreciate fully the changes found in Ankle Keratosis.

(a) Surface Markings of the Skin. In textbooks of anatomy and dermatology, the surface markings of the skin are generally divided into three main classes.

(i) The Papillary Ridges. Papillary ridges are present on the palms of the hands and the soles of the feet. Their complex pattern on the finger-tips is used by criminologists for identification purposes.

(ii) Flexure Lines. These lines are caused by bands of fibrous tissue which anchor the skin to the deeper

structures over or near joints. The flexure lines of the ankle have already been described and names have been given to them according to their position; supra-malleolar, infra-malleolar, and tarsal lines. Included in this category are the creases on the volar aspects of the hands used in palmistry and the lines which appear on facial expression, and which are caused by the attachment of muscle fibres into the skin.

(iii) Simon's Lines. These lines cover the skin with a "network of linear furrows of variable size which divide the surface into a number of polygonal or lozenge-shaped areas." (Gray, 1932).

Knowledge of the characteristics of this third group of surface markings, Simon's lines, is necessary for a proper appreciation of the detailed study of Ankle keratosis.

Flexure lines and papillary ridges are clearly visible to the naked eye, but Simon's lines are less obvious, and in normal skin are not easily seen except in a few areas, such as the back of the hand and the wrist. It is only when examined under a low magnification of three to six diameters, and particularly after treatment of the skin with Charcoal Ointment that their complex pattern can easily be demonstrated. In conditions which cause pruritus and lichenification, and in diseases such as ichthyosis, Simon's lines are exaggerated and no special measures are required

for their detection. The areas of skin which they outline are spindle-shaped over the greater part of the body; less often they are quadrilateral or triangular. Erasmus Wilson described these lines in 1851. He believes that they are caused by movements of the skin, since the lines are more marked over joints like the elbows, knees, and knuckles, where the range of movement is greatest. Oscar Simon (1873) in his description of the furrows, has demonstrated that they represent a depression of the epidermis between groups of papillae and that their direction corresponds with that of bundles of collagen fibres in the corium. In sections of the skin taken across the direction of the furrows the collagen bundles are cut transversely, and when the section is cut in the line of the furrows the main direction of the bundles is longitudinal.

In an investigation in which wounds of the skin were caused by blunt instruments, Dupuytren 1834 described lines of tension which are caused by the distribution of connective tissue bundles in the corium. A blunt instrument produces a linear wound, the direction of which is dependent on the lines of tension and therefore on the arrangement of collagen bundles in the corium. Wood Jones (1920) draws attention to these two separate findings and states that Simon's lines are the surface manifestation of tension lines.

Tension or cleavage lines have been described in detail

by Langer (1861), and his name is often given to them. The terms Simon's lines, Langer's lines, cleavage lines, and tension lines are frequently used synonymously, but Simon's lines should be restricted to the visible creases or furrows, and the others to the lines of tension in the deeper structures of the skin. Cox (1941) has made a study of both linear systems and has confirmed the fact, that in general there is a relationship between Simon's lines and tension lines. He has also shown that on the extensor aspect of the ankle and in a few other areas, this relationship does not exist.

(b) Simon's Lines in Normal Skin. In normal skin treated with Charcoal Ointment only a trace of the ointment is retained in Simon's lines. Examination with a powerful hand lens or by the dissecting microscope shows that the lozenge-shaped areas outlined by Simon's lines are further subdivided, and that the pattern obtained varies in different parts of the body. For instance, on the dorsum of the hand, the main direction of Simon's lines is seen to be transverse, and as they approach the ulnar side of the hand they bend distally in an oblique fashion. Although the main direction is transverse, each individual line runs parallel to the other line for only a short distance, after which it bends up or down, intersecting other transverse lines to enclose the lozenge-shaped areas. Cutting across

the course of these Simon's lines are lesser longitudinal lines which, on the dorsum of the hand, behave in a similar but less regular manner. In certain parts of the skin these lesser markings are poorly developed, while in other parts they are much more regular, running roughly parallel to each other in more or less straight lines. They are very clearly seen on the anterior aspect of the ankle-joint in the mid-malleolar and tarsal spaces. They divide the lozenge-shaped areas in this part of the skin into quadrilateral areas of variable size. The size of these areas varies with age, but, while it may often be fairly uniform in one individual, it may vary greatly in different individuals of the same age. Because of the wide range in the size of the normal areas, it is possible to give only an approximate idea of their size at the different ages by taking the mean of six observations for each age group. In an infant of six months, the average size of the rectangular area in the mid-malleolar region is 0.30 mm. by 0.60 mm., in a child two to three years old 0.42 mm. by 0.70 mm., in a child of seven to ten years 0.45 mm. by 0.91 mm., and in an adult 0.60 mm. by 1.0 mm. Lozenge-shaped areas are present on the dorsum of the foot and their main direction is transverse. They are subdivided by numerous fine vertical lines into long rectangular areas. Over joints such as the knee, elbow or knuckle, the areas are mainly triangular in

shape. When viewed from the surface, all these triangular or rectangular areas appear flat and smooth. Occasional areas have a fine transverse line running a short distance into the rectangle or triangle, but in normal skin there is no more subdivision of the area than this. See Plates No. 23, 24 and 25.

(c) Variations in the Pattern of Simon's Lines at the Ankle. (i) Ankle Keratosis. The appearance of the skin markings in infants and young children, who are least likely to have been subjected to external influences of pressure, friction, or 'weathering', is taken as the normal. Apart from an increase in the size of the rectangular or triangular areas, the characters of the markings seen in infancy are present in older children and adults when the texture of their skin is smooth and soft. The frequency of variations in texture, and of other minor changes in the skin in otherwise healthy individuals is confirmed by variations in the normal pattern of skin markings as seen by the method described above.

The most common alteration in the pattern of Simon's lines at the ankle is a coarsening of the transverse and longitudinal lines and a subdivision of the rectangular areas by off-shoots from these lines. The surface of the rectangular area may have a stippled appearance or it may

be divided into eight to twelve small round seed-like bodies of equal size and shape. The grooves between the small rounded bodies, when examined by the Charcoal Ointment method, are blackened and cover the rectangular area with a mosaic-like pattern. This type of subdivision of the rectangular area will be referred to as mosaic. Three types of mosaic pattern may be described.

(1) First degree Mosaic. The grooves which form the mosaic are shallow, and the little seed-like bodies are flat and almost level with the rest of the skin surface.

(2) Second Degree Mosaic. The grooves are deeper and the seed-like bodies are raised in a regular fashion like little hillocks, giving an appearance similar to seeds on a raspberry.

(3) Irregular Mosaic Pattern. Occasionally the rectangular areas are subdivided by a deep mosaic pattern but the skin surface is very irregular. This is due to the fact that in a group of five or six rectangular areas the seed-like bodies are considerably raised, while in an adjacent group of rectangular areas they are flat, and by comparison with the former may even appear depressed.

Frequently the rectangular areas are subdivided by grooves which break them up into smaller parts of irregular shape and size. This arrangement will be called 'irregular subdivision'. It is unlike the mosaic pattern in that the

latter is essentially regular.

When the stratum corneum is hypertrophied, Simon's lines and the various subdivisions of the rectangular areas become more marked. The amount of Charcoal Ointment which they retain is a rough guide to the extent of the hyperkeratosis. Details of this subdivision may be quite obvious without special treatment, since dust and dirt may be deposited in the grooves. See Plates No. 26, 27, 28, 29, 30, 31, 32 and 33.

There may be gross hypertrophy of the stratum corneum without subdivision of the rectangular or quadrilateral areas. In this case thick hard plaques of hyperkeratosis are seen arranged in little squares or rectangles. Deep grooves which may contain dirt particles, lie between these plaques and correspond to Simon's lines and the lesser vertical lines at the ankle. Their depth is caused by a heaping-up of the superficial layers of the epithelium covering the rectangular areas. A similar type of keratosis on the knee or elbow where the natural areas are triangular, would present triangular instead of quadrilateral plaques. The changes in this type of case are so gross that it is unnecessary to use Charcoal Ointment to pick out the details. The surface of the plaque is hard, smooth, semi-translucent, and of a yellowish colour. On close inspection, the bases of the grooves appear red in colour. When the plaques are softened

and removed, the underlying skin is seen to be swollen, producing distortion and enlargement of the rectangular areas, the surfaces of which are irregularly stippled or pitted. Adjacent areas may show a mosaic pattern or irregular subdivision. See Plates No. 34 and 35.

The change from normal to abnormal skin markings may be gradual or abrupt. When a sudden change occurs, the characteristics of both normal and abnormal markings are very striking. On the normal side, Simon's lines always appear very superficial, and the areas which the grooves outline, extremely smooth and shiny by comparison with the rough broken-up areas or the grossly thickened plaques on the keratotic side.

Ankle Keratosis has been subdivided on clinical grounds into three degrees for comparative purposes. Doubtful Keratosis has also been recognised, but since it is not associated with a palpable thickening of the skin, it has been grouped with skins showing no evidence of keratosis.

The following abnormal skin markings occur in the different degrees of Ankle Keratosis.

Doubtful Keratosis:- Coarse markings occur with or without superficial subdivision, or a first degree mosaic pattern in the rectangular areas.

First Degree Keratosis:- Coarse markings are seen with second degree mosaic, stippling, or irregular subdivision of the rectangular areas.

Second Degree Keratosis:- An irregular mosaic pattern may occur, but more often the changes seen in First Degree Keratosis are present to a more marked extent. The grooves are deeper and retain more of the Charcoal Ointment. Small keratotic plaques may be seen.

Third Degree Keratosis:- Thick keratotic plaques occur with very deep grooves between them, giving an appearance of fissuring.

(ii) 'Weathering'. The characteristic lesion of acute 'weathering' is the formation of 'chaps', which are true fissures of the epidermis in the direction of the Simon's lines. They may extend for a distance of two or more rectangular areas. In front of the ankle they may be either transverse or longitudinal. Towards the middle third of the leg anteriorly, they form a semicircular pattern with the convexity upwards. The base of the 'chap' is a deep red colour; it may bleed readily or serum may be seen to exude from it. This is interpreted as indicating its penetration of the corium. The skin adjacent to the 'chap' appears swollen, and stippling of the rectangular areas may be seen. See Plate No. 36. With healing of the 'chap' a linear scab develops. The surrounding skin is red due to engorgement of the capillaries, and the surface is covered with fine white powdery scales. A type of thickening of the ankle skin occurs, in which plaques of hyperkeratosis are present but are less adherent to the underlying skin than is usual in typical second or third

degrees of Ankle Keratosis. The plaques may be lifted upwards slightly at their edges, giving a suggestion of scale formation. This change is believed to be associated with 'weathering', and is frequently seen at or above the supramalleolar areas in children with second or third degrees of keratosis. See Plate No. 37. In 'weathering' of the skin, there may be much roughening without a corresponding degree of skin thickening. The roughened scaly skin retains the Charcoal Ointment even more than keratotic skin, and as a result the skin surface may appear very black. Therefore the amount of Charcoal Ointment retained on the skin is not of itself an indication of the degree of keratosis.

(iii) Other Minor Abnormalities. Scars appear as opaque white shiny patches or streaks in which skin markings are absent.

The skin surrounding localised inflammatory areas on the foot, such as chilblains or pressure marks from ill-fitting boots may show a well-marked mosaic pattern without an appreciable thickening of the epidermis.

(2) Histology.

Description of the Main Histological Features. Sections of the skin were obtained for study of the histology of

Ankle Keratosis from biopsies in the following cases.

(a) A case of first, second, and third degree keratosis of the skin over the Tendo Achilles at the boot-top level in a boy wearing boots. See Plates No. 38 and 39.

(b) A case of second (almost third) degree keratosis from the mid-malleolar region of the foot in a boy wearing boots.

(c) A case of 'weathering' of the foot in the tarsal region without any evidence of keratosis.

(d) A case of second degree keratosis with a well-marked mosaic pattern in a boy who wore shoes.

(e) A case of marked second degree keratosis with 'weathering' and 'chap' formation in a boy who wore boots. The biopsy in this case was made in the mid-supra-malleolar region. In the proximal part of the section both keratosis and 'weathering' were present, while in the distal part only keratotic changes were seen.

The main features of the sections will now be described.

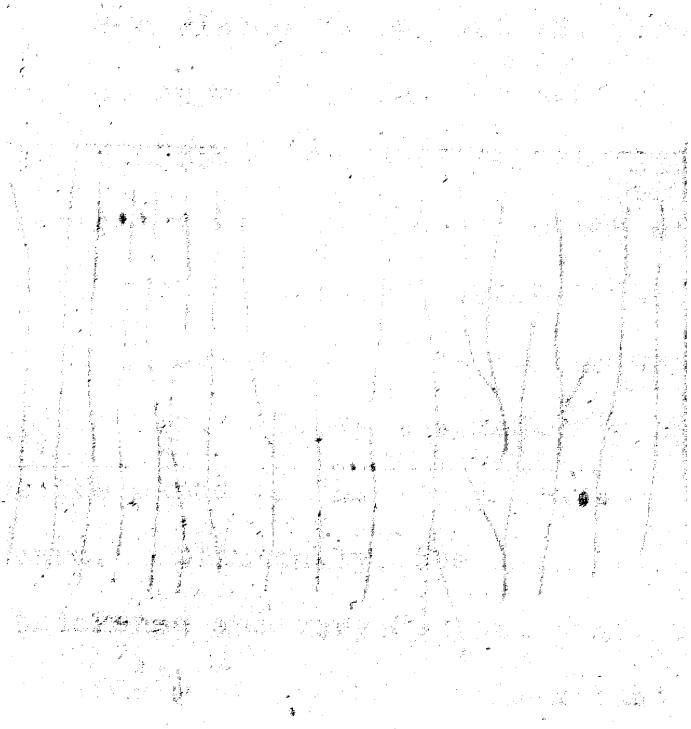
Section (a). There is a well marked hyperkeratosis with gross thickening of the stratum corneum, the surface of which is irregular giving it a papilliform appearance. In the depressions or grooves of the surface, the continuity of the epithelial squames in the stratum corneum is broken, forming 'cracks' in which dirt and charcoal particles are

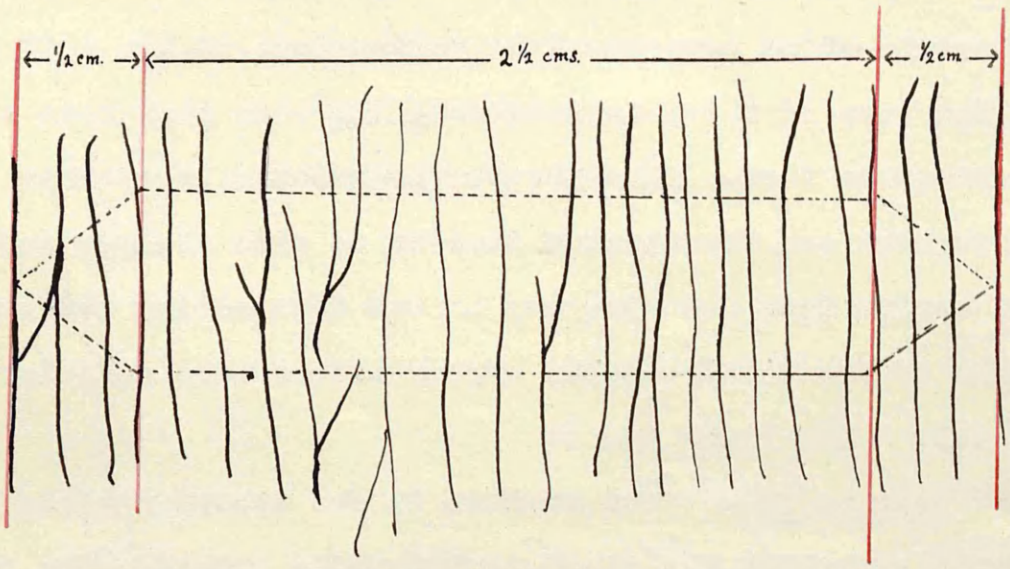
visible. The papillae are broad and relatively short and some of them appear to be compound in nature. The interpapillary processes are very narrow except at fairly regular intervals which correspond to depressions of the epidermis. At the base of these depressions, the rete pegs have a rectangular form. The stratum granulosum is regular throughout and the stratum lucidum is also clearly seen. The corium does not show any marked abnormality but the walls of the blood vessels appear rather more cellular than normal. See Plate No. 40.

Section (b). The section in the second case of keratosis resembles the first in its major points - the hyperkeratosis, the occurrence of some compound papillae and the occasional broad rectangular-shaped interpapillary processes. There are also numerous 'cracks' in the stratum corneum in which charcoal and dirt particles are seen. The following additional changes were noted. (1) At the bases of some of the 'cracks' small wedges of parakeratosis occur, and (2) the stratum granulosum forms a layer of variable depth, being thickest in the interpapillary portion and becoming narrow towards the crest of each papilla.

Section (c). There is some hyperkeratosis and while the surface of the stratum corneum is fairly even, it is interrupted by 'cracks'. Some of the cracks are associated with parakeratotic wedges, others appear as simple breaks in

Fig.20





Drawing of the main Simon's Lines in skin of mid-tarsal region prior to biopsy (d). Black dotted lines show the position of the incisions. The specimen sent for histological examination measured $2\frac{1}{2}$ cm by $\frac{3}{4}$ cm. It contained 17 to 18 Simon's Lines and approximately 95 seed-like bodies which formed the mosaic pattern.

See Plate No.43 and Fig.No.21.

Fig.20.

the continuity of the epidermis without any underlying parakeratosis. See Plates No. 41 and 42. The inter-papillary processes supporting the 'cracks' of the stratum corneum tend to be broader and more rectangular in shape. The stratum granulosum is irregular in depth after the manner seen in Section (b) and only a trace of stratum lucidum can be seen. No abnormality of the corium was observed.

Section (d). This biopsy was made for the purpose of determining the cause of the mosaic pattern which so frequently occurs. Clinically, the skin in this case was considerably thickened and very dry, and after the application of Charcoal Ointment showed a well-marked mosaic pattern of the second degree. The area to be sectioned was marked off with carbol-fuchsin and measured. Simon's lines were enumerated as were the approximate number of seed-like bodies which give rise to the mosaic pattern. The details are shown in Fig. 20. In the photograph of the section (Plate No. 43) groups of four to seven papillae are seen separated by depressions of the epidermis. At the base of each depression the rete peg has a rectangular form. The total number of depressions or grooves in the section corresponds to the number of Simon's lines (17) enumerated before the biopsy was made. The surface of the section is also seen to be further subdivided by little hillocks formed by the papillae and their epithelial covering. In

a normal skin, the irregular surface of the papillae is smoothed over by the stratum mucosum so that the stratum granulosum, stratum lucidum, and stratum corneum are regular in outline. That the persistence of this papilliform arrangement on the skin surface is responsible for the mosaic pattern described, was confirmed by enumeration of these projections before and after section, when they were found to correspond almost exactly. The pattern of the papillae in this specimen is regular, there is no great variability in the thickness of the individual layers, compound papillae are absent, as are the 'cracks' in the stratum corneum seen in the preceding sections.

Section (e). This section was taken from an area showing keratosis in its distal half and marked 'weathering' in its proximal half. The epidermis and cutis are thickened. In the 'keratotic' area, the papillae of the corium are long, moderately cylindrical and occasionally compound. The stratum granulosum stains deeply and is fairly regular in outline. The interpapillary processes are moderately bulky. In the 'weathering' area, the papillae are shorter and broader, and the stratum granulosum is less distinct due to smallness and diffuseness of the keratohyaline granules. Parakeratosis is seen to occur as a sheet of acidophilic epithelial squames with pyknotic nuclei. There are in addition three small wedges of para-

keratosis at the bases of 'cracks' in the epidermis similar in nature to those described in sections (b) and (c). This parakeratosis is always associated with 'cracks'. It may extend in a cone-shaped fashion for some 80 μ on either side and below the deep termination of the 'crack', or it may form a sheet of parakeratosis which bridges the area between two adjoining cracks. The latter appearance is believed to occur when a surface depression, supported by its parakeratotic wedge, is cut longitudinally. The sheet of parakeratosis extends for about 80 μ beyond the far side of the last 'crack'. Cornification does not seem to be complete even in the keratotic areas as there are throughout the section elongated basophilic fields between the layers of squames in the stratum corneum. This produces a lack of homogeneity which is a feature of the normal stratum corneum. See Plate No. 44.

DISCUSSION.

(1) Ankle Keratosis. The main histological features of Ankle Keratosis appear to be a hyperkeratosis with irregularity of the skin surface, producing 'cracks' in the stratum corneum, in which extraneous particles, dust, dirt, and charcoal, collect. The papillae tend to be broader and shorter than normal, and at the base of each surface depression, the rete pegs are rectangular in shape. The

stratum granulosum is regular and stains deeply. These changes are best seen in section (a). See Plate No. 40.

The presence of dirt and charcoal particles in the 'cracks' of the epithelium, excludes the possibility that they might be artefacts caused during preparation of the section. The almost constant presence of rectangular rete pegs at the base of the surface depressions, suggests that the latter are anatomical features. In section (d) a very close correlation was found between the number of Simon's lines before biopsy, (see Fig. 20 opposite page 127), and the number of surface depressions in the section. See Plate No. 43. In describing the skin furrows, Simon (1873) said that they were caused by depressions of the epidermis between groups of papillae. It can be assumed that, in section (d) at least, surface depressions of the epidermis represent Simon's lines.

The mosaic pattern so frequently seen in minor skin abnormalities, has been shown to be caused by swelling of the papillae of the corium and a corresponding irregularity of their epithelial covering.

(2) 'Weathering'. Where 'weathering' occurs, hyperkeratosis is also seen, but the main features are wedges of parakeratosis which seem to form at the bases of the 'cracks', since many 'cracks' occur without associated parakeratosis but the reverse has not been observed. The tangential

distance from the edge of the parakeratotic area to the centre of the 'crack' was found to measure 80 μ on either side of the 'crack', in the three sections in which this feature occurred. The thickness of each parakeratotic area rapidly falls off towards its edge, giving isolated areas a cone-shaped appearance. In some cases however, apparently when one of the 'cracks' is cut longitudinally, the parakeratosis forms a sheet of cells in the deepest layers of the stratum corneum. From the histological appearances and from the clinical findings, it is suggested that 'cracks' with parakeratotic wedges at their base may in some cases represent 'chaps' cut transversely.

The histological changes believed to be characteristic of 'weathering' are best seen in section (c). (See Plates No. 41 and 42.) The clinical diagnosis in this case was - Moderate 'Weathering' with 'Chap' formation and without any evidence of Keratosis. The main feature of the 'weathering' end of section (e) also closely correspond to this description. (See Plate No. 44). Some degree of parakeratosis is also present in section (b) and if the above deductions are correct, this parakeratosis might be taken to indicate the presence of 'weathering' although clinically the case was thought to represent Keratosis only.

Parakeratosis is found in association with scaly skin lesions, and in typical 'weathering', fine white powdery

Table XlV

MICROMETER READINGS OF BIOPSY SECTIONS

	Section (a)	Section (b)	Section (c)	Section (d)	Section (e)	Section (e)
	First, Second and Third Degree Keratosis	Second Degree Keratosis	'Weathering' with 'Chap' Formation	Mosaic Pattern in Second Degree Keratosis	Second Degree Keratosis	Keratosis and 'Weathering'
	μ	μ	μ	μ	μ	μ
Maximum Thickness of Cutis	140.0	130.0	96.0	93.0	97.0	97.0
Average Length of Papillae	15.6	19.0	15.1	18.0	21.7	13.1
Average Width of Papillae at Tip	7.6	3.4	3.6	3.2	4.6	5.9
Average Width of Papillae at Base	10.6	6.0	4.7	6.3	6.5	7.7
Average spacing i.e. width of ten papillae and ten interpapilliform processes	124.0	106.0	109.0	112.0	135.0	101.0
Thickness of Stratum Granulosum	1.4	4.1 to 2.1	4.7 to 2.8	1.6	4.8 to 3.0	1.6
Thickness of Stratum Lucidum	1.3	trace	trace	trace	0.3	--
Thickness of Stratum Corneum	10 to 50	33.0	17.8	6.7	27.4	--
Average Thickness of Parakeratotic area	0	2.4	11.9	0	0	4.7
Thickness of Parakeratotic area at cracks	--	--	--	--	--	6.6
Width of rete peg at base of Simon's Line	--	--	--	38.6	--	--

Table XlV

scales are seen. It has been noted that in a few cases of Ankle Keratosis the edges of the keratotic plaques are lifted upwards, giving the appearance of early scale formation. The association of keratosis and 'weathering' in the same case, and the occasional difficulty of deciding where the one process begins and the other ends, has been described. Not infrequently it is obvious that both conditions are present together in the same portion of skin. It is not surprising therefore to find histological evidence of 'weathering' in a case diagnosed clinically as Keratosis.

In Table XIV are given the detailed measurements of the principal features of the biopsy sections.

(3) Congenital Ichthyosis and Ankle Keratosis. Since all cases of congenital ichthyosis show a second or third degree of Ankle Keratosis, it is interesting to compare the histological findings in the two conditions. In reports of the histology of ichthyosis, the principal change consists of hyperkeratosis in which the horny layer forms a loose network. The granular layer is either absent or decreased in depth (Andrews, 1938. Percival et al. 1946). There is thinning of the prickle-cell layer and flattening of the papillary body so that the line between the epidermis and the corium may become almost straight (MacLeod & Muende, 1945). In all the sections of Ankle Keratosis which were

examined, the granular layer was quite distinct, measuring 1.4 to 4.8 μ in depth. The papillary bodies also remained quite distinct. It seems probable that the keratosis seen at the ankle in congenital ichthyosis is merely an increase in the general pathological process at that part, but that minor trauma may provide the stimulus for its localisation.

C. GENERAL REVIEW OF THE CLINICAL COURSE.

The outstanding feature of the clinical course of Ankle Keratosis is its seasonal incidence. There is a tendency for a first degree keratosis to become a second degree or a third degree keratosis towards December, January and February, and then improve gradually during the succeeding months, sometimes disappearing altogether in the Summer. A child may be free from keratosis most of the year and show only mild changes in two or three of the winter months. Not all cases of third degree keratosis disappear in the Summer, but most of them improve to at least a second degree and more often a first degree keratosis. In addition the area of skin affected becomes much reduced in size. Only a small minority of children fail to show a seasonal improvement. This cycle of events may be repeated every year between the ages of five or six years and adolescence, after which keratosis is uncommon and little

more than a first degree change is ever seen.

Keratosis is closely related to the type of footwear worn and its site may change if boots are worn instead of shoes, and vice-versa. If for any reason the skin is protected from exposure to the weather or from friction, the keratosis may improve or disappear altogether. This occurs during illnesses, when the child is sent to bed or kept indoors. One case was seen in January, in which the left foot had been bandaged for three to four weeks on account of a septic blister. Before the blister had developed the skin was moderately keratotic, and after it had been bandaged for three to four weeks, the keratosis had disappeared. The right foot, which had not been bandaged and which had shown a degree of keratosis similar to the left, now showed a more severe and extensive keratosis.

Cold winds, hard water, the use of strongly alkaline soap, and lack of general care such as the proper drying of skin after baths, wearing of damp boots, perhaps a size bigger than is necessary, are external factors which influence the development of 'weathering', a condition which is closely related to Ankle Keratosis. Acute 'weathering', under suitable conditions will appear in one or two days, but such a rapid development of Ankle Keratosis was never observed. On the other hand a third degree keratosis may change in a day or two to a second degree or even a first

degree keratosis by deliberate removal of the keratotic plaques with alkalies and friction. Unless treatment of this nature is continued, such a keratosis is likely to recur in the course of two to three weeks. Keratosis may however occur with clinical evidence of 'weathering', and vice-versa. Just as 'weathering' may appear in one or two days, it may also become healed in a short space of time. Spontaneous improvement of keratosis is as a rule more gradual.

Ankle Keratosis causes no complaint other than its dirty appearance and roughness to the touch. It is neither painful nor itchy.

There is no clear evidence that heredity plays any part in this condition, apart from the following facts; that children born with anything from a general dryness of the skin to a severe degree of ichthyosis will almost certainly show Ankle Keratosis, and that under conditions, such as were seen at the Cottage Homes, and which favour the development of this lesion, the only children over five years of age who appear to escape are those with very oily skins.

COMPLICATIONS:

The presence of fissures and 'chaps' in and about the keratotic skin might be expected to give micro-organisms access to the dermis. In spite of this, practically no

secondary skin sepsis was seen, and no other complications were noted.

D. REVIEW OF TREATMENT.

The effect of care of the skin on the course of Ankle Keratosis has been clearly demonstrated in the experiment at Ponteland Cottage Homes where the incidence of keratosis in ten children was reduced in six weeks from 80 per cent to 20 per cent. In addition, there was a considerable improvement in the degree and extent of keratosis, so that by according points to each child before and after the experiment, the average number of points per child was reduced from 4.5 to 0.8. By contrast, over the same period of time, the incidence of keratosis in the Control House decreased from 77 per cent to 61.5 per cent, but the average number of points per child rose from two to four, indicating an increase in the severity or in the extent of the keratosis. See Fig. 11 opposite page 113.

The results of this investigation confirmed the impression gained in the other experiments that the interest aroused in the foster mothers by repeated visits and examinations of the children, of itself caused an improvement. In Control Houses where no special treatment was given, and in Experimental Houses before dietary supplements were started or before they could possibly have taken effect, an improvement was noted.

Fig. 23

Fig. 24

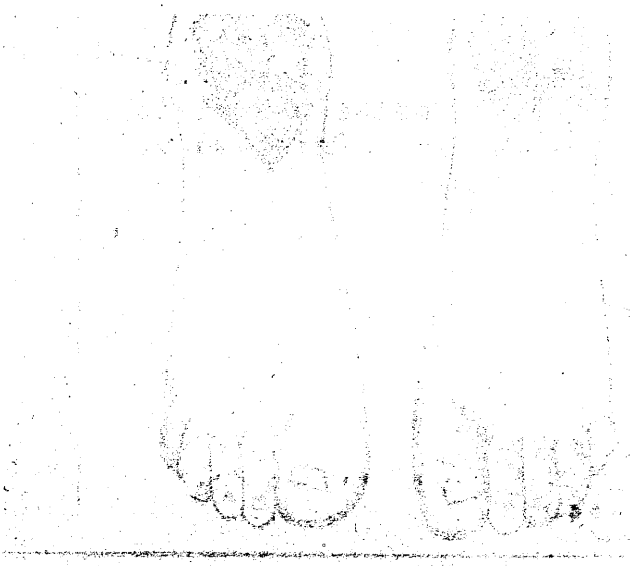


DIAGRAM TO SHOW THE OVERNIGHT CHANGE IN ANKLE KERATOSIS IN A GIRL SELECTED FOR SPECIAL TREATMENT

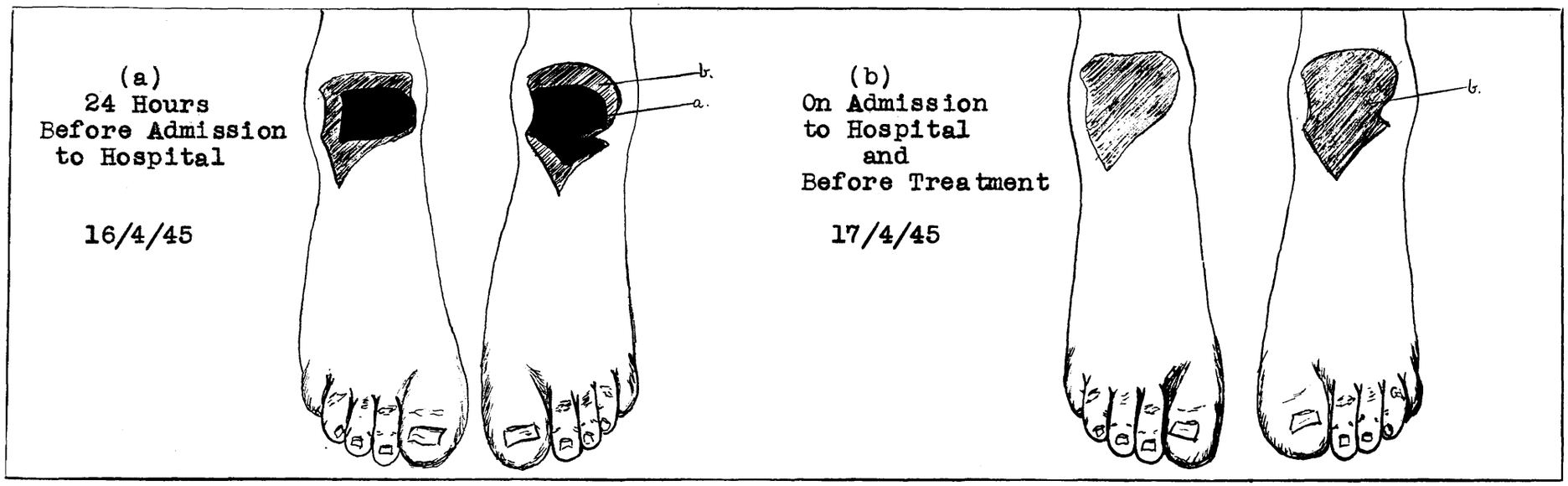


Fig.23 See Plate No.45

a - Second Degree Keratosis
b - First " "
c - Doubtful "

DIAGRAM TO SHOW THE EFFECT OF HOSPITALISATION AND OF TREATMENT TO THE LEFT ANKLE

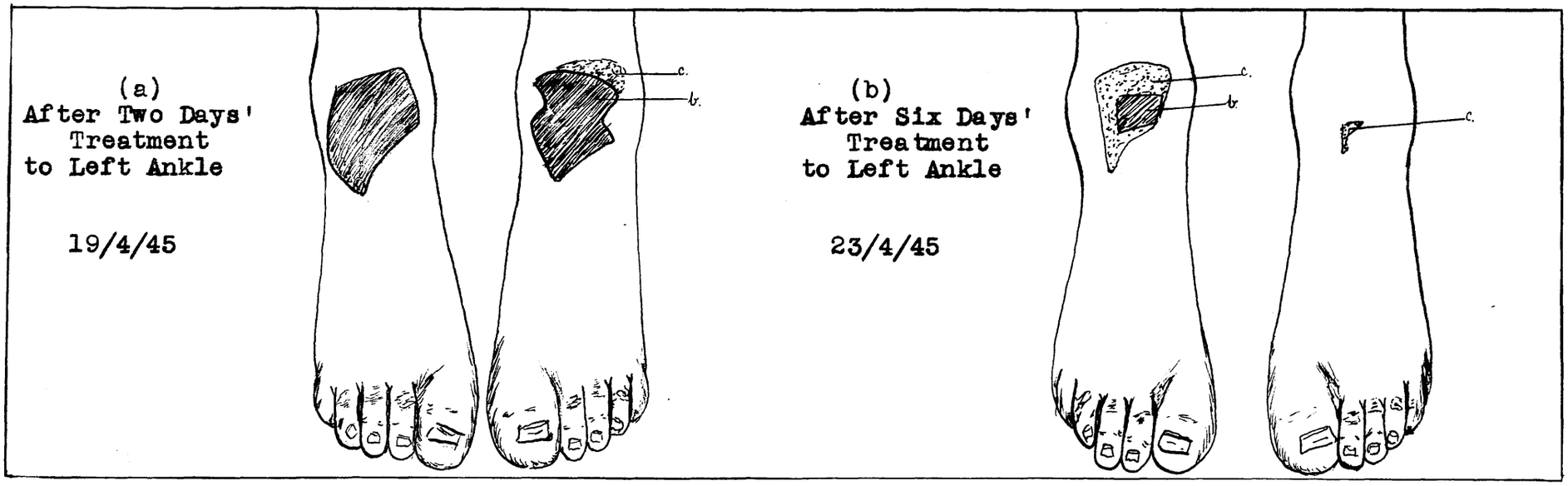


Fig.24 In Fig.23 (b) are shown the extent and degree of Ankle Keratosis Before Treatment.
See also Plates No.45 to 51.

keratosis reduced from a second to a first degree. See Fig. 23 and Plate No. 45. The extent of skin involved was unchanged and it was therefore decided to continue the test. It was not possible to allow the child to go outside, but during the day she was allowed to play in the wards. The left ankle was chosen for treatment and the right was used as the control. Unguentum Eucerin Hydras was applied night and morning and the feet and legs were washed twice daily. After two days' treatment the extent of the keratosis was somewhat reduced and the markings on both ankles were shallower, especially on the left. Four days later, the skin of the left ankle felt smooth and soft to the touch, and there was only a tiny patch of doubtful keratosis in which the Charcoal Ointment was retained, and where the rectangular areas were subdivided by a superficial mosaic pattern. See Plates No. 46, 47, 48, and Fig. 24. At the same time the keratosis on the right or control ankle was further reduced in extent, but the surface markings remained deeper than normal. On this ankle, without treatment, during the six days of the experiment, the area of skin affected by keratosis was reduced from 5.0 x 6.5 cms. to an area of 2.5 x 4.0 cms. (See Plates No. 49, 50, 51, and Fig. 24).

The child was re-examined two weeks after her return to the Homes. The untreated ankle showed an increase in the

extent of the keratosis, and the treated one showed the same tiny area of doubtful keratosis, as described for the 23rd April, the sixth day of the experiment. The increase of Ankle Keratosis on the control leg was undoubtedly due to exposure to weather and other types of minor trauma, and it appears probable that those traumatic factors did not affect the treated ankle because the skin was saturated with emollient ointment. It is felt that the application of such an ointment to the skin has a marked effect in causing improvement or cure of Ankle Keratosis, and that this effect is aided by protection from exposure to trauma such as may be caused by strong alkalies and cold winds.

PROPHYLAXIS.

From what has been written it is clear that prophylaxis of Ankle Keratosis depends on general care of the skin. Cleanliness is important, but too frequent washings are liable to damage the skin unless special precautions are taken. Ordinary baths are probably not harmful as the quantity of water used will ensure that the soap is all washed off, but the skin must be well dried afterwards. Where foot baths are used, care must be taken to remove the soap thoroughly before drying. Furthermore, it is better to use a superfatted soap as a result of which the harmful effects of alkalies on the skin are less apparent. When the water is naturally hard, more soap is used to produce a lather, and

extra precautions must be taken. In districts where the water is hard, and particularly in cold windy weather, some emollient ointment rubbed into the skin after bathing will help to prevent the development of keratosis.

CHAPTER V

DISCUSSION OF THE SIGNIFICANCE OF ANKLE KERATOSIS

Many facts about Ankle Keratosis have been collected, both by the mass survey method in which large numbers of cases are examined for some of the salient features, and by detailed study of individual cases under varying conditions. These facts have been presented in the preceding chapters. It is now possible to consider what place Ankle Keratosis occupies in medical Science.

The results of the survey show that Ankle Keratosis is a condition which is not associated with any constitutional upset. It is more frequently seen in apparently healthy children than in hospital patients suffering from all varieties of disease. The frequency and nature of past illnesses of school children bear no obvious relation to the development or severity of this condition. Failure to treat Ankle Keratosis does not cause any serious complication and in Summer it tends to disappear spontaneously. In adult life few cases are seen, and it would appear that a natural improvement or cure occurs. It is completely lacking in symptomatology, except when it is associated with 'weathering', in which case some local discomfort or pain may be caused on washing and on exposure to cold. It is thus obvious that Ankle Keratosis is not of great clinical significance as a

disease process, but must be considered as one of the Minor Skin Abnormalities. Its significance as such will be discussed below.

Apart from brief references to its occurrence in deficiency states, (Snyder, 1923; Stannus, 1941; Sinclair, 1945) and to its association with Follicular Keratosis (Stannus 1945), no record of Ankle Keratosis has been discovered in the literature. This may be explained by its failure to produce symptoms or complications. Shaw (1946), however, had noted the condition in school children in 1912, but his observations were not published. There is no evidence to suggest that Ankle Keratosis is a new disease. Several adults remember having had the condition when they were young, and 'boot scruff' is quite familiar to many people in the North East of England.

INFLUENCE OF HEREDITY.

The influence of environmental conditions on the development of Ankle Keratosis has been shown to be so great that any part played by heredity in the etiology of the condition, though difficult to exclude, must be of secondary importance.

It is believed that a hereditary factor may be responsible for the dry or oily nature of the skin, and it is interesting to note that in institutions with a high incidence of the lesion, children with oily skins were less affected than the others.

The only disorder constantly associated with keratosis in the ankle region is congenital ichthyosis, which is due to an inherited abnormality of the skin. In Summer, ichthyosis like Ankle Keratosis shows a spontaneous improvement which is said to be caused by a natural increase in the secretions of the skin at that season. In its macroscopical appearances, the thickening of the ankle skin in ichthyosis resembles that found in Ankle Keratosis, but the histological features differ in the two conditions. Since no biopsy of the ankle skin was obtained in any of the cases with congenital ichthyosis, it is not possible to say whether the lesion corresponds to a superimposed Ankle Keratosis, or is simply an exaggeration at the ankle of the congenital abnormality. Ichthyosis, however, is believed to be an unimportant factor in the etiology of Ankle Keratosis, since the latter condition occurs in approximately a third of the school population, whereas ichthyosis is an uncommon disease. In the present series, seven cases were seen in two thousand eight hundred and fifty-three children aged from two to seventeen years, giving an incidence of 0.25 per cent.

ENVIRONMENTAL CONDITIONS OR THE ROLE OF TRAUMA.

Ankle Keratosis appears to be a reaction of the skin to certain irritant factors. From its position, the skin is constantly exposed to all types of minor trauma in addition to trauma of more serious degree, and the skin over joints

and bony prominences is particularly susceptible. The custom of wearing leather boots or shoes introduces a variety of traumatic factors which affects the skin of the feet and legs in particular. The soles of the feet are subjected to pressure and friction whether or not shoes are worn, although in the absence of shoes a greater degree of hyperkeratosis develops. On the other hand, well-fitting shoes protect the skin of the dorsum of the foot, which normally is soft and smooth. Ill-fitting boots or shoes produce pressure sores, corns and blisters on the pressure points, but none of these conditions is related to Ankle Keratosis. The types of trauma with which we are here concerned, are pressure and friction near the edge of the boot or shoe, and exposure to wind, cold, moisture, hard water, soap, and alkaline solutions. It is likely that in any one case two or more types of trauma may be concerned in the production of keratosis.

The movement of the edge of the boot or shoe on the skin causes a certain amount of friction. The area of skin affected by friction is not so extensive as the area affected by Ankle Keratosis, although it bears a close relationship to the severest degrees of this condition. But the amount and area of skin affected by friction are increased by wearing footwear a size too large. Further, the tight lacing necessitated by wearing ill-fitting boots may restrict the circulation of blood to a

particular area, resulting in an impairment of nutrition there. The degree of friction caused by wearing boots and shoes will also vary with the amount of exercise taken. This factor may partly explain the age and sex incidence of Ankle Keratosis and the tendency in certain cases for one foot to be more affected than the other. The absence of friction in the ankle region in children confined to bed or to the house on account of sickness may partly explain the low incidence of the condition in hospital patients. It cannot however explain the geographical distribution of the lesion. Several cases of keratosis have been described in which friction is the main etiological factor. This keratosis, which occurs on the knees, elbows, malleoli, and other parts of the body, resembles Ankle Keratosis in its macroscopical appearances. Other cases have been cited in which the etiology of the keratosis could not be explained by friction.

The presence of leather over the skin of the foot causes a sharp line of demarcation between skin which is protected, and that which is exposed to the weather and other external factors. Lewis (1941) has studied the effect of temperature on the skin and has emphasised that the distal ends of the extremities are the parts most susceptible to cold. He has shown that cold, like heat causes swelling of the skin, and that in the presence of wind, skin which is wet, cools very

rapidly. The harmful effect on the skin, of frequent applications of alkaline soaps has been demonstrated by various workers. (White, 1920; Jordan et al., 1940). Alkalies alter the normal reaction of the skin surface, and Parkhurst (1940) reports that, after washing the skin with soap and water, it takes three and a half hours for the hydrogen-ion concentration to return to normal. Jordan (1940) states that people with oily skins tolerate soap better than people with dry skins. Soaps remove the normal greasy protective coating and render the skin more easily affected by trauma. (Klander, 1940). Skin which is frequently treated with strong alkaline solutions, exposed to damp or wet stockings and then to the cooling effect of cold dry winds, loses its elasticity, cracks readily, and becomes dry and scaly. These are the changes described for 'weathering'.

In children with 'weathering' of the legs, that part of the skin covered by the shoe leather is protected and remains normally smooth. The tongue of the boot offers less effective protection than does the thicker leather of the boot itself, so that the skin of the mid-malleolar and mid-supramalleolar areas may show signs of 'weathering' in children wearing boots. The protection offered by thick woollen stockings is not sufficient to prevent these changes, but ankle-socks which are usually of double thickness appear to have greater protective qualities.

The types of trauma which cause 'weathering' appear to have a definite influence on the development of Ankle Keratosis. The area of skin affected in the two conditions is similar, although 'weathering' is more widely distributed over the legs. The relationship between the area of affected skin and the footwear is practically identical in both 'weathering' and Ankle Keratosis. When both conditions are present in the same child, typical keratosis is seen nearest, and typical 'weathering' farthest, from the edge of the boot or shoe. Either condition may be present independently of the other. The age incidence might be explained by the increased exposure of children of school age to all kinds of weather, and by the degree of care expended on washing and drying of the feet and legs. These factors may also be responsible for the high incidence of severe degrees of keratosis in children from the lower income groups, in boys as compared with girls, and in institutional children as compared with those living in their own homes. In the four regions of Scotland and England which were examined, no single factor appears to be related to the varying incidence of severe degrees of Ankle Keratosis, but the significant increase of third degree changes in the North East of England may possibly be caused by the hard water and cold East winds there. On the other hand, the low incidence of Ankle Keratosis in hospital patients may be due to the fact that

their skin is not exposed to many of these traumatic factors. The protective action of an emollient ointment has been fully demonstrated, and it is effective even if friction of the footwear on the skin continues to act, as in the experiment in the Ponteland Homes.

The rate of onset and of cure of typical 'weathering' is more rapid than occurs with Ankle Keratosis. It is conceivable, however, that the continued action of the traumatic factors responsible for 'weathering' may produce a chronic lesion which takes longer to cure and which may resemble Ankle Keratosis. In the absence of any evidence of 'weathering', keratosis frequently occurs, although histological examination of the skin in one such case showed wedges of parakeratosis in relation to 'cracks' in the epidermis, an alteration which is typical of 'weathering'. Finally, sections of 'weathering' of the skin show considerable hyperkeratosis in addition to the other changes described.

The results of a house to house investigation made at East Hartford suggest, that in children of the same social status, Ankle Keratosis occurs more frequently in some families than in others. There are several possible explanations for this finding. It may be due to a keratotic diathesis, but the evidence for this is very meagre. Some nutritional deficiency arising from familial dietary habits may possibly be responsible. This will be discussed later in detail. It

was found that the average size of family in the keratotic group was larger than in the non-keratotic group, and the standard of living tended to be lower. A large family usually results in a smaller amount of money being available for food, and in less individual attention being paid to the children. The conclusion was reached that lack of individual attention and general care were the most important factors in the etiology of the condition.

INFLUENCE OF NUTRITION.

The study of Ankle Keratosis was undertaken in the first place because of an impression that its presence might indicate a minor nutritional deficiency. This possibility is not excluded by the fact that minor degrees of trauma appear to be definitely related to the incidence of the condition. Indeed it was thought that trauma might produce keratosis only in those children who suffer from a nutritional deficiency, and thus explain the freedom from keratosis of the remaining two thirds of the school population. Such a relationship exists in pellagra, between skin lesions and nutritional deficiency. (Stannus, 1941; Bean et al., 1941; Sinclair, 1945).

It was felt that a lesion which shows a seasonal incidence and which is more frequently observed in children of the lower income groups might be caused by some defect in the diet. The majority of poor families are known to eat a diet which

may be deficient in several important factors such as animal protein, fat, and vitamins. The geographical survey showed that there was a significantly low incidence of second and third degrees of keratosis in the Midlands and South of England as compared with the West of Scotland and the North East of England. It was not possible to exclude a dietary factor as the cause of this variation, since, although rationing of foods was in force all over the country, non-rationed foods such as fruit and vegetables were more abundant in the South and Midlands than farther North. From January to June the vitamin C content of food is normally lower than at other times and during wartime this difference became more marked. (Harris & Olliver, 1943). Furthermore, in wartime the consumption of fats has been greatly reduced. Animal experiments have shown that a fat-deficient diet can cause a scaly type of dermatitis, (Burr, 1940); and Smedley-Maclean (1944) and Hawes (1945) have suggested that such a deficiency may be related to the increase in recent years of dry scaly skins and of Follicular Keratosis.

The lack of correlation between Ankle Keratosis and the nutritional state as recorded by the School Medical Officer, was not considered inconsistent with its possible value as a sign of nutritional deficiency. The unreliability of clinical evaluation of the nutritional state is the main reason for the search for improved methods of assessment. Further,

the recorded occurrence of normal height and weight measurements in the presence of severe avitaminosis, rules them out as valuable indications of minor degrees of malnutrition, particularly when assessing the state of nutrition in individual children.

In the detailed study of the lesion as it occurred in children at East Hartford, a familial tendency was apparent. One of the possible explanations for this was a nutritional factor arising out of dietary customs in the different families. Although detailed dietary surveys were not made, no great difference was observed between the nature of the diet in the keratotic and non-keratotic families.

The failure of the nutritional experiments which were carried out at the Ponteland Homes led to the abandonment of the above hypothesis. Supplementing the diet with vitamins A and D, vitamin B complex, or with vitamin C, had no demonstrable effect on the course of Ankle Keratosis. The effect of food supplements was also tested lest any dietary factor not included in the selected vitamins be responsible for the prevalence of the lesion. Twelve weeks was thought to be a period of time long enough to give definite results, had some specific nutritional factor been concerned in the etiology. The experiments were conducted at a time when Ankle Keratosis naturally becomes more severe and extensive, but in spite of this fact, improvement was most marked in the Control Houses.

In contrast to the negative results obtained in these experiments, the rapid response of the skin to local care, and the application of an emollient ointment appeared to be specific. Not only did the severe cases improve, but minor changes recorded as doubtful or as first degree keratosis, were completely cured within a few weeks.

It is thus evident that not only does Ankle Keratosis come under the classification of Minor Skin Abnormalities, but its occurrence is of little significance and cannot be related to any nutritional or other disorder. Its presence in severe degree however, apart from that type associated with congenital ichthyosis, reflects on the social background of the home, and on the amount of care taken in washing and drying of the skin, and on the condition of the footwear.

In the introduction to this thesis, attention has been drawn to difficulties in the interpretation of many 'deficiency' signs, some of which have later proved not to be specific. The importance of testing the reliability of such signs cannot be over-emphasised. This involves a widespread and detailed investigation to ensure that the results will be statistically significant and that the conclusions will stand the test of time. It is hoped that this study of Ankle Keratosis, although producing mainly negative results, has succeeded in interpreting correctly its significance as a Minor Skin Abnormality, and will prevent its inclusion as a

'deficiency' sign in the evaluation of nutritional states.

In conclusion the following remarks quoted from an address by Albright (1944) appear to be relevant:- 'Let our unhappy colleague whose work has produced important negative evidence keep his sense of humor; his more discerning colleagues recognise that, in the labyrinth of Science, to point out that one door after another is not the right one is of great help to those who follow.'

CHAPTER VI

S U M M A R Y

1. DEFINITION OF ANKLE KERATOSIS.

Ankle Keratosis is the name given to a thickening of the skin about the ankle. Roxburgh's definition of Keratosis has been adopted. He states that it is a circumscribed area of hyperkeratosis.

2. LITERATURE.

In the literature only brief references to keratosis about the instep have been found. It has been mentioned as occurring in chronic pellagra, chronic vitamin A deficiency, and in association with Follicular Keratosis.

3. DESCRIPTION OF ANKLE KERATOSIS.

In the North East of England, Ankle Keratosis is known as 'boot scruff'. The skin is thickened, dirty-looking, and rough to the touch. Three degrees of keratosis are described. The extent of the lesion is variable.

4. ASSOCIATED CONDITIONS.

(a) All cases of Congenital Ichthyosis present a localised thickening of skin in the ankle region. This appears to form part of the general skin abnormality, but taken alone, is indistinguishable from the condition described as Ankle Keratosis.

(b) In many cases, particularly in institutional children

the keratosis was closely associated with Asteatosis or 'Weathering'.

(c) The only other skin abnormality which occurred with any frequency was Follicular Keratosis.

5. INCIDENCE OF ANKLE KERATOSIS.

Figures for the incidence are based on the examination of one hundred and thirty-eight adults and two thousand eight hundred and fifty-three children aged from two to seventeen years.

(a) Total Incidence.

Ankle Keratosis was found to occur in approximately 30 per cent of the population, and in 8.97 per cent the lesion was severe in degree.

(b) Age Incidence.

No case was seen in children under two years. In those under five years and in adults, the condition occurs infrequently and in a mild form. It is common in children of school age, 31 to 33 per cent of whom are affected. Most cases were very mild, but in 7 to 8 per cent of school children second degree changes were seen, and third degree changes occurred in 1.5 to 2 per cent.

(c) Sex Incidence.

Boys have a higher incidence and a more severe type of keratosis than girls.

(d) Seasonal Incidence.

A seasonal variation in the frequency and severity of

Ankle Keratosis was shown to occur.

(e) Geographical Incidence.

A consideration of the incidence of Ankle Keratosis in four representative areas of Scotland and England shows that third degree keratosis occurs more frequently in the North East of England than in the other areas examined. The incidence of all grades of keratosis was significantly low in the South of England, and the infrequency of severe keratosis there and in the Midlands is also statistically significant.

(f) Regional Incidence.

All degrees of Keratosis occurred with greater frequency in children from Newcastle-upon-Tyne than in those from the towns and villages of Northumberland. This variable incidence could not be explained by the differences between town and country conditions of life.

(g) Social Status.

Study of the social status of the children is not conclusive, but there appears to be a tendency for Ankle Keratosis to occur with greater frequency in families from the lower income groups. The condition has been noted, however, in children of the professional classes. Institutional children show a significantly higher incidence of the lesion than any other class of child.

(h) Familial Incidence.

A study of twenty families shows an apparent familial tendency towards the development of Ankle Keratosis. Many fathers reported that as boys they had had 'boot scruff'.

(i) Influence of Past and Present Disease.

The incidence of Keratosis is lower in sick than in healthy children, and no relationship was found between the frequency or nature of past diseases and the development of the lesion.

6. ETIOLOGY OF ANKLE KERATOSIS.

(a) The Influence of Heredity.

No real evidence was obtained that the condition is hereditary.

(b) The Influence of Nutrition.

No relationship was found between minor degrees of malnutrition and Ankle Keratosis.

(c) Influence of Minor Types of Trauma.

Ankle Keratosis appears to be a response of the skin to various irritant factors. There is a close relationship between the lesion and the footwear.

(i) Friction. The area of skin affected by friction of the footwear corresponds roughly to the distribution of third degree keratosis. Several cases of Ankle Keratosis, however, cannot be explained by friction of the footwear.

(ii) Exposure to Damp, Cold, Wind, Alkalies, and Hard

Water. The effect of these traumatic factors on the skin is to produce the condition called 'weathering'. 'Weathering' and Keratosis may co-exist or may occur independently of each other.

The age, sex, seasonal, and familial incidence of the lesion can be explained by these environmental factors, and by the time and care expended on washing and drying of the skin. These factors may also explain the more frequent occurrence of Ankle Keratosis among children of the lower income groups. The hard water and the cold East winds in the North East of England are thought to be related to the high incidence there of third degree changes.

(7) PATHOLOGY.

The morbid anatomy is described in detail, and a special technique for this type of study is described.

Biopsy material was obtained in five cases and the histological appearances are described and discussed.

(8) CLINICAL FEATURES.

(a) Symptoms.

Ankle Keratosis causes no complaint other than its dirty appearance and roughness to the touch.

(b) Course.

It usually improves or disappears in Summer, and reappears in the Winter or Spring. In adult life spontaneous cure apparently takes place.

(c) Complications.

There are no complications. 'Weathering' is frequently associated.

(d) Treatment.

Treatment consists of:

(i) Protection of the skin from the types of trauma listed above.

(ii) Care in the washing and drying of the skin particularly in districts where the water is hard and when wintry weather prevails.

(iii) The application of an emollient ointment either as a prophylactic or as a therapeutic measure.

(9) SIGNIFICANCE OF ANKLE KERATOSIS.

Ankle Keratosis is classified as a Minor Skin Abnormality. It has no nutritional significance.

Its presence in severe degree reflects on the social background of the child and on the amount of time and care devoted to the washing and drying of the skin.

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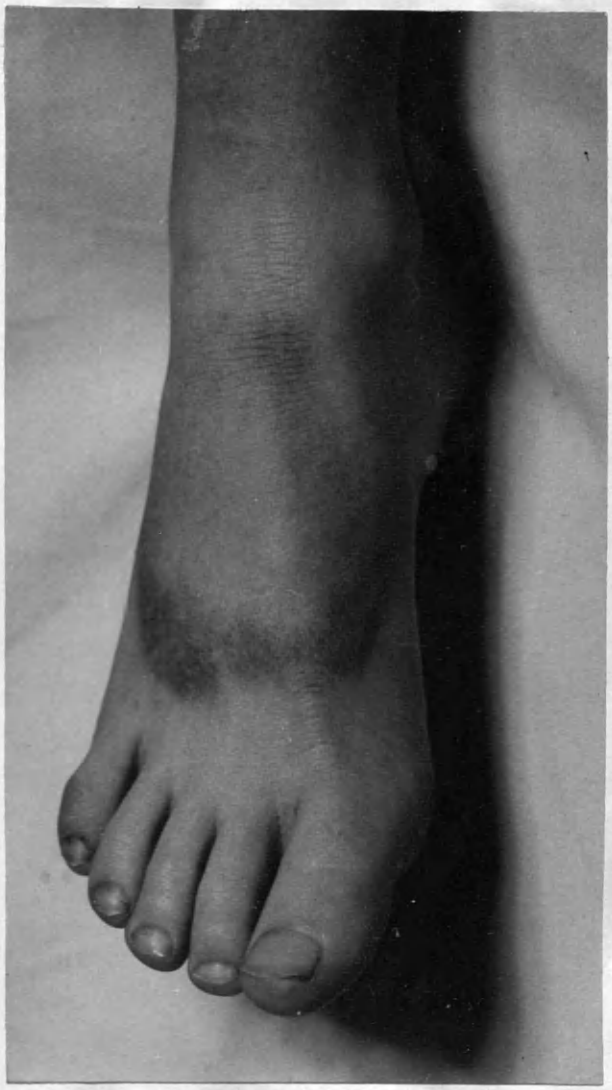


Plate No.1
J.M. 27/4/44

Sandal distribution of Ankle Keratosis.

(Skin treated with Charcoal Ointment)

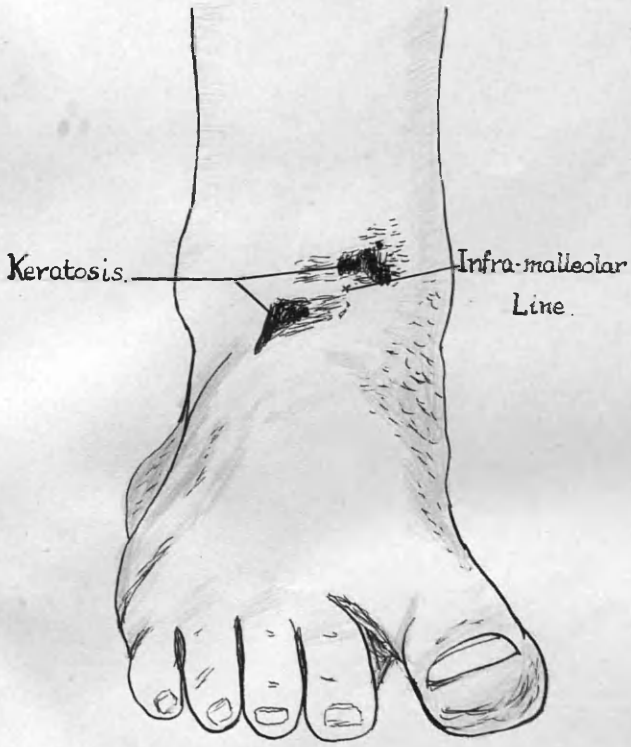


Plate No.2
E.R. 22/5/45

Shoe distribution of Ankle Keratosis.

Note the freedom from Keratosis of Infra-malleolar Line.

(Skin treated with Charcoal Ointment)

Fig.1.

Plates No.3 and 4
J.B. 7/3/45

Shoe distribution of Ankle Keratosis
with and without shoes.

Keratosis present on both ankles - Left
ankle treated with Charcoal Ointment.

Plate No.5
M.A. 4/1/46

Shoe distribution of Ankle Keratosis - (Untouched)

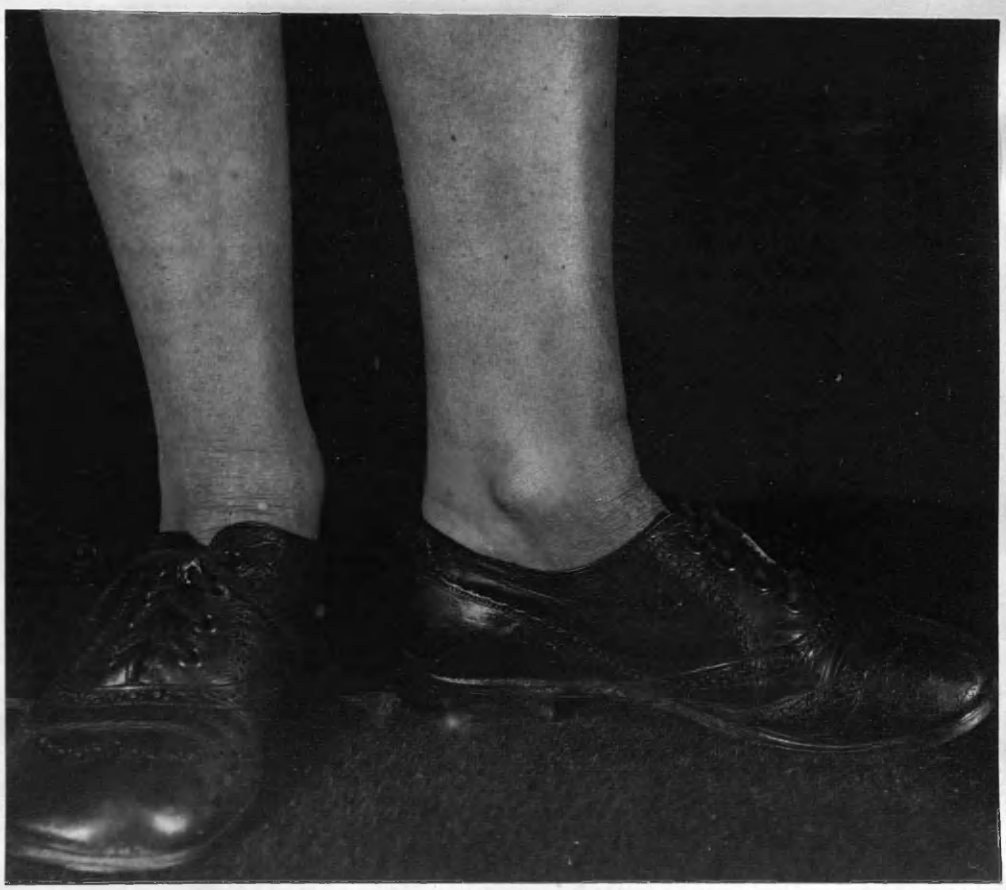


Plate No.6
M.A. 4/1/46 See Plate No.5

Shoe distribution of Ankle Keratosis (Untouched)

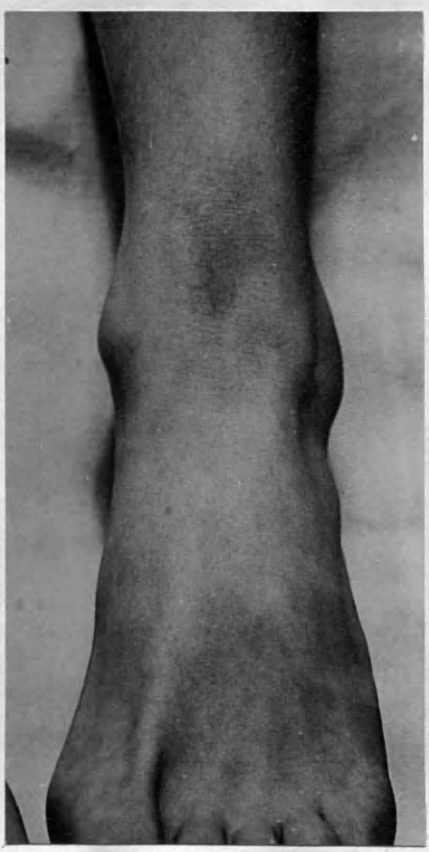


Plate No.7
W.M. 3/10/44

Typical mild Ankle Keratosis in Boot Position.

(Keratotic area shaded lightly with pencil)

Plate No.8
N.W. 4/1/46

Boot distribution of Ankle Keratosis showing the relationship between the site of Keratosis and the boots.

Plate No.9
N.W. 4/1/46

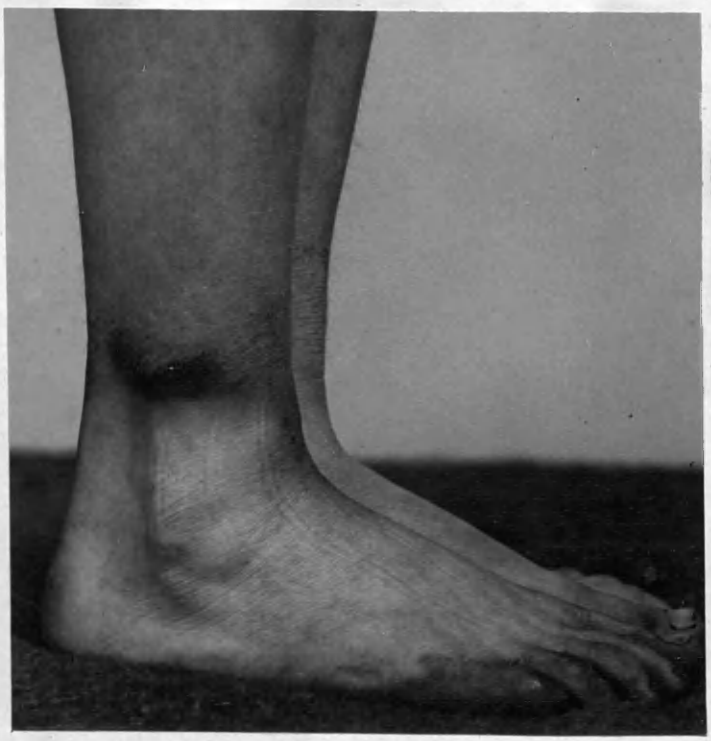


Plate No.10
B.W. 16/7/45

Boot distribution of Ankle Keratosis, lateral aspect. Keratosis is above the Boot-Top Level.

(Small area treated with Charcoal Ointment)

Plate No.11
B.W. 16/7/45

Posterior aspect of leg showing boot distribution of Ankle Keratosis.

(Skin not previously treated with Charcoal Ointment)

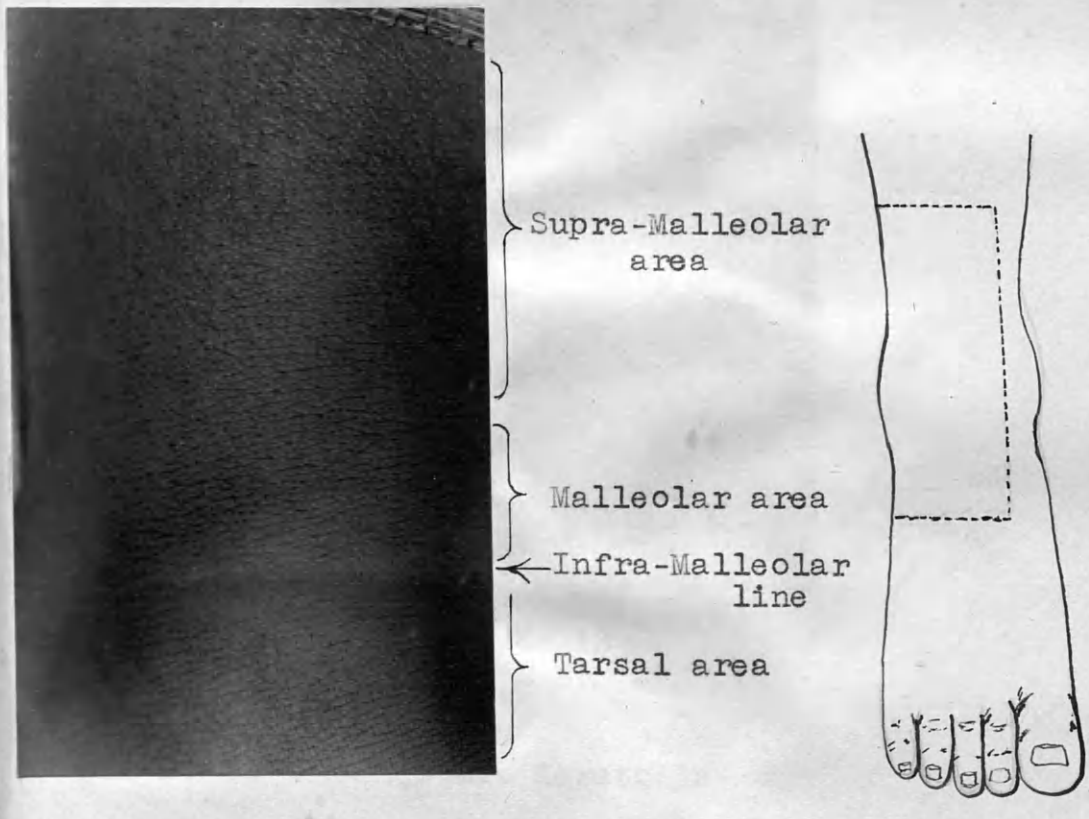


Plate No.12
D.P. Jan. 1945

Ankle region of infant 4 months old treated with Charcoal Ointment to show normal infantile skin markings with well marked Infra-Malleolar Line.

Magnification = 3X

Diagram to show area of skin photographed in Plate No.12.

Fig.3.

Plate No.13
L.N. 29/9/44

Crutch Keratosis

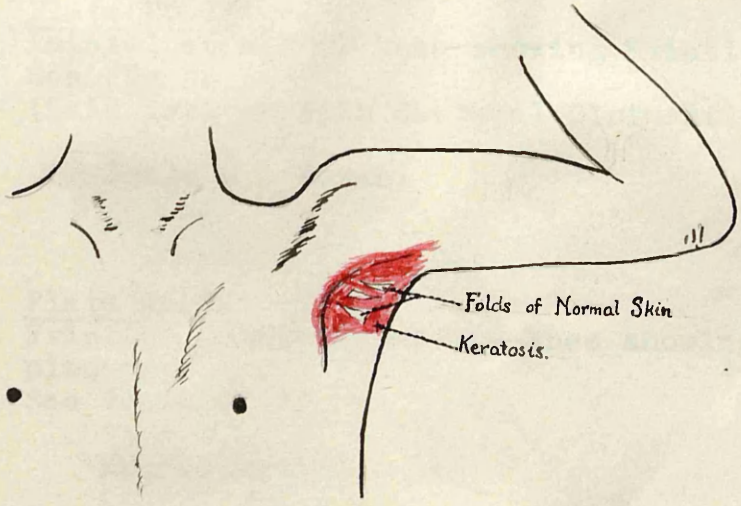


Diagram to show distribution of Crutch Keratosis

Fig.6.

Plate No.14
G.G. Oct. 1944

Plate No.15
G.G. Oct. 1944

Plate No.14
Lateral aspect of knee showing Friction Keratosis.
See Fig.No.7.
(Skin treated with Charcoal Ointment)

Scale - ½ Normal.

Plate No.15
Friction Keratosis of the knee showing Keratotic plaques.
See Plate No.14.

Magnification - 1½X

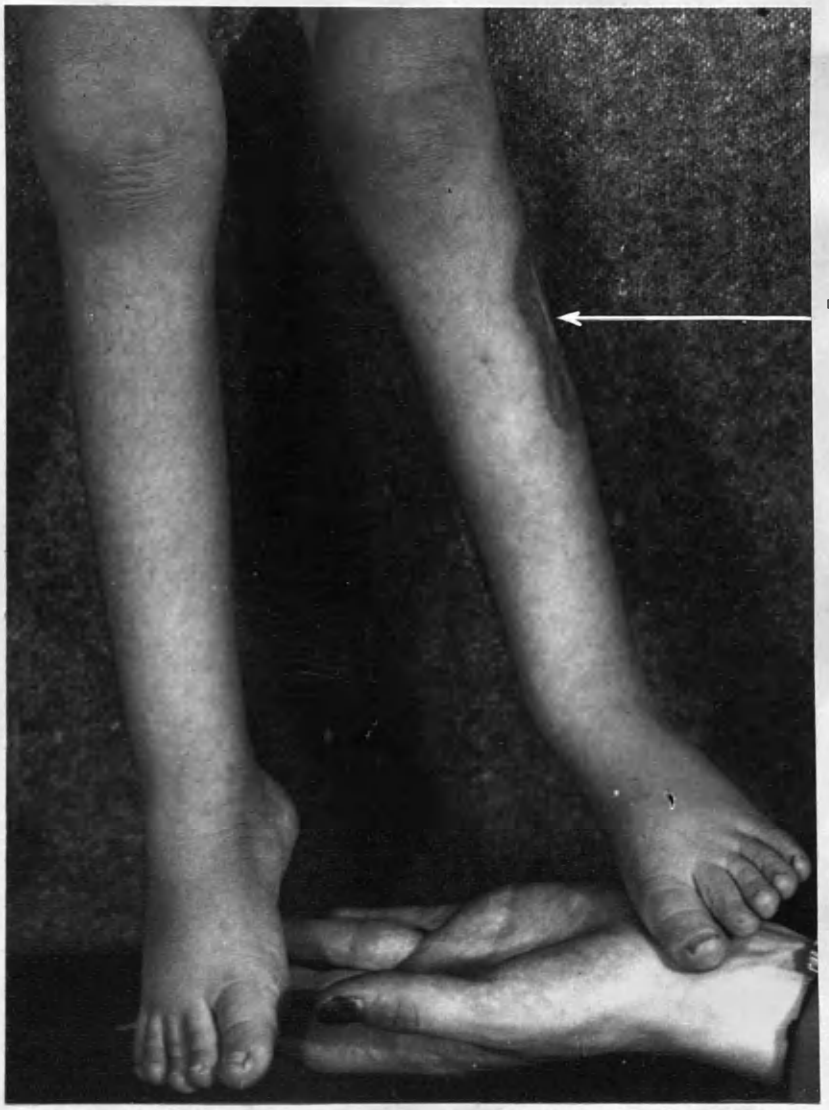


Plate No.16
D.P. 28/8/44

Friction Keratosis of both knees, of the Right medial malleolus and of the medial aspect of the Right Foot in a boy with paralysed legs.

(Skin not treated with Charcoal Ointment)

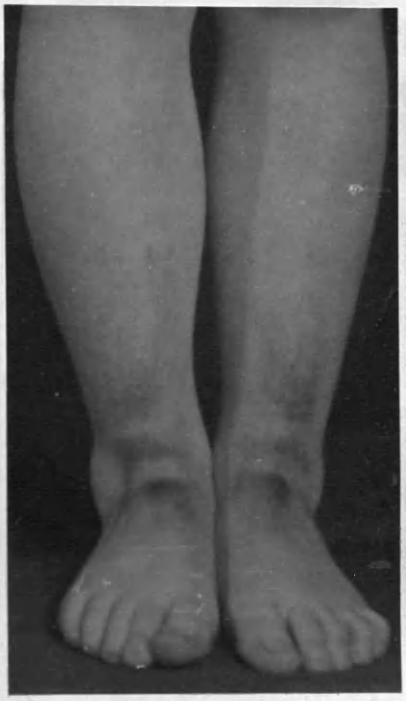


Plate No.17
J.L. Mar.1945

Plate No.18
J.A. June 1945

Plate No.17
Keratosis in the Tarsal and Malleolar areas.
'Weathering' in the supra-malleolar area.

(Skin treated with Charcoal Ointment)

Plate No.18
Keratosis in malleolar and supra-malleolar areas.
Associated 'Weathering' above boot-top level.
Supra-malleolar line is unaffected by keratotic process.

(Skin of right ankle treated with Charcoal Ointment)

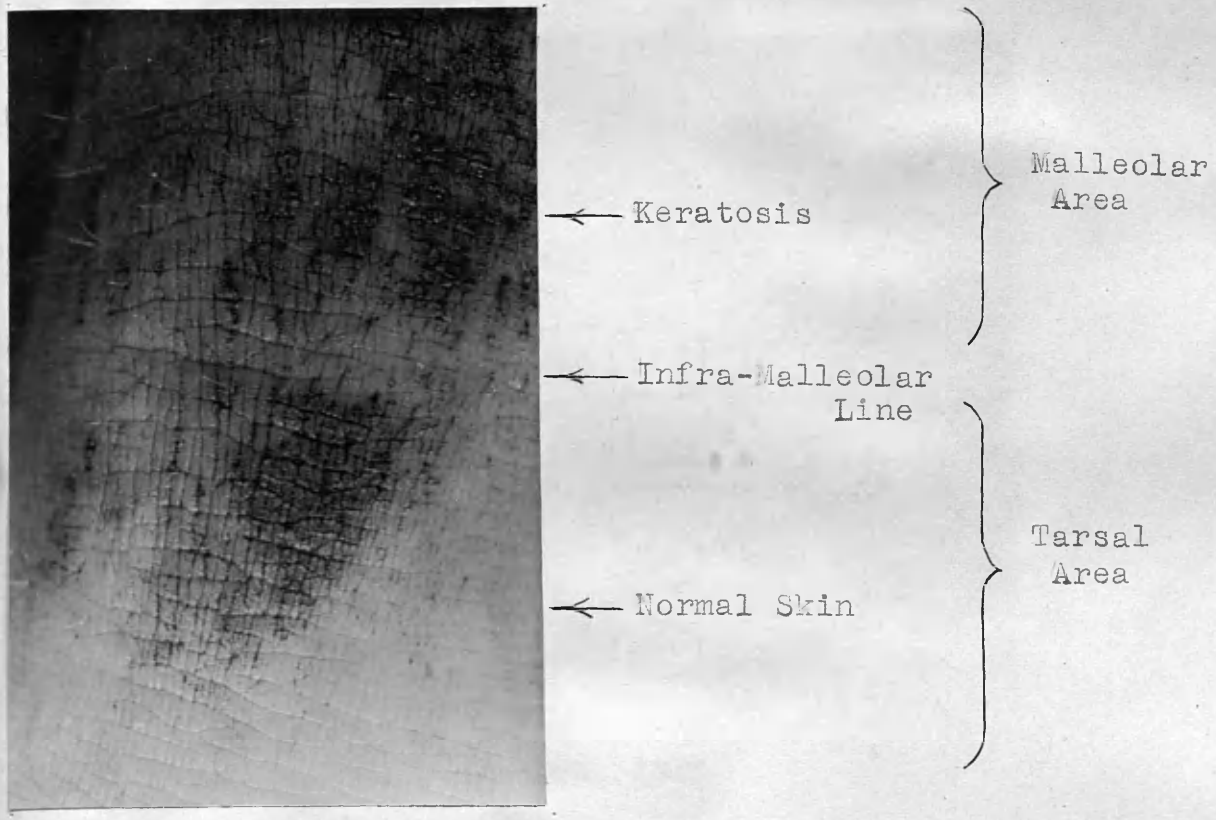


Plate No.19
J.D. Mar.1945

Ankle Keratosis involving the skin of Malleolar and Tarsal areas. Infra-Malleolar line is unaffected by the keratotic process. Note also the sharp line of demarcation between the normal and keratotic skin in the Tarsal area.

Magnification = 3X

Plate No.20
W.H. Dec. 1945

Middle third of leg showing numerous 'chaps'.

(Skin not treated with Charcoal Ointment)

Plate No.21
K.S. Oct.1944

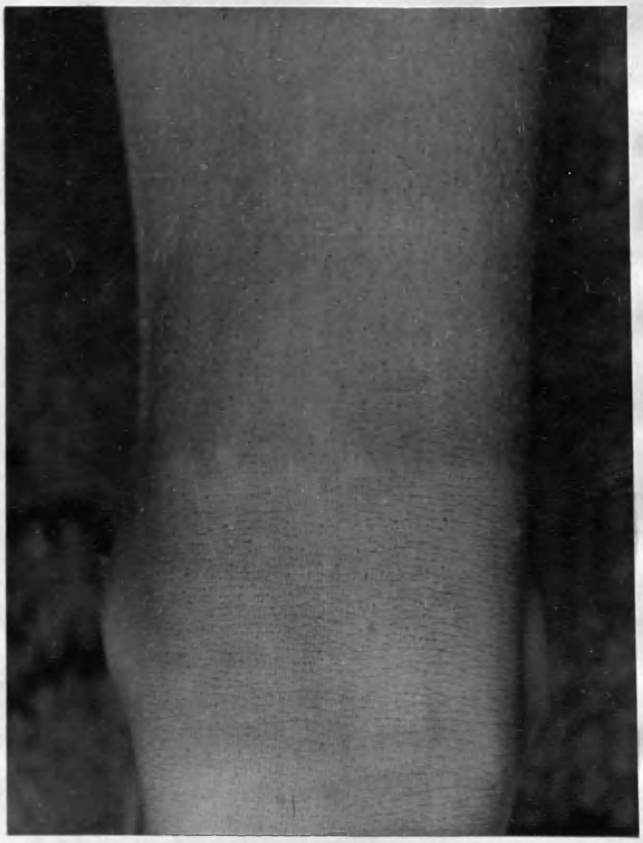
Plate No.22
K.S. Oct.1944

Photographs of Keratosis and 'Weathering' to show their Relationship to Footwear.

'Weathering' is mainly above the Boot-Top Level.

Keratosis is mainly below the Boot-Top Level.

(Skin treated with Charcoal Ointment)



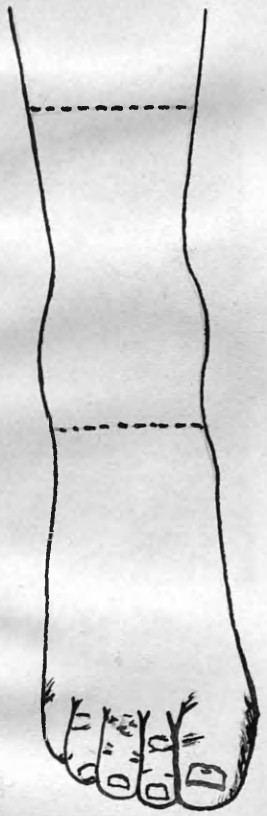


Plate No.23
L.W. Oct.1944

Ankle region in child of 5 years treated with Charcoal Ointment to show normal pattern of Simon's Lines.

Diagram of ankle region of right foot. Dotted lines show the extent of skin surface photographed in Plate No.23.

Fig.12.

NORMAL SKIN

Plate No.24

Plate No.25

Plates No.24 and 25.

Skin of Malleolar region treated with Charcoal Ointment to show normal skin markings in two children aged 10 years. Note the wide variation in the size of the rectangular areas in children of the same age.

Magnification = 3X

DOUBTFUL KERATOSIS

Plate No.26

Plate No.27

Plate No.26 : Coarse Skin Markings.

Simon's Lines are deeper and retain more Charcoal Ointment than normal. There is no appreciable thickening of the skin on palpation.

Magnification = 3X.

Plate No.27 : Superficial or First Degree Mosaic Pattern. The mosaic pattern is most marked in the upper part of the photograph.

Magnification = 3X.

FIRST DEGREE KERATOSIS

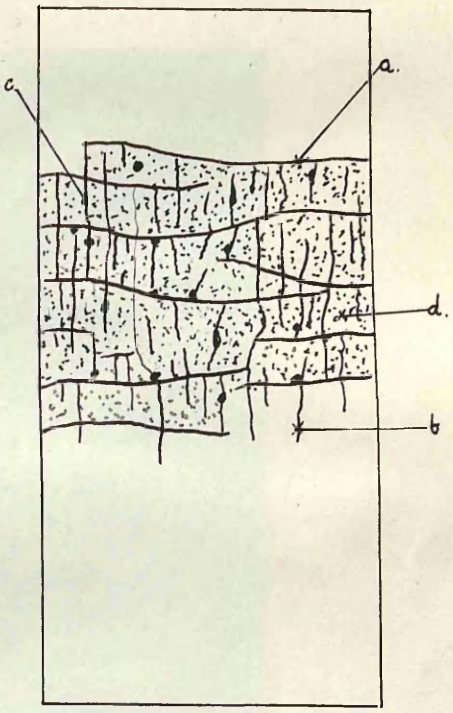


Plate No.28

Simon's Lines are coarse and retain more Charcoal Ointment than normal. The rectangular areas are covered with pin-point depressions giving the appearance of 'stippling'.

Magnification = 3X.

Diagram to show the main features of Plate No.28.

a - Transverse Simon's Line

b - Longitudinal Simon's Line

c - Hair follicle

d - Rectangular area showing 'stippling'.

Fig.13.

FIRST AND SECOND DEGREE KERATOSIS

Plate No.29

Keratotic Skin over and around the head of the talus on the dorsum of the foot, treated with Charcoal Ointment. Second degree mosaic and coarse skin markings present.

Magnification = 3X.

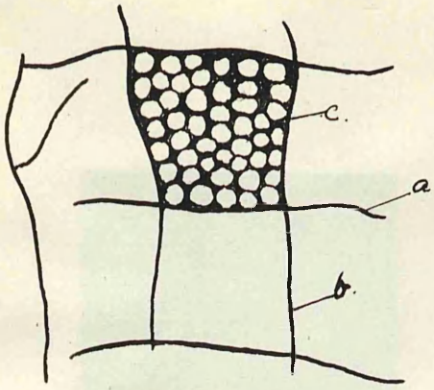


Fig.14

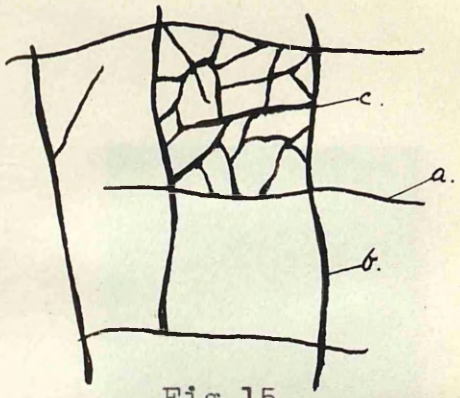


Fig.15

Fig.14 - Mosaic Pattern

a - Transverse Simon's Line
b - Longitudinal Simon's Line
c - Mosaic pattern filling rectangular area

Magnification = 8X

Fig.15 - Irregular Subdivision

a - Transverse Simon's Line
b - Longitudinal Simon's Line
c - Irregular subdivision of rectangular area

Magnification = 8X

Plate No.30

Irregular subdivision of rectangular areas. Simon's Lines are deeper and retain more Charcoal Ointment than normal. The normal rectangular areas are broken up by irregular side branches from Simon's Lines.

Magnification = 3X

Plate No.31

Plate No.32

Plates No.31 and 32

Irregular Mosaic Pattern. Before and after treatment with Charcoal Ointment.

Magnification = 3X

SECOND DEGREE KERATOSIS

Plate No.33

Second degree Keratosis.

Skin treated with Charcoal Ointment.

Magnification = 2X

THIRD DEGREE KERATOSIS

Plate No.34

Third degree Keratosis. Skin not treated with Charcoal Ointment. Simon's Lines are very deep and contain dirt particles. Quadrilateral areas are covered with keratotic plaques except in lower third of the plate where an abrupt change to normal skin occurs.

Magnification = 3X

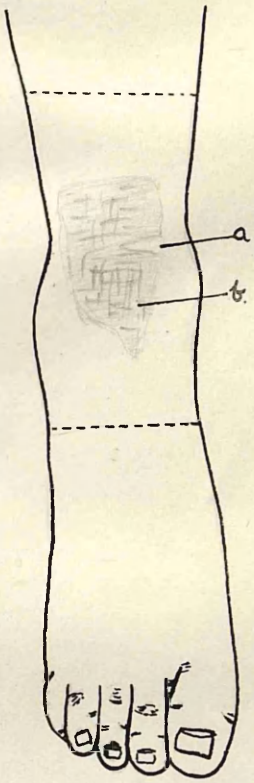


Plate No.35

Third degree Keratosis in Malleolar Area.

Natural size

Diagram showing area of skin photographed in Plate No.35.

a - Supra-Malleolar Line

b - Keratotic Plaques

Fig.16.

Plate No.36

Weathering with 'chaps' or 'keens'

Skin treated with Charcoal Ointment. 'Chaps' retain charcoal and stand out clearly. Some stippling and swelling of the rectangular areas is present round the larger 'chaps'. 'Chaps' develop along Simon's Lines and may be longitudinal or transverse in direction.

Magnification = 3X

Plate No.37
K.S. Oct.1944

(See Plates No.21 and 22)

Keratosis and 'Weathering' in skin of leg immediately above the malleoli.
(Skin treated with Charcoal Ointment)

Magnification = 3X

Plate No.38
B.T. June 1945

Plate No.38 and Fig.No.17
Heel and posterior aspect of leg showing Keratosis at boot-top level before biopsy.

a - First degree keratosis
b - Second degree keratosis
c - Third degree keratosis
d - Tendo Achilles
e - Line of biopsy incision
f - Medial Malleolus

Fig.17.

Plate No.39
B.T. June 1945

Keratosis of Tendo Achilles at boot-top level.

Skin treated with Charcoal Ointment.

Ink line shows position of biopsy passing through first, second, and third degrees of keratosis from above downwards.

Magnification = 3X

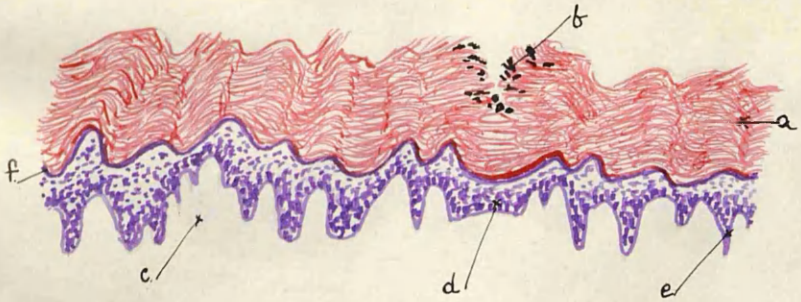
Plate No.40
B.T. June 1945

Section (a) - Second and Third Degree Keratosis

Magnification = 25X

Diagram to show the main features of Section (a). Second and Third Degree Keratosis.

See Plates No.38, 39 and 40.



a - Hypertrophied Stratum Corneum

b - 'Crack' in stratum corneum containing dirt particles

c - Compound Papilla

d - Square rete peg at base of 'crack'

e - Narrow interpapillary process

f - Stratum granulosum

Fig.18.

Plate No.41
J.L. Jan.1946

Section (c) showing simple "crack" in stratum corneum.

Magnification = 250X

Plate No.42
J.L. Jan.1946

Section (c) showing "crack" with parakeratotic base in stratum corneum.

Magnification=250X

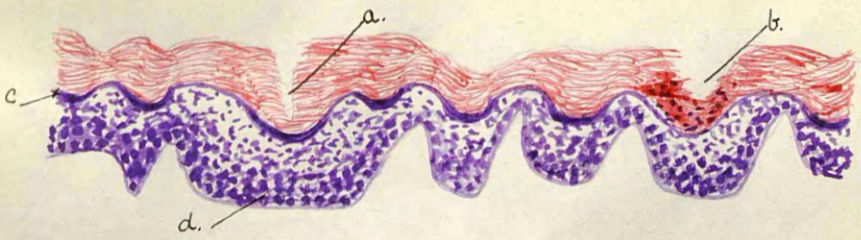


Diagram to show the main features of section (c) 'Weathering'.
See Plates No.41 and 42.

a - Simple 'crack' in epidermis

b - 'Crack' with parakeratotic wedge at its base

c - Stratum granulosum

d - Rectangular rete peg supporting the 'crack' in stratum corneum.

Fig.19.

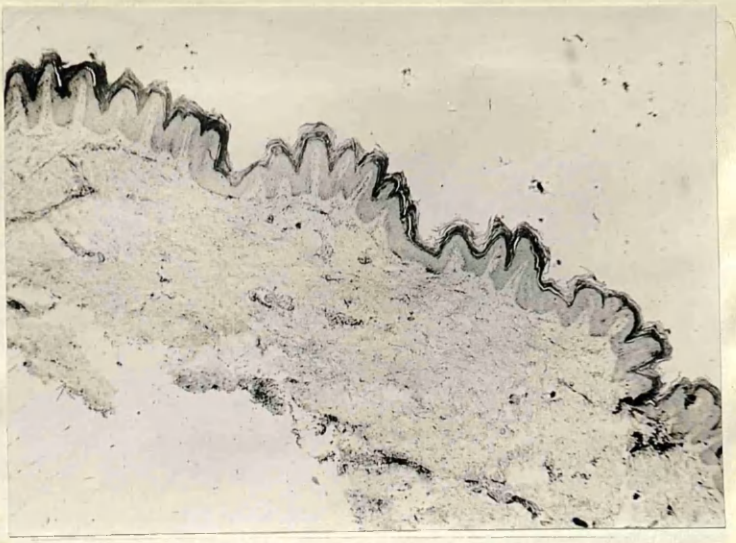
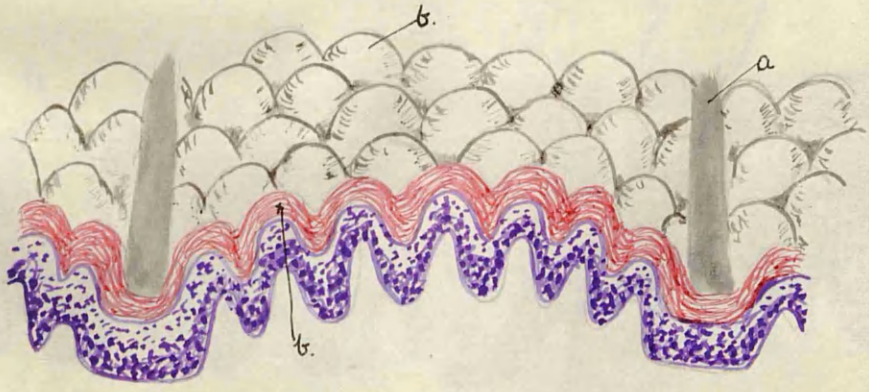


Plate No.43
H.M. Dec.1945

Section (d). Second degree keratosis with marked mosaic patterning.

Magnification - 25X

Diagram of section (d) to show the formation of the mosaic pattern.



a - Simon's Line

b - Hillock formed by papilla and its epithelial covering.

See Plates No.29 and 43 and Fig.No.14. (above Plate No.30)

Fig.21.

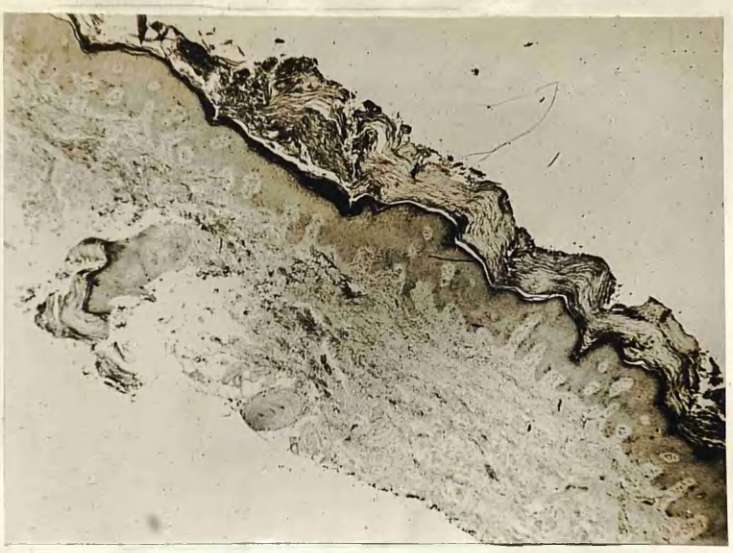
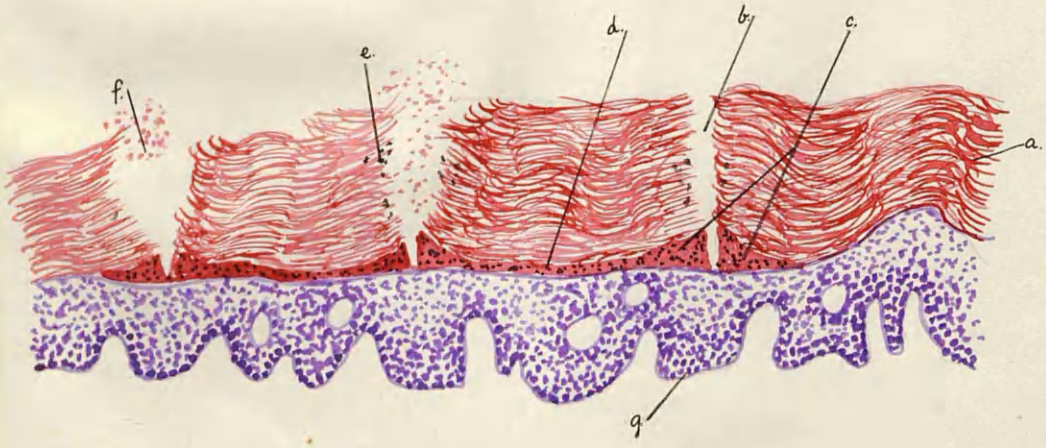


Plate No.44

Section (e) showing 'weathering' on the left and keratosis on the right of photograph.

Magnification = 25X

Diagram to illustrate the main features of Plate No.44.



a - Hyperkeratosis
b - 'Crack' in epithelial squames
c - Wedge of parakeratosis at base of 'crack'
d - Layer of parakeratotic tissue bridging the gap between two 'cracks'.
e - Dirt particles
f - Red blood corpuscles
g - Rectangular rete peg at base of 'crack'

Fig.22.

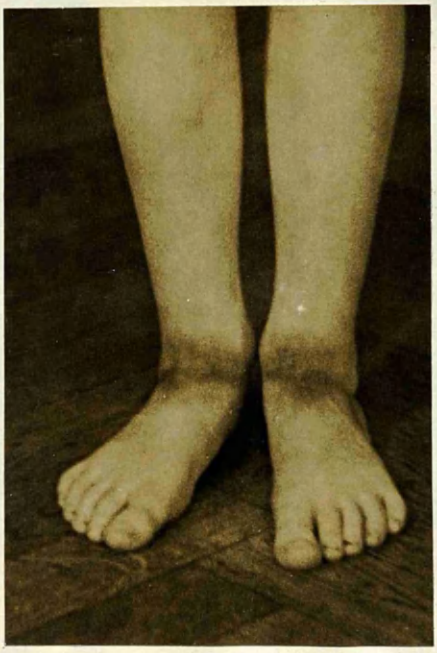


Plate No.45
A.G. 17th April 1945

Extent of Keratosis on both ankles shown by application of Charcoal Ointment.

Before Treatment.

Mid-Tarsal and Mid-Malleolar Areas of Left Foot.
Showing rate of cure of Keratosis on Treatment.

Plate No.46
17th April
Before treatment

Plate No.47
19th April
After two days'
treatment

Plate No.48
23rd April
After 6 days' treatment

Mid-Tarsal and Mid-Malleolar Areas of Right Foot which received no treatment.

See Fig.23 and 24.

Plate No.49
17th April

Plate No.50
19th April

Plate No.51
23rd April