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**DERMATITIS AND COEXISTING
FUNGOUS INFECTIONS AMONG
PLATE PRINTERS**



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DERMATITIS AND COEXISTING FUNGUS INFECTIONS AMONG PLATE PRINTERS

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DERMATITIS AND COEXISTING FUNGOUS INFECTIONS AMONG PLATE PRINTERS^{1 2}

INTRODUCTION

In July 1936 the Public Health Service was requested by the director of a large printing establishment to investigate various complaints of skin lesions among plate printers. In October 1936 the Division of Industrial Hygiene of the National Institute of Health began a study of the above condition.

For a number of years plate printers employed in this establishment had suffered from recurrent lesions of the skin of the hands and forearms. In certain cases these lesions had rendered the employees totally disabled for their usual occupation for varying lengths of time and also disabled for other work. These cases have been very resistant to treatment, even after removal from their occupational exposure, and several employees have had relapses immediately upon returning to their usual occupation. The majority of these cases had been diagnosed as dermatitis venenata. The exact substance responsible for the skin lesion was undetermined clinically. Many of these cases had also a certain irritant fungus infection of the feet. Therefore, the purpose of this study was to determine, (1) the potential skin hazards associated with this industry, (2) the incidence and type of the dermatitis among the employees of this establishment, (3) the exact etiological factor in each case of dermatitis, and (4) to develop methods of control.

In order to accomplish this purpose the following procedure was followed: An occupational analysis was made which was designed to present information on three factors: (1) Occupational data pertaining to the number of employees by occupation and their activities, (2) the materials used, and (3) the sanitary facilities.

At the completion of the occupational analysis a medical examination of all plate printers was made in order to determine the type and incidence of the dermatitis. This examination included an occupational history, past and present medical histories, a thorough examination of the skin, and a mycological examination of material from the hands and feet. Following this part of the medical examination.

¹ Acting Asst. Surg. R. H. Price made the patch tests and assisted in the tabulations.

² Submitted for publication July 30, 1938.

patch tests with all the inks then in use at this printing plant were made on all employees who had a dermatitis of the hands at the time of the examination or who had a history of ever having had a dermatitis of the hands, as well as patch tests on an adequate number of controls. This examination was made in order to assist in the determination of the exact etiological factor in individual cases of dermatitis.

PRELIMINARY OCCUPATIONAL ANALYSIS

There are eight sections of a large building which are concerned with plate-printing operations. With the exception of one section, which is devoted entirely to rotary printing, the seven main sections utilize hand printing methods. This report is concerned with the latter sections where manual methods of printing are used. Rotary printing is essentially a mechanical operation, and the printers do not come into close contact with ink.

In all, 1,091 workers are employed in this establishment. Of these, 378 are exposed to inks. Three hundred sixty-five, or 96 percent, of these men exposed to inks were examined, as well as 24 controls. The chief occupations for the employees under consideration are presented in table 1.

TABLE 1.—*Total employed by occupation and sex*

Occupation	Males	Females	Total
Total.....	414	677	1,091
Plate printers ¹	331	0	331
Printers' assistants.....	0	665	665
Messengers ²	35	0	35
Ink men ²	12	0	12
Clerks.....	0	12	12
Foremen.....	12	0	12
Rotary press printers ¹	24	0	24

¹ Controls—no ink exposure.

² Handle inks.

³ Exposure to gasoline, slight exposure to inks.

DESCRIPTION OF OCCUPATIONS

Plate printers.—The plate printers wiped the excess ink from the engraved plate after it was daubed with ink by press rollers, by passing the bare hands rapidly over the plate. This operation required considerable skill since heavy wiping might draw too much ink from the engraved plate and thus delete essential parts of the printed sheet, and too light a touch might cause a smearing of the printed sheet. In order to facilitate the wiping of the plate, the printer passed his hands over a molded block of whiting (calcium carbonate) prior to wiping the plate. The excess ink which accumulated on the hands was wiped on an apron, which was usually heavily encrusted with

dried ink from previous use. During any interval in which the plates are left standing, the printer cleaned the plate with gasoline to remove all traces of the ink and thus prevent drying in the engraved portions of the plate.

To clean the hands after the course of work, the printer used a common sink containing light mineral oil in which were placed several pieces of cheesecloth. The printer immersed his hands in this oil and wiped them with a cheesecloth until the ink was removed. The hands were then washed with ordinary soap and water. These soaps were common brands of soap widely used.

Practically all printers in a section used the one trough of the section. The oil in the oil trough soon became discolored, and contaminated with the various inks and dirt and other material from the printers' hands and arms. Fresh oil was placed in the trough once weekly. However, once or twice daily the oil was drained from the trough and foreign matter in the oil was allowed to settle, and the supernatant oil was poured off and placed back in the trough. Therefore it was apparent that all men in one section had exposure to all the inks used in that section over a week's time, unless they did not use the common trough.

After the hands were washed in the oil trough, which takes away most of the ink, the men washed their hands and arms in either hot or cold water, using white or yellow soap. A large number of the men used a stiff brush on the hands, some used salts of tartar (potassium carbonate) with the brush, others used ordinary white sand, and some used all of these cleansing agents. After this the men used paper towels to dry the hands.

The hands were cleansed in the above manner twice daily, and the extent of the abrasive action of the above mechanical cleaners was great, especially when the friction from wiping the plates is considered.

Printers' assistants.—Each printer had two assistant printers, generally girls, one of whom placed the paper to be printed on the engraved plate, and the other removed it after being printed. The paper used was slightly dampened in order that the ink from the engravings might be drawn to the paper and thus secure an even impression. The printers' assistants took care of the material printed by each machine and noted any obvious errors in the printing or any other faults which might develop in the plate itself.

Messengers.—Messengers carried the printed and unprinted sheets to and from the printers. The messengers did not come in contact with any ink.

Ink men.—Ink men cleaned the ink fountains of the various machines and supplied the ink as required. Since all the inks contained

a certain amount of drier, a considerable amount of cleaning of the fountain was necessary. Gasoline was used to clean the fountains.

Clerks.—The clerks kept tallies on output and pay rolls.

Foremen.—The foremen were responsible for allotting the work to the various printers and for giving a secondary check to the sheets printed. They moved continuously about their respective sections and made such corrections on the printing procedure as might be required.

Rotary-press printers.—The rotary-press printers did not wipe the plates with their hands. They operated rotary presses on which the excess ink was removed from the printing surface by mechanical means.

Inks used.—The materials used in the printing sections were inks and dampened paper. Approximately 80 percent of all the inks used had a green base. Roughly, 20 percent was black ink. However, 13 different inks were used. These inks were very complex in nature, as at least 30 coloring or tinting compounds entered into their composition in addition to fillers, varnishes, oils, and driers. The constituents of the inks were, as a rule, insoluble.

SANITARY PROVISIONS

In every case, as has been noted, the illumination, floor area, and ventilation were adequate. The cleaning services were conducted once each day and consisted of dry sweeping and washing. The printing machines were cleaned at the end of the day's work by a special force working usually at night. All the workers were provided with lockers, but no clothing changes were provided. The washing facilities were adequate. Showers were provided for each section.

PHYSICAL EXAMINATIONS

The physical examinations, including the mycological examinations, were made in November 1936. All physical examinations were made at the printing establishment. Two or more physicians examined each case. No patch tests were made at this time. The patch tests were made in January and February 1937, and a description of the method used and the results obtained will be given in a later portion of this report. All employees with dermatitis of the hands were observed over a period of 4 months.

GENERAL DESCRIPTIVE DATA

There were 389 individuals examined; 318 of these were plate printers, 47 were skilled helpers, and 24 were plate printers working on

rotary presses. Twenty-seven of the plate printers, because of their unwillingness, were not given a complete examination, but a complete history was taken and an examination of the hands made as in the other cases. All of the plate printers examined were white males.

The 24 rotary-press printers, at some period during their employment, worked as plate printers. However, at the time of this study, all of them had been rotary-press printers from 7 to 22 years. Their exposure to substances potentially capable of producing dermatitis was essentially the same as the plate printers, except that they did not wipe the excess ink from the engraved plate after it was daubed with ink by the press rollers, and they had relatively no ink exposure.

The rotary-press operators were of the same racial extraction, of similar age distribution, and of the same general economic status as the plate printers. They had been employed for approximately the same length of time as the plate printers. The rotary-press printers were used as controls in this study.

The skilled helpers were both white and colored men. Of the 47 skilled helpers, 12 were ink men and 35 messengers or general utility men. The ink men carried buckets of ink to the presses and cleaned the ink from the buckets. The messengers and general utility men carried printed and unprinted sheets to and from the printers. The ink fountains on the presses were cleaned by either ink men or other skilled helpers, depending upon which happened to be available when the work was to be performed. The only exposure of the skilled helpers to inks was in cleaning the buckets and fountains. These men used gasoline (with 1.7 percent benzol content) on gauze for cleaning inks from their hands and occasionally in cleaning the edges—but not the surface—of the plates when taken from the presses, also in cleaning the ink fountains.

PLATE PRINTING STUDY

Name _____ Age _____ Age began work _____ Years
worked _____ Years plate printed _____ Nativity: Subj. _____ Moth. _____
Fath. _____ Eyes: D L Hair: D L

Occupation	Place and years of employment				Type of plate used	Colors of ink used	Percent time each ink was used
	Section	Yr.	Other	Yr.			
1. Pres.							
2.							
3.							
4.							
5.							
6.							
7.							

Remarks: _____
Total time idle (est.) _____

FIGURE 1.—Form used for recording occupational history.

HISTORY

FAMILY HISTORY

Hay fever..... Asthma..... Urticaria.....
 Migraine..... Ringworm..... Athlete's foot.....
 Other skin diseases.....

PAST MEDICAL HISTORY

Hay fever..... Asthma..... Urticaria.....
 Migraine..... Ringworm..... Athlete's foot.....
 Increased sweating—Feet: Yes No. Other parts: Yes No.

DERMATITIS OF HANDS; Yes No. Date of onset.....

Duration..... Number of relapses.....

Treatment: Private physician Self treatment Outpatient—

What treatment did you the most good?.....

Duration of dermatitis after leaving work.....

Loss of working time: Yes No. Duration.....

Seasonal exacerbation: None Fall Winter Spring Summer.

Occupation at time of dermatitis and type of chemicals used.....

Description: Palms Dorsum Weeping Fissures Itching Lichenification
 Erythema Vesicles-Pustules. (Circle initial lesion.)

OTHER SKIN DISEASE: Yes No.

Location..... Duration..... Date of onset.....

Diagnosis..... Occupation and specific chemicals used
 at time.....

Pruritis of lesion: Yes No.

PRESENT MEDICAL HISTORY

DERMATITIS OF HANDS: Yes No.

Date of onset..... Duration..... Number of relapses.....

Treatment: Private physician Self treatment Outpatient.

What treatment did you the most good?.....

Duration of dermatitis after leaving work.....

Loss of working time: Yes No. Duration.....

Seasonal exacerbation: None Fall Winter Spring Summer.

Occupation at time of dermatitis and chemicals used.....

Description: Palms Dorsum Weeping Fissures Itching Erythema-lichen-
 fication Vesicles Pustules. (Circle initial lesion.)

OTHER SKIN DISEASES: No Yes.

Location..... Duration..... Date onset.....

Diagnosis..... Occupation and specific chemicals used
 at time.....

Pruritis of lesion: Yes No.

Do you use section shower? Yes No How often?.....

Do you walk on floor with bare feet? Yes No.

Do you use oil trough for cleaning hands? Yes No.

Do you use common towel? Yes No.

Remarks:

.....

.....

.....

.....

FIGURE 2.—Form used for recording past and present medical history.

EXAMINATION

Markedly overweight Markedly underweight.

Skin color: Normal Pale Flushed.

Tremor: None Fine Coarse.

Adenopathy: None Epitrochlear Inguinal Moderate Marked.

Perspiration: Normal Increased Dermographism: Present Absent.

Width of interdigital spaces: Normal Abnormal.

SKIN LESIONS:

Distribution: Symmetrical Asymmetrical Hands Feet Palms Fore-
arm Soles Between digits (numbers) Right Left Inguinal
Axillae Between thighs Perianal Scalp Other locations.

Configuration: Arciform Annular Irregular.

Induration: Present Absent. Destruction: None Atrophy Scarring.

Color: Pink Fawn Grey Violet Other color-----.

Type: Macules Papules Pustules Vesicles Edema Wheal Folliculitis
Scales Crusts Fissures Ulcers.

Border of lesions: Elevated Erythematous Scaling Polycyclic Satel-
lite lesions.

Nails: Hands Feet Chalky (number) Right Left Destruction
Thickened Discolored Raised at free edge Striae Paronychia.

Texture: Thick Thin Pliable Wrinkled Smooth Rough.

Pruritis: Present Absent.

Description of first appearing lesion: -----

Remarks: -----

Examined by -----

FIGURE 3.—Form used for recording the dermatological examination.

LABORATORY

DIRECT (MICROSCOPIC)

Squames from hands----- Palms----- Interdigital spaces: 1 2 3 4

5 Forearms-----

Squames from feet----- Sole----- Interdigital spaces: 1 2 3 4 5.

Scrapings from fingernails: 1 2 3 4 5.

Scrapings from toenails: 1 2 3 4 5.

Other locations -----

Remarks: -----

Culture palms: -----

Interdigital spaces: -----

Arms: -----

Fingernails: -----

Soles: -----

Interdigital spaces: -----

Toenails: -----

DIAGNOSIS AND REMARKS: -----

FIGURE 4.—Form used for recording mycological examination.

OCCUPATIONAL HISTORY

A careful occupational history was taken in order to determine the workers' entire industrial experience. This history revealed: (1) the total number of years the individual had worked; (2) each occupation in which he had been employed, with especial reference to his occupation as a plate printer, the type of plates, inks, and cleaning materials used, and (3) the duration of each occupational exposure and the industry in which it occurred, including each section in which

the employee had worked, and the length of time employed in each section.

Ninety and five-tenths percent of the plate printers and 95.9 percent of the rotary-press printers had been employed at this establishment for 15 years or longer. The labor turn-over was extremely small, and the great majority of the printers remained on duty until they were retired because of old age. Twenty-six and six-tenths percent of the plate printers and rotary-press printers had been employed for 35 years or longer.

The skilled helpers had been employed for a much shorter period. Seventy-four and five-tenths percent had been employed for 5 years or less.

The majority of the plate printers, rotary-press printers, and skilled helpers had spent their entire working time at these occupations at the present place of employment. All the employees with dermatitis of the hands when examined, and all who gave a history of having had dermatitis of the hands, incurred this condition while working at this establishment. None of the plate printers who had dermatitis of the hands at the time of the examination had worked there less than 15 years.

The years of employment of the plate printers and the rotary-press printers were approximately the same.

AGE DISTRIBUTION

It will be noted from table 2 that none of the plate printers and none of the rotary-press printers were under 30 years of age, and only 1.2 percent were under 40 years of age. The average age of the plate printers and rotary-press printers was 52.6 years, while the average age of 10,143 male industrial workers studied by Britten and Thompson was 35.3 years (Public Health Service Bulletin No. 162). The average age (52.6 years) of men with dermatitis was no different than the average age (52.7 years) of plate printers in general.

TABLE 2.—Age distribution of plate printers, rotary-press printers, and skilled helpers

Age in years	Plate printers		Rotary-press printers		Skilled helpers	
	Number	Percent	Number	Percent	Number	Percent
Total.....	318	100	21	100	47	100
Under 20.....	0	0	0	0	0	0
20-29.....	0	0	0	0	30	63.8
30-39.....	4	1.2	0	0	2	4.2
40-49.....	117	36.8	10	41.7	9	19.2
50-59.....	143	45	10	41.7	3	6.4
60+.....	54	17	4	16.6	3	6.4
Average age, years.....	52.7		52.5		33.7	

SECTION DISTRIBUTION

Of the eight sections, one, section 2, was utilized for rotary-press printing only, and all the rotary-press printers, 24, worked in this section. No cases of dermatitis of the hands were found among the rotary-press printers, and no rotary press printers gave a history of having had a dermatitis of the hands while employed as a rotary-press printer.

Section 8 was a wetting section and no plate printers were employed in this section.

Sections 4 and 9 used black ink only, and the remaining sections used various colored inks.

Each of the three skilled helpers who had dermatitis of the hands when examined worked in a different section, one in section 3, one in section 8, and one in various sections as a relief worker; each had been employed for more than 2 years in these sections, and in each case the dermatitis of the hands began while employed in these sections. The 44 skilled helpers who were negative at the time of the examination were employed in relatively equal numbers in relation to the plate printers in the various sections.

Nine, or 42.8 percent, of the plate printers with dermatitis of the hands were working in sections 4 or 9 at the time of the examination. However, none of these printers had developed dermatitis of the hands while working in either of these sections. Since black ink was used exclusively in these two sections, it was customary to transfer men with dermatitis to these sections in order to prevent further exposure to colored inks. This must be kept in mind during study of the tables that accompany this bulletin because these changes of exposure seriously complicated the interpretation of these data. However, men having various colored inks on their hands and forearms from other sections used the oil trough and wash rooms of sections 4 and 9.

Forty-two and eight-tenths percent of the printers with dermatitis of the hands at the time of examination and 16.2 percent of the printers who gave a history of dermatitis contracted the dermatitis of the hands while employed in sections 5 and 6. Both of these sections were sections in which various colored inks were used, and in which the color of the inks varied from week to week, depending upon the type of printing being done. Various inks were also used in sections 3 and 1. Section 7 used colored inks to a less extent, since quite a bit of black ink was used in this section.

Forty-three and three-tenths percent of the plate printers who gave a history of having had a dermatitis of the hands while employed at this establishment contracted the dermatitis while employed in an old building, which was in use until 1914. This old building consisted of a main room, where some 300 men were employed, and four small

rooms, in each of which approximately 40 men worked. All these printers used hand presses. An additional printing room was located in the basement, where 25 men did plate printing on the only power presses then in use at the establishment. There were no rotary presses in the old building.

The exposure of the plate printers to various colored inks was very similar in the old building to that in the new, except that one man would print approximately 800 sheets a day, compared to 2,400 to 4,800 on a power plate press. The printers, with ink on their hands from plate printing, would operate the presses by turning wheels.

The washing and cleaning facilities in the old building were practically the same as in the new, including the use of oil troughs, sand, yellow and white soap, salts of tartar, and brushes.

It is impossible to determine at this time the exact exposure of men by sections in the old building to correspond with that in the new.

The study of the section distribution of the printers reveals that only one of the printers contracted dermatitis of the hands while employed in sections 4 and 9, where black ink alone was used, and his dermatitis was due to cleaning the hands with sand, and that no cases occurred in the rotary-press section, section 2, and that only one case occurred in section 8, the wetting section, and this case was due to contact with the solution of glue. It will also be noted that dermatitis of the hands was incurred only in the sections using colored inks.

The duration of employment in the above sections will be discussed later.

CLEANING MATERIALS

The following materials were used by the printers to cleanse the hands of inks:

- Light mineral oil.
- Benzine (gasoline).
- White and yellow soap.
- Water.
- Cheesecloth.
- Sand.
- Salts of tartar.
- Hair brushes.
- Potassium carbonate.
- Towels, both paper and cloth.

The cleaning process is described on p. 13.

The mineral oil used in the oil troughs was a commercial grade with a specific gravity of 0.865 at 60° F., and having a flash point of 347° F.

The benzine or gasoline used to clean the plates was ordinary, commercial gasoline. A sample of this gasoline was fractionally dis-

tilled to determine its benzol content. 400 cc of the crude gasoline yielded 31.5 cc of material boiling with 78° to 90° C. range (benzol boils at 80.3° C.). This fraction was again fractionated, yielding 7 cc—the maximum “benzol” fraction. This material was nitrated, reduced, and tests were made for aniline. These tests were positive. The quantity of benzol was, however, very small and not over 1.7 percent in amount.

Several kinds of soap were used for cleaning the hands. The two principal ones were (1) a white, floating, toilet, cake soap made from soda and a mixture of high-grade tallow with 25 to 30 percent of cocoanut oil, of light color, without offensive odor, and thoroughly saponified, with free alkali not exceeding 0.15 percent, chloride under 1 percent, and free of resin, sugar, and foreign material; (2) ordinary laundry soap made from soda and fats, uniformly mixed, with no excessive proportion of resin, and containing only a moderate amount of material not soluble in alcohol, with free alkali 0.5 percent or under; (3) a powdered soap of light color, free from disagreeable odor, a compound of soda and fats, without resin, with 0.5 percent free alkali or less which was used for cleaning the floors and woodwork. However, some of the printers asked for and received this powdered soap from the washroom attendants to mix with the sand to use in cleaning their hands.

Cheesecloth was used to rub the oil and ink from the hands and forearms after washing in the oil trough.

Clean, dry, silver sand, obtained from local sand and gravel contractors, was used.

The salts of tartar (potassium carbonate, U. S. P.) was purchased by the printers.

The brushes, usually of the hog bristle type, were also purchased individually by the printers.

Paper or cloth towels were used to dry the hands. The finger nails were usually cleaned by packing soap under the nails and removing the soap with the point of a pocket knife.

The workroom for each section contained a shower bath, and the majority of the printers used this shower at the end of the day's work. During the time the printers were undressing, using the shower, and dressing, they walked over the floor with the bare feet.

Cases of dermatitis were tabulated according to the method of cleaning hands that was in use at the time of examination. The interpretation of these data was complicated by the fact that plate printers changed the method of cleaning their hands when they found they had dermatitis. This does not mean that the cleaning materials were not a factor in the cause of the dermatitis; it may well be that the cleaning materials did play some part in the cause of the

dermatitis, and also in the aggravation of the dermatitis, after it once was incurred.

The rotary-press printers and the skilled helpers did not come in contact with ink to the same extent as the plate printers. The only time the rotary-press printers got ink on their hands was when they filled the ink fountains or handled freshly printed sheets. They, therefore, got only a small amount of ink on their hands. It was not difficult for them to clean their hands, and the abrasive action of the cleaning materials was practically nil compared to that received by the plate printers.

Some skilled helpers were exposed to a small amount of ink when they cleaned the ink fountains and ink buckets, but many of the skilled helpers had no exposure to ink. The chief substance to which the skilled helpers were exposed was benzine, which they used to clean the ink fountains and ink buckets. According to the histories obtained from the skilled helpers, 21 used benzine to clean the ink fountains and buckets, 7 used benzine to clean the ink from their hands, and 19 had no exposure to benzine. Only three skilled helpers had a dermatitis of the hands at the time of the examination and none of these was due to their exposure to ink.

TYPES OF PLATES USED

The plates used by the plate printers were made of either steel or iron, and were chromium plated. They were $16\frac{1}{2}$ inches by $18\frac{3}{4}$ inches in width and length, respectively, and $\frac{3}{16}$ inch in thickness. The printing surfaces had depressions of almost infinitesimal depth.

The physical effects of hand polishing the faces and backs were the same, and the quantitative exposures to inks were identical in each. Black ink alone was used on the faces, and inks of various colors were used on the backs.

Although approximately 25 percent of the plate printers worked on face plates, and 57.9 percent of the plate printers who had dermatitis of hands when examined were thus employed, this is explained by the fact that the latter men were assigned to faces in order to avoid exposure to colored ink.

It has not been shown that the type of plate is important in the production of dermatitis, except for the color of ink used thereon.

INKS USED

Detailed description of the inks is given in the section on patch testing.

Of the 21 plate printers who had dermatitis of the hands when examined, 11 were then working with black ink, 1 with green, 1 with red, and 8 with miscellaneous colors. As previously mentioned, none

of these 11 men had developed his original dermatitis while working with black ink, but had been changed to the black from exposure to various colors because of having dermatitis.

Except for the black-ink work, the variety of colored-ink exposure was so great and the changes of employment from one color to another so frequent that it is impossible to chart useful information as to the specific colors involved.

It appears that black ink, per se, is not a factor in the production of plate printers' dermatitis, but that exposure to various colored inks is of etiological importance.

PAST AND PRESENT MEDICAL HISTORIES

The past and present medical histories were taken on each employee, and were designed to reveal (1) the personal history and the family history of the allergic conditions, hay fever, asthma, urticaria, migraine, and chronic eczema; (2) the history of dermatitis of the hands, with the date of onset, duration of the dermatitis, number of relapses, by whom treated, the duration of the dermatitis after leaving work, loss of working time, seasonal exacerbation, the occupation and the type of chemicals used at the onset of the dermatitis, and a description of the dermatitis; and (3) the history of dermatitis other than dermatitis of the hands, with its location, duration, and diagnosis.

Thirty-seven plate printers gave a history of having a dermatitis of the hands which they considered due to their occupation. Three of these plate printers are now employed as rotary-press printers, and have had no dermatitis of the hands since being employed as rotary-press printers. None of these 37 employees had a dermatitis of the hands at the time of the examination.

TABLE 3.—History of the allergic conditions, hay fever, asthma, migraine, urticaria, and/or chronic eczema

	Plate printers								
	Present dermatitis			History of dermatitis			No dermatitis		
	Per-cent	Num-ber positive	Total	Per-cent	Num-ber positive	Total	Per-cent	Num-ber positive	Total
Family history.....	23.8	5	21	21.6	8	1 37	15.7	40	263
Past personal history.....	38.1	8	21	37.9	14	1 37	16.8	44	263

¹ Three rotary-press printers who gave a past history of dermatitis developed the lesions while working as plate printers, hence they are tabulated as plate printers here.

The allergic disorders, hay fever, asthma, urticaria, migraine, and chronic eczema occurred somewhat more frequently in the families of men with dermatitis than in the families of men who did not have dermatitis, but this does not seem to be an important difference.

Past personal histories of allergy were reported more than twice as often among plate printers with dermatitis present and those who had had the skin disorder, than among those who had never had dermatitis of the hands. These positive histories were one-sixth more frequent among the plate printers with dermatitis present than it was among the plate printers who gave a history of dermatitis of the hands.

The number of men and the incidence of dermatitis in the rotary press and skilled helper groups are too small to draw any conclusions as to their allergic histories.

TABLE 4.—*Date of onset of the dermatitis among plate printers according to the past medical history*

Year of onset	Dermatitis of hands at present (number)	Past history dermatitis of hands (number)
Total.....	21	37
1900-1905.....	2	4
1906-10.....	4	3
1911-15.....	2	8
1916-20.....	3	6
1921-25.....	2	3
1926-30.....	3	4
1930-35.....	4	5
1936.....	1	4

It will be noted from the above table that during each 5-year period, two to four cases occurred among the employees with dermatitis of the hands at the time of examination, and three to eight cases occurred among the employees who gave a history of having had a dermatitis of the hands. When the above cases are considered by each year instead of 5-year groups, the same relative proportion of cases is shown. It is, therefore, observed that the incidence of dermatitis was approximately the same per year from 1900 through 1936.

TABLE 5.—*Duration of dermatitis of the hands according to past and present medical histories*

Duration in years	Dermatitis of hands at time of examination (number)	History of dermatitis of the hands (number)
Total.....	21	37
Less than 1 year.....	2	25
1 to 5 years.....	5	12
6 to 10 years.....	3	0
11 to 15 years.....	1	0
16 to 20 years.....	1	0
21 to 25 years.....	3	0
26 to 30 —ears.....	4	0
More than 31 years.....	2	0

The duration of the dermatitis of the hands among employees with the condition present at the time of the examination varied from less than 1 year to more than 30 years, while among the employees who gave a history of dermatitis of the hands but who were negative at the time of the examination, the duration varied from less than 1 year to less than 5 years.

In seven of the cases of dermatitis of the hands at the time of the examination, the dermatitis had been present continuously since its onset. In the remaining 14 cases the dermatitis of the hands had been intermittent, with periods of a few months to several years of freedom from dermatitis of the hands. In the seven cases that were continuous, the severity of the dermatitis of the hands ranged from very severe, causing the employee to be off duty, to very mild lesions, causing no inconvenience to the employees.

TABLE 6.—Duration of dermatitis of the hands after leaving work

Duration of dermatitis of hands after leaving work	Dermatitis of hands at time of examination (number)	History of dermatitis of the hands (number)
Total.....	21	37
Less than 1 week.....	1	4
1 to 2 weeks.....	2	4
3 to 4 weeks.....	5	3
1 to 2 months.....	2	2
3 to 4 months.....	2	2
More than 4 months.....	1	1
No loss of working time.....	8	21

Among the employees who gave a history of dermatitis of the hands but were negative at the time of the examination, there was a higher percentage of cases who did not stop working on account of the dermatitis, and also a higher percentage who recovered from the dermatitis in 1 to 2 weeks after stopping work, than among those employees with dermatitis of the hands at the time of the examination.

It will be noted that 23.8 percent of the cases with dermatitis of the hands at the time of the examination and 13.5 percent of those cases giving a history of dermatitis of the hands did not recover within one month after stopping work. It is possible that secondary infections may have been the cause of some of these prolonged recoveries.

TABLE 7.—Estimate of the total loss of working time of all employees due to dermatitis of the hands—(per employee)

Loss of working time in months:	Number of plate printers who have lost the amount of time specified
Less than ½ month.....	9
½ to 1 month.....	5
1¼ to 2 months.....	2
2¼ to 3 months.....	2
3¼ to 4 months.....	3
4¼ to 5 months.....
5¼ to 6 months.....	2
12 months.....	1
36 months.....	1
66 months.....	1
Total.....	26
Number with dermatitis or with history of dermatitis and no loss of working time.....	32

The above table is an estimate of the total loss of working time by plate printers due to dermatitis of the hands from 1910 to 1936. It was impossible to get an accurate account of the time lost. It will be noted that approximately one man's working time for 13 years has been lost due to dermatitis of the hands in this one establishment since 1910.

Forty-one men out of a total of 58 had no seasonal exacerbation of the dermatitis. Of the 17 men who did have seasonal exacerbation, this was in the spring in two instances, summer in 11, autumn in 2, and winter in 2. There was no seasonal exacerbation of the dermatitis among the skilled helpers who had dermatitis of the hands.

TABLE 8.—*Ink used at onset of dermatitis*

Inks used	Dermatitis of hands at time of examination		Past history of dermatitis of hands		Total
	Number	Percent	Number	Percent	
Total.....	21	100	37	100	58
Green ink.....	9	42.8	13	35.1	22
Colored inks, general.....	3	14.3	6	13.5	8
Red ink.....	2	9.5	1	2.7	3
Black ink.....	0	0	7	18.9	7
Blue ink.....	1	4.8	2	5.4	3
Gold ink.....	0	0	2	5.4	2
Orange ink.....	0	0	1	2.7	1
Gold and black ink.....	1	4.8	0	0	1
Green and red ink.....	1	4.8	0	0	1
Purple and pink.....	0	0	1	2.7	1
Red, green, and orange.....	0	0	1	2.7	1
Black and green.....	0	0	1	2.7	1
Unknown.....	4	19	2	5.4	6
Stamp glue.....	0	0	1	2.7	1

Of the employees who gave a history of dermatitis of the hands, or had dermatitis of the hands at the time of the examination, 56.9 percent stated they were working with green ink at the onset of the dermatitis.

Although the men were working with specific colored inks at the time of the occurrence of the dermatitis, they were exposed to other colored inks when they cleaned their hands, as was noted in another part of this report, and therefore too great importance can not be attached to the ink they were working with at the time as the definite etiologic factor.

The general description of dermatitis of the hands as given by the plate printers was that, in most cases, redness (usually with itching) would appear, followed in a day or two by small, elevated areas (vesicles) resembling ivy poisoning. New crops of these lesions would appear every few days. There would often occur oozing of serum from the elevated areas, sometimes, but not always, due to the patient's

scratching the surface. In other cases dryness of the skin, redness, and cracking (or fissures) would occur. In many cases all these symptoms would occur, either simultaneously or in cycles.

TABLE 9.—Description of the dermatitis according to past medical history

Description	Past history of dermatitis of the hands		Dermatitis of hands at present	
	Number	Percent	Number	Percent
Total number examined.....	37	100	21	100
Location:				
Palms.....	5	13.5	9	42.8
Dorsum.....	32	86.4	12	57.1
Weeping.....	25	67.5	9	42.8
Fissures.....	8	21.6	5	23.8
Itching.....	28	75.6	12	57.1
Lichenification.....	1	2.7	1	4.8
Erythema.....	10	27.0	2	9.5
Vesicles.....	20	54.0	11	52.3
Pustules.....	3	8.1	3	14.3

TABLE 10.—Length of time after beginning work before dermatitis of hands developed

Length of time after beginning work before dermatitis developed (years)	Plate printers			
	Dermatitis of hands at present		History of dermatitis of hands	
	Number	Percent	Number	Percent
Total.....	21	100	37	100
0-0.9.....	0	0	2	5.4
1-1.9.....	2	9.5	2	5.4
2-2.9.....	1	4.8	2	5.4
3-3.9.....	1	4.8	2	5.4
4-4.9.....	1	4.8	2	5.4
5-9.....	6	28.5	6	16.2
10-14.....	2	9.5	4	10.8
15-19.....	1	4.8	5	13.5
20-24.....	1	4.8	5	13.5
25-29.....	3	14.3	3	8.1
30-34.....	2	9.5	2	5.4
35-40.....	1	4.8	2	5.4

There was marked difference in the length of time after beginning work at this establishment before the onset of the dermatitis of the hands.

At the time of the examination 47.6 percent of the employees with dermatitis of the hands and 59.7 percent of the employees who gave a past history of dermatitis of the hands had worked for 10 years or more at this establishment before the occurrence of any dermatitis of the hands.

TABLE 11.—Description of the dermatitis of the hands at the time of the physical examination

Description	Plate printers	
	Number	Percent
Total number.....	21	100.0
Distribution:		
Symmetrical.....	5	23.8
Asymmetrical.....	16	76.1
Between digits.....	6	28.5
Right hand only.....	7	33.0
Left hand only.....	0	0
Both hands.....	14	66.6
Palms.....	9	42.0
Dorsum.....	14	66.6
Configuration:		
Arciform.....	0	0
Annular.....	2	9.5
Irregular.....	19	90.4
Destruction:		
Atrophy.....	1	4.8
Scarring.....	1	4.8
Induration.....	10	47.6
Texture of skin:		
Smooth.....	9	42.0
Rough.....	4	19.0
Thick.....	5	23.8
Thin.....	3	14.3
Predominant type of lesion at time of examination:		
Macules.....	4	19.0
Papules.....	5	23.8
Pustules.....	2	9.5
Vesicles.....	4	19.0
Edema.....	0	0
Wheal.....	0	0
Folliculitis.....	0	0
Scales.....	2	9.5
Crusts.....	1	4.8
Fissures.....	2	9.5
Ulcers.....	1	4.8
Border of lesions:		
Elevated.....	7	33.0
Erythematous.....	3	14.3
Scaling.....	9	42.0
Polycyclic.....	2	9.5
Pruritus.....	14	66.6

EXAMINATION OF THE SKIN

At the completion of the history the employee was stripped and the entire skin surface was examined minutely. All examinations were made with natural illumination. The slightest skin abnormality of the hands and arms was noted, and any skin lesion was described in detail on the physical examination form (fig. 3).

As noted in another part of this report, 21 plate printers and 3 skilled helpers had a dermatitis of the hands at the time of the physical examination.

The above table gives a description of the dermatitis on the day of the first examination, since the severity and type of the lesions changed from day to day.

It is desired to emphasize the fact that these cases of eczematous dermatitis did not present a picture characteristic or diagnostic of any given specific causative agent.

MYCOLOGICAL EXAMINATIONS

The mycological study was made in order to determine whether pathogenic fungi were either primary or contributing etiologic agents in the dermatitis.

After an examination of the skin of the entire body was completed special attention was given to an examination of the hands and feet for clinical evidence of fungous infection. A notation of clinical dermatophytosis of the feet was made when one or more of the manifestations noted by Whitfield were present, viz, (1) acute vesiculo-bullos manifestations with the characteristics of vesicular eczema; (2) chronic intertriginous manifestations, characterized by whitened, sodden masses of epithelium between the toes; (3) chronic hyperkeratotic manifestations characterized by large and irregular masses of overgrown horny layer. All of these manifestations are usually accompanied by itching.

The difficulties encountered in making a diagnosis of dermatophytosis of the feet from the appearance of the lesions alone are great, and this is especially true of the intertriginous type. In this study a definite diagnosis of dermatophytosis of the feet was made only when pathogenic fungi were found either by microscopic examination or by culture.

TABLE 12.—*Dermatophytosis of feet*

	Plate printers				Rotary-press printers				Skilled helpers				Total		Patch tests			
	Dermatitis hands at present		No dermatitis of the hands		Dermatitis hands at present		No dermatitis of the hands		Dermatitis hands at present		No dermatitis of the hands				Positive		Negative	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Total number examined.....	21		266		0		23		3		41		354		13		82	
Microscopic examination, positive for pathogenic fungi of feet.....	7	33.3	92	34.5	0	0	8	34.8	1	33.3	9	21.9	117	33	5	38.5	28	34.2
Culture positive for pathogenic fungi of feet.....	0	28.9	71	26.7	0	0	5	21.7	1	33.3	10	24.4	93	26.2	5	38.5	21	25.6
Clinical evidence of dermatophytosis of feet.....	8	38	83	31.2	0	0	6	26.1	0	0	13	31.5	108	30.5	0	40.1	28	34.2
One or both microscopic or cultural examinations positive for pathogenic fungi of feet.....	8	38	100	37.6	0	0	8	34.8	1	33.3	12	29.1	129	36.4	6	46.1	30	36.0
Clinical evidence of dermatophytosis of feet, and either microscopic or cultural examinations or both positive for pathogenic fungi of feet.....	5	23.8	56	21.1	0	0	4	17.4	0	0	21	51.3	83	23.4	4	30.7	14	17.1
Clinical evidence of dermatophytosis of feet, but negative by microscopic and cultural examination.....	3	14.3	34	12.8	0	0	2	8.7	0	0	9	21.9	47	13.3	2	15.3	9	11
Either clinical evidence of dermatophytosis of feet or microscopic examination or cultural examination positive for pathogenic fungi of feet.....	11	52.4	133	50	0	0	10	43.5	1	33.3	21	51.3	176	49.7	7	53.8	41	50

NOTE.—Of the 318 plate printers, 25 had only an examination of the hands, and on 8 no specimens for mycological study were made.

EXAMINATION OF MATERIAL FROM HANDS AND FEET

Following the physical examination of the men, material was taken in sterile, labeled Petri dishes from the hands if there were lesions and if it was possible to get material without undue trauma; and routinely from the feet. Part of this material was examined directly under the microscope, and part was held for culture. The material consisted of skin scrapings, loose squames from the edge of scaling lesions, and the roofs of vesicles. When nails were affected scrapings of the nail tissue were also taken.

In making the examination a portion of the collected material was placed on a microscope slide, covered with a drop of 10 percent NaOH, and examined after a few minutes, or as soon as it had cleared sufficiently. By the time this examination was made the patient had left, so that when no fungi were found in a given specimen it was not possible to collect additional squames for a reexamination. In some cases the subsequent culture of the remaining portion of the specimen yielded positive results. In other cases the converse was true. The fungi were isolated in pure culture by collecting material in a sterile Petri dish, exposing it for a few minutes to 80 percent alcohol, and planting upon honey agar² slants. The cultures were transferred to fresh slants to free them of bacterial contaminations which were present in some instances.

The data obtained falls into four groups. (1) There were specimens of which both the microscopic and culture examinations were positive; (2) of others, the microscopic examination was positive but no cultures were secured; (3) the direct examination of some specimens gave negative results, but a fungus grew in the cultures. Finally, (4) there were some individuals who were clinically positive and who were probably actually infected, but both laboratory methods failed to demonstrate the presence of fungi in the specimens collected. These discrepancies could have been largely eliminated had it been practicable to hold the patient until the direct examination of specimens was completed, or to recall him at a later time. Because of the conditions under which the investigation had to be carried out neither of these procedures was deemed advisable, and it is therefore recognized that this report probably indicates a slightly lower incidence of dermatophytosis of the foot than actually existed among the men examined.

In view of the small amount of material which was collected from most of the men, and in view of precautions which were taken to avoid any mixing of specimens, it is felt that a positive result either

² The formula for honey agar is essentially that recommended by Sabouraud, viz., honey, 60 grams; Fairchild's peptone, 10 grams; agar, 20 grams; water, 1 liter. pH is adjusted to 5.5.

from microscopic examination or from culture is a suitable basis for a positive report from the laboratory study, even in the absence of a perfect correlation between these two methods of examination.

The further lack of correlation between clinical findings and laboratory findings is due in part to the faults of the method explained above, and in part to the difficulty of diagnosing dermatophytosis on the basis of clinical evidence alone. It is hardly possible to correctly diagnose dermatophytosis of the foot in every individual seen, without depending in part on laboratory examination. Fissures and scaling in the interdigital spaces is not always caused by the dermatophytes, and, on the other hand, there may be a mild or latent infection due to one of these fungi without scaling being evident until the surface is scraped, as with a scalpel.

A tabulation of the results of the laboratory examination shows that 117 in 354, or 33 percent, were found to be positive for dermatophytosis by microscopic examination; 93 in 354, or 26 percent, were found positive by cultures; and 129 in 354, or 36.4 percent, were found to be positive by one or both of these methods.

Trichophyton mentagrophytes (9) (including the varieties usually designated *T. gypseum*, *T. interdigitale*, and *T. pedis*) (5) was isolated in cultures from 71 cases. *Trichophyton purpureum* (*T. rubrum*) was isolated in 18 cases. *Epidermophyton floccosum* (*E. inguinale*) was isolated in 5 cases. All these isolations were from the feet. One man had a dermatophytosis of the foot caused by two fungi, *T. purpureum* and *E. floccosum*. The fungi will be further discussed from the standpoint of their variability in another section of this report.

Hands.—No lesions of the hands were seen in these men which resembled dermatophytosis either from the history or by actual clinical examination. Neither was any fungus found in squames from the hands, nor was a pathogen cultured at any time from the hands of these men. There is no clinical or laboratory evidence that these plate printers were suffering from dermatophytosis of the hands. There was some evidence, however, of a dermatophytid reaction in three of the men.

MYCOLOGICAL STUDY OF OIL TROUGHS

It had been suspected that a pathogenic fungus might be either causing or complicating the dermatitis of the hands of which the men complained. Early in the investigation, therefore, oil from the oil troughs where the men cleaned the ink from their hands was carefully examined to see if fungi were present.

Three representative samples were collected and taken to the laboratory. One sample, No. 1, was clean oil from the bottom of a container from which an oil trough had been filled.

Sample No. 2, taken from a trough evidently used by men working with green ink, appeared greenish and slightly dirty when in the trough, but when a test tube was filled by allowing oil to flow from one of the wash cloths in the trough it appeared comparatively clean. A very small amount of light colored sediment settled out.

Sample No. 3 was from a trough where men using black ink had washed, and it was very turbid. When a tube was filled by allowing oil to flow from one of the wash cloths in the trough the oil was opaque, but upon standing a heavy black sediment fell to the bottom of the tube, leaving the supernatant oil nearly as clear as in the other samples.

Cultures from oil.—Ten to twelve cultures were made from each sample of oil taken. Some were very heavily inoculated.

Sample No. 1 showed no growth.

Sample No. 2 produced a single colony in each of two tubes of a species of *Mycoderma*. This fungus does not appear to be a pathogen, and its appearance in these tubes is not considered of etiologic significance. Another nonpathogenic fungus which was not identified appeared late in a third tube.

Sample No. 3 produced no growth in any tubes.

Twenty-nine of thirty-two culture tubes inoculated with oil remained sterile. The fungi producing the three colonies appearing in the remaining three tubes were not pathogens and were not recovered in culture from the hands of the men. *Staphylococcus*, the microorganism most often found in cultures made from the hands, did not grow in any of the cultures inoculated with the oil. It appeared, therefore, that the oil used by the men in cleansing their hands did not serve as a culture medium. In fact, a bactericidal action was suggested by the results of these culture tests. These were not properly designed, however, to adequately test a possible fungicidal or bactericidal property of the oil, and the following investigations were therefore carried out:

Fungicidal property of the oil.—About 20 cc of sample No. 1 (the unused oil) was poured into a clean, sterile test tube. The greater part of one of the colonies of *Mycoderma* (a mass of fungus hyphae and spores approximately 6 by 4 by 2 mm in size) was rubbed on the inside of this tube. The fungus was mixed as thoroughly as possible with the oil, but it would not emulsify. Exposure to the oil was, therefore, not complete. The mixture of fungus and oil was kept at room temperature throughout the experiment. It was continually shaken for ten minutes, and occasionally thereafter. At the end of the ten minutes ten culture tubes were inoculated with the fungus hyphae and spores taken from the oil. Similar test cultures were made at the end of exposure periods of 20 minutes, 1 hour, 7 hours, and 80 hours. In making these cultures the danger of confusing a possible fungi-

static action (10) exerted by the oil carried over in the inoculum was minimized so far as possible by freeing the inoculating loop of excess oil before the culture tube was inoculated.

Inoculation tests showed that the fungus was still viable after 80 hours in the oil. It is recognized that the exposure to the oil was imperfect due to the failure of the fungus cells to form a uniform emulsion. The test indicates, however, that the oil does not possess appreciable fungicidal properties.

It was possible that the fungus tested was more resistant to the oil than were other fungi. Identical tests were therefore made to determine the fungicidal action of the oil upon a pink *Torula* isolated from the hands of one of the men. Similar results were obtained.

Bactericidal property of the oil.—Although no colonies of bacteria appeared in the cultures made from the oil, it was deemed desirable to find out whether the oil was bactericidal to bacteria exposed to it. The bacteria obtained in culture from the hands of two men were used as test organisms. The method of testing outlined above in the testing of the fungicidal property of the oil was followed.

There was growth of the bacteria after 80 hours in the oil. The oil does not appear to be bactericidal.

MYCOLOGICAL STUDY OF THE FLOORS OF THE SHOWER BATHS

Because of the prevalence of dermatophytosis of the feet among the plate printers, the shower and locker rooms used by the men from the various sections were inspected and material was collected for examination and culture. When inspected, the rooms were in fairly good condition, although the lighting was poor, and the floors of the locker rooms were dark in color and with a comparatively rough surface, so that the presence of dirt was not readily detected.

On the floors in the corners of the shower rooms, and in the angles formed by the seats and the walls of these small rooms, there were small amounts of debris of varied composition. This was scraped off with sterile scalpels, put in labeled sterile Petri dishes, and brought to the laboratory for examination and culture.

Direct examination.—The material contained chemicals, probably those used in cleaning; sand, presumably brought in by the men from the troughs where they removed the ink from the hands; bits of cloth; spores of nonpathogenic fungi; pollen grains; epithelial debris; and unidentified material. Examination of the material was hindered by the presence of grains of sand, which made it difficult to obtain thin preparations; and by the presence of opaque particles which partially obscured the field of view. Numerous isolated and grouped epithelial cells, and pieces of epithelium up to a half milli-

meter or more in size were found, but in none of these were the hyphae of ringworm fungi seen.

Cultures on honey agar were made from the various samples taken. The most common fungus encountered in these cultures was a species of *Fusarium*, which at first bore a superficial resemblance in colony characters to *Trichophyton*. It proved to be entirely different on further study. Other microorganisms which developed in many cultures were species of *Aspergillus*, *Penicillium*, *Alternaria*, *Chaetomium*, *Monilia*, *Cephalosporium*, *Pachybasium*, yeasts, and bacilli. No pathogenic fungi were found.

Failure to isolate any dermatophytes from the floors of showers and locker rooms was probably due to the rapid growth of more vigorous organisms and the consequent suppression of pathogens. When the rooms were being used by so many men with dermatophytosis of the foot it is incredible that there should be no infected epithelial scales on the floors. Probably an improvement in the technique of examination and isolation would have revealed the presence of ringworm fungi on the floors. Laboratory tests readily demonstrate that the dermatophytes remain viable for months in infected hairs and epithelial squames, and that under suitable conditions they enter a saprophytic phase and produce numerous spores in such debris. The spores produced in the saprophytic phase are capable of initiating dermatophytosis when applied to the skin.

Davidson and Gregory (2), continuing and extending earlier investigations of Plaut (8), point out that keratinized tissues are not readily attacked by most microorganisms, and that when hairs and skin scales naturally infected by the dermatophytes are deposited where conditions of moisture and temperature are suitable they constitute, in effect, a selective culture medium upon which these pathogenic fungi readily grow and sporulate. It is generally assumed that this potentially infective material is commonly present on floors used by individuals with dermatophytosis, and that it is largely responsible for the dissemination of the disease.

It is therefore desirable to take sanitary precautions which will minimize the danger of leaving infected epithelial debris on floors used by many individuals. A prophylactic measure in general use, and described by Osborne and Hitchcock (7), is the placing of rubber pans containing a solution of sodium hypochlorite in such a place that all persons using the shower bath must walk through it. They recommend using a one percent solution to allow for dilution, and the solution must be renewed daily. They point out that sodium thio-sulphate, which has sometimes been used, is not suitable because it is rendered ineffective by combination with residual chlorine in the water of swimming pool or shower. Dependence on this chemical

would be further contraindicated by its lack of fungicidal properties in vitro.

Clinical tests indicate that the sodium hypochlorite foot bath is of definite value in control of epidemics of dermatophytosis. It is not recommended as a therapeutic measure, although chlorine is known to be an effective fungicide. Even the short exposure to hypochlorite in the foot bath, however, combined possibly with an increased attention to proper foot hygiene which the program encourages, is a valuable prophylactic measure.

IDENTIFICATION OF THE DERMATOPHYTES ISOLATED FROM FEET

In identifying pathogenic fungi, and particularly the dermatophytes, one is confronted by a confused nomenclature and a large number of "species." Many of these species are based on slight differences in growth habit which are not actually valid for species delimitation. The presence, in the literature, of nearly 200 species names of ringworm fungi probably is due largely to the failure of investigators to take cognizance of the capacity of these fungi to produce variants or mutants. The study of single spore isolates and the selection of inoculum from indicated areas in old cultures of dermatophytes will very often yield variants unlike the parent species, and often like other "species" (4). It is significant in a consideration of the species question that two or more types of fungi are sometimes isolated from the same patient; and that it is from those strains which upon isolation from the patient do not exactly correspond to any common species that one is most likely to secure further mutations. Furthermore, the lack of correlation between the variety of a given species and the clinical manifestations on the patient of this variety tends to throw doubt on the validity of some of the "species" names. Dowding and Orr (3) report that in a series of patients from whom they isolated several varieties of *Trichophyton mentagrophytes* (*T. gypseum*) there was a total lack of correlation between the varieties isolated and the clinical types of lesion they caused.

The assumption that variants or mutants appear also in nature or on the parasitized host is theoretically probable and receives support also from observed facts. Such variants, whether arising in a natural habitat or in artificial culture, are not new species, and it is undesirable both from the standpoint of a convenient terminology in clinical medicine and from that of accuracy in a systematic study and classification of the dermatophytes to so designate them. Critical comparative studies of many newly isolated strains of dermatophytes, with the fact of variability of strains recognized, are needed to solve the problems of species delimitation.

The present study was unusually suitable for a consideration of this point. The preliminary examination of 354 men and the collection of material for culture was completed in a few weeks. The material was promptly planted on agar slants, and 94 newly isolated strains from clinically similar sources were available for study. In brief, the results of this study have confirmed previous observations, namely, that dermatophytes isolated from cases of dermatophytosis of the foot fall for the most part into a few groups of typical strains, but a few strains in any large series of a given group or species vary in color, rate of growth, or type of colony. If the group is sufficiently large there will be a fairly complete series of intergrading forms between these divergent types.

SINGLE SPORE ISOLATION

In the study of the fungi isolated from this group of men great care was taken to insure the purity of the cultures. The most certain method of doing this is to isolate single spores which are then planted upon a suitable culture medium. In all subsequent studies which are made of the strain the progeny of this single spore are used. Only by following this procedure can one be sure he is dealing with a pure strain and not with a mixture of two or more. In the routine isolation and identification of dermatophytes in the clinic it is not necessary to go to the trouble of picking single spores; but it is particularly important to observe this precaution when one is studying variations in fungi.

The dissociation of a newly isolated strain of a dermatophyte whose pedigree has not been thus determined might be due to the presence in the original culture of a mixture of two or more strains. It will be remembered that in this series, for example, two dermatophytes belonging to different genera were isolated from the foot of one of the men examined. Two strains of fungi more closely related might be carried along together indefinitely by the ordinary method of mass transfer of inoculum, and their eventual dissociation is apt to be misinterpreted.

The fungi in this series were isolated from the patient by the usual method. It was noted that there was an interesting series of intergrading forms, and 28 representative strains were selected for single spore isolation and further study.

The isolation of single spores is readily accomplished without elaborate equipment. The method used in this study is similar to one in common use in many mycology laboratories. The spores from a culture are suspended in sterile physiologic salt solution. A drop of this suspension is spread upon the surface of some clear hard agar such as 4 percent cornmeal agar in a Petri dish. By test one can determine the dilution of the spore suspension which will give a suitable distribution of spores on the surface of the agar. The spores must be numerous enough to be readily found, but not so closely spaced that it is difficult to remove one without disturbing its neighbors.

The cornmeal agar plate is put away at room temperature or at 30° C. until the spores have germinated. This may be 8 to 48 hours, depending upon the temperature and the species. The next operation should be performed in a sterile room. The plate is opened

under a dissecting microscope of good magnification, and isolated spores are picked out with a very fine nichrome needle sharpened to a knife edge. If the spores have germinated it is easier to select an isolated one. Either an entire germinated spore or a hyphal tip from such a spore is removed and placed on an agar slant in such a position that its further development can be observed and other spores, if present, can be detected. After the fungus has grown it is transferred to a sugar-free culture medium to retard development of the "pleomorphic" change.

The small conidia of the dermatophytes are uninucleate. Any variation subsequently appearing in the progeny of a single spore isolated in the above manner presumably indicates, therefore, some alteration which may be in some degree comparable to the mutations of higher organisms.

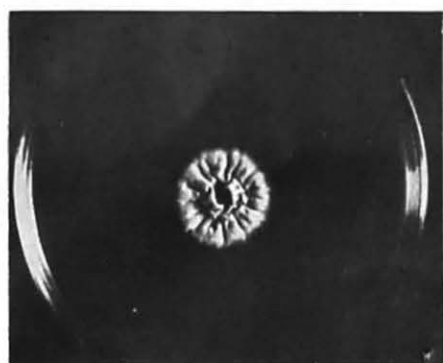
From 10 to 30 single spores were picked from each of the 28 selected strains. Some of these, particularly spores of *Trichophyton purpureum*, failed to grow, but in all except two cases each selected strain was represented by from 5 to 25 lines established from single spores. These multiple lines were established in order to learn whether there were present in a given selected strain a mixture of types of variants. In the selected strains no such mixture was detected. All single spores from a given strain produced similar colonies and in subsequent transfers that were properly timed this similarity to each other and to the parent strain was maintained. When transfers were made at too long time intervals, however, variants did appear (fig. 7, 16 and 18). This appearance of variants in old cultures was expected because of observations made in earlier studies (4).

The isolates were studied in several series of parallel cultures kept under controlled environmental conditions. Careful measurements were made at various ages, and pertinent data on color and other characteristics were recorded. It is not necessary to report here the details of this phase of the study.

The dermatophytes isolated will be grouped and discussed according to species, and the variations within the species, as illustrated by this series of strains, will be discussed in a general way.

EPIDERMOPHYTON FLOCCOSUM

Five strains of *E. floccosum* (*E. inguinale*), one of which is illustrated in figure 5, 1, were isolated in this series. While these showed slight variations in degree of pigmentation and surface configuration of the colonies, there could have been no question regarding the identity of any of the strains. This species, when planted upon honey agar produces a greenish yellow colony, the surface of which is



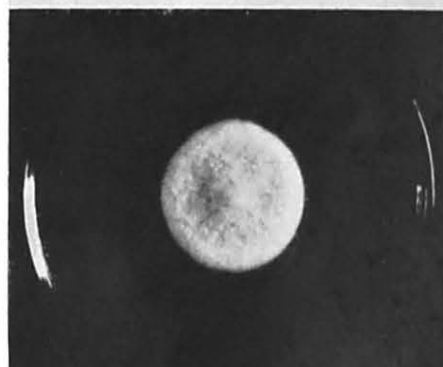
EPIDERMOPHYTON FLOCCOSUM

1



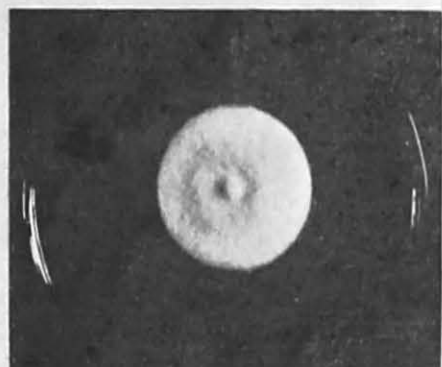
TRICHOPHYTON PURPUREUM

2



TRICHOPHYTON PURPUREUM

3



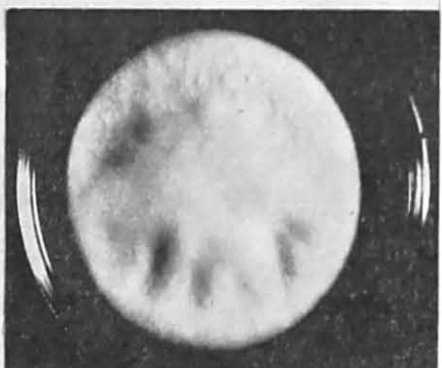
TRICHOPHYTON PURPUREUM

4



TRICHOPHYTON MENTAGROPHYTES

5



TRICHOPHYTON MENTAGROPHYTES

6

FIGURE 5.—CULTURES ON HONEY AGAR PHOTOGRAPHED AFTER TWO WEEKS' INCUBATION AT 30° C. X½.

raised into irregular, radial, and tangential folds. This characteristic appearance is soon obscured (usually in two or three weeks at room temperature) by an overgrowth of a white floccose "pleomorphic" mycelium. This development represents a type of mutation which many of the dermatophytes undergo. When once established, transfers from this "pleomorphic" mycelium reproduce only the "pleomorphic" culture which is composed of a white, floccose, more or less sterile mycelium. The original type of growth cannot be recovered. The "pleomorphic" growth of many species is so similar that it is difficult or impossible to identify a fungus thus altered.

TRICHOPHYTON PURPUREUM

T. purpureum (*T. rubrum*), illustrated in figure 5, was isolated from 18 of the men examined. Three types, differing principally in rate of growth and depth were represented. The colonies of this species on honey agar tend to become dome shaped (figure 5, 2), but the dome may be low (figure 5, 3), or almost lacking (figure 5, 4). The aerial mycelium can be separated from the substratum only with great difficulty, and when torn and scraped away with a needle leaves a dull purplish tough layer of densely matted hyphae on the surface of the medium. It is this pigmented growth that suggested the name given it by Bang (1) in his excellent description of the fungus and of the clinical picture it creates in crural and generalized dermatophytosis. This pigment is first visible on the reverse side of the culture, often as a ring midway between the center and the periphery of the colony. Later the pigment extends from the center of the colony to within a few millimeters of the periphery. In a colony 3 or 4 weeks old the dull purple pigment is visible by transmitted light through the surface layer of white floccose hyphae. This color is distinctly different, in most strains, from the reddish brown pigment of *T. mentagrophytes*.

Trichophyton purpureum is a common pathogen in the south, and most strains isolated are typical, but in many isolated in the north the pigmentation is not so apparent and some strains are distinguished with difficulty from some strains of *T. mentagrophytes*. Some of the strains in this series which exhibited marked radial folding (figure 5, 5 and 6, and figure 6, 7 and 8), had characteristics of both species. They are here listed with the latter. Such intermediate forms may indicate a closer relationship between the two species than is usually recognized.

TRICHOPHYTON MENTAGROPHYTES

This fungus was isolated from 71 of the men from whom cultures were made. *Trichophyton mentagrophytes* is considered to be the

correct name for the varieties variously known as *T. gypseum*, *T. niveum*, *T. interdigitale*, and *T. pedis* (5). There are probably a few additional synonyms. This species name antedates the others (9) and the many varieties of the fungus can be included under this name better than under any of the descriptive names later used. It is a definitely established and easily observed fact that one of these varieties can give rise to another. The variation is usually in the direction of a more floccose type of growth. It is also a fact that in a large series of strains there are bridging or intergrading forms which tend to break down artificial "species" lines. *Trichophyton mentagrophytes* is a species which includes many varieties. This conception causes less confusion than the attempt to recognize these varieties as fixed species.

The photographs indicate more clearly than a written description the types of colony represented in this series. All cultures were grown on the same lot of honey agar and were incubated together at 30° C. for two weeks. Each of the colonies is characteristic of the respective strain as determined by previous observations of plate cultures and by multiple cultures of the strains incubated with this series. So long as strain No. 241, for example (Figure 6, 12), is properly cared for by frequent subculture on honey agar, it will, at the end of two weeks at 30° C. develop the type of colony illustrated in figure 6, 12. The same is true of the other strains, the radial folds of strain No. 147, for example (figure 6, 8), appearing in each subculture. However, when this culture is a month old the folds become obscured by an overgrowth of floccose hyphae.

Variants do appear, however. In this particular set of plate cultures the inoculum was taken from old cultures, and two of the strains developed some colonies of the expected type and some colonies of a type new for the respective strains. In figure 7, 15 the type of colony characteristic of strain No. 39 is illustrated. Figure 7, 16 shows a variant of this strain which grew more rapidly and produced a zone of canary yellow in the mid-zone which is dark in the photograph. The center of the colony is also marked by a depression instead of an umbo. Similarly strain No. 20 (fig. 7, 17) gave rise to a variant producing a thin flat colony with an unusually large amount of reddish brown pigment (fig. 7, 18).

The variation in color of different strains of *T. mentagrophytes* is sometimes striking. The variety most commonly isolated from dermatophytosis of the foot in northeastern United States is cream-colored at the center with a snow white periphery. This tint may be very pale (fig. 6, 9) or deep (fig. 6, 10). It may be replaced by a clear yellow (fig. 7, 16). Some strains are pure white (fig. 7, 13). In others the entire aerial mycelium finally becomes pink or peach



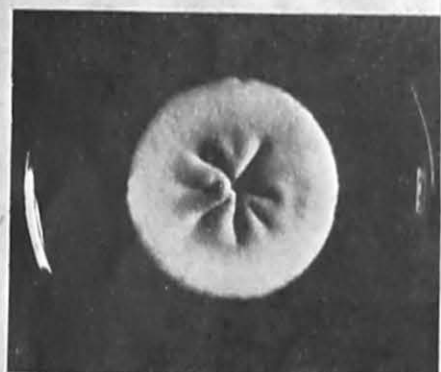
TRICHOPHYTON MENTAGROPHYTES
7



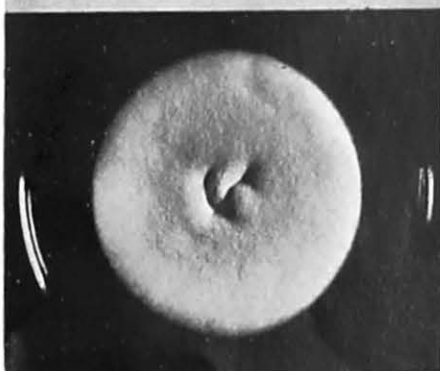
TRICHOPHYTON MENTAGROPHYTES
8



TRICHOPHYTON MENTAGROPHYTES
9



TRICHOPHYTON MENTAGROPHYTES
10

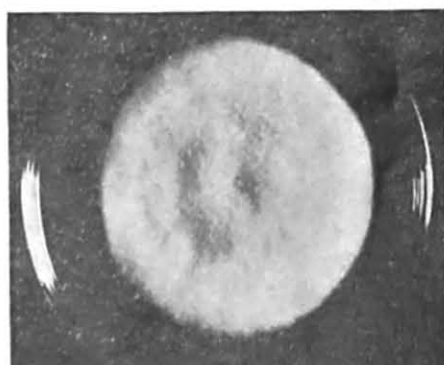


TRICHOPHYTON MENTAGROPHYTES
11

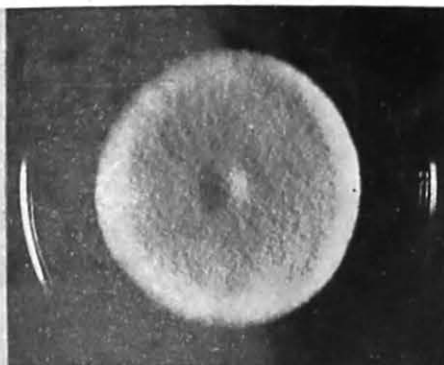


TRICHOPHYTON MENTAGROPHYTES
12

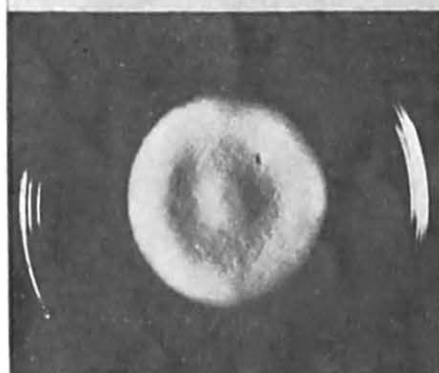
FIGURE 6.—CULTURES ON HONEY AGAR PHOTOGRAPHED AFTER TWO WEEKS' INCUBATION AT 30° C. X $\frac{1}{2}$.



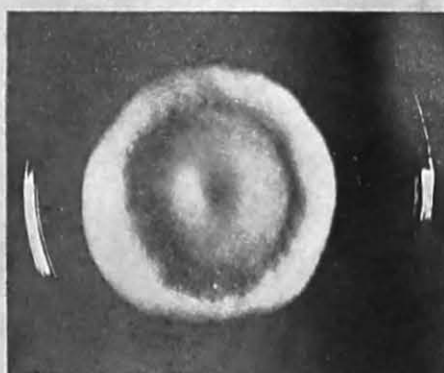
TRICHOPHYTON MENTAGROPHYTES
13



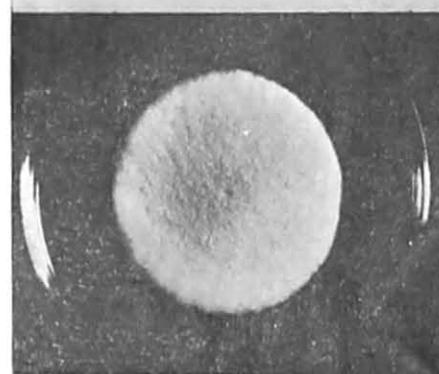
TRICHOPHYTON MENTAGROPHYTES
14



TRICHOPHYTON MENTAGROPHYTES
15



VARIANT OF STRAIN SHOWN AT LEFT
16



TRICHOPHYTON MENTAGROPHYTES
17



VARIANT OF STRAIN SHOWN AT LEFT
18

FIGURE 7.—CULTURES ON HONEY AGAR PHOTOGRAPHED AFTER TWO WEEKS' INCUBATION AT 30° C. $\times\frac{1}{2}$.

colored. This was true of strain No. 20 (fig. 7, 17) in this series. The amount of reddish brown pigment seen in the reverse side of the colony also varies with the strain.

A central pit (fig. 6, 9); a central umbo (fig. 7, 14); a flat surface (fig. 7, 17); short, irregular, radial folds (fig. 6, 10); concentric zones (fig. 7, 16); a thick floccose growth (fig. 6, 12 and fig. 7, 13); thin floccose growth (fig. 7, 17); and thin powdery growth (fig. 7, 18); are some of the characteristics of particular strains of this species. They cannot be taken to typify distinct species because: (1) a complete series of intergrading forms can be isolated from individuals with dermatophytosis; and (2) under controlled laboratory conditions a pedigreed culture arising from a single spore can give rise to two or more colony types.

As shown by table 12, there was no difference between the mycological findings on the feet of the plate printers who had a dermatitis of the hands and the findings of men whose hands were free of dermatitis, and there was likewise no difference in clinical evidence of dermatophytosis of the feet between these two groups. The same findings hold true for the rotary press printers, who were used as controls. Also dermatophytosis of the feet was no more and no less prevalent among persons who reacted positively to patch tests than among persons who reacted negatively.

PATCH TESTS

PROCEDURE IN MAKING PATCH TESTS

All patch tests on both subjects and controls were made with the same batch of ink. Special care was taken not to mix the inks. Each subject was specifically questioned as to his sensitiveness to adhesive tape before patching.

The patches used for the patch test work consisted of: One-half inch squares of 3-ply gauze; 1-inch squares of surgical oiled silk, and 2-inch squares of water-proof adhesive tape. Gauze squares and oiled silk squares were cut in sufficient numbers to last the entire experiment. In order to facilitate handling, the adhesive was cut and in the center of each piece a square of oiled silk was stuck. About 100 pieces of adhesive, with the oil silk attached, were placed on a strip of crinoline bandage. This was rolled up until ready for use.

Six-inch wooden applicators were used to apply the ink to the patient's back. One applicator was used for each ink spot and then discarded.

The patches (13 test patches and 1 control) were placed on the subject's back. The skin of the back was carefully examined beforehand to be sure that no dermatitis or breaks in the skin were present. The back was used for patch testing because of the large number of patches and the necessity of placing all patches at one time in order to take the employee away from his occupation as short a time as possible; owing to the nature of the work no other part of the body could be used for so great a number of patches.

The patch was left in contact with the skin of the back for 24 hours, unless symptoms of stinging, pain, etc., made it necessary to remove the patch. Each subject was instructed to immediately report to the physician when the patch test became so uncomfortable that he thought injury to the skin was being caused. The skin was observed for at least 15 minutes after removal of the patch.

The classification of Stauffer (11) was followed in the interpretation of the tests:

- I. Reddening.
- II. Reddening, infiltration, and formation of vesicles.
- III. Formation of vesicles and blisters.
- IV. Large, confluent blisters.
- V. Separation of epidermis, eventually ending in necrosis.

All examinations of patch tests were made in natural illumination.

The patch test was examined at the end of 24, 48, and 72 hours after removal of the patch.

The 13 inks which were used in the patch tests were each composed of 2 or 3 pigments and 3 to 11 other constituents (oils, dryers, varnishes, and modifiers of consistency). These inks were, and had been, in use for the past year or longer at this establishment. No component of any ink handled by the printers in their work was absent from one or more of the inks used for the tests.

As noted in the occupational survey, all of the men examined had some degree of skin exposure to gasoline (benzine), i. e. plate printers in cleaning the plates, rotary press printers in cleaning the presses, and the skilled helpers in cleansing hands, plates, and ink containers. Gasoline is known to be a general irritant, unless proper protection is used. Therefore no patch tests were made with gasoline.

TABLE 13.—Number of subjects who gave positive reaction to patch test with whole inks

Inks	Plate printers with dermatitis of the hands		Plate printers with history of dermatitis of the hands		Plate printers who had never had dermatitis of the hands (controls)		Industrial Hygiene Laboratory Personnel (controls)		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Total number patched.....	18		33		50		20		121	
Green ink No. 411..	3		0		0		0		3	
Black ink No. 2....	0		0		0		0		0	
Orange ink No. 311..	6		0		0		0		6	
Red ink No. 128....	7		1		0		0		8	
Purple ink No. 236..	1		1		0		0		2	
Black ink No. 601..	0		0		0		0		0	
Orange ink No. 313..	9		1		0		0		10	
Blue ink No. 233....	3		0		0		0		3	
Yellow ink No. 316..	5		1		0		0		6	
Pink ink No. 124....	3		1		0		0		4	
Brown ink No. 505..	4		0		0		0		4	
Brown ink No. 518..	4		0		0		0		4	
Brown ink No. 513..	7		0		0		0		7	
Number of men with positive reactions to any ink.....	9	50.0	4	12.1	0	0	0	0	13	10.7

Patch tests were made on 121 individuals. These individuals were separated into the following groups: Eighteen were plate printers who had dermatitis of the hands at the time of the examination; 33 were plate printers who gave a past history of dermatitis of the hands; 50 (controls) were plate printers who had been employed at this establishment for 10 years or longer, and who had never had a dermatitis of the hands; 20 (controls) were members of the Industrial Hygiene Laboratory of the National Institute of Health, who had never had any known contact of any sort with printing inks.

Of the 58 employees who either had a dermatitis of the hands at the time of the examination, or gave a past history of dermatitis of the hands, 7 were not tested since they were not on duty during the time of the patch testing.

Among the 121 individuals patched, 13 gave positive reactions to one or more whole inks.

No positive patch tests were obtained among the 50 plate printers, or the 20 Industrial Hygiene Laboratory individuals who were used as controls.

To the 13 whole inks used in the patch tests, two or more individuals gave a positive reaction to one or more, with the exception of the black inks No. 2 and No. 601.

From the table it will be noted that orange ink No. 311, red ink No. 128, brown ink No. 513, orange ink No. 313, and yellow ink No. 316 gave the greatest number of positive reactions. However, one or more individuals gave a positive reaction to one or more of the other inks. Three plate printers gave a positive reaction to 10 or more of the inks; these three men had dermatitis of the hands at the time of the examination.

Nine, or 50 percent, of the plate printers who were patched and who had dermatitis of the hands at the time of the examination gave positive reactions to the inks. All but one of these plate printers reacted to 3 or more inks.

Four, or 12.1 percent, of the plate printers with a history of dermatitis of the hands, but negative at the time of the examination, gave a positive reaction to the inks. Three of these printers reacted positively to one ink only and one reacted positively to two inks.

The 50 plate printers who had the same exposure to the inks as the plate printers with dermatitis of the hands, or those with a history of dermatitis of the hands, all reacted negatively to all the inks.

The 20 employees of the Industrial Hygiene Laboratory, who had never had any contact with printing ink, reacted negatively to all the inks.

ANALYSIS OF THE INKS

A careful study of the chemical analysis of the 13 inks used in the patch tests was made, and it was found that no one constituent was common to all the 13 inks. The four inks, orange No. 313, red No. 128, orange No. 311, and brown No. 513 did not contain substances that were not found in one of the black inks that gave no positive reaction or in some of the other inks that gave only one positive reaction.

The 13 inks in use were very complex in nature, as at least 30 coloring or tinting components entered into their composition in addition to fillers, varnishes, oils, and driers.

In addition to this, the types of oils and driers varied from one ink to another and such substances as varnishes and driers were complex in character, each being composed of a variety of ingredients. In addition to this, there existed the possibility of reaction of the ingredients of a given ink with one another, or of oxidation reaction in the finished product promoted by one of the ingredients, so that the ink as actually used would differ in effect from patch tests conducted with its original component parts. Some of these coloring materials were organic as well as inorganic and therefore presented a further complexity of structure.

ELIMINATIVE PATCH TESTS

It was inferred that the constituents of the inks other than colored pigments were inert and that the pigments composed of basic lead chromate and of lead oxide were the greatest offenders. However, it was noted that some men had shown positive reactions from inks containing neither of these pigments. It would have been manifestly impossible to patch each of the individuals against all of the pigments and the component parts of the paste (there were over one thousand combinations of the components), and furthermore, as explained above, to patch the individuals to each component part of the inks would not have been the same as patching them to the whole ink. Therefore, an eliminative method of patch testing was devised in order to approximate as closely as possible the exposure of men handling the suspected substances, and also to avoid setting up conditions not present in the first patch tests.

Three or four patch test preparations were made from each ink, depending upon whether the particular ink contained two or three pigments. Preparation "A" of a given ink would represent the whole ink with the first pigment eliminated. Preparation "B" would be the whole ink with the second pigment only eliminated. Preparation "C" would be similar, except that the third pigment would be eliminated, the first two pigments and the paste still present. Preparation "X" would be the paste with all coloring materials out.

The procedure of making the patch tests was identical with that described in connection with the first patch testing, except that broken down inks were used instead of the whole preparations. A control patch was used on each man. Also, other men (for controls) were patched with the same preparation in addition to those who had been found sensitive to the particular inks. The men used as controls were plate printers with dermatitis of the hands present or who gave a history of dermatitis of the hands but had failed to react positively to inks in the first patch testing.

Using this method of procedure, 12 men who either gave a history of dermatitis of the hands or had dermatitis of the hands at the time of patching and who gave a positive reaction to the patch tests with the whole inks were patched. Twelve controls were also patched.

The results of this elimination process of patching were variable.

All of the preparations "A," "B," "C," and "X" contained "X" (paste). Six men showed negative reactions to preparations "A," "B," "C," and "X," whereas they gave positive reactions to the six whole inks from which these preparations were made.

Five men showed positive reactions to each preparation "A," "B," "C," and "X" of six inks from which these preparations were made.

Three men showed positive reactions to the preparations "A," "B," and "C," but negative to "X" of three inks from which these preparations were made.

Four men showed positive reactions to preparations "X" (paste) and negative reactions to one or more of the preparations "A," "B," "C" of six inks.

Only one man gave a negative reaction to "X," and a negative reaction to one of the preparations "A," "B," "C" of one ink.

These results were so variable and contradictory that further patching with either modifications of the whole inks or with separate ingredients was not made. Furthermore, the above eliminative method of patching had necessitated placing 10 to 16 patches on at each time and since all of the positive reactions with both the whole inks and the broken down inks had shown vesiculation, the backs, the thighs, and the arms of the men would not have been in condition for further patching for several months.

A negative patch test is not conclusive evidence that ink is not the cause of the dermatitis. It is often impossible to reproduce the actual conditions of industrial exposure, as repeated contact, friction, maceration, heat, cold, sweat, etc. These additional factors enable the substance, negative in the test, to cause dermatitis.

Individuals with a family and personal history of allergic disorders show a tendency to become sensitive to proteins with which they come in contact in massive doses.

CLASSIFICATION OF THE DERMATITIS

The clinical manifestations of the dermatitis fell under five classifications.

I. CHRONIC ECZEMATOUS, VESICULAR TYPE

A chronic inflammation of the skin characterized by slight redness followed by isolated groups of papules. In a short time vesicles, varying from the size of a millet seed to a large marble, appeared. These vesicles were filled with a clear serum, and were easily ruptured, leaving moist, denuded areas. The discharge dried rapidly, forming light crusts. Upon removal of the crusts the underlying area was dry, glistening, and scaly, with small fissures present. The scaliness and fissures usually remained for months. In an occasional case pustules and ulcers followed the ruptured vesicle; these usually healed fairly quickly without noticeable scar formation. There was intense itching during the vesicular stage of the lesion.

Crops of new vesicles appeared, each being followed by the above symptoms. The duration of the lesions extended from a few weeks to several months, and a few patients stated that they had had the scaly and fissured lesions of the hands for over 15 years.

The lesions in the majority of the cases were asymmetrical, affecting both hands, however, a few cases had the lesions on the right hand only. The dorsum of the hand, the interdigital spaces, the palms, and the wrists were usually affected. Approximately one-third of the cases had never had the lesions on the palms of the hands. The texture of the skin bore no definite relation to the incidence of dermatitis.

Sixteen of the 21 plate printers with dermatitis of the hands were of this type. There are given below two case histories typical of this classification.

CASE HISTORY NO. 1

Age.—42.

Occupational history.—Plate printer for 28 years, last 19 years of this time at present place of employment. Now working in section 5 for past 1½ months, using red ink. Previously he had worked in all sections, using all colors of inks. Denies exposure to any substance capable of producing dermatitis outside of his work. Was employed at present establishment for 3 years before dermatitis of the hands began.

Cleaning materials used.—Uses oil trough, salts of tartar, white soap, and brush to clean hands.

Family history.—Negative for allergic disorders and skin diseases.

Past medical history.—Onset of dermatitis of hands was in 1920. Duration 2 years. Six to eight relapses; these occurred only when he returned to colored ink work. Duration of dermatitis after leaving work 2 weeks. No seasonal exacerbation. Following the World War he was unable to work with inks other than black, although prior to the World War he worked with all types and colors. The rash appeared on the arms and hands as a wet itching surface with fissure formation. No evidence of lesions elsewhere on the body. He has had four X-ray treatments of hands. He complained of vesicles on his palms and dorsum of hands, and weeping fissures. Itching was present.

Present medical history.—No active dermatitis of hands at time of examination in October 1936.

Examination of the skin.—January 26, 1937: Umbilicated papules, pink in color with induration. Asymmetrical distribution—right hand on palm. Scaling present. Right palm dry, rough, reddened, fissured, also few umbilicated papules, probably resulting from ruptured vesicles. February 15, 1937: Dermatitis same as in January.

Clinical evidence of dermatophytosis of feet.—Negative.

Mycological examination.—Negative.

Patch tests.—Positive to all inks, except black.

Loss of working time because of dermatitis.—2 months.

Duration of dermatitis after leaving work.—2 weeks.

Diagnosis.—Industrial dermatitis of hands.

Occupational.—Yes.

Type.—Chronic, eczematous, vesicular.

Cause.—Colored inks.

Disability.—None at present.

CASE HISTORY NO. 1

Age.—48.

Occupational history.—Plate printer for 20 years, last 14½ years of this time at present place of employment. Now working in section 9, has worked in this section for past ½ year using black ink in printing faces. Previously he had worked in various sections using various colored inks. Uses benzine to clean plates. Denies exposure to any substance capable of producing dermatitis outside of present place of employment. Was employed there for 4 years before dermatitis began.

Cleaning materials used.—Uses oil trough and white soap to clean hands.

Family history.—Negative for allergic disorders and skin diseases.

Past medical history.—Urticaria in childhood. Athlete's foot past week. History of increased sweating—general distribution. Dermatitis of hands first in 1909—3 days after using green ink. The dermatitis disappeared one week after he left work. He complained of vesicles on palms, dorsum of hands and between fingers; weeping, itching, lichenification, and erythema were present.

Present medical history.—Onset: February 1936. Duration: to date. No relapse. Treatment by private physicians. He thinks X-ray treatment helped him. No loss of working time. Condition seems worse in summer. He was using red ink at the onset—transfer to black ink caused no improvement. Description: vesicles, weeping, fissures, itching, erythema. Other skin disease: dermatitis of abdomen for several months beginning in July 1936. He used section shower occasionally, walked on floor with bare feet.

Examination of the skin.—October 1936: Macules and crusts on dorsum of hands and forearms, pink color, annular configuration. Skin thick and wrinkled. Pruritis present. Hands: Has smooth, worn appearance of palm of right 3rd,

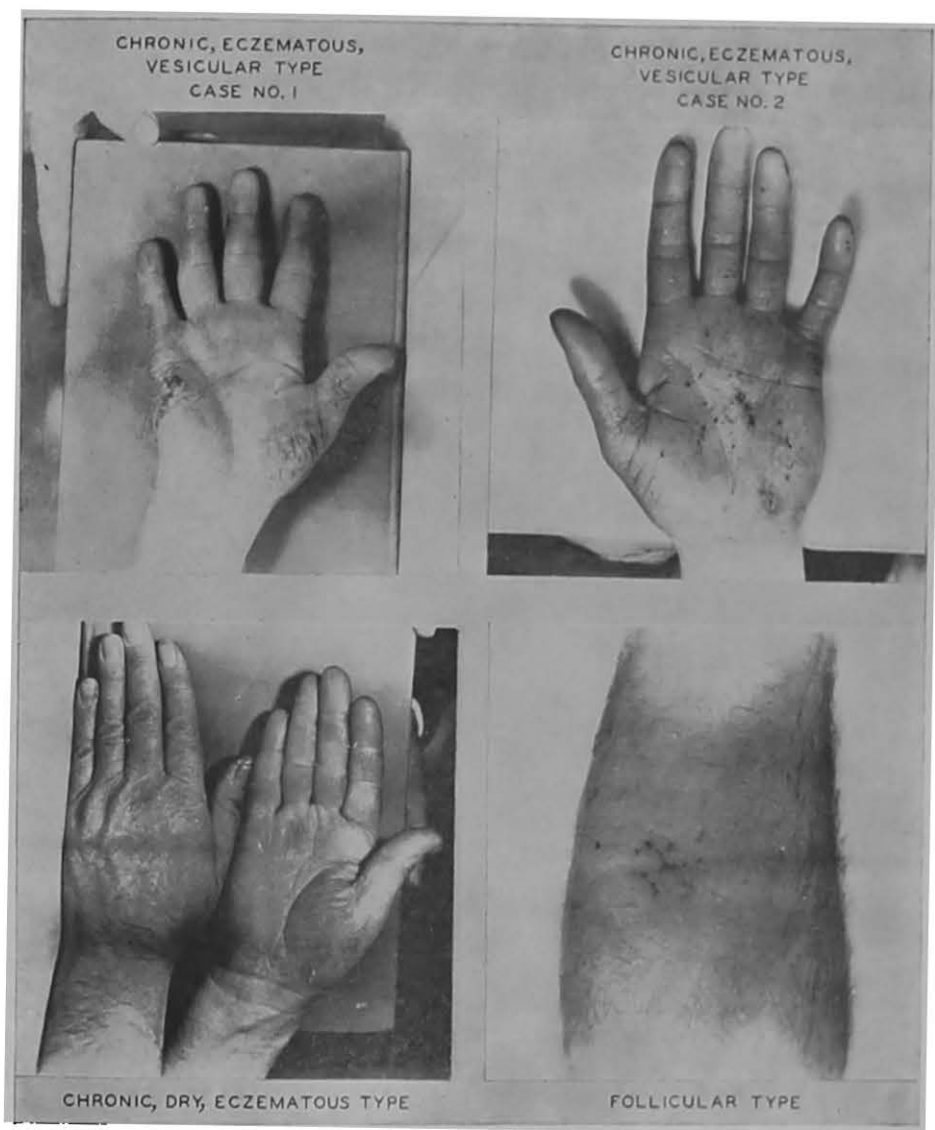


FIGURE 8.—TYPICAL CASES OF DERMATITIS FOUND ON EXAMINATION OF PRINTERS.

4th, and 5th fingers. Several areas between fingers of both hands and ulnar side of wrists show erythema, crusting, and fissures. Lesion on left lower ulna, annular and in position to receive friction. Has fissures between toes with sodden, grey appearance of skin of toes. Fine scales on rest of feet.

January 26, 1937: Vesicles right forearm and left hand, pink and fawn color, on elevated erythematous round bases. Also crusts, fissures, and ulcers, right index and middle fingers—palmar surfaces. (Note.—Present exposure is in use of oil troughs containing colored inks.)

February 15, 1937: Same findings as in January, except that the vesicles of the left hand had ruptured and become umbilicated papules. Fissures had also developed around distal portion of left thumb nail.

February 23, 1937: Same finding as February 15.

Clinical evidence of dermatophytosis of feet.—Positive.

Mycological examination.—*Epidermophyton floccosum* grew in culture from feet.

Patch tests.—Positive to green, orange No. 311 and No. 313, red, blue, yellow, pink, and all three brown inks.

Loss of working time because of dermatitis.—Three and one-half months.

Duration of dermatitis after leaving work.—One week.

Diagnosis.—Industrial dermatitis of hands and forearms, and dermatophytosis of feet.

Occupational.—Yes.

Type.—Chronic eczematous vesicular.

Cause.—Colored inks.

Disability.—None at present.

II. CHRONIC DRY ECZEMATOUS TYPE

A chronic eczema of the hands marked by infiltration, and the formation of small, thin, whitish scales, and fissures, occurring on the dorsum, the palms, and between the digits with no itching and no vesicular formation.

This type of lesion was found in two plate printers and in each occurred only on the right hand. A typical case history is given below.

CASE HISTORY NO. 3

Age.—62.

Occupational history.—Plate printer for 47 years, last 36 years of this time at present place of employment. Now working in section 4, has worked in this section for 13 years, using black ink, printing faces. Previously worked in sections 7, 9, and 13, for 23 years using all colors of inks. Uses gasoline to clean plates. Denies exposure to any substance capable of producing dermatitis outside work. Was employed at present establishment for 14 years at same occupation before dermatitis began.

Cleaning materials used.—Does not use the usual cleaning materials.

Family history.—Negative for allergic disorders and skin diseases.

Past medical history.—Dermatitis of hands first noticed in fall of 1914. Duration at that time was 2 months. He has had numerous relapses since. Duration of dermatitis after leaving work—14 days. He was away 15 days altogether. He was using green ink at the onset. He complained of vesicles on dorsum of hands, later weeping and erythema. Itching was present.

Present medical history.—Onset March 1936.

Examination of the skin.—October 1936: Skin shows usual evidence of senile changes. Pustules, asymmetrical in distribution on hands and forearms. Irregular in configuration. Induration present. Border of lesions elevated and erythematous. Previous dermatitis began with small vesicles appearing first between fingers. Itching was intense until blisters break, then itching subsides. Present lesions of small pustules about hair follicles on dorsum of hands and a few on forearms.

January 27, 1937: No skin lesions of hands or forearms. The pustules disappeared one week after the first examination.

February 15, 1937: Pink and grey scales now are present on palms, asymmetrical in distribution, irregular configuration, induration present. Palms dry and rough. Present dermatitis said to have been of 3 days' duration.

Clinical evidence of dermatophytosis of feet.—Negative.

Mycological examination.—Negative.

Patch tests.—Negative to all inks.

Loss of working time because of dermatitis.—One-half month.

Duration of dermatitis after leaving work.—One-half month.

Diagnosis.—Industrial dermatitis of hands.

Occupational.—Yes.

Type.—Chronic dry eczematous.

Cause.—Gasoline in cleaning plates, and epithelial injury caused by wiping the plates, and colored inks.

Disability.—None at present.

III. FOLLICULAR TYPE

The pores of the skin of the dorsum of the hands and forearms were found to be enlarged and occluded with dried ink in about 20 percent of the plate printers. The dried ink could not be removed by the usual cleaning methods. The extent of the plugging of the pores of the skin varied, in the majority of the cases only a few pores would be occluded while in a few cases almost every pore of the skin of the forearms and hands was occluded. Seven cases among the plate printers were found revealing numerous pit-like scars around the hair follicles of the forearms and dorsum of the hands. One plate printer had a pustular perifolliculitis of the dorsum of the hands, with severe plugging of the pores of the skin of each hand and forearm, and numerous pit-like scars from previous folliculitis. His case history is given.

CASE HISTORY NO. 4

Age.—48.

Occupational history.—Plate printer for 30 years, all of this time for present employer. Now working in section 9; has worked in this section 3 years, using black ink, printing faces. Previously he had worked in all sections, using all colors of inks. Uses gasoline to clean plates. Denies exposure to any substance capable of producing dermatitis, outside of regular employment. Worked at present establishment at the same occupation for 20 years before dermatitis began.

Cleaning materials used.—Uses oil trough, sand, white soap, yellow soap, and brush to clean hands.

Family history.—Negative for allergic disorders. Son has athlete's foot.

Past medical history.—Athlete's foot off and on during past 7 years. Dermatitis of hands began 10 years ago. Duration 2 to 3 weeks. He did not remember the type of ink exposure at time of onset. He complained of pustules on dorsum of hands.

Past medical history.—Pustules on the dorsum of the hands for the past 3 weeks.

Examination of the skin.—October 1936: Pustules dorsum of right hand and forearm. Asymmetrical distribution. Border of lesions elevated, erythematous. He has a deeply seated, apparently pustular lesion dorsal surface of right wrist. Has several scars on dorsal surfaces of hands and wrists where similar lesions have been incised. Pores on dorsum of hands, wrists, and forearms, are enlarged and blocked. He has been troubled with pustular lesions intermittently for at least 10 years. They occur only on hands and wrists, dorsal surfaces.

Clinical evidence of dermatophytosis of feet.—Positive.

Mycological examination.—Positive for *Trichophyton* from scrapings from toe nails, by microscopic examination.

Patch tests.—Refused.

Loss of working time because of dermatitis.—None.

Duration of dermatitis after leaving work.—Does not know.

Diagnosis.—Pustular perifolliculitis of hands and forearms, and dermatophytosis of feet.

Occupational.—Yes.

Type.—Plugged pores, folliculitis.

Cause.—Dried ink, occluding pores of skin, staphylococcus infection.

Disability.—None at present.

IV. CHRONIC, ECZEMATOUS, FISSURE TYPE

A chronic generalized eczema of the hands and wrists, characterized by induration, roughness, extreme dryness, and wrinkled appearance of the skin, with the presence of numerous, firm, white, thin scales, with no itching and no vesiculation.

Three skilled helpers who cleaned the ink fountains and cleaned their hands with benzine had this type of skin lesion. A typical case history is given below.

CASE HISTORY NO. 5

Age.—40 (colored male).

Occupational history.—Skilled helper at present place of employment for 18 years. Relatively no exposure to inks. Cleans ink fountains with gasoline. Denies exposure to any substance capable of producing dermatitis outside of this work. Was employed 17 years at present establishment before dermatitis began.

Cleaning materials used.—Cleans hands with sand and white soap.

Family history.—Negative for allergic disorders and skin diseases.

Past medical history.—No allergic disorders or skin disease.

Present medical history.—Dermatitis of hands began less than a year ago. He has had no treatment. No loss of time because of dermatitis. At time of onset and since he has handled various colored inks and has cleaned ink fountains with benzine. He complained of scales on the palms.

Examination of the skin.—October 1936: Macules and scales, symmetrical distribution on both palms. Pruritis absent. Patient has occasionally noticed a mild scaly dermatitis of palms of his hands during the past year. This has occurred several times. It does not itch. Clears up spontaneously without treatment in 2 to 3 days. He has lost no time because of this condition. He thinks using more than the usual amount of benzine some days may be the cause. Lesions at present irregular, scaly patches on palms of hands and palmar surfaces of fingers.

January 25, 1937: No dermatitis of hands.

February 26, 1937: No dermatitis of hands.

Clinical evidence of dermatophytosis of feet.—Negative.

Mycological examination.—Negative.

Patch tests.—Negative to all inks.

Loss of working time because of dermatitis.—None.

Diagnosis.—Industrial dermatitis of hands.

Occupational.—Yes.

Type.—Chronic eczematous fissure.

Cause.—Gasoline plus abrasive action of sand in cleaning hands.

Disability.—None.

V. DERMATOPHYTIDS

A chronic vesicular or squamous eruption of the hands, the vesicles either superficial or deep, and accompanied by various degrees of inflammation, with intense pruritis. No microorganisms could be recovered from the hands, but they were abundant in the primary infection of the feet.

Three plate printers had this type of dermatitis of the hands. A typical case history is outlined below.

CASE HISTORY NO. 6

Age.—43.

Occupational history.—Plate printer for 26 years, all of this time for present employer. Now working in section 9. Has worked in this section 4 years, using black ink, printing faces. Previously he had worked in all sections, using all colors of ink. Uses gasoline to clean plates. Denies exposure to any substance capable of producing dermatitis outside of work. Was employed at present establishment about 1 month before dermatitis began (off duty several years).

Cleaning materials used.—Uses oil trough, salts of tartar, and white soap to clean hands.

Family history.—Negative for allergic disorders and skin diseases.

Past medical history.—Athlete's foot present during past 8 years. Dermatitis of hands began 29 years ago and has continued ever since. No treatment helped him. No loss of time from work. No seasonal exacerbation. He does not remember type of ink exposure on onset. He complained of vesicles deeply situated on dorsum of hands.

Present medical history.—Dermatitis of hands as described under past medical history.

Examination of the skin.—October 1936: Small, deeply situated vesicles, dorsum of hands and fingers. Induration present. Papules also present. Pruritis, none at present but occurs when he has been away from work 2 days.

January 25, 1937: Pink papules, dorsum of right hand. Asymmetrical distribution. Slight induration present. Border of lesions erythematous.

February 15, 1937: No dermatitis present on hands.

February 26, 1937: No dermatitis on hands. He states that the dermatitis usually occurs when he is away from work, that it disappears when he is working.

Clinical evidence of dermatophytosis of feet.—Positive.

Mycological examination.—Positive for *Trichophyton mentagrophytes* by culture and microscopic examination.

Patch tests.—Negative to all inks.

Loss of working time because of dermatitis.—None.

Duration of dermatitis after leaving work.—Dermatitis becomes worse while off duty.

Diagnosis.—Dermatophytosis of feet. Dermatophytids of hands.

Occupational.—Possible.

Type.—Chronic eczematous vesicular.

Cause.—Fungus infection of feet.

Disability.—None.

In general, the skin of the hands of the plate printers unaffected by dermatitis was soft and pliable with the absence of callous formation. The absence of scars on the hands was noticeable.

Worn, shiny areas were found in the palms of a few of the plate printers. According to the plate printers, these areas were caused by rubbing the palms with pumice stone in order to remove rough areas of the palms that would interfere with the wiping of the plates.

According to the statements of the plate printers, small traumatic wounds of the hands healed quickly.

MEDICAL CRITERIA FOR ESTABLISHING PROOF OF PROBABLE INDUSTRIAL DERMATITIS ACCORDING TO SULZBERGER (12)

I. Criteria of first order (indispensable).

1. Inception occurring during a period of industrial exposure with reasonable incubation period.
2. Amelioration—after cessation of exposure. Retention of causal agents or complicating factors may aggravate or prolong the disease.
3. Recurrences and exacerbation on exposure.

II. Criteria of second order (adjuvant).

1. Appearances in areas of maximum exposure.
2. Lesions and localization characteristic.
3. Reaction to presumptive causal agents.
4. Skin tests produce similar reactions.
5. Other fellow workers similarly affected.
6. Appearance soon after new exposure.
7. A dermatitis and not some other dermatosis.
8. Lack of exposure to nonindustrial irritant.

As will be noted in the occupational survey, the plate printers and skilled helpers had the following potential skin hazards associated with their occupations:

DIRECT FACTORS

Mechanical.

- a. Friction of the palms of the hands from wiping the plates.
- b. Abrasive action of the cleaning materials, sand, brushes, and oil-saturated cheesecloth.
- c. Plugging of the pores of the skin by ink.
- d. Drying of hands by vigorous, repeated use of either cloth towels, paper towels, or cheesecloth, and also improper drying of hands.

Chemical factors.

- a. Inks, on the plates, in the oil troughs, and on the aprons of the plate printers (massive exposure).
- b. Solvents, gasoline used for cleaning plates.
- c. Salts of tartar (Potassium carbonate) used for its detergent action in cleaning the hands.
- d. Soaps, prolonged, vigorous, and repeated bathing of the hands with soap and water.
- e. Oil troughs, which contain many colored inks, debris from employee's hands, and possibly small amounts of gasoline.

Infections.

- a. Fungal infection of feet, and possibly of hands; the use of common shower baths, on the floor of which were found epithelial debris.
- b. Bacteria, staphylococcus infection of plugged pores of skin, causing folliculitis; causing secondary infections of the open lesions of the hands.

INDIRECT FACTORS

It is possible that the above mechanical and chemical agents may cause the hands of the plate printers to become more susceptible to dermatophytid reactions, in those plate printers who have dermatophytosis of the feet (6).

It is possible that dermatophytosis of the feet may increase the susceptibility of the hands of the plate printers to allergic reactions to the inks (13).

Mental and nervous factors: It is well known that the course of a case of dermatitis may be greatly modified if the affected person is under nervous or emotional strain. Exacting precision work like this does require the closest attention, and in highly-strung individuals it would not require a great deal of additional nervous tension (possibly arising from worry or personal grievances) to produce a mental state that would complicate his state of health in numerous ways.

All of the potential skin hazards enumerated above, under both direct and indirect factors, played some part in the cause of the dermatitis of the hands among the employees of this printing establishment, and to determine the actual, single primary etiological agent in each individual case is difficult and in many cases impossible.

The repeated contact with the chemical substances, the friction from wiping the plates and cleaning the hands, the maceration due to constant contact with moist substances, and heat, cold, and sweat are factors influencing both the onset of the dermatitis and the chronicity of the dermatitis of the hands among these employees.

SUMMARY

This bulletin discusses the technique employed in conducting a study of the working environment and dermatological examination of plate printers. The purpose of the investigation was to study the relationship between the industrial environment and certain skin diseases.

A discussion of the occupational survey, describing the occupations and the process of plate printing, as well as the occupational exposure to inks, cleaning agents and other substances, and a discussion of the dermatological findings is given.

POSITIVE FINDINGS

Age.—The average age of the plate printers and rotary press printers was 52.6 years and 17.1 percent of the plate printers were 60 years of age or older.

Industrial dermatitis of the hands and the past medical history of industrial dermatitis of the hands was approximately the same for each 10 year age group.

Duration of employment.—Twenty-six and six-tenths percent of the plate printers and rotary-press printers had been employed as such at the present establishment for 35 years or longer, while 74.5 percent of the skilled helpers had been employed for 5 years or less.

All the plate printers who had dermatitis of the hands had worked at the present place of employment for 15 years or longer.

Section distribution.—Forty-two and eight-tenths percent of the plate printers with dermatitis of the hands were working in sections 4 and 9 at the time of the examination. Only one plate printer developed dermatitis of the hands while employed in sections using black ink only, and his dermatitis was caused by cleaning his hands with sand. It is customary to transfer employees with dermatitis to the sections using only black ink.

Cleaning materials.—The cleaning materials, mineral oil, contaminated with various inks and debris, soaps, sand, salts of tartar, and brushes were found to be a definite factor in the causation of the dermatitis. Gasoline, which is used to clean the plates and the ink fountains, was also an etiological factor in the dermatitis.

Printing plates.—The type of plate was not found to be important in the production of dermatitis, except for the color of ink used thereon.

Inks.—Eleven of the thirteen inks used at this establishment caused dermatitis of the hands among the plate printers. The greatest offenders (listed in order of their frequency) were: orange No. 313, red No. 128, orange No. 311, and brown No. 513.

MEDICAL HISTORY

Family and personal histories.—The allergic disorders—hay fever, asthma, urticaria, migraine, and chronic eczema—occurred somewhat more frequently in the families of men with dermatitis than in the families of men who did not have dermatitis. The same relationship is true for the past personal histories of allergic disorders.

Date of onset of the dermatitis.—The incidence of dermatitis was approximately the same per year from 1900 through 1936.

Duration of the dermatitis of the hands.—From less than 1 year to more than 30 years.

Duration of dermatitis of the hands after leaving work.—Thirty-eight percent and 56.7 percent, respectively, of the employees with dermatitis of the hands, and employees who gave a history of dermatitis of the hands, had no loss of working time because of the dermatitis. The majority of the remaining affected employees recovered in from 1 week to 2 months after leaving work.

Estimate of the total loss of working time because of dermatitis of the hands.—Thirteen years working time for one man, during the period 1910 to 1936.

Seasonal exacerbation of the dermatitis.—None.

Inks used at onset of dermatitis.—Fifty-six and nine-tenths percent of the plate printers, who either had a dermatitis of the hands, or a history of dermatitis of the hands, were working with green ink at the onset of the dermatitis, according to the medical history.

Length of time after beginning work at present establishment before dermatitis developed.—Approximately 50 percent of the employees had worked at present place for 10 years or longer before the dermatitis developed.

Description of the dermatitis.—Industrial dermatitis of the chronic eczematous type.

Mycological examination.—Pathogenic fungi of the feet were found in 33 percent by microscopic examination, 26.2 percent by culture, 36.4 percent by one or both of these methods of examination. Thirty and five-tenths percent revealed clinical evidence of dermatophytosis of the feet, and 49.7 percent had either or both clinical evidence or laboratory findings of dermatophytosis of the feet.

Epidermophyton floccosum was isolated from five of the men, *Trichophyton purpureum* from 18, and *T. mentagrophytes* from 71. The strains were isolated within a short period of time, and therefore

provided exceptionally good material for a study of variations and species limits. Representative strains were selected, and comparative studies of strains were based on from 5 to 25 single spore isolates from each of 28 selected strains. A variety of culture types containing intergrading forms illustrates the variability of this species.

The controls, the plate printers with dermatitis of the hands, and the plate printers with a past history of dermatitis of the hands, had the same relative incidence of dermatophytosis of the feet by all of the above methods of examination.

No pathogenic fungi were found by culture or by microscopic examination on the hands.

Oil troughs.—The oil of the oil troughs did not possess fungicidal or bactericidal properties.

Shower baths.—Laboratory examination of material taken from the shower bath floors revealed numerous nonpathogenic fungi, bacteria, and epithelial cells.

Patch tests.—Of the 121 individuals who were patch tested to the 13 inks used, 13 gave positive reactions. No positive tests were obtained among the 70 controls.

Fifty percent of the plate printers who were patched, and who had dermatitis at the time of the examination, gave positive reactions to the inks.

Twelve and one-tenth percent of the plate printers with a past history of dermatitis of the hands gave a positive reaction.

Results of the patch tests with component parts of inks were variable.

PROCEDURE USED IN MAKING DIAGNOSIS OF THE DERMATITIS

The definition of industrial dermatitis, and the criteria for the diagnosis, were used in accordance with that defined by Sulzberger.

Definition after Sulzberger (12).

A skin condition to be definitely industrial must be related to an occupation:

- a. With due regard to the time element
- b. And beyond reasonable doubt.

(1) Directly, from such causes as—

- Mechanical.
- Chemical.
- Thermal.
- Infections—bacteria, fungi, parasites.
- Actinic.

(2) Indirectly

- a. By complications of an occupational trauma, or the treatment of such a trauma.

b. By exaggeration of pre-existing skin disease.

Sequelae and complications to be regarded as industrial.

Diagnosis.—All cases diagnosed as industrial dermatitis developed during a period of industrial exposure, with a reasonable exposure period.

All of these cases showed evidence of amelioration after cessation of exposure, and recurrence after exposure.

All of the skin lesions diagnosed as industrial dermatitis were on areas having the maximum occupational exposure.

The lesions were of the eczematous type which type comprises the majority of the industrial dermatoses.

Skin tests produced positive reactions in all the cases diagnosed as caused by inks per se, and half of all the cases diagnosed as industrial dermatitis gave a positive reaction to inks. (The remaining half were due to mechanical trauma from the cleaning agents, sand, salts of tartar, and stiff brushes, plus the friction due to the wiping of the plates, gasoline, and possibly reaction to the inks; also dermatophytids of the hands. These cleaning agents were not used in patch tests.)

Other plate printers similarly occupied have had the skin lesions. The dermatitis was of the industrial type.

As far as could be ascertained, the plate printers diagnosed as having industrial dermatitis were not exposed to nonindustrial irritants.

RECOMMENDATIONS

I. *Pre-employment examinations.*

1. Complete pre-employment physical examinations should be made of plate printers, rotary press printers, and skilled helpers by a physician who knows the hazards to the skin of workers from these occupations.

The examining physician should specifically watch for the following conditions, and individuals who have these conditions should not be employed for the above occupations:

a. Personal history of allergic disorders as asthma, hay fever, chronic eczema, urticaria, and migraine.

b. Constitutional diseases that are apt to predispose one to skin diseases, as diabetes mellitus, endocrine disturbances, neurasthenia, and other diseases of this type.

c. Seborrhic disorders of the skin.

Patch tests, using all the inks then in use at a particular establishment, should be made on each individual before employment, and if he gives a positive reaction he should not be employed in a position that will expose him to this ink.

II. *Periodic medical examinations.*

Periodic medical examinations of plate printers should be made, paying particular attention to the evidence of skin diseases.

Any employee with dermatitis should have a careful examination, following the procedure used in this study, to determine whether the dermatitis is of occupational origin.

If the dermatitis is of nonindustrial origin, the employee should be advised by the physician whether or not to continue work, since a nonindustrial dermatitis of the hands may be aggravated by plate printing.

If an individual is found with an industrial dermatitis, a careful study should be made of his occupational exposures, especially his exposure to inks, solvents, and cleaning materials, and the causative agent removed from his occupational environment.

Practically, the only treatment necessary is the removal of the causative agent from the employees' working environment and protection against secondary infections, chiefly by cleanliness.

Strong antiseptics, salves, and intensive physical therapeutic measures have been found to be inadvisable in the treatment of this type of industrial dermatitis.

All employees should be advised to report immediately to the physician the occurrence of any skin disease.

III. *Changes in the occupational environment.*

1. Cleaning of the plates with gasoline should not be done by plate printers. Neither gasoline nor other solvents should be used in any way by plate printers. A skilled helper who is properly protected should clean the plates. These skilled helpers could be kept in the sections and called by the plate printers when it is necessary to clean the plates. After the skilled helper has cleaned the plates, they should be carefully freed of all solvent before the plate printer uses the plate.

2. Cleaning materials used in cleaning the hands.

a. The use of a common oil trough should be discontinued. Some method should be instituted whereby each printer uses oil not used by other printers. Consideration should be given to a vegetable, animal oil, or one of the commercial hydrogenated fats. Some experimentation may be needed to select the proper oil and to select the proper method of dispensing the oil.

b. The use of abrasive cleaning agents, sand, and stiff brushes should be prohibited.

c. The use of salts of tartar as a detergent should be prevented.

d. Only a good grade of neutral soap should be used.

e. Clean pieces of cheesecloth and a supply of individual paper towels should be furnished printers daily.

The proper method of cleaning the hands is one of the most important factors in preventing industrial dermatitis of the hands, and the fullest cooperation of individual plate printers is necessary.

IV. *Sanitary measures.*

Shower baths and wash rooms should be kept clean, and the floors of these rooms should be thoroughly scrubbed down daily with soap and hot water.

No employee should be allowed to walk on the floor of the wash rooms with bare feet; individual sandals which can be cleaned readily should be used.

Separate lockers for work clothes and street clothes should be furnished plate printers to prevent the soiling of the street clothes with inks and other substances capable of producing dermatitis. The lockers should be kept clean.

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