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Ringworm of the feet

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RINGWORM OF THE FEET

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Senior Thesis

John N. Stewart

1932

INTRODUCTION

Epidermophytosis, fungus infection, ringworm, tenia of the feet, or "athlete's foot" is a well known, but much confused and poorly understood disease. Most of the confusion may be traced to several causes: its reputation as being a new disease (probably because it is increasing), its treatments being as widely diversified and as numerous as they are unsatisfactory; because it is known to be very communicable in some cases while it is not in others; and because it is very widely distributed.

It is regarded by many as trifling and unimportant. However, it is of enough annoyance to hundreds that its name, "athlete's foot" has been commercialized with great success.

The disease may be entirely asymptomatic and go unnoticed, or it may be of such severity as to cause the patient to be confined to bed or to his rocker without shoes or hose for one or more weeks. The results may be very serious when the disease becomes complicated.

With the ever increasing vogue of public swimming pools, showers, gymnasiums and other community athletic enterprises, new and potent modes of spread are resulting. The disease already has its hold on a large percentage of our population and has become of real

importance.

This paper is designed to point out the results of an examination of 362 apparently normal students from ages of five to over twenty-five years, with the idea of getting the approximate incidence, types and severity of ringworm of the feet, as well as some information regarding etology.

In addition I have tried to comb through the literature in an effort to summarize the information leading to one object: Some sort of a working basis for the understanding of the disease; a means of definite diagnosis, a laboratory means of tracing epidemiology, and thus a check for its rapid increase in prevalence.

HISTORICAL

Until the last fifteen years of the nineteenth century, ringworm in all its types and in all its situations was thought to be due to one fungus - the trichophyton. The clinging to this belief is somewhat strange, because, although the brilliant work of Sabouraud, independently pursued but a few years back, by which the plurality of fungi causing this malady was established, it was, as this distinguished investigator subsequently ascertained and pointed out, practically an elaboration of what Gruby had indicated fifty years before. The significance and brilliancy of his discovery during all this interim had remained not only unappreciated, but unrecognized. Bazin, a Parisian dermatologist and research worker, in a French volume, Recherches sur la nature et le traitement des teignes, Paris, 1853, confirmed the observations of Gruby's work. (See Williams - 1)

About this time it was learned that Malmsten in 1844 had independently discovered one of Gruby's fungi which he called the *Trichophyton tonsurans*. The common belief was that this fungus was one of the common molds without much significance as a cause of disease. Perhaps one of the factors involved in the failure to grasp Gruby's significant work was an incident

involving the work on a disease of the scalp. In the first decade of the nineteenth century a London physician, Thomas Bateman, applied the term "porrigo declavans" to the scalp disease now known as Bateman's disease, or alopecia areata. Later Gruby unfortunately applied the term "porrigo declavans" to a scalp disease caused by a small-spored fungus (*Microsporon audouini*). Other workers following Gruby's time, in fact up until about 1890, erroneously believing the *M. audouini* to be associated with Bateman's disease or alopecia areata, always looked in vain for his supposed fungus, which was soon considered mythic.

The common idea at this time was that the fungus *Trichophyton* was one of the common molds without specificity. The *Trichophyton* was only gradually accepted by the dermatologists as the etiologic factor in all ringworm cases. This view continued to be held until the result of Sabouraud's studies was announced.

Sabouraud, who has done so much in the investigations of the fungi, based his earlier classification upon the size of the fungus elements and their relations to the hair shaft and root, as well as their resistance to potassium hydroxide solutions. His classification then consisted of two main divisions: (1) *microsporon*, or small spored fungus; (2) the

megalosporon or trichophyton, or large-spored fungus. He further divided the megalosporons or trichophytos into, (1) *Megalosporon ectothrix* or *Trichophyton ectothrix*, now commonly referred to as "ectothrix" in which the fungus is found on the outside or chiefly near the surface of the hair shaft; (2) *Megalosporon endothrix* or *Trichophyton endothrix*, in which the fungus is found on the inside of the hair shaft; (3) "endo-ectothrix" which was supposed to be an ectothrix of long-standing which had penetrated into the cortex of the hair.

The *Megalosporon endothrix*, or *Trichophyton endothrix*, was further divided into two subspecies; (a) resistant, which was little affected by the potassium hydroxide solutions; (b) fragile variety, more or less disintegrated by the hydroxide.

Later investigations by Sabouraud disclosed that the etiologic fungi were in reality in much larger numbers than it had originally been supposed, and that it was not possible to identify them all by the differences referred to. He found that some of the *Trichophyton endothrix* had small round spores that might be confused with the microsporon group. These and other reasons led to the necessity of establishing other more certain means of individual identification. He found the most convenient for the purpose

was culture, which had as its foundation the famous Sabouraud's medium. According to these later studies, more than fifty varieties of the two classes of fungi were found to be associated with ringworm, but of which over a score are rarely seen.

This classification which gradually took form in the last two decades of the nineteenth century has suffered little revision from the works carried out since, but has had many additions and elaborations. By this time nearly all dermatologists believed with Sabouraud that each fungus was a more or less specific cause, producing a fairly true clinical picture, but, as in the case of the bacteria, the features, character, and behavior of the ringworm vary considerably according to the part involved, whether it be general, non-hairy surface, the genitocrural region, the scalp, and so on. Also the ringworm itself may undergo morphologic variations over a period of years. (2)

Finally, when one looks at the classification which has evolved during the past sixty years, one is confronted with its complexity and involvement due to the establishment of new main groups of fungi based on clinical as well as cultural behavior. "It has become a homily by now that fungus classification is badly jumbled; this is due partly to the attempt to utilize both clinical and mycologic characters as

the basis for classification - an unwise plan. For instance, the achorions are those organisms which produce cups on the skin; microsporons are organisms which have small spores, and trychophyton and epidermophyton refer to the habitat of the fungus. That is, there is nothing consistent about this hybrid, quasi-clinical classification". Weidman (3)

The foregoing is a brief summary of the developments of the work on the fungi in a general way. None of the fungi mentioned have to do with the causation of the disease of the feet to be dealt with in this paper, but any discourse on the "newer fungus", as it has been called by Whitfield and other modern investigators, must necessarily be brought up to date by some sort of introduction to the previous work in mycology.

The "newer fungus", or the epidermophyton, has been brought to light during the some thirty years of this century. Those responsible for the discovery of this fungus are; Lang, whose work antedated the work of the others to be mentioned by about ten years, and whose name is affixed to the genus name; Castellani (4) exponent of the Castellani classification based upon the morphology of the fungi in vitro; Sabouraud (5); Whitfield, to whom we owe the Whitfield's ointment; C. J. White of Boston and others.

It was found that the fungus causing eczema

marginatum (tinea cruris) was in many ways distinct from the ordinary ringworm fungi. It had always been supposed to be one of the trichophytons, but unlike any other species of this class - in which, however, Sabouraud placed it - it rarely attacks the scalp. (6) "It is also the pathogenic fungus in some cases of eczematoid and vesicular and vesiculobullous eruptions on the hands and feet; this fungus is thought to be of human origin". Stelwagon (12).

Epidermophytosis itself has a shorter and somewhat more stabilized history. It began to attract the attention of the general practitioners and dermatologists during the first ten years of this century. In 1910 it was still considered a new disease, although it was prevalent enough in some parts of the world to attract great workers five years before. From 1907 to 1911 the discoveries of Whitfield and Sabouraud were announced. (7 & 8). The now generally used types of treatment were then brought out, Whitfield advocating removal of superficial layers of the epidermis with salicylic acid combined with the antiseptic powers of benzoic acid. Sabouraud brought out the benefits following the use of Tincture of Iodine with Potassium Iodide in painting solution.

In this country the disease became to be considered prevalent by 1915. Many new treatments were evolved.

New paints and stains, as well as "soaks" and "bakes" for the feet, were tried with no more constant success than the methods used in Europe and Great Britain.

Classifications of the disease were attempted on every hand. (1) This together with the new discoveries and classifications in mycological laboratories caused a vast confusion in terminology. (9) At the present time there is still much confusion in nomenclature, and the vast number of treatments are only indicative of the number of therapeutic failures to arrest this disease.

The increase in prevalence, whether it be real or apparent, as White suggests (9), together with the stubborn resistance to treatment, accounts for the vast amount of literature, suggested treatments and general confusion of this disease.

CLINICAL CLASSIFICATION

The disease as seen on the feet may be classified clinically into various groups or types. These classifications vary a great deal with authors, due to the different methods of using the nomenclature and to the fineness to which one may carry the classification. Striker and Friedman (10) have gone so far in simplification as to class all cases as either symptomatic or asymptomatic. Others have carried the work to the other extreme. The fact that there are many types does not necessarily carry with it the meaning that there is a specificity for each type of lesion by a certain species of fungus.

A simple and complete classification used by myself after the suggestion of Dr. Donald J. Wilson of this city is:

1. Scaling
2. Fissures
3. Vesicular
4. Eczematoid
5. Callous
6. Nail involvement
7. Complicated by epidermophytosis hands
8. Complicated by keratolysis exfoliata
9. Clinically negative

This classification is based upon the clinical appearance of the skin and nails of the feet and hands, and was used in recording the findings to be described in a later chapter on Prevalance.

For further description of the appearance of these types see Clinical Diagnosis to follow.

The classification used herein is very similar to that used by C. J. White. (9) He used his similar classification in the study of his private patients. The modification used herein was chosen because it was advantageous for this type of work.

ETIOLOGY

The fungi concerned with ringworm of the feet is the Epidermophyton group. These fungi were discovered during the 1890's by Lang, (See History) studied in this country and in Europe by many investigators, and classified by the various methods. (Weidman - 3) The latest classification is perhaps the one by Castellani (4) - made in 1927-28 - which is based on the behavior of the fungus growth on various culture media and their appearance under the microscope: (Also see Castellani, 11.)

Definition: Trichophyton with mycelial filaments and spores present in the lesions and with pluriseptate spindles present in the cultures; does not attack the hairs or hair follicles, but grows in the superficial layers of the epidermis.

Type Species: Epidermophyton cruris Castellani, 1905.

Remarks: The fungi belonging to the genus, which has been investigated by Sabouraud and me, grow superficially on the skin without invading the hair follicles; they do not produce suppuration.

Castellani's Classification of the Epidermophytos
Castellani, 1927-28

Class I (Fungi Imperfecti)

FUNGI-

Class II
Ascomycetes-

Order
Aspergillales-

Family
Aspergillaceae-

Tribe
Trichophytoneae-
(Castellani
& Chalmers)

Genus
Epidermophyton
(Lang)

GENUS.

Epidermophyton Lang, 1890.
" Sabouraud, 1907.

Principle Species:

E. cruris Castellani, 1905.
E. perneti Castellani, 1907.
E. rubrum Castellani, 1907.
E. interdigitale Priestly,
1917.

The Epidermophyton grows superficially in the skin. It is said by most authors not to invade the scalp, the hairs or hair follicles. Stelwagon (12) calls our attention to a case in the literature, however, in which it has apparently invaded the scalp. (6)

It is agreed that suppuration is never caused by this fungus. In the bullous type, there are bullae filled with a more or less cloudy, sticky fluid which may be mistaken for a serous-like suppurative process, but these bullae have been found to be nearly sterile, the organism being confined to the superficial layers of the epidermis.

It has been shown that the infected scales of epidermis will remain viable for periods up to and even over a year. (D.L.Farley, 13) This being true, reinfection from one's own clothing, rugs or bath mats, seems highly probable. Many such instances are not recorded, although White (9) cites several such instances. He also states, ".....in all my 1,013 examples only a relatively few instances of familial infections could be detected - in fact less than 6% of this rather large number."

The role of hyperhidrosis is undoubtedly a very important one. The very high incidence of sweating as a symptom in these cases makes it a part of the clinical picture. The sodden epidermis resulting from sweating makes an excellent culture bed for fungus implantation. It is probable that the acidity and salts in the sweat may either lower tissue resistance or promote fungus attack. Weidman (3) quotes,

"Von Graffenrid (14) was unable experimentally to inoculate the skin with Trichophyton pedis until he had produced maceration of the skin and maintained it for sometime".

Levin and Silvers (16) have isolated fungi of the Kauffmann-Wolf group from sweat of the feet and believe this to be the source of infection in five out of eight cases.

Reinfection occurs from poor hygiene, i.e. infrequent washing of feet and changing of hose, from shoes, bathroom floors and mats, and from the resistant lesions on the same foot. The later is expecially true of lesions of the nails. Williams and Barthel (17).

Bacteria play an important part in epidermophytosis, as is shown by cultures taken from the feet of apparently normal persons. (Cornbleet, 15) Weidman goes so far as to ask: "How commonly are bacteria the primary and sole agents?"

PREVALENCE

"During the World War ringworm was found to be the most common skin disease. The United States Public Health Service reported that one-half of all the adults have this disease at some time and that in the Gulf States almost the entire population is affected. Nine-tenths of the habitues of the gymnasiums have this skin condition. Most people attending gymnasiums or pools at golf clubs, fraternal organizations, public bath houses, military organizations, hotels, schools - in fact, anywhere where the feet are exposed - are found to have this ringworm. Ruggles (18) of Rochester, N.Y., taking thirty-four cases at random at the Rochester Y. M. C. A., found everyone to be infected." Gould, Albany (19).

The geographical distribution of ringworm of the feet is shown by Legge (36) who found that the majority (85% in athletics) of the entrants to the University of California have the foot infection. These students come with it from as remote parts as China and Japan. (Also see Mitchell, 20). "A survey of thirty-five universities disclosed between 50% and 90% of the students to be involved." Gould, Albany (19).

Weidman (23) states that in the University of Pennsylvania 67% of 100 Freshman Medics have more or

less severe ringworm of the feet.

Osborn and Hitchcock (21) in their article on prophylaxis says that 90% of young athletic adults have the infection, and that 25% to 30% of junior high pupils are infected.

Dr. Donald J. Wilson of this city, working along the same lines made up a classification in convenient forms and examined the freshman medical students at the University of Nebraska in 1931. Through his kind consent and cooperation I was allowed to assist him in the examination. Using the same classification forms, I obtained permission from Dr. E. L. McQuiddy to examine the feet of the Technical High gymnasium class students during his annual health examination work. Then permission was obtained to examine the students of Pershing School during Dr. J. T. Myers' Public Health survey work among rural schools.

The list of examined students, totaling 362, was distributed over an age scale of from five to twenty-five years and over. The Pershing School group had no regular access to common showers or pools; the Technical High group were all daily using the same shower and dressing rooms; and the medical group mixed on the question of the use of common showers.

This arrangement was planned to get a fairly average cross section of apparently normal students

of all ages.

The points to be brought out by such an investigation are these:

1. Incidence as regards age.
2. Incidence as regards use of gymnasiums, showers, etc.
3. Incidence as regards total number.
4. Incidence of different types.
5. Incidence of symptomatic and asymptomatic.

Table I is the complete data resulting from combining the records into age groups from five to twenty-five years and over.

1. Incidence as regards age:

By glancing down the first three columns of Table I one sees as a general rule the incidence rises with the age. Table II shows the percentages of positive cases at the different ages. The incidence varies from 10% to 29% among the grade school ages; 16% to 33% among the junior high pupils; 70% to 80% among the high school students using gymnasiums; and 90% to 100% among age groups over high school age. The incidence among the Medical Student group was 96.7%, with ages over 23 years 100% positive.

C. J. White (9) in a report of 1,013 private cases gives an age incidence table analysing his cases as to decades in life, see Table III.

TABLE I

K E	1	8	9	2	4	3	5	2	0	1	3	6	3	3	0	2	9	3	1	0	3	2	71
EPIDERM	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
HANDS	0	0	0	1	0	0	1	1	0	10	11	36	25	20	8	15	13	5	9	3	5	5	2
GYMS-POOLS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ETC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NEGATIVE HISTORY	6	16	21	19	23	23	23	8	12	13	3	21	10	6	5	8	5	7	3	1	1	2	234
POSITIVE HISTORY	0	0	0	0	0	0	0	4	0	4	11	17	15	19	5	15	13	5	8	4	4	4	128
MACULES	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
NAILS	0	0	0	0	0	0	0	0	0	2	3	8	5	3	3	8	9	4	5	5	5	2	61
ECZEMATOID	0	0	0	0	0	0	0	0	0	1	1	1	2	3	0	2	2	1	3	1	1	2	20
CALLUSES	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	1	0	0	1	0	6
VESICLES	0	0	0	0	0	0	1	0	0	1	0	2	1	1	0	1	0	0	0	0	1	2	10
FISSURES	0	0	0	0	1	1	0	2	1	1	3	6	5	3	4	1	2	2	2	2	1	0	38
SCALES	1	3	2	2	5	2	6	2	2	4	9	28	20	17	6	23	16	11	10	5	4	6	184
POSITIVE	1	3	2	2	5	3	6	4	2	4	11	29	21	23	7	23	17	11	10	5	5	6	200
NEGATIVE	5	13	19	17	18	20	15	8	10	13	3	9	4	2	3	0	1	1	1	0	0	0	162
TOTAL	6	16	21	19	23	23	21	12	12	17	14	38	25	25	10	23	18	11	11	5	5	6	362
AGES	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	OVER 25	ALL AGES

TABLE II

Age	Total Numbers	Percent Positive
5	6	17%
6	16	17%
7	21	10%
8	19	10%
9	23	21%
10	23	13%
11	21	29%
12	12	33%
13	12	16%
14	17	24%
15	14	70%
16	38	73%
17	25	80%
18	25	92%
19	10	70%
20	23	100%
21	18	90%
22	12	92%
23	11	91%
24	5	100%
25	5	100%
over 25	6	100%
All ages	362	55.2%

TABLE III

Age Incidence (White)	
18 mo.	2
1st. decade	10
2nd. "	117
3rd. "	260
4th. "	225
5th. "	162
6th. "	128
7th. "	48
8th. "	8
9th. "	1

The results here are comparable to those just given. The incidence in White's group rose rapidly up to the third decade, then diminished rapidly. He gives no explanation. There is one factor that varies besides the age in such a group, namely; the use of common pools, showers, etc. Whether there are other factors involved such as susceptibility varying with age, one cannot prove, nor has anyone in reports in the literature shown such to be the case up to the present time.

One interesting fact brought out, while examining the children in the lower grades in Pershing School,

was that about half of the children were barefoot, and not one of these children showed any signs of the disease. This fact will be brought up later in TREATMENT, discussing White's "beach" treatment.

2. Incidence as regards gymnasiums, pools, etc.

There were twenty-seven negatives (26%) out of a total of 103 in the Technical High group, yet all were using the same showers and dressing rooms daily. This may have a dampening affect upon any emphasis I may try to place upon the importance of the common shower as a major agent of transmission. However, there comes in the same factor as in any communicable disease, that of resistance and susceptability. This will be dwelt upon in Etiology.

TABLE IV

	PERSHING	TECH.HI.	MEDICAL	ALL
Number				
Examined.....	169	103	90	362
Positive History of Showers etc..	3	103	61	168
Negative History of Showers etc..	166	0	29	194
Positive Cases.....	39	74	87	200
Negative Cases.....	130	29	3	162

Table IV shows the number of positive histories of common showers and pools and the number of positive cases. You will note that in the case of Technical High, the number of positive cases is less than 100%

possible exposure. This again refers back to the matter of resistance, contributory causes and so on. In the cases of the Pershing and medical groups, the incidence is far greater than the use of public showers. This would seem rather conflicting with the Technical High results, if one is to believe that showers are a potent means of transmission. To this I can only say that there are, of course, many other modes of spread such as private baths in homes and fraternity houses, etc., that would not fall under the heading of public showers.

That such public institutions are of prime importance as a fomite cannot be doubted. Many of the students in the medical group who knew they had the disease (many were entirely asymptomatic) traced the onset directly to the use of a specific bath house, gymnasium, fraternity shower and so on. More will be said concerning this in Prophylaxis.

3. Prevalence as regards total numbers.

In the opening paragraphs I cited a number of percentages of positive cases given by various authors on various groups of patients. The results of this investigation show that of the total of 362 cases, 55.2% showed some clinical form of the disease. See Table II.

These figures, of course, are of little value as

an indication of the true incidence because of the limitation to students and because of the small number. I have been unable to find other figures based upon a fair cross section of the population and of large enough number of cases to be of real value as an index of the true incidence of epidermophytosis.

4. Incidence of the various clinical types.

In examination of apparently normal subjects, one would not expect to find as many of the acute symptomatic types as would the dermatologist. This was found to be the case. Most of the cases were very mild, benign and of more or less short duration with the exception of the older groups, some of whom had had the infection for several years. Table V shows the percentages of the clinical types. White's Table VI shows the number of the various types he has classified from his analysis of 1,013 private patients. The apparent discrepancy between his ratios and those herein is due to the fact mentioned above. His figures show the vesicular form at the top of the list, while I found only 5% of the positive cases had vesicles. The explanation is that the vesicular type is acute and usually causes enough symptoms to bring the patient to seek medical attention.

TABLE V

Of the 200 positive cases:

92%	had	scales
19%	"	fissures
5%	"	vesicles
3%	"	callouses
10%	"	eczematoid type
30%	"	nails involved
1%	"	macular type
64%	"	symptoms
36%	"	no symptoms
84%	"	used pools, showers, etc.
1%	"	epidermophytosis of the hands
35%	"	keratolysis exfoliata

TABLE VI (White)

TYPES	INCIDENCE	
vesicles	382	cases
scales	370	"
macules	305	"
fissures	112	"
callouses	52	"
maceration	159	"

TABLE VIII (White)

INCIDENCE AND OCCUPATION	
Housework or none.....	224
Students.....	172
Clerks.....	153
Doctors, Nurses, and Dentists.....	69
Salesmen.....	41
Lawyers.....	29
Clergymen.....	14
Others.....	289
Total.....	1013

TABLE VII

	SYMPTOMS	NO SYMPTOMS	TOTAL
Scales alone	42	103	143
Fissures	8	30	38
Vesicles	9	1	10
Callouses	5	1	6
Eczematoid	20	0	20
Nails involved	20	41	61

5. Incidence of symptomatic and asymptomatic types.

Striker and Friedman (10) classify all types of epidermophytosis into two types, symptomatic and asymptomatic. My conclusions drawn from their presentation of a study of 1,073 cases are that all asymptomatic cases are potentially symptomatic, and are important factors in the dissemination of the disease. They found that

the intertriginous and hyperkeratotic clinical types were usually asymptomatic; and that the vesiculobullous and eczematoid clinical types were rarely asymptomatic.

Referring to Table V you will note that of the 200 clinically positive cases, 64% were symptomatic and 36% were without symptoms. Further Table VII shows that the scaling types are mostly without symptoms, while all the others, notably the eczematoid type, have a high incidence of symptoms.

Incidence and occupation.

The part played by occupation in the causation, or at least the promotion of the disease, is shown by figures taken from White (9) and seen in Table VIII. These are the only figures I could find relative to occupation. However, Striker and Friedman (10) have shown that there is approximately the same incidence in the free dispensary service as in private practice.

SYMPTOMS

The subjective symptoms of epidermophytosis are few in number, but they are consistent and never vague. The symptoms are of little value in the diagnosis of the condition, but may be, and often are, so severe that herein lies a problem which may tax the ingenuity of the practitioner in spite of the multitude of therapeutic measures available.

All the symptoms are aggravated during the warm seasons, and subside with the advent of cooler weather. Damp weather may also make symptoms more severe.

Itching and burning are the symptoms most often elicited. The itching may vary from slightly aggravating to almost unbearable, at which time the patient feels he must, and often does, remove his shoes and hose and rubs his interdigital spaces until raw. The itching is worse after the feet have perspired or become warm. After bathing the feet in cool water and changing to clean hose the feet feel better. Many say that their toes itch after retiring.

Burning is a symptom usually given by the sufferer of deep fissures, the acute vesico-bullous, or the eczematoid. It is also made worse by heat and perspiration. Washing, drying and changing to dry hose gives some relief.

Another common symptom is hyperhidrosis. Most patients having any symptoms will also add that their feet sweat a lot.

Pain is a complaint in the severe fissured types, in cases of massive hyperkeratosis of the sole or heel, or in cases of soft corn. The patient may even tell you he has a soft corn or a tender callous on the bottom of his foot. Pain to pressure may be so severe in the eczematoid type as to prevent the patient's wearing shoes.

In the more observant, the complaint may be that they have noticed scaling between the toes and some redness; or perhaps they have noticed their nails having friable, rough edges. There is usually no pain with such, and the symptom is one of aroused curiosity. At least one-third of the clinically positive cases are entirely without symptoms.

CLINICAL DIAGNOSIS

For a proper examination of the skin of the foot for Ringworm one should insist upon a more or less rigid technique, whether it be the following or a better one, lest he should miss points of importance in the examination and infect his own hands.

A good light, as in all examinations of skins, is necessary. I have found that one can best expose the interdigital spaces of the foot by having the patient sit in a chair in front of the seated examiner with the heels raised to about desk height on a stool or chair arm. In this position the examiner can see the soles, the junction of the toes and sole and the interdigital spaces by spreading apart the toes. By a little ventral flexion of the foot the dorsum may be examined.

As a precaution against infecting ones own hands, the patient's feet may be placed on a paper towel while being examined, and the washing of one's hands thoroughly with green soap. This procedure was used in examination of the students' feet and apparently no infection followed on our hands.

1. Scaling type. (92%)

Early in the disease scales are one of the first manifestations. They are termed primary and secondary.

In what may be called the primary type, the scales are commonly seen along the webs and sides of the toes, at the junction of sole and toes or the soles. They are small, partially adherent and usually white.

Frequent searchings emphasize the fact that the fourth interspace is the favorite seat of scales, followed by the third as a poor second. When forcibly removed from their seats they do not bleed, but often leave pinkish bases. In many cases they are so numerous and thick that the patient may mention it as a symptom.

In the secondary type of desquamation, the scales may be most commonly observed after or in connection with almost any of the other forms of epidermatophytosis, including epidermatophytids. It is usually, however, seen following the vesicular type as a split-pea sized hollow circle, denoting a bursted vesicle.

2. Nail involvement (30%).

A high percentage of the cases examined had one or more nails involved. These are usually in the types of long-standing. These nails are recognized by several characteristics: Loss of lustre, vertical fissures, dryness, yellowish or greyish discolorations, sodden, friable mass of keratotic material beneath free edge, separation of the nail from its bed, and an irregular, friable free margin.

3. The Fissured type (19%).

It is common on examination of the ventral folds of the toes and the webs to find small, straight breaks in the skin, rather deep and red, but rarely bleeding. The most common site is the interspace between the two lateral-most toes. These are painful and usually the site of considerable itching and burning.

4. Vesicular form (5%).

On the feet this lesion is practically limited to the toes and soles. They appear as intracutaneous, discrete (but may coalesce), rather uniform, thin-walled, dome-shaped, varying in size from one-half millimeter to one and one-half centimeters. They rupture easily, exuding a thin serous exudate, seldom or never pustular. They are often bluish in color.

The vesicular form prefers the lateral aspects of the toes and the ventral crease of toes is a close second. It is common as a subjective symptom to have the patient remark that they come on in hotter weather, when the condition is at its worst, in crops, and disappear again during the cooler weather.

5. Callous formation type (3%).

On the soles, the heels, the pad over the distal phalanges of the toes and the inner aspect of the distal joint of the big toes, one often finds abnormally

thickened skin which is commonly yellow and dull, but often white and sodden. In fact, any location on the foot where the epidermis is normally thick, one often finds callous formation. On the soles, particularly over the ball of the foot, there is a tendency for a dry, yellowish discolored hyperkeratosis, having straight, short, shallow, dark cracks running in every direction, particularly near the margins.

The diagnosis is made, therefore, by the presence of a superficial, erythematous intertriginous lesion, having the characteristics of any of the above and is confirmed by laboratory examinations to be outlined next. The use of trichophytin as a sensitization reaction for diagnosis is of value only in the deep-seated mycotic lesions. Garzella (22).

LABORATORY DIAGNOSIS

I am indebted for most of the material on the laboratory diagnosis of epidermophytosis to Weidman, (3-23), especially his article on Laboratory Diagnosis.

As far as the diagnosis of ringworm of the feet is concerned, there are two major phases: first, the determination of whether or not there is a fungus present; second, the determination of the species concerned. The former is largely a matter of direct microscopic examination of the scrapings of the epithelium of the toes and nails. Cultures at present rarely give further results, when microscopic examinations fail. I think all workers now agree that often numerous examinations fail before the fungus is finally discovered. There seems little need for more or less uncertain and detailed serologic and other immunity reactions, when the causative agent can be visualized so readily by the realitively simple technique now available. There are now used three common proceedures: (1) the well known alkali technique, (2) staining, and (3) cultures.

1. Technique of making an alkali examination.

Scrapings are made by the use of a small, rather dull scalpel. The area chosen is preferably at or near the margin of the lesion. These scales should

be placed deep side up on a glass slide, one or two small drops of 10% sodium hydroxide solution placed over them and a cover slip applied. In three to ten minutes, depending upon the bulk and thickness of the scales, the preparation is ready for study.

The fungus can usually be seen with low power, but confirmation by high power is better.

2. Staining Method for Extemporaneous Preparations, Weidman (3).

"This technique is not proposed as a substitute for the long established sodium hydroxide method in which the mere presence or absence of fungus is to be determined. But in those cases in which it has been impossible to demonstrate fungus, the search for yeast cells and bacteria is in order; or, when the details of fungi are to be established, it is recommended. The method involves two factors: First the rapid clearing of the specimen, and second, the staining. Without the first, fungus could scarcely be recognized in such thick scales as are seen in the hand and foot ringworm. As clearing agents, the stronger alkalis are at once excluded on account of their destructive effect on dyes, and recourse is had to glycerin. Mixtures of glycerine and saturated alcoholic solutions of various dyes were found useful, but not as much as Giemsa's stain. (I have tried to improve the diagnosis

of obscure cases in such a way as to clinch it by staining methods, but without success. A dye is still awaited which will specifically differentiate fungus substance from keratin, fat and other components of the epiderm. Dr. Wilhelmina S. Scott and Dr. Theodore Cornbleet (15) have independently essayed this in my laboratory. The more commonly used dyes, dissolved in glycerine, were applied to favus, tinea versicolor and tinea cruris materials. None of them approached Giemsa's as a specific differentiating agent.)

"The technique is as simple as for the classic sodium hydroxide preparation; a minute drop of undiluted Giemsa's stain is stirred into the scrapings (specimens as thin as possible) and the coverslip applied. Heat must not be employed. In a few minutes all structures will become blue - more so in some parts of the field, less so in others. In from one to five minutes, a drop of distilled water is run under the coverslip - the drop must be a small one, for an excessive amount of fluid will thicken the stratum of mounting medium and dilute the glycerine too much, resulting in a poorly cleared preparation. Nuances of color between the red and blue will now occur, affecting both tissue elements and micro-organisms, and varying in different parts of the preparation, depending on the extent to which the water has

differentiated the dye. One must accordingly select the most favorable places for study, but the color changes may later be varied at will by withdrawing some of the fluid with filter paper. The latter maneuver is valuable also as a routine because it flattens the scrapings (capillary pressure by the coverslip), reduces the thickness of the mounting medium (increases visibility) and facilitates subsequent ringing of the coverslip when semi-permanent preparations are desired."

3. Cultures.

This cannot be the place for a detailed differential diagnosis between the various fungi. The following can only be the roughest sort of generalities. The organisms may be cultured in one of two convenient ways: (a) Culture by the use of the hanging drop preparation; (b) Culture by the use of standard media in slants or dishes. Stain the above two cultures with Giemsa's stain.

Briefly, most of the saprophytes that occur in this connection are highly colored - the familiar green, brown or black forms. Since few, if any, of the pathogens are thus highly colored, such may be dismissed in the ordinary case. Fungus colonies that grow rapidly, becoming an inch in diameter within about three or four days, are probably saprophytic; also those

that fill the tube with loose, fluffy growth within five or six days. (11). The probable pathogens are those which make their appearance within from three to seven days, grow slowly (requiring from seven to ten days before attaining a diameter of one inch at the most) and remain white or at most become yellowish white with age. They may be downy throughout their entire lifetime or become powdery at some stage; this is utterly variable, according to species.

As far as diagnosis is concerned, when microscopic examinations of the hydroxide preparations or of the stained scrapings or cultures are made, the fungi fall into four categories: (1) the obvious saprophyte, (2) the long, seldom-branching pathogen, (3) the "Mosaic" fungus, and (4) Yeast cells.

(1) "The obvious saprophyte, that is, one that is not inherent in the skin, is not encountered frequently, usually because they are difficult to absolutely pass on without further culturing or staining. When the mycelium and spores have a scrambled arrangement, or rather, a lack of arrangement; when the spores and segments are ridiculously large, peculiarly shaped, bizarre in form and general appearance; when they have a diffuse brownish or greenish color; when the immediate matrix in which they lie contains less of the epidermal detritus and more of the extraneous

matter (dirt) - when these features are present it may be surmised that the fungus is not of the fungi imperfecti," Weidman (3), and hence one of the saprophytes or one of the pathogens. This, of course, presupposes some knowledge of the appearance of the pathogens as well as the fungi imperfecti.

(2) Long, seldom branching mycelium is the kind which is beyond question a pathogen and an indicator of ringworm, and is familiar to all who have examined scrapings of *E. cruris* infection of the groin. Stelwagon (12).

(3) The mosaic form has been questioned even as to its fungous nature, and is thought by many to be a degenerated form. Its segments are irregularly shaped, and are separated from each other by definite spaces having a moth-eaten appearance. Their edges and corners are rounded off. They do not have any organized internal structure.

(4) "Yeast" cells. These are useful only insofar as they indicate the presence of fungous materials.

The question of fungus negative cases when one is sure that the clinical picture is one of an epidermophytotic lesion presents such a problem that it has produced no little discouragement and pessimism among those who are having their first attempt at laboratory diagnosis of this disease. It may be suggested that

much success has been met with by several men by the use of dextrose dressings to the foot for one week (Karo Corn syrup 4%). This procedure might prove useful as a routine in all fungus negative cases. King (25).

The use of laboratory diagnosis, aside from merely ascertaining the presence or absence of the fungus, is questioned by many a practitioner, and probably dermatologist for that matter. What can be gained by determining the different ringworm species concerned in foot cases? As things stand today, in a practical way it probably is of little avail; but as instruments for the intensive and basic study of the subject in the future, such a determination means everything. It probably has its greatest usefulness in the work on dissemination such as the epidemics referred to in the chapter on prevalence. Quoting Weidman again, "Picture what would happen in our laboratories if this obstinate condition appeared at the angle of the mouth or the nostril instead of within the shoes."

TREATMENT

There is apparently no specific treatment for ringworm of the feet. Nearly every antiseptic has been tried at some time or other. Among these are iodine; potassium iodide; mercurochrome in aqueous, acetone, and alcohol solutions; camphor and iodine; phenol; acetic acid; 1:2000 permanganate of potassium; ointments containing salicylic acid plus many various antiseptics, as well as the Whitfield's ointment; ointments containing tar, as pine and tar ointment; Pick's ointment; and the various dyes and paints as chrysarobin, gentian violet, mercurochrome 220 soluble, iodine and K I paint, carbolfuchsin paint of Castellani; and many others.

In general there are but few types and principles of treatment. In the acute stages of the disease, all authors agree that rest and a soothing, mildly antiseptic wash is beneficial. The condition will usually clear as far as the toes and nails and then become chronically stubborn.

Removal of the superficial layers of epidermis by peeling ointments containing up to 8% concentration of salicylic acid, such as Whitfield's is considered by most authorities almost necessary to get a proper application of the fungicidal drug as well as removal

of the fungus-laden epidermis. Gould and Carter (26). The hyperkeratoses are reduced by this method. At this stage the dyes have a good effect. Castellani (27). These dyes and paints may be alternated with the peeling ointments at one to several day intervals.

Infected nails present the greatest problem. Some advocate scraping the nails and cleaning out the sodden debris at the free edge daily and painting with one of the dyes. More drastic measures such as Whitfield's ointment followed by strapping over the nails with adhesive tape, producing avulsion, (28-29-30) or surgical avulsion of the nail.

Hyperhidrosis should be controlled by soaking the feet in cold formalin or alum solutions twice daily with a change to dry, clean hose.

Other quite different methods of treatment have been suggested. Weidman (23) noting that the fungi were very thermoabile, suggested baking the feet in a dry heat. C. J. White (9) has reported success with having his patients spend as much time as possible on the beach, the grinding action of the sand producing exfoliation, and the dry heat, sun and sea-water apparently having an inhibitory affect upon the growth of the fungus.

A California physician even reports good success by the use of ordinary gasoline as a foot bath. Crawford (31).

PROPHYLAXIS

As is true in the case of any disease, no matter how specific the cure, if the prophylaxis is satisfactory, therein lies the real site of attack. If the treatment of epidermophytosis were on a specific basis and could be cured without recurrence, the value of prophylaxis would depreciate very little. Inasmuch as the present treatment is far from specific and hardly to be called ideal or even satisfactory, prophylaxis is to be the answer to the problem. The prophylactic treatment as has been in use the past few years has been proven to be very satisfactory. There are two recent reports of prophylaxis on a large scale, the results of which were followed through and found to be almost astonishingly good, considering the stubbornness of the infection dealt with.

The use of various means of protecting the feet from contact with the floors of dressing rooms by the use of paper, rubber and other types of slippers was, of course, found to be valueless because of the fact that such slippers must be removed when washing the feet in the showers themselves. When many are using the showers at the same time, especially children, it can readily be seen how easily the slippers themselves would become sources of infection or reinfection.

In April, 1931, Gould of Albany, reported a program of prophylaxis in the schools there with very good results. (19). He tells, "Early in November, 1929, foot baths containing sodium thiosulphate were installed between the locker and the shower rooms. Each pupil on leaving the shower was requested to immerse the feet in this chemical bath on the way to the locker. In so doing, the solution was well spattered over the locker room floor, so that from the time the pupil left the shower until the time of dressing, the feet were constantly in contact with this thiosulphate solution. The sulphite solution was found efficient as low as 3%, so that starting with from 10% to 15%, plenty of allowance is made for the dripping into the bath of plain water. The bath was changed after each class of from thirty to fifty pupils. The sulphite solution is ideal in being colorless and practically odorless. Four weeks after the thiosulphate baths were installed, the ringworm infection had entirely disappeared from the Junior High School."

Gould also suggests in his paper that one may employ a dusting powder containing 20% powder of sodium thiosulphate in boric acid powder to the feet after bathing. The powder may be dusted lightly on the feet between the toes and even in the shoes and

hose as a further precaution.

In August, 1931, Osborne and Hitchcock (21) of Buffalo reported their results with prophylaxis in the schools in Buffalo. In a search for a cheap and efficient fungicide, they employed a series of laboratory experiments conducted along the lines of the methods used by Schamberg and Kolmer (32) and by Kingery and Adkisson (33). They found that sodium hypochlorite in a dilution to 0.5% was sufficient to kill cultures of the common fungi in fifteen seconds. Using this information they began on a program of prophylaxis in the Buffalo High Schools: "... had a special rubber pan prepared, whose inside measurements were two feet on a side. These pans were made of heavy rubber and weighed approximately sixty pounds. One pan was placed on the floor of the corridor between the dressing rooms and the shower baths and another pan was placed at a point past which all the pupils had to pass just before putting on their clothes. The pans were filled up to the 2 inch mark with 0.5 per cent sodium hypochlorite solution and this solution was changed every morning. Although the solution was never diminished to such an extent that a refill was necessary, it was evident that a large number of persons stepping in and out of the pan on the way to the shower bath might gradually

deplete the solution. A slight, but not appreciable, dilution of the chemical occurred. In order to allow for this dilution and for a fair margin of error, we have recently recommended the use of 1 per cent sodium hypochlorite instead of 0.5 per cent solution. At the suggestion of the physical education department, a "well" was built in the tile floor, as shown in the illustration, the entire width of the corridor through which the pupils passed from the dressing rooms to the showers, swimming pool and gymnasium. They also passed through the "well" on the return to the dressing rooms. This seems to us an ideal arrangement, obviating the necessity of purchasing rubber pans.

"Up to May 2, 1931, this method of prophylaxis has been employed in the Buffalo high schools for a period of from nine to twelve months. The Physical Directors of each school have been carefully advised regarding the method and the checking of results. All the complaints have been transmitted to the director of physical education of the Buffalo public schools. He has informed us that in former years a great many complaints were received and that many new cases of ringworm of the feet appeared each year among high school students. The director of physical education of the public schools of Buffalo reported that this year he had not received a single complaint

from parents or pupils because of the appearance of ringworm of the feet. The various directors of the different schools have been well informed on the disease and have been unusually alert in the detection of new cases. We were happily surprised when none were reported for the entire year. In private practice we have noticed a drop in the incidence of new cases of ringworm of the feet in high school pupils of the city of Buffalo. Our records fail to show a single new case, although numerous ones have appeared from the surrounding towns.

"In reporting the experimental work with sodium hypochlorite as a fungicide and in our year's experience with it in the Buffalo high schools, we believe that an effective method of prophylaxis of ringworm of the feet has been developed but that an extended trial is necessary. A great deal depends on the cooperation of the department of physical education as well as of the pupils. If the method, as outlined, should prove to be generally efficacious, ways and means should be found to compel all pupils to pass through the fungicidal solution. The installation of permanent "wells" in the floors of runways and halls seems to us to be the ideal arrangement.

"Note: - Since this paper was submitted for publication, all the pupils in the high schools of

Buffalo have been rechecked for evidences of recent infection. No new instances of ringworm infection of the feet have appeared since the method of prophylaxis outlined was instituted."

The use of sodium hypochlorite has the advantage of being cheap and effective in high dilutions, 0.5%, yet it is non-irritating in as high concentration as 2%.

BIBLIOGRAPHY

1. Williams, Chas. M., The Enlarging Conception of Dermophytosis, Arch. Derm. & Syph., 15:541, (April) 1927.
2. Weidman, F. D., Morphologic Variations in Ringworm Species of Toes Followed in Primary Cultures Over a Period of Years, Arch. Derm. & Syph., 13:374 (March) 1926.
3. Weidman, F. D., Laboratory Aspects of Ringworm, Arch. Derm. & Syph., 15:415, (April) 1927.
4. Castellani, Sir Aldo, Fungi and Fungous Diseases, A. M. A. Pub., Chicago, (1927-28) No. 616:96, C27.
5. Sabouraud, Intertrigo Mycosis, J.A.M.A., 71:410, (August 3) 1918, abstract.
6. Weiss, A Case of Epidermophyton Infection of the Scalp, J.A.M.A., (September) 1917, (Quoted by Stelwagon).
7. Whitfield, Brit. Jour. Derm., 1911, p.36, (Quoted by Stelwagon).
8. Whitfield and Sabouraud, Brit. Jour. Derm., 1911, pp. 375-402, (Quoted by Stelwagon).
9. White, Chas. J., Fungous Diseases of the Skin, Arch. Derm. & Syph., 15:387, (April) 1927.
10. Striker, A., and Friedman, R., Symptomatic and Asymptomatic Ringworm of the Feet, Arch. Derm. & Syph., 24:430, (September) 1931.

11. Castellani, Sir Aldo, Fungi and Fungous Diseases, Arch. Derm. & Syph., 16:383, (October) 1927.
12. Stelwagon, H. W., Diseases of the Skin, Chicago, (1922), pp.1160-1198.
13. Farley, D. L., Viability of Ringworm Fungi in Dry Cutaneous Material, Arch. Derm. & Syph., 3:759, (June) 1921.
14. Von Graffenrid, C., Dermat. Wehnschr., 6:361, (May 25) 1918. (Quoted by Weidman).
15. Cornbleet, T., Cultures From the Skin of Apparently Normal Feet, Arch. Derm. & Syph., 13:670, (May) 1926.
16. Levin, O. L., & Silvers, S. H., Isolation of Ringworm From Sweat, Arch. Derm. & Syph., 23:1094, (June) 1931.
17. Williams, C. W., and Barthel, E. A., Tinea of the Toe-Nails as a Source of Reinfection in Tinea of the Feet, J.A.M.A., 93:907, (September 21) 1929.
18. Ruggles, E. W., Some Phases of Epidermophytosis, New York State J. Med., 29:740, (June 15) 1929, (Quoted by Gould - 19).
19. Gould, W. L., Ringworm of the Feet, J.A.M.A., 96:1300, (April 18) 1931.
20. Mitchell, J. H., Further Studies on Ringworm of the Hands and Feet, Arch. Derm. & Syph., 5:174, (February) 1922.

21. Osborne, E. D., and Hitchcock, Blance S., Prophylaxis of Ringworm of the Feet, J.A.M.A., 97:453, (August) 1931.
22. Garzella, N., Trichophytine in Diagnosis of Fungus Infections, Arch. Derm. & Syph., 14:584, (September) 1926.
23. Weidman, F. D., Epidermophytosis - The Newer Ringworm, J.A.M.A., 90:7, (February 11) 1928.
24. Weidman, F. D., and McMillan, T. M., Comparison of Ingredients of Ringworm Culture Media, Arch. Derm. & Syph., 4:451, (October) 1921.
25. King, Howard, Ringworm of the Feet, J.A.M.A., 88:1674, (December) 1927.
26. Gould, A. G., and Carter, Edna K., Fungistasis in Ringworm of the Toes and Feet, Arch. Derm. & Syph., 22:225, (August) 1930.
27. Castellani, Sir Aldo, Treatment by Fuchsin Paint, J. Trop. Med., 32:77, (March) 1929.
28. Hodges, R. S., Ringworm of the Nails, Arch. Derm. & Syph., 4:1, (July) 1921.
29. Clark, A. S., Extensive Ringworm of the Nails of the Feet, Arch. Derm. & Syph., 14:482, (October) 1926.
30. Phillips, Tinea of the Nails of Hands and Feet, Arch. Derm. & Syph., 14:96, (July) 1926.

31. Crawford, Gasoline Footbath for Ringworm of the Feet, J. A. M. A., 96:1251, (April 11) 1931.
32. Schamberg, J. F., and Kolmer, J. A., Studies in Chemotherapy of Fungus Infections, Arch. Derm. & Syph., 6:746, (December) 1922.
33. Kingery, L. B., and Adkisson, Alva, Certain Volatile Oils and Stearoptens as Fungicides, Arch. Derm. & Syph., 17:499, (April) 1928.
34. Like, O., Ringworm Infection of the Feet, Arch. Derm. & Syph., 24:666, (July) 1931.
35. Ormsby & Mitchell, Ringworm on Hands and Feet, J.A.M.A., (September 2) 1916.
36. Legge, R. T., Ringworm of Feet, J.A.M.A., 92:1507, (May 4) 1929.