UNITED STATES TREASURY DEPARTMENT
PUBLIC HEALTH SERVICE

Public Health Bulletin No. 215
October 1934

SKIN HAZARDS IN AMERICAN INDUSTRY

Dermatitis in the Rubber Industry
By Senior Surgeon Louis Schwartz
U.S. Public Health Service

Dermatitis in Oil Refining
By Senior Surgeon Louis Schwartz
U.S. Public Health Service

Dermatitis in Synthetic Dye Manufacturing
By Senior Surgeon Louis Schwartz
U.S. Public Health Service

Dermatitis in Candy Making
By Senior Surgeon Louis Schwartz
U.S. Public Health Service

Dermatitis Among Silk Throwsters
By Senior Surgeon Louis Schwartz
U.S. Public Health Service
and
Dr. Louis Tulipan, Professor of Dermatology
New York University

Dermatitis in the Manufacture of Linseed Oil
By Senior Surgeon Louis Schwartz
U.S. Public Health Service

Dermatitis Due to Perfume
By Senior Surgeon Louis Schwartz
U.S. Public Health Service

Dermatitis Due to Pyrethrum contained in an Insecticide
By Senior Surgeon Louis Schwartz
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PREPARED BY DIRECTION OF THE SURGEON GENERAL

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON: 1934

For sale by the Superintendent of Documents, Washington, D.C. - - - - - - - Price 10 cents

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SKIN HAZARDS IN AMERICAN INDUSTRY[1]

DERMATITIS IN THE RUBBER INDUSTRY

The plants of 7 rubber manufacturing companies employing normally about 30,000 workers, and manufacturing almost every sort of rubber article, were visited, and 8,367 workers actually examined.

The sickness records of these companies, especially in regard to the occurrence of dermatitis, were examined for a period of at least 1 year previous to the time of the present study, and the employees of 4 of the largest companies were kept under observation for the occurrence of dermatitis for a period of 1 year after the beginning of the study. It is from these facts that the data for this article were obtained.

Literature

Dermatitis has been known to exist in the rubber industry for a long time. The terms " rubber itch " and " rubber poisoning " have been commonly applied to the condition.

(1) R. Prosser White states that hexamethylenetetramine is the most active cause of dermatitis in the rubber industry. He also names aniline, paraphenylenediamine, thiocarbanilide, and parantiro-dimethylaniline as causes of dermatitis. He further states that the compounders, mixers, and calenderers are most affected by the action of these skin irritants, and that in hot weather hexamethylenetetramine mixing with the slightly acid perspiration on the skin is changed into formaldehyde, and this, undergoing further oxidation, is changed into formic acid, which causes the actual irritation of the skin. A 1 percent solution of hexamethylenetetramine is sufficient to start the dermatitis.

(2) Kober and Hayhurst state that about 3 percent of all the workers in the rubber industry are affected with dermatitis.

(3) D. E. Cleveland reported cases of dematitis consisting of large vesicles on both hands and forearms resulting from hexa-nitro-di-phenyl-amine, and he states that aniline oil is even a more toxic accelerator.

(4) R. S. Quinby states that the chief hazards in the rubber industry are lead, benzol, aniline, and urotropine. He states that antimony pentasulphide, para-nitroso-di-methyl-aniline, and all sulphur chlorides cause dermatitis.

(5) H. J. Cronin observed that stearic acid mixed with lead oxide and sulphide to soften rubber sets up a dermatitis.

(6) Lothar E. Weber in enumerating hazards of the rubber industry names litharge as a most dangerous health hazard, and yellow pigment next. Others are arsenic, sulphides, gasoline, benzine, carbon disulphide, sulphur chloride, paraphenylenediamine.

(7) The National Safety Council Transactions name a long list of chemicals used in the rubber industry as dangerous. They also state that compounding

[1] Submitted for publication Jan. 12, 1934.

is rated as one of the most hazardous processes in the industry, and that insurance companies class compounders among those whose mortality is expected to run from 50 to 100 percent above the average. Mixing-room workers are thought to be exposed to similar hazardous compounds.

(8) J. S. Millard states that when dermatitis has once been produced by the action of hexamethylenetetramine, the individual becomes sensitive to that irritant and is likely to suffer from dermatitis from a far slighter exposure than was necessary to produce the original attack. He divides the causative factors in the rubber industry into mechanical and chemical, and states that the mechanical irritants are inert substances, such as soapstone and zinc oxide, which cause the skin to become dry and thickened, attended often by intense itching. He prevents this by protecting the skin in the early stages with a soothing ointment applied before going to work each day, and again at night for a period of 2 weeks, or until the skin adjusts itself to the occupation, after which the ointment is seldom needed. The chemical irritants he names are sulphur chloride and hexamethylenetetramine, and he states that a protective ointment containing an alkali has been found to be helpful in preventing dermatitis from hexamethylenetetramine. He observed that dark, oily skinned individuals are preferable to blonds for occupations which cause skin irritations, and that Negroes are entirely immune.

(9) L. J. D. Healy gives a list of compounds used in the rubber industry, and classifies them in groups according to their toxicity as:

Group A. Highly toxic.
B. Moderately toxic.
C. Slightly toxic.
D. Low relative toxicity; no hazards with ordinary handling.

He sent out a questionnaire to manufacturers asking them to name some of the newer accelerators and antioxidants which cause dermatitis or toxic symptoms. The following substances are named:

B.B. accelerators.—A condensation product of butylaldehyde and dimethyl paraphenylene diamine.

Furac no. 2.—Zinc salt of dithiofuroic acid.

Grasselerator no. 102.—Contains hexamethylenetetramine.

Para nitroso dimethylaniline base B.C. Safex.—A patent accelerator marketed as a dry yellow powder.

Super sulphur no. 2.—An oxidized lead salt of dimethyl dithiocarbonic acid.

Trimene base.—A polymerized condensation product of formaldehyde and ethylamine. The trimene contains traces of hexamethylenetetramine as an impurity.

Tuads.—A grayish crystalline substance with a melting point of 150° C. It is an oxidized product of carbon disulphide and dimethylamine. Causes inflammation of the membranes of the nose, especially to persons susceptible to hay fever.

(10) K. R. Moore reports that in 7 factories employing 5,000 workers in Australia, dermatitis occurred only in 2 factories, and was due to contact with paraphenylenediamine and hexamethylenetetramine, and the dermatitis ceased when these 2 substances were discontinued. He states that hot unvulcanized stock brings out the action of these irritants on the skin; the perspiration reacting with hexamine to form formic acid.

(11) W. S. Burrage performed intradermal skin tests upon employees in a rubber factory who were suffering with severe skin disturbances due to their work, and concludes that dermatitis of this type should be investigated not only from the chemical point of view, but also from the point of allergy.

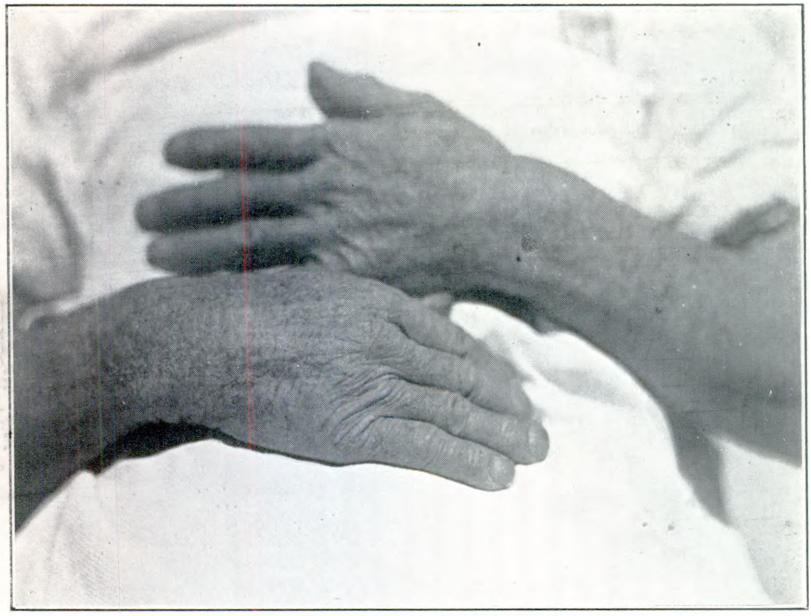

FIGURE 1.—CHRONIC ECZEMA FROM RUBBER COMPOUNDS.

FIGURE 2.—KNUCKLES OF A BLOW OFF AND BLOW ON WORKER ON MANDREL CURED TIRE TUBES.

FIGURE 3.—DERMATITIS FROM RUBBER COMPOUNDS IN A MILL WORKER.

(12) P. A. Davis gives the formula, symptoms of poisoning, treatment and prevention for a list of chemicals used in the rubber industry, and states that antimony, arsenic, ethylacetate, thiocarbanilid, guanidine, and their compounds may cause dermatitis. Other references are as follows:

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Process Study

Rubber is derived from a milky substance called "latex" that flows from the bark of the rubber tree. It coagulates somewhat like the curd separates when milk turns sour. This curd-like substance is lifted off, run through rollers, and comes out in sheets of pure rubber. It is then dried and ready for shipment.

Exposure to the air will bring about this coagulation, but acid is usually added to the sap to expedite this process.

In order to make rubber serviceable, various compounds must be added to it. Sulphur is the one compound that is essential to all manufactured rubber, but there are hundreds of other compounds used for various purposes, to give the rubber hardness, wearing properties, resistance to abrasion, to soften it and make it more workable, to give it weight, etc.

Rubber must also be cured in order to make it serviceable. This curing is done by various means, such as steaming, dipping in hot water, exposure to sulphure-mono-chloride S_2Cl_2, and to carbon disulphide CS_2, either in vapor form or dipping into the solutions. Various chemical compounds known as accelerators are used to hasten this cure. Other compounds called antioxidants are used to prevent the decomposition of rubber. Coloring agents are also used.

Tire Manufacture

The crude rubber is first washed clean of extraneous matter and then cut into suitable sizes for milling. There is practically no skin hazard in doing this work.

Milling consists in passing the rubber between two rollers which move in opposite directions and make of the rubber one homogenous mass. There is no skin hazard in this part of the operation.

The rubber is then mixed with various compounds and again milled in "mix mills", which thoroughly incorporate the compounds into the rubber. The workers in the compound room and on the mix mills are exposed to the action of the chemicals used in the rubber, and often suffer with dermatitis.

From the mix mills the rubber is ready to go into the tread and calender rooms. Treads are made by feeding the rubber into a machine which forces it out through suitable dies. Tubes are made in the same manner. Calendering is the process of impregnating the fabric used in the manufacture of tires with the rubber. The employees handling the hot rubber coming out of the tread and tube machines, and those working on the calenders are exposed to the action of the chemicals used in compounding the rubber, and often suffer from dermatitis.

Tires are built by placing layer upon layer of fabric at right angles to each other until four, six, eight or more plies are made. The bead is inserted between these plies. Chafing strips are put around the body and a breaker strip is added on top of the fabric. The side wall and the tread are next put on and the tire is ready for curing.

Tire builders are also exposed to the compound in the unvulcanized rubber, and are often affected with dermatitis. The builders of heavy truck tires often suffer with painful cracks and callouses of the hands as a result of their occupation.

Before curing, a rubber air bag (resembling an inner tube, except that the walls are made of much heavier rubber) is inserted into the tire, which is then clamped into an iron mold and cured. In order to separate easily the air bag from the tire after the curing process the air bag is immersed into a solution called "dope" before being placed into the uncured tire. This "dope" is strongly alkaline and sometimes causes dermatitis.

Tube Making

After the tubes come through the tube die they are cut into suitable lengths. The ends are spliced, valves and valve patches put in, and they are ready for curing. Some of the tubes are cured on circular forms called "mandrels." The men pulling the tubes on and off the mandrels have calloused hands and the skin over the last joints of the fingers on the dorsal aspect is thickened and tender from friction with the tube and the mandrel. The nails are also worn down to the quick from grasping and pulling on the tubes.

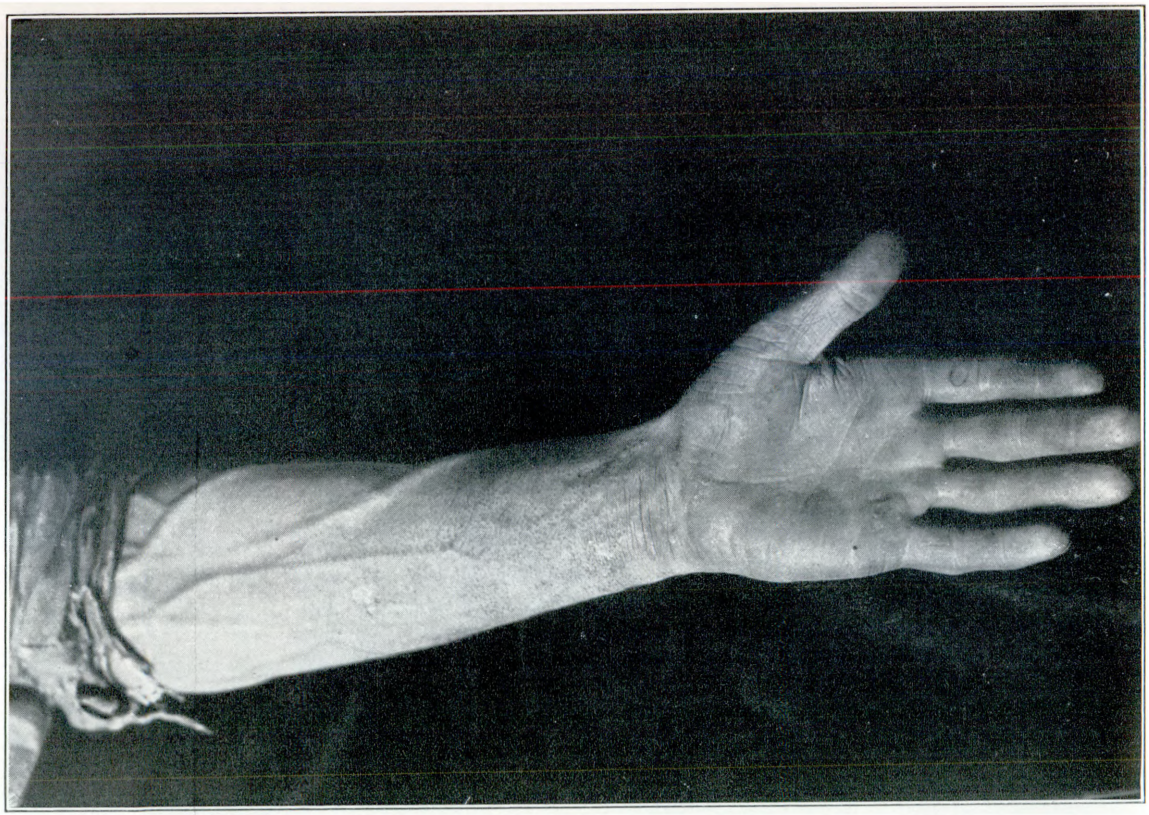

FIGURE 4.—DERMATITIS OF TIRE BUILDERS' HANDS AND ARMS.

FIGURE 5.—DERMATITIS FROM DUST OF RUBBER COMPOUNDS IN COMPOUND ROOM WORKER.

Vapor Curing

Thin rubber goods, such as toy balloons, surgeons' gloves, etc., are usually made by the dipping process. The rubber is milled, compounded, and then dissolved in naphtha and placed in trays into which metal forms are dipped. After a coating of rubber is deposited on the forms they are taken out of the solution and allowed to dry. They are then re-dipped and dried many times to acquire the desired thickness of rubber. They are then cured by dipping in a solution of sulphur monochloride and carbon disulphide, or they can be steam cured in steam chambers. Curing is also done by dipping into vats containing water about 200° F., or by exposing to a vapor of sulphur monochloride in a closed chamber and then neutralizing by exposing to a vapor of ammonia.

Dermatitis is not infrequent among workers handling vapor-cured rubber, and is due to the irritating action of the sulphur monochloride remaining on the rubber.

The anode process is a recent development in making thin rubber goods. It consists of dipping a metal form into a solution of naphtha containing rubber and its compounds, and turning on an electric current. This results in the deposition of rubber onto the metal form.

Another method is to dip a porcelain form into a solution called "gel", and then immerse the form in a solution of naphtha containing rubber. An action takes place between the gel and the solution which results in a rapid deposition of the rubber on the form.

Dermatitis is of rare occurrence among workers in rubber goods manufactured by this process.

Chemicals Used in Compounding Rubber in the Plants Examined

The chief accelerators used in the plants examined are:

Mercapto-benzo-thiazole.
Butyraldehyde aniline.
Diphenyl guanidine.
Tri-phenyl guanidine.
Tetramethyl thiuram disulphide.
Tetramethyl thiuram monosulphide.
Grasselerator 808, which is a condensation product of aniline and aldehyde.
Grasselerator 833, an alkaline compound.
Butyl amine.
Butyl aldehyde.

Hexamethylenetetramine is used only in small quantities for special processes where its action is preferable to other accelerators.

Anti-oxidants.—Phenyl beta naphthylamine, phenyl beta naphthylamine paraphenylenediamine, di tolyl amine, "V.G.B.", which is a condensation product of aniline and aldehyde, metatoluylene

diamine, and phenylalphanaphthylamine are the chief anti-oxidants used in these plants.

Compounds.—Sulphur, carbon black, lamp black, zinc oxide, graphite, zinc stearate, iron oxide, chromium oxide, mercury oxide, lead oxide, and various dyes are used in compounding rubber. The principal solvents are gasoline, naphtha, benzol, and ethyl acetate.

NOTE.—For a full list of chemicals used in the rubber industry see "The Rubber Age."

Bloom

Rubber acts as a solvent for certain materials, and it is a better solvent for these materials when it is hot. Therefore, rubber, while being vulcanized under heat and pressure, will dissolve more of the materials than when it is cold. When the rubber cools after vulcanizing, the excess of the materials dissolved is re-crystallized from the rubber and forms what is called "bloom" on the surface of the rubber, and free crystals in the substance of the rubber.

Bloom forms when there is a surplus of free material over and above the saturation point of the rubber. Usually the bloom is the unchanged compound present in excess, but it may be new compounds formed in the rubber during the vulcanizing process. Some accelerators and anti-oxidants bloom to the surface more rapidly than others. Bloom is usually an undesirable product, but in rare instances, as in the paraffin bloom, it may be useful to protect the rubber.

Cases of dermatitis have been reported as occurring in users of rubber products which were attributed to bloom on the rubber.

Occurrences of Skin Diseases in Rubber Workers

In three of the plants employing about 28,000 workers there occurred during the period from 1927 to 1931 two hundred and forty-one cases of occupational skin diseases which were severe enough to be reported.

From a comparison made of the number of cases actually treated in the dispensary of one of these plants, and with the number of cases reported for compensation, it was determined that there are more than 10 times as many cases of dermatitis occurring in the plant than are actually deemed to be severe enough to be reported.

Seasonal occurrence.—A month-by-month examination of dermatitis occuring in these plants shows that it is more frequent in the warm months than in the cold months; the least number occurred in December and the highest number occurred in July.

Occupations where dermatitis occurs.—A tabulation of the occupations of those having dermatitis shows that by far the largest number of cases occur among workers handling rubber compounds, and un-

FIGURE 6.—RUBBER COMPOUND DERMATITIS (NITRO-CAPTAX).

cured compounded rubber. Comparatively few cases occurred among workers with uncompounded raw rubber or with compounded cured rubber.

Occupational skin diseases occurring during the year of observation.—In three of the plants there occurred from July 1931 to July 1932 ninety two cases of occupational dermatitis.

Present Survey

In an examination of 8,367 workers, 84 cases of occupational dermatitis were found. It was noted that workers who are subject to skin irritation from materials with which they work usually have their shirt sleeves rolled down to protect their arms while at work, whereas those who do not suffer from such conditions have their arms and chests exposed. Sixty-two of the cases occurred among workers handling compounds or compounded unvulcanized rubber. Occupational dermatitis was found in 11 cases who handled cured rubber. Five of these cases were due to rubber solvents and four due to chlorine remaining on rubber stock. There were no cases found that could be attributed to pure rubber, and only one case which may have been caused by vulcanized compounded rubber.

Boils on the arms and the legs of workers in the mill rooms and the compound rooms were of frequent occurrence.

Skin Irritants in the Rubber Industry

Among the accelerators used hexamethylenetetramine is the one most irritating to the skin. In one plant where "hex" was used in only small quantities from 1927 to 1929, there was during that period an average of 34 cases per year of occupational dermatitis; but sometime in 1930 they began using "hex" extensively in a portion of the plant to replace an accelerator which had proved unsatisfactory, and during that year the cases of occupational dermatitis reported increased to 50.

In one factory where "hex" was used as an accelerator in a certain stock, it was noticed that a considerable number of the girls handling this stock developed dermatitis. Patch tests performed on those affected showed that they were sensitive to the hexamethylenetetramine. Cases were found among the workers who stated that when they first began to work with "hex" they developed a dermatitis, but that later on they became "hardened" to it. Also, that when they stopped working with it for about 2 or 3 weeks they developed a dermatitis when they again began to work with it.

Di ortho tolyl guanidine, diphenyl guanidine, and triphenyl guanidine were also found to be irritating to some workers.

Tetramethyl thiuram disulphide, and tetramethyl thiuram monosulphide are also irritating to the skins of certain individuals.

An outbreak of dermatitis among some linesmen wearing rubber gloves in which tetramethyl thiuram disulphide was used as an accelerator was proved by Drs. Osborne and Putnam (13) to have been due to hypersensitivity to tetramethyl thiuram disulphide. An outbreak of dermatitis in a rubber factory was also shown to be due to hypersensitivity to tetramethyl thiuram disulphide of workers handling it for the first time.

Other accelerators now used which have been found to be skin irritants to certain individuals are dinitro phenyl, thiocarbanilide, and para-nitroso-dimethyl-aniline. The latter is said to decompose on the skin into paraphenylenediamine.

Of the anti-oxidants, metatoluylene diamine, phenyl alpha naphthylamine, and phenyl beta naphthylamine have been found to irritate the skin of hypersensitive individuals. Any of the accelerators or anti-oxidants may come out of the cured rubber in the form of bloom, if the curing is not properly done, or if too great an amount of them are mixed with the rubber. Such bloom may cause dermatitis. Some of the accelerators and anti-oxidants used in rubber manufacture may not in themselves be skin irritants, but when heated with other rubber compounds, as happens when the rubber is being vulcanized, may form compounds which cause dermatitis.

Summary

Previous to 1926 dermatitis was very prevalent among rubber workers, but since then the number of cases has materially diminished. This is partly due to the fact that a large number of rubber manufacturers have discontinued the use of such skin irritants as hexamethylenetetramine and paraphenylenediamine, and instead are using new accelerators which are less harmful. The installation of modern machinery and manufacturing methods in which the worker comes in contact with irritating chemicals less frequently than formerly also decreases the skin hazards. However, the number of cases of occupational dermatitis occurring in the rubber industry is larger than the number actually reported to the State departments of health, because many cases are not reported either because they are trifling in character and the worker treats himself, or in other cases he is afraid that if he reports himself to be suffering with dermatitis he may be transferred to another department where he will not earn as much money, or that he may even lose his position.

Most of the accelerators and antioxidants used are harmless to normal skin, but hypersensitivity may occur toward any of them. In the manufacture of these accelerators and antioxidants the intermediate products are often powerful skin irritants.

Acids, alkalies, and solvents used in rubber manufacture often cause dermatitis. Dermatitis is more common in the compounding rooms and among mix-mill workers than in other portions of the plant.

Soapstone

Soapstone, which is used extensively to prevent rubber from sticking, often penetrates the clothing and causes dermatitis. This is especially true of the coarser varieties of soapstone in which the crystals are long and needlelike.

Preventive Measures

The following measures are advocated to lessen the incidence of dermatitis in the rubber industry:

(1) The elimination of irritating accelerators, antioxidants and other compounds, and substituting for them nonirritating ones.

(2) Testing new compounds for irritating or poisonous properties before using them in the plant.

(3) Eliminate dust from the plant, especially in the compound rooms and the mixing rooms. This can be done by using dustproof containers, dustproof mechanical mixers, and appropriate exhaust ventilation.

(4) Selecting workers immune to the irritating effects of the chemicals with which they work. It has been found that negroes and dark, oily-skinned individuals are less apt to become affected by irritants used in the rubber industry than are blonds. Patch tests can be performed on new employees to determine their sensitivity to the chemicals with which they will come in contact, and those found to be sensitive should not be employed.

(5) Frequent medical inspections should be made to discover those having occupational dermatitis and they should be transferred to other occupations in the plant.

(6) Emphasis should be placed on personal cleanliness, compelling workers exposed to irritating chemicals to bathe after work and furnishing them with clean working clothes at frequent intervals.

(7) The use of protective ointments on exposed parts of the body have in some cases been found to be beneficial.

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DERMATITIS IN OIL REFINING

This paper is based on a study of 8 oil refineries employing about 14,000 people, of which 4,507 men were examined, and on sickness records of 11,000 employees kept over a period of 2 years.

Process Study

The refineries examined use all the varieties of crude oil obtained in North and South America, including Pennsylvania, California, Ranger, Mid-Continental, Mexican, Peruvian, Venezuelan, Texas, etc., having paraffin, asphalt, naphthenic and mixed bases.

The character of these various crudes, as well as the final products desired, determine the manner in which they are treated.

The crude oil is distilled in batteries of crude stills and a number of cuts are made at different times in the distillation process. The number of cuts depends on the kind of crude, and on the products desired. The most common cuts made are gas, the lightest of the hydro-carbons; naphtha, or crude gasoline, from which stock all grades of straight run gasoline are made; water white or crude kerosene, which is the base for painters' naphtha and turpentine substitutes, and all grades of kerosene and mineral seal oil.

Gas oil, the next heavier product, is a somewhat discolored non-viscous oil that is used to a great extent in the cracking process for the production of gasoline and kerosene.

The next heavier distillate is paraffin distillate, which, of course, is only obtained from crudes having a paraffin base. This is a highly discolored oil of medium viscosity, which, upon subsequent refining, yields paraffin wax and lubricating oils.

Wax tailings is the next product, and is a gummy, dark brown substance. Whatever is left in the stills after this is known as coke.

Certain grades of crude are distilled in coke stills which are large iron cylinders, and the residual product of this distillation is coke. Crudes with an asphalt base leave as a residual product the asphalt, which is used for road making.

In order to meet the various market specifications, gasoline and kerosene are treated to remove certain deleterious materials, such as asphalts, resinous substances, and compounds of oxygen, nitrogen, and sulphur. The chemicals used in the treatment of gasoline, kerosene, and oil are sulphuric acid, caustic soda, fuller's earth, and liquid sulphur dioxide. After the acid treatment, which takes place

in large cylinders, the product is washed in water and neutralized with caustic soda and filtered through fuller's earth before it is ready for the market. Sometimes, the characteristics of the sulphur compounds remaining in the distillate make it necessary to combine neutralization with a process called "sweetening." Before the sweetening process the product has a certain sourness due to the presence of hydrogen sulphide, or "mercaptans." The chemicals used in sweetening are caustic soda, litharge, and flowers of sulphur in one method, and in another method sodium hypochloride and chloride of lime.

Paraffin is obtained from crude having a paraffin base, the paraffin distillate being used for this purpose. This distillate is put under pressure and cooled in an apparatus called a plate press in order to press out the wax. The wax collects on plates in the press and when the press is opened the plates are taken out and the wax is scraped off. This wax is impure and is further purified by liquifying it in shallow pans and then cooling it until it solidifies, and then slowly raising the temperature and allowing the oil to "sweat" out. The apparatus in which this purifying process is done is called the "sweater." This sweating is repeated until the paraffin is pure. It is then further purified by filtering it through bone black. It is then molded.

As stated before, coke is a by-product from the distillation of certain crudes. After the coke stills run for a while, the residual coke must be cleaned out. In one type of coke still there is a manhole which is opened after the still is sufficiently cooled and men go in, break up, and shovel out the coke. This is a hazardous operation and it has been found that colored men do this work better than white men. Burns and scalds on the hands are common in this operation, and it is often necessary to use gas masks in cleaning the stills.

On the hands of white men who have cleaned the coke from the stills there are often left the results of burns in the form of telangiectatic spots. This has not been noted on the skins of colored people.

A less hazardous type of coke still is the type which has the lower half of the ends of the cylinder in the form of a hinged door that can be opened up and the whole floor of the still exposed. Before such a still is filled with crude oil there is laid in the bottom of it a series of diamond shaped iron grates connected with steel chains. These become imbedded in the coke as it forms. When the still is opened to clean out the coke, a cable is attached to this series of gratings, and by means of a winch, the whole bed of coke is broken up and loosened by traction on the cable. The remaining part is then shoveled out by colored men. There are also coke ovens in some

FIGURE 1.—WAX WARTS. PARAFFIN PRESSMAN.

FIGURE 2.—WAX BOILS. PARAFFIN PRESSMAN.

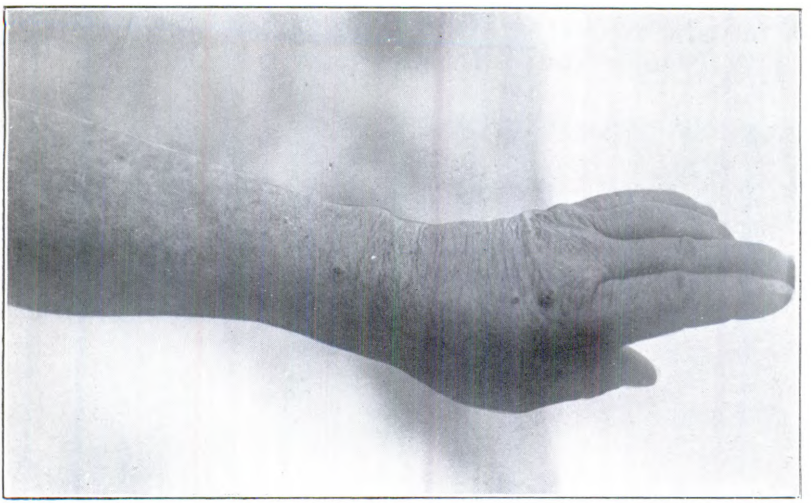

FIGURE 3.—PARAFFIN KERATOSES AND TELANGIESTASES IN AN OIL REFINERY WORKER.

of the refining plants which make coke from the remnants and tailings of the distillation process. This is done by heating the tailings in these brick-lined ovens. Some light gas is recovered, drawn off, and mixed with the lighter distillates, and coke is left in the ovens. These ovens have removable ends and when they have deposited in them a certain amount of coke they are opened up and a powerful ram is pushed through them which shoves out the coke.

Certain refineries have their own modified methods of distillation. For instance, in one refinery the lubricating oil is distilled over hot mercury vapor. The hot mercury vapor is totally enclosed so that none of it can escape and perhaps cause mercury poisoning in the workers. In the rooms in which these mercury vapor stills are located there are placed selenium indicators which will detect minute fractions of mercury in the air. When mercury is present, even in minute fractions, the selenium paper will change from light yellow to a pink.

Some of the refineries manufacture various byproducts, such as insecticides, soaps, greases, candles, and wax products.

Insecticides are made by using extracts of pyrethrum flowers in various petroleum distillates.

Soaps are manufactured mostly from a proportion of grease which is made by mixing soap and lubricating oil in various proportions. The different proportions of these two ingredients and the differences in the viscosity of the oil make the differences in the resulting grease. As a generality, the more soap used the harder is the grease.

Candles are made in two ways, by molding the paraffin in forms and by dipping the wick into the molten paraffin. As many as 50 dippings are made, depending on the thickness of the candle desired. Aniline dyes are used in this process to color the candles.

Combinations of naphtha and carbon tetrachloride are also made and used as a cleaner. In this process all the apparatus is totally enclosed so as to protect the worker from the fumes of the carbon tetrachloride.

There were no marked differences in the skin conditions found in the various refineries using different crudes except in the case of crudes with a paraffine base.

An analysis of the sickness records of 6,000 men in 1 refinery for a period of 2 years shows 42 cases of industrial dermatitis.

The records of another refinery employing 4,000 men show 98 cases diagnosed as industrial dermatitis over a period of 29 months, and the records of still another refinery employing 1,000 men over a period of 16 months show 56 cases of industrial dermatitis. So that, among 11,000 men employed for an average of 2 years in 3 refineries there occurred 196 skin conditions diagnosed as of industrial origin.

71465—34——2

In 1 of the refineries where more complete records were kept, out of 16,625 treatments over a period of 29 months, there were 98 cases of skin conditions of industrial origin. During the same period there were 232 skin cases diagnosed as nonindustrial, among which there were included 104 with a diagnosis of dermatitis and eczema with no etiology given. It is possible that among this group of cases there were some of industrial origin.

Most of the cases diagnosed as of industrial origin were due to acids, alkalies, caustics, and explosions.

In the present survey the conditions noted in table no. 1 were seen. About 10 percent of all the employees who work in the oil refineries and whose hands are usually covered with dirt and grease were found to have on the backs of their hands and on their forearms, and sometimes on the legs, many pinhead to pea-sized, flat, slightly pigmented papillomata or keratosis. These papillomata occurred even in larger percentages among machinists, mechanics, and the general laborers in the plant, but was reduced to about 10 percent when other personnel whose hands are not soiled by their occupation were included in the count. Warts similar to this have been described by Teleky and Brezina as occurring in about 25 percent of the men employed in a Dutch briquette factory.

Telangiectatic spots were found on the exposed parts of many white men. These telangiectatic spots were round erythematous macules varying from pinhead to dime size, which disappeared on stretching the skin, and the men state that they were caused by exposure to hot coke when cleaning the coke from the old style stills. Some of the men stated that they were caused by immersing the hands in hot paraffin during the sweating process. The papillomata and these telangiectatic spots cause no symptoms.

Other observers have also noted an excessive number of epithelioma among workers in oil and wax.

Among the 4,507 workers examined during this survey, 12 cases of epithelioma were noted. Of this number 2 were on the face, 7 were on the lip, 1 was on the hand, 1 was on the right ear, and 1 case in a wax worker (and this was the only case observed during the survey) was on the scrotum. This man also had one on the dorsum of the hand.

Three of the plants examined made wax from paraffin base oil, and 81 men who worked in the wax presses were examined. Among these there were 19 cases of boils and oil acne and 25 cases of characteristic wax warts on the hands and the forearms. These wax warts differ in appearance from the papillomata described in workers in oil, dirt, and grease, by the fact that the wax warts are more raised and more verrucous, and are nonpigmented, and often occur on the

FIGURE 4.—PAPILLOMATA ON HANDS AND FOREARMS OF WORKER IN OIL REFINERY.

FIGURE 5.—PARAFFIN TUMOR OF SCROTUM (PROBABLY EPITHELIOMA). PARAFFIN PRESSMAN. NOTICE WAX WARTS ON HANDS.

inner surface of the forearms as well as on the dorsum of the hands and the forearms.

Oil acne differs from ordinary acne vulgaris in the fact that it does not occur on the face but on the arms, shoulders, body, and legs, and forms around a hair follicle. When the lesions of oil acne suppurate they become oil or wax boils.

Burns

Burns are very frequent in all refineries and they constitute a large percentage of skin afflictions. Burns occur from sulphuric acid used in the treatment of the oil, from the caustic soda used to neutralize the acid, and from explosions and fires, and from cleaning the coke out of the coke ovens and stills.

In that portion of the plant where the oil is treated with sulphuric acid and in the portion where sulphuric acid is recovered and reconcentrated, the danger from acid burns is greatest. When sludge is cleaned from the acid tanks the men doing this work, usually negroes, wear complete suits of rubber, including boots, clothes, hats, goggles, and gas masks to protect them from the acid and the fumes. When they come out of the tanks they are required to go immediately under a shower, clothed in their protective suits, so as to wash off the acids.

The tanks in which the acid oil is neutralized by the action of caustic soda also require periodic cleaning, and the men entering them are protected in the same manner as those cleaning the acid tanks, because there is caustic deposited on the sides of the tanks and in the sludge.

In that portion of the plants where barrels are cleaned, caustic soda in solution is used, and cases of dermatitis of the forearms and the hands due to it sometimes occur.

Occasionally an employee becomes sensitized to petroleum distillates and develops a skin eruption. Such men are usually given other occupations or leave the plant of their own accord.

Some of the refineries make insecticides as a byproduct, and occasionally dermatitis arises among those workers sensitive to the insecticide. The insecticides used in the refineries studied consisted of petroleum extracts of pyrethrum flowers.

Preventive Measures

Most of the refineries provide safety appliances for the prevention of burns from acids, caustics, and coke, in the form of rubber suits, goggles, and gas masks. Many of them also have shower baths installed in those departments where acids and alkali are used, so that if any of the men are burned they can step immediately under these showers. Some of these showers act automatically as soon as

a person steps underneath. Some of the refineries also have large bathtubs filled with water scattered throughout the yard so that men who are burned can immediately be placed in them.

Coke stills with removable ends instead of manholes and with mechanical means of cleaning out the coke, such as the grates and rams before described, lessen the hazard in cleaning them.

The small pigmented papillomata occurring among the workers whose hands are continually dirty with grease, oil, and dirt, could in a large measure be prevented by the compulsory wearing of gloves, and by compelling the men to wash their hands with soap and water at noontime before eating their lunch and immediately after they stop work for the day.

The oil acne and the wax warts occurring among the wax pressmen might also be prevented by compelling the men to take a shower bath, using soap and hot water, immediately after stopping work for the day, and changing to clean clothes. They should also be compelled to have their working clothes washed and changed frequently, because they become saturated with the oil. Some plants have regulations for this purpose, but they are not always carried out. In addition to this, the maintenance of an efficient medical and first-aid department, preferably with a full-time medical officer and registered nurse, with physical examinations of new employees and a yearly examination of all employees, is recommended.

TABLE I.—*Skin conditions noted in present survey of oil refineries*

Diseases:	*Cases*
Papillomata	406
Oil acne	20
Wax warts	25
Tinea of hands	10
Tinea of wrist	1
Lichen planus	2
Sycosis vulgaris	1
Epithelioma of—	
Cheek	3
Lip	6
Hand	2
Scrotum	1
Dermatitis due to—	
Ivy	1
Caustic soda	1
Cement	1
Wax	1
Acne rosacea	1
Wax boils	1
Acid burn	2
Burn	1
Psoriasis	4

Diseases—Continued.	*Cases*
Eczema of hands	1
Senile eczema	2
Dermatitis venenata	1
Dermatitis venenata due to—	
Insecticide	1
Liquor cresolis	1
Turpentine	1
Caustic soda	1
Dermatitis mycotic due to monilia	1
Dermatitis, cause unknown	1
Acne vulgaris and seborrhoic dermatitis	1
Furunculosis	1

DERMATITIS IN SYNTHETIC DYE MANUFACTURING

This paper is based on examinations of 5 dye manufacturing plants employing a total of 3,800 men.

The medical records of these plants showed a total of 4,777 cases of accidents and illnesses treated in the plant dispensaries. Of this number 15 percent were skin cases; more than half of these were due to acid and caustic burns, and the remainder, over 40 percent, were cases of dermatitis.

About 50 percent of all the skin cases occurred in the maintenance and repair departments. The men working in these departments repair pipes, vats, and tanks, and in so doing they come in contact with all the chemicals in the plant.

An analysis of 400 cases of dermatitis which have occurred in the plants shows the causes of cases to have been as follows:

Acid burns	Benzanthrone
Alkali burns	Benzidine
Sodium burns	Diphenyl
Di nitro chlor benzol	Beta naphthol
Bismarck brown	Crystal violet
Bleach	Soda ash
Azo colors	Phenylglycine
Hot lead	Nitro-benzol
Safranine	Naphthalene
Erio black	Para amino phenol
Guanidine	Alpha naphthylamine

In about 25 percent of the cases the irritating chemical was not determined. Most of these cases occurred in the summer months, and it is recognized by the workers that heat and perspiration add to the irritating action of these chemicals.

In addition to the cases of dermatitis there were 72 cases of conjunctivitis caused by the following chemicals:

Hyrdogen sulphide	25	Sodium hydrosulphite	1
Auramine	3	Formaldehyde	1
Crystal violet	3	Para nitro toluol sulphonate	1
D.N.C.B	3	Victoria green	1
Safranine	3	Anthracene silver salt	1
Victoria blue	2	Lime	1
Sodium sulphide	2	Aniline	1
Borneol	2	Alpha naphthylamic acid	1
Benzanthrone	2	Caustic dust	1
Methyl violet	2	Black X dye (Azo)	1
Camphene	2	Unknown chemicals	11
Ammonia	2		

Process

Synthetic dyes are prepared from the coal tar derivatives anthracene and naphthalene. They are subjected to the action of nitric and sulphuric acid in processes called nitration and sulphonation, and the resulting compounds are again acted on by other chemicals until the final product is produced. The compounds developed before the final products are known as intermediates.

The reactions take place in kettles, vats, and autoclaves, and the intermediates and the finished dyes are separated by filtering through filter presses, gravity filters, suction filters, or mechanical filters; then dried by heat or vacuum, or both, in various forms of dryers, then ground or flaked. The pure dye is usually mixed with a diluent (salt or dextrine), or made into a paste with molasses. This is done in order to standardize the color.

The dyes are variously classified according to composition or derivation. One classification taken from the "Color Index," of the Society of Dyers and Colorists, is as follows:

1. Nitroso coloring matters.
2. Nitro coloring matters.
3. Mono-azo coloring matters.
4. Dis-azo coloring matters.
5. Tris-azo coloring matters.
6. Tetrakis azo coloring matters.
7. Stilbene coloring matters.
8. Pyrazolone coloring matters.
9. Ketonimine coloring matters.
10. Triphenylmethane and diphenylnaphthylmethane coloring matters.
11. Xanthene coloring matters.
12. Acridine coloring matters.
13. Quinoline coloring matters.
14. Thiazole coloring matters.
15. Indamine coloring matters.
16. Indophenol coloring matters.
17. Azine coloring matters.
18. Aniline black and allied coloring matters.
19. Oxazine coloring matters.
20. Thiazine coloring matters.
21. Sulphide coloring matters.
22. Hydroxyketone coloring matters.
23. Anthraquinone (acid and mordant dyes) coloring matters.
24. Anthraquinone (vat) coloring matters.
25. Arylidoquinone (vat) coloring matters.
26. Indigoid coloring matters.

Another more simple classification, according to Becall, Challenger, Martin, and Sand, in "Dyestuffs and Coal-Tar Products", is as follows:

1. Azo dyes.—These contain the azo group—N=N— and are subdivided into mono-azo dyes, pyrazolene dyes, and stilbene dyes.

2. Anthracene dyes.—These include alizerine dyes, vat dyes from anthracene, and indanthrene dyes.

3. Indigo, thio indigo, and indigoid.

4. Di and tri arylmethane dyes derived from di and tri phenyl methane.

5. Azine dyes.—These include rosulin, safranine, nigrosine.

6. Pyrone.—Among these dyes are fluorescine, eosine, and rhodamine B.

7. Oxazine dyes.

8. Thiazine, thiazole, and sulphide dyes.—Some of these are methylene blue, primuline, thioflavine T., sulphur black.

9. Acridine dyes.

10. Minor groups of dyes which can be subdivided into: Class (A), nitro dyes, which are all acid wool dyes; (B) nitroso phenyl, which are mordant dyes; (C) quinoline dyes, used in photography; (D) oxyketone dyes, which are also mordant dyes; (E) indamines, and indophenols, used for making sulphur dyes; (F) aniline black.

Occupations with Special Skin Hazards

Men loading chemicals into kettles, vats, etc. (if this is done by hand), are exposed to their action. Workers removing the material from filter presses are also apt to develop dermatitis. Continuous mechanical suction filters minimize this hazard.

Men working on dryers, especially the old stove dryers, are also prone to develop dermatitis. Where vacuum steam dryers are used or where there is a continuous drum dryer the hazard is greatly lessened.

Handling and dumping trays containing dry chemicals entails a dust hazard, and men doing this work are apt to develop dermatitis unless these trays are emptied of their contents in closed chambers and under suction hoods. Men operating the grinders are also exposed to the dust of irritating chemicals. The least hazard to men handling the dryers and the grinders is when totally enclosed revolving drum dryers empty through an enclosed system into grinders which in turn discharge through an enclosed system into barrels. In some places only distinct brunettes or colored men are employed in the grinding and mixing operations, because the management has found that they are less apt to develop dermatitis than are blondes.

Men working on flaking machines are also apt to come in contact with irritating chemicals.

The repair or maintenance department in dye manufacturing plants usually comprises about one-third of the entire force, but the incidence of dermatitis in this department is about 50 percent of all the cases occurring in the plant. When repairs are to be made, the men must enter kettles, vats, and retorts which contain irritating materials with which the operator does not usually come in contact. When underground pipes are to be repaired it is necessary to dig up

FIGURE 1.—DERMATITIS DUE TO DINITROCHLORBENZOL.

the ground which has been soaked with the irritating chemical leaking from the damaged pipe.

Newly employed men are more apt to become affected with dermatitis, either because they are less aware of the dangers from the chemicals than are the older employees or because they are less immune. Some of the new men when they develop a mild dermatitis keep on working with it and finally become immune. Others who develop a severe attack which necessitates a lay-off from work do not as a rule develop that immunity, and must be taken off the job or even removed from the plant. Sometimes workers who had been working in the plant for many years develop dermatitis from the materials which they handle; such men have become sensitized to the materials with which they work, and they rarely ever again become immune. More often they become sensitive to more and more substances, developing what is known as poly-sensitivity. Some times a worker who has been in the plant for many years will be moved to a new process and will develop a dermatitis from contact with the new chemicals.

The dermatitis does not usually develop immediately after contact with the offending chemical. A period of time varying from a few hours to a few days elapses after exposure to the irritant before the dermatitis sets in, and for this reason the worker often cannot tell which one of the many chemicals he has handled was the cause of the dermatitis. Sometimes the period between starting the work and the time that the dermatitis appears may be a matter of weeks. This may be due to the cumulative effect of continued irritation, or it may take that long to become sensitized. Many of the intermediates used in dye manufacture are known to be sensitizers.

Chemists working in the laboratories often contract dermatitis from compounds not ordinarily used in the plant. Many chemists know that they are hypersensitive to certain chemicals, and a few chemists have been found who have a poly-hypersensitivity. Cases were seen that were so sensitive that entrance into a building in which the offending substance was present caused an erythema of the face. This was especially true of hypersensitivity to di-nitro-chlor-benzol.

Practically all nitro and nitroso compounds are skin irritants, and sensitizers to a considerable percentage of people, but most any of the chemicals used in dye manufacture may cause dermatitis in hypersensitive individuals. The following is a list of intermediates that have been found during this study to have caused dermatitis:

Acids, sulphonic
Anthraquinone, chlorinated
Anthracine (silver salt)
Alpha naphthylamic acid
Amino azo benzol
Benzidine
Benzanthrone
Beta methyl amino anthraquinone
Bismarck brown
Beta oxy naphthoic acid

Benzoyl para amino phenol
Beta hydroxy naphthoic acid aniline
Benzoyl benzoic acid
Brom-benzanthrone
Beta naphthol
Cresol
Chlor benzol
Chlor aniline (para and ortho)
Di nitro benzol
Di nitro phenol
Di nitro anisol
De hydro thio meta xylidine
Di chlor aniline
Di nitro toluene
Di nitro chlor benzene
Formic acid
Guanidine
Indo-phenol
Iso-rosinduline
Mischler's hydrol
Meta toluene diamine
Methyl anthraquinone (chlor and beta)
Nitraniline, para and meta
Naphthylamine alpha and beta
Nitro benzene
Nitro di methyl aniline
Naphthalene
Nitro benzanthrone
Nitroso di ethyl aniline
Nitro beta methyl anthraquinone
Orange R. thiazole
Ortho nitro toluol
Ortho nitro chlor benzol
Ortho amino phenol
Phenyl hydrazine
Phenyl hydrazine para sulphonic acid
Phthalic anhydride
Phenyl glycine, (an intermediate in the making of indigo)
Para tolyl nitrile
Para nitroso-phenyl
Para nitro benzoyl chloride
Para nitro ortho amino phenol
Para nitro chlor benzol
Para nitro toluene
Polysulphide
Para amino phenol (fur dye and photo developer)
Resorcinol
Sodamind, (an intermediate in making indigo)
Toluene
Toluidine

Manufacturing plants specializing in various products have different chemicals as their chief causes of dermatitis, but the opinion is unanimous that outside of acid and alkali burns, di nitro chlor benzol is the most powerful skin irritant. It is used in the making of sulphur blacks, and in the pure state or in strong solution will irritate any skin. A 0.5 percent solution in alcohol used as a patch test for 24 hours will cause a marked reaction. A worker who claimed that he was not affected by it was patched with a 5 percent alcoholic solution and after 24 hours had an inflamed ulcerated area under the patch.

Nitroso di ethyl aniline, an intermediate used in the making of basic colors, is also a powerful irritant. Metallic sodium and sodamid, which are used in the manufacture of synthetic indigo, often cause accidental burns. Various sulphonic acids contain sufficient sulphuric acid to cause dermatitis. Alpha naphthylamine, benzidine, benzanthrone, and anthraquinone are also frequent causes of dermatitis, although they are not general irritants. By far the largest number of finished dyes are innocuous, but the following have been known to cause dermatitis.

Aniline black
Bismarck brown
Brilliant indigo 4G
Black X dye
Crystal violet
Chrysoidine R.

FIGURE 2.—REACTION TO .6 PERCENT ALCOHOLIC SOLUTION OF D.N.C.B. LEFT ON FOR 24 HOURS, IN A CASE HYPERSENSITIVE TO IT.

FIGURE 3.—DERMATITIS OF LEGS DUE TO DUST OF IRRITANT DYE INTERMEDIATE (DYE WORKER).

Erio black
Hydron blue
Indanthrene violet R.
Indanthrene violet R.R.
Indanthrene dark blue R.
Ionamine A.S.
Meta phenylene di amine
Methyl violet
Metani yellow
Para phenylene diamine
Pyrogene violet brown (a sulphur dye)
Orange Y.
Orange R.
Safranine
Sulphanthrene pink F.F.
Thio-flavine
Victoria blue
Victoria green

Diagnosis

Workers in dye plants are apt to attribute all cases of skin irritation to the chemicals they handle: dermatophytosis, rhus poisoning, urticaria, psoriasis, and even scabies have been claimed by them to be due to the chemicals which they handle. They are most apt to confuse the fungus infections and their allergic reactions with chemical contact dermatitis.

The patch test should be used in all cases where the diagnosis is in doubt. The patient should be patched with the chemicals he handles unless it is known that he has handled a general irritant without proper protection, because in such cases the cause of the condition is more or less obvious. General irritants should not be used as patches. Only such dilutions of them should be used as have been found by experiment not to irritate the normal skin when left on for 24 hours. Materials which fellow-workers handle in pure form without developing dermatitis may be put on pure as patch tests on suspected hypersensitive workers. The patches should be applied on a clear portion of the skin and allowed to remain on for 24 hours, at the end of which time the reaction is observed. Sometimes it is necessary to leave the patch on for a longer period, even 4 or 5 days, before a reaction occurs. In case of a negative reaction it must be borne in mind that reactions may develop at the site of the patch 3 or 4 days after the patch has been removed. These are known as delayed reactions.

Chemical contact dermatitis in the acute stage is usually an erythematous, edematous, vesicular rash occurring on the exposed parts. It usually occurs in new workers, and there is an interval varying from a few hours to a number of days or weeks between contact with the offending material and the appearance of the eruption.

When there is a dust exposure as in the case of the grinders and mixers the covered parts may become affected because the dust penetrates the clothes. In such exposures the belt line, the ankle, and other places of friction are apt to become affected. The face and the back of the neck are favorite sites for dermatitis where there is exposure to dusts.

Irritating vapors affect the face and the eyes and liquids and solids usually affect the dorsum of the hands and the inner surfaces of the forearms.

Mild cases of dermatitis may simply consist of an erythema with a few papules and slight desquamation, while severe cases usually develop vesicles which break and healing is attended with considerable desquamation.

Chronic cases of chemical dermatitis resemble chronic eczemas due to any cause, and it is difficult to discover the offending chemical even by patch tests, because it is not unusual to find that these workers are hypersensitive to many substances.

During the course of this study the following materials have been applied for 24 hours to normal skins without causing a reaction, but they did cause a reaction in hypersensitive individuals:

Di nitro chlor benzol	0.5 percent alcoholic solution.
Amino azo toluene	2 percent alcoholic solution.
Beta naphthol	20 percent in olive oil.
Di ortho tolyl guanidine	Pure powder.
Di ortho tolyl thiourea	Do.
Mono benzyl para amino phenol	Pure
Meta toluyluene diamine	Do.
Michler's hydrol	5 percent alcoholic solution.
Naphthylamine	2 percent alcoholic solution.
Nitroso di ethyl aniline	1 percent alcoholic solution.
Phenyl alpha naphthylamine	Pure.
Pontamine black	Solid powder.
Para nitro benzoic acid	Pure.
Phenyl glycine	Do.
Tetra methyl thiuram mono sulphide	Do.
Tetra methyl thiuram di sulphide	Do.

Any of the finished dyes may be placed on the skin in pure form and can be left on for 24 hours without irritating the normal skin.

Aniline and many of the intermediates used in dye manufacture when taken into the system either through the lungs or through the mouth cause cyanosis or blue lip, and treatment rooms for this condition are maintained in all of the plants.

An excessive amount of papillomata and carcinoma of the bladder has been noted among workers in synthetic dyes. Various substances, such as aniline, benzidine, toluene, di nitro phenol, beta naphthylamine, etc., have been blamed as causative agents. In one plant where it is thought that di nitro phenol is the cause of papilloma of the bladder, the men are examined every 6 months for di nitro phenol in the urine, and if it is found to be present, they are removed from contact with the material.

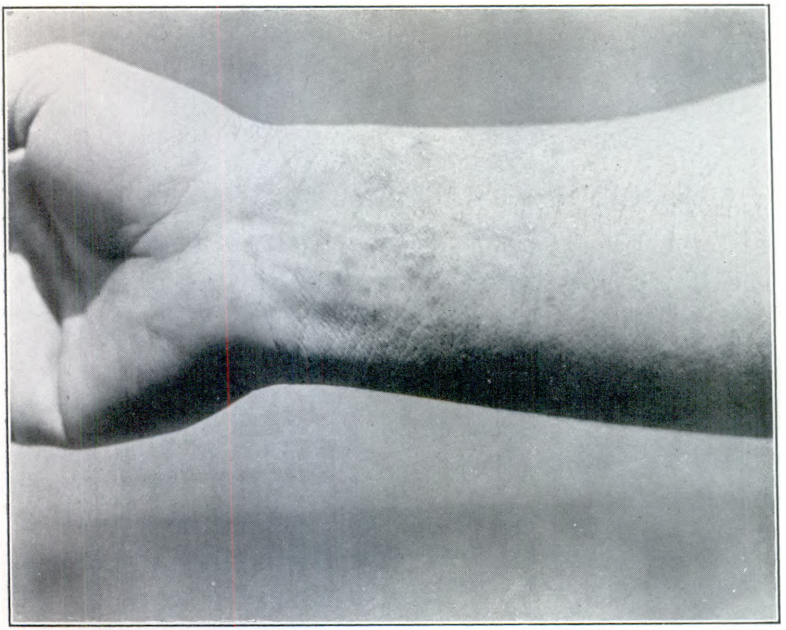

FIGURE 4.—DERMATITIS DUE TO PHENYL GLYCINE.

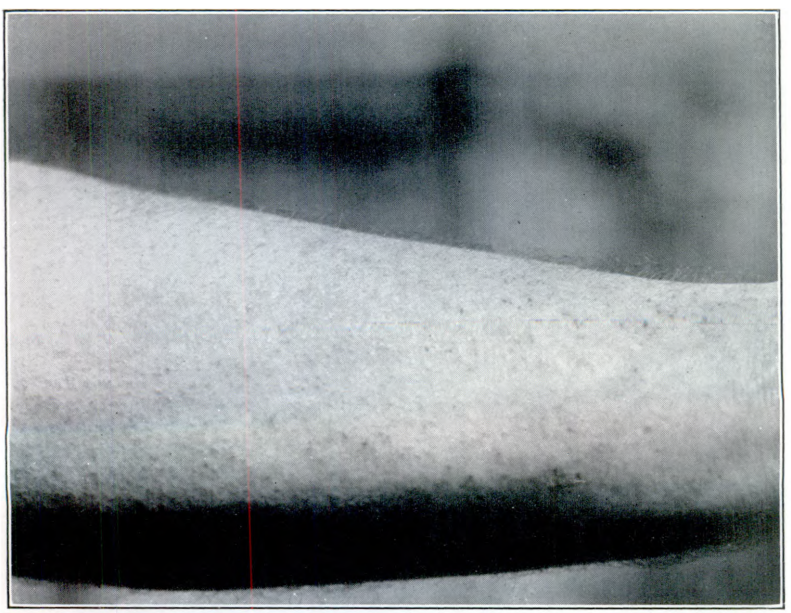

FIGURE 5.—DERMATITIS DUE TO INTERMEDIATE CONTAINING 20 PERCENT H_2SO_4.

FIGURE 6.—DERMATITIS IN PRESS CLEANER DUE TO NAPHTHALENE INTERMEDIATES IN DYE MANUFACTURE.

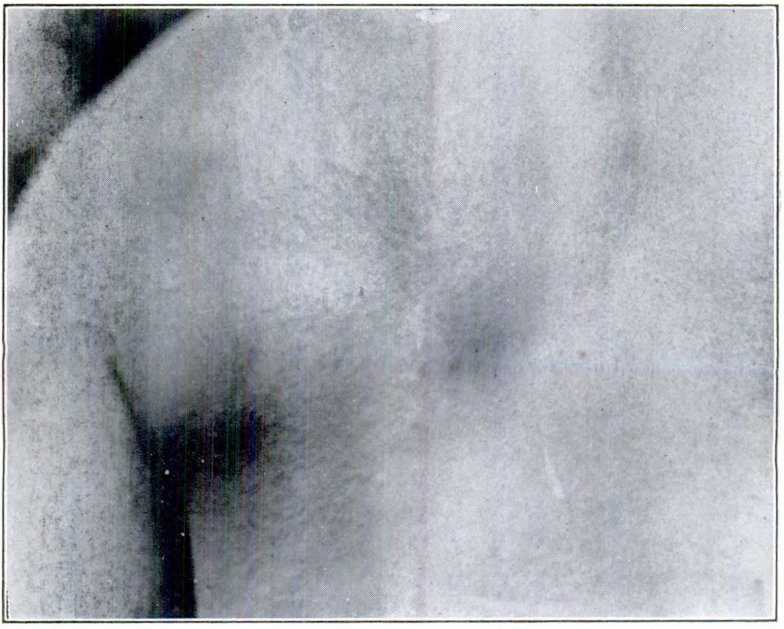

FIGURE 7.—DERMATITIS OF BACK DUE TO IRRITANT DUST OF DYE INTERMEDIATE. DYE WORKER.

Prevention

Of prime importance in the prevention of dermatitis is the selection of workers. New applicants for positions should be stripped and examined for skin diseases. None should be taken who show any signs of eczema or who give a history of plant poisoning of any kind. Those who give a history of having had urticaria, hay fever, or asthma, should also be rejected, because such persons are apt to have hypersensitive skins.

Patch tests should be made on each applicant with the known irritants that he will handle in his job, and if he shows hypersensitivity to any of them he should not be employed. Chemicals known to be skin irritants should only be handled by workers known to be immune to their action, and workers who have acquired a hypersensitivity to any of the materials with which they work should be removed from contact with those materials.

The ideal to be attained in the prevention of dermatitis is to keep the irritating materials from coming in contact with the workers. In order to accomplish this, totally enclosed processes should be installed whenever old apparatus wear out, or when new plants are erected.

The use of modern machinery, such as rotary vacuum filters discharging into continuous drum dryers, which in turn discharge into totally enclosed grinders that empty through enclosed pipes into barrels, helps to keep irritating chemicals from coming in contact with the workers. Kettles and vats and autoclaves should be so constructed that when they are opened for inspection or for loading, a suction exhaust system will automatically begin operating and draw dust or fumes away from the opening.

Suction filters should be used where rotary vacuum filters are impractical, and filter presses should only be used for processes where other types of filters will not answer.

Modern vacuum steam dryers should replace old-fashioned stove dryers in processes where continuous drum dryers cannot be used. Before the pans taken from dryers are emptied they should first be placed in a closed box connected with exhaust ventilation so that dust does not spread to the worker. Materials should be handled in a moist state whenever possible, because in this state they are less apt to cause dermatitis than when they are dry and dusty.

The allaying of dust by systems of exhaust ventilations in the building, and by performing dusty operations in an enclosed space under ventilating hoods will help to prevent dermatitis. The floors should be vacuum cleaned and not swept. Raw materials should be unloaded from enclosed barrels by suction methods.

The workers should be supplied with clean underclothing and work clothes every day, and they should be compelled to take shower baths after the days' work. When gloves are used they should be worn with the sleeve of the shirt over the glove so as to prevent the entrance of dust or liquids. Where dust cannot be allayed, or where there are irritating fumes that cannot be kept away from the worker, protective ointments on the exposed parts have helped to prevent dermatitis. Although there are many such preparations on the market, ordinary cold cream, lard, lanolin, or vaseline will also answer the purpose.

Goggles and respirators are often used to protect the eyes and the lungs from irritating dust and fumes. The chafing of the skin of the face at the point of contact between the goggles or the respirators, and to which the workers object, may be prevented by means of a mild ointment at these points.

Workers often use strong soaps and bleaches to remove dirt and dye from their hands. The use of these should be prohibited, because they are often the cause of dermatitis. The management should supply nonirritating soaps or chemicals for this purpose.

In some plants only colored men are employed for such occupations as cleaning filter presses, grinding, and mixing colors, because it is thought that they are less apt to develop dermatitis than are white men. While this has not been conclusively proved, it is a fact that the dye and the dirt show less against dark skin than against white skin.

The education of the workers as to health hazards to which they are exposed, by frequent talks on safety, and the rigid enforcement of safety rules, with discharge as the penalty for violation, helps to keep down the incidence of dermatitis.

The medical staff should make periodic examinations of all workers to discover unreported cases of dermatitis.

Treatment

The treatment of dermatitis in these plants consists in allowing mild cases to continue work while using some protection for the parts, such as long sleeves and gloves, and a protective ointment. When workers treated in this manner recover they become "hardened" or develop an immunity. This immunity continues while the worker continues work, but lasts only a short time; a week or two, after work is discontinued; so that, if for any reason the worker is away from his job for a week or two, he again develops dermatitis upon resuming work, just as he did at first.

Severe cases of dermatitis should be taken off the job and be given a mild lotion like calamine or boric acid, with the addition

of an antipruritic if there is much itching. When they recover they should be placed in another part of the plant where they will not come in contact with the offending chemical, or, preferably, they should be discharged.

The treatment and disposition of chronic cases is a puzzling problem. If they must be retained in the factory they should be given positions where they are removed from all contact with chemicals. Desensitization has not met with much success in the treatment of these chronic cases.

DERMATITIS IN CANDY MAKING

This study is based on an examination of 1,235 workers in 4 candy factories. Of these 820 were kept under observation for 1 year.

Process

Chocolate is made by roasting, hulling, and grinding the chocolate bean. The ground bean is passed through roller presses which liquefy it. Sugar, powdered milk, and other ingredients are then mixed with it. Some of the ground chocolate is passed through hydraulic filter presses which press out the oil to make cocoa butter. The portion that is left after this process is the powder called "cocoa" Cocoa butter is often used to enrich ordinary chocolate.

The liquid chocolate as it comes from the roller presses is poured into molds which are placed in a cooled room called the "ice box" and there solidified.

When bonbons, creams, nuts, fruits, and other centers are to be covered with chocolate they are dipped into a batch of semisolid chocolate and then cooled and solidified in a cooling room. The dipping is done either by hand or by machinery. In the hand-dipping process the girl grasps the center between the fingers and whirls it through a batch of semisolid chocolate until there is sufficient coating on it. The coated centers are then placed on trays and solidified in the cooled room. The finished chocolate-covered candy is placed on a traveling belt around which girls work. These girls sort and place the chocolate into paper containers and then into suitable sized boxes.

Hard candies are made by boiling sugar and water, or glucose and water, and kneading and pulling the resultant mass either by hand or by machine, in order to swell it and make it white by mixing air with it. Flavors usually consisting of essential oils and vegetable coloring matters are also added. Shaping and cutting of the hard candy is done over gas flames.

Conditions Found During Present Study

Because there is a yearly examination of food handlers required by the board of health, which weeds out many having skin diseases, we found fewer skin diseases in this industry than in others where such an examination is not required.

There is no skin hazard from dust in this industry. The only dust present is from the starch in the starch room, where the centers are made. No cases of dermatitis were found due to this cause.

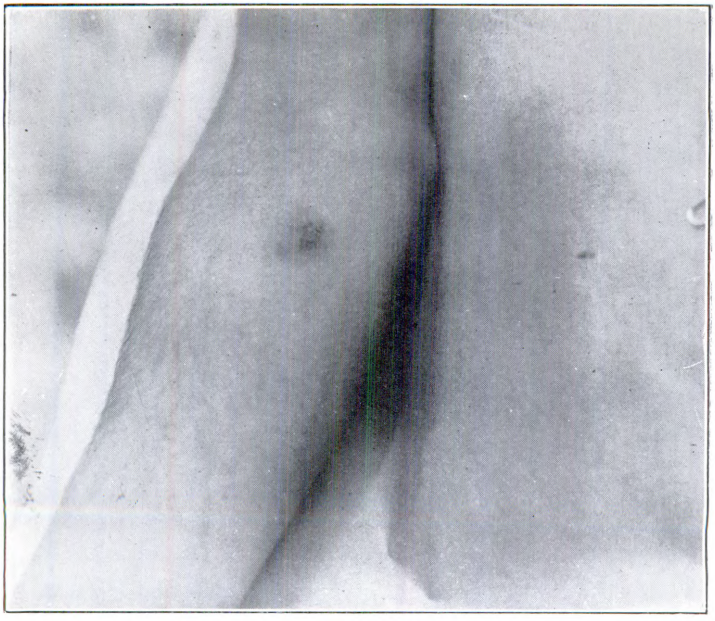

FIGURE 1.—PATCH TEST AFTER 24 HOURS. CINNAMON OIL DERMATITIS.

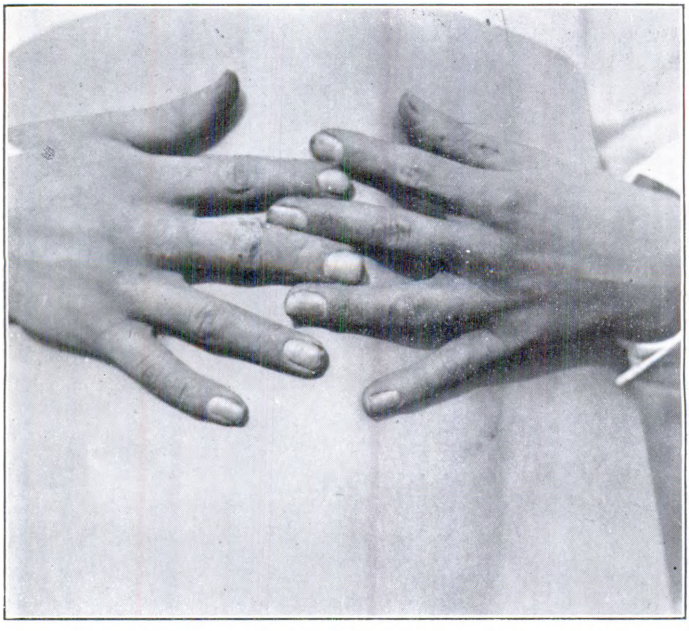

FIGURE 2.—CINNAMON OIL DERMATITIS. CANDYMAKER.

Girls placing candy in small papers and in silver foil have the skin on the ends of their fingers and around the roots of their nails cut in many places from the paper and from the foil, and these cuts sometimes become infected. Many of the girls doing this work wear strips of adhesive tape wound around their fingers to prevent them from getting cut by the foil or the paper. They prefer the adhesive to wearing gloves.

Girls tying boxes of candy with cord and ribbons have cuts and callouses on their hands and fingers from the cord.

Among the makers of hard candy, who work with the hot candy and over gas jets, burns of the hands and the arms are common. They are usually of minor importance and necessitate no lay-off from work. Occasionally a severe burn occurs, and sometimes a minor burn may become infected.

Men mixing and handling granulated sugar used in hard candies often show a dry, hard, and fissured condition of the skin of the palms and dorsum of the hands, which is accompanied by inflammation of the skin at the root of the nails and desquamation of the skin of the fingers. Twenty-six such cases were found during the course of this study.

There is occasionally found among the hard-candy makers an individual who is hypersensitive to one or more of the essential oils used for flavoring. The most common of these essential oils are the oil of cassia, which is distilled from cinnamon bark; oil of peppermint, oil of orange peel, oil of lemon, oil of anise, oil of birch, and oil of cloves. Extract of vanilla is also used a great deal for flavoring. Three cases of dermatitis were found resulting from oil of cinnamon, as proved by patch tests. Two of these cases were acute, and occurred in workers who were newly employed in the factory, and one was a chronic case who had been working in the factory for a number of years.

History of Cases of Cinnamon-Oil Dermatitis

Case I.—M. F., male, age 17, white, single, helper in hard-candy department. He has worked for 2 years at this occupation.

Past history.—States that for the past 2 years he had an eruption during the summer on his hands, arms, and fingers.

Present examination.—He has dark hair and eyes, with thick, oily skin. He stated that 1 week ago, subsequent to an excursion into the woods, he developed an itching around his hands and fingers. On the dorsum of his hands there was an erythematous, vesicular, papular dermatitis resembling dermatitis venenata. He was given calamine lotion and placed at work in another part of the plant. He was not seen again until 2 months later, when he had a desquamating dry dermatitis, with a few vesicles, on the palms and the dorsum of both hands and fingers, the forearms, and on the elbows. He thought this was due to turpentine which he used to remove paint from his hands. He was given some Lassar's Paste, and continued to work, wearing gloves

while working. The condition seemed to improve but never became entirely well. Six months after he was first seen, he was forced to stop work for 1 week on account of an acute exacerbation. Two weeks after his return to work it was decided to test him with patch tests made up of the essential oils which he used. Accordingly, he was patched with oil of cinnamon, oil of sassafras, and oil of peppermint; 1 part of the essential oil to 49 parts of olive oil being used. Twenty-four hours later, when the patches were removed, he showed a marked erythematous and oedematous area, a ++ reaction under the oil of cinnamon patch, and no reaction under the sassafras and peppermint patches. This man was hypersensitive to cinnamon and was ordered not to work with it. Shortly after he left the factory and was not seen again.

Case II.—S.S., male, age 19, white, single. At the time of his examination he worked in the starch room. Previous to that time he had worked at hard candy for 2 months. He denied having had any previous skin diseases. His skin was olive-colored, thick, and moist in texture. The symptoms began 2 weeks ago, 1 week after he sustained some slight burns on his hands.

Present examination.—He had an erythematous, papular eruption with a few vesicles on the dorsum of his right hand. He also had scaling between his toes. A patch test performed in a similar manner to that in case I raised a blister under the cinnamon patch, a +++ reaction, and gave no reaction under the sassafras and peppermint patches. He was advised not to work at hard candy making.

Case III.—J. F., age 35, male, white, married, had been working at making hard candy for 2 months. He denied any previous skin diseases. His complexion was fair, his skin thick and moist. Symptoms began 1 week ago with itching of the hands. Examination showed an erythematous, papular, vesicular eruption over the dorsum of both hands, with ulceration around the roots of the nails. Patch tests done in the same manner as in the above two cases gave an erythematous, oedamatous, vesicular eruption under the cinnamon patch, a +++ reaction, and no reaction under the sassafras and peppermint patches. This man was also advised not to work at hard candy making.

Two cases were found who had a dermatitis as a result of hypersensitivity to citric acid, and one case was found who had a dermatitis due to hypersensitivity to a certain chocolate. The latter, a chocolate dipper, developed a dermatitis on the hand and on the arm with which she did the dipping, every time she worked with a variety called "home-made chocolate." It was found that the particular chocolate which gave her the dermatitis was made by the "Dutch" process, in which the ground nuts are roasted and then sprinkled with potash, and allowed to stand from 24 to 48 hours. The nuts ferment during this period, after which they are roasted. About 2 pounds of potash to 100 pounds of chocolate are used in this process.

Case History of Chocolate Dermatitis

L. D., chocolate dipper, female, age 20, white, dark complexion with a thin, dry skin. She has been at the same occupation for 6 years. She had a similar eruption 2 years ago that lasted 2 weeks and necessitated giving up her work. The present attack began 3 days ago with an itching. She noticed that whenever she works with a certain brand of chocolate this condition occurs.

Description of lesion.—There were a few scattered papules and vesicles, and scratch marks on the dorsum of the right hand and the fingers extending to the wrist and forearm. She uses this hand for dipping the centers into chocolate. Her left hand showed no lesions. Patch tests with the chocolate gave negative results after 72 hours. She would not allow any further patching. She was removed from the work of chocolate dipping and her condition cleared up. The history of this case tends to the diagnosis of dermatitis due to hypersensitivity to a certain mixture of chocolate and potash.

Workers employed in peeling nuts and cutting fruit have their hands immersed in water and are also exposed to the action of the juices from these substances. Occasionally a worker is found who will develop a dermatitis from such causes.

Nine cases of fungus infections of the hands were found in the course of this study, and are worthy of note as an index of the occurrence of this infection on the hands. In only two of these cases was the disease limited to the hands. If the entire body of all the workers had been examined the incidence of fungus infection would no doubt have been found to be greater.

Summary

Among 1,235 workers in candy factories observed for a period of one year, 32 cases of occupational dermatitis were found. During the same period 73 cases of nonoccupational dermatitis occurred among them. The chief skin hazard in this industry was found to be sugar. This hazard can be eliminated to a great extent by compelling the workers to wear clean white gloves laundered every day.

Individual hypersensitivity to the essential oils used as flavoring agents occasionally causes dermatitis.

Hypersensitivity to a chocolate containing potash was found in one worker.

DERMATITIS AMONG SILK THROWSTERS

Dermatitis occurs among handlers of silk with varying frequency. In some factories where silk is prepared for weaving and knitting (called silk throwing) outbreaks have occurred from time to time.

Literature

Carroll M. Salls, Ph.D., determined that a rash occurring among workers in a silk factory was due to dust from silk cocoons that were imported from Africa, and that there were barbed particles on the silk that were probably parts of the bodies of the silk worms.

Gowdey states that the cocoons of the genus Anaphe, indigenous to Nigeria, contained urticating hairs derived from the body of the larvae which cause a painful irritation of the skin of those handling them, and that soaking the cocoons before and after removing each envelope (there being three envelopes in a cocoon) lessens the danger of dermatitis from these hairs.

N. C. Foote states that there is a venom present in the spines which adds to the irritating effects of the pricks, but that the venom is in such minute quantities that an analysis of it is extremely difficult.

P. M. Gilmer states that alkalies and heat, either dry or moist, temporarily inhibited the effects of the poisons contained in the hair, but that the virulence returned after an interval of from 48 to 72 hours, and that the irritating properties of the hairs were destroyed by a strong alkali or dilute potassium permanganate.

The silk handled by the silk throwers comes to them in skeins after it has been unwound from the cocoons and spun into a thread. Each thread contains the silk from 3 to 8 cocoons. Before the silk is unwound from them the cocoons are soaked in hot water.

The handlers of the dry silk skeins (as they are taken out of the bales from which they are shipped), were not found to have dermatitis.

An examination of the personnel of two silk throwing plants employing about 2,000 people showed that dermatitis which could be attributed to silk handling (there were many cases found which had no connection with their occupation, such as ringworm, scabies, urticaria, etc.) occurred only among those handling wet silk. In one of these factories, among 100 girls who handled wet silk (either hanging the silk to dry after it came out of the extractors, when it

FIGURE 1.—SHOWING HOW SKEINS OF DAMP SILK COME IN CONTACT WITH THE DORSUM OF THE HAND.

FIGURE 2.—DERMATITIS CAUSED BY WETTING SOLUTION FOR SILK CONTAINING SOAP AND CRESOL.

contained 50 percent of moisture, or winding it after drying, when it contained about 25 percent of moisture), 35 had dermatitis on the hands or forearms. The girls hanging the silk to dry had dermatitis on the forearms whereas the girls winding the silk had it on the dorsum of the hands.

Before silk winders put the skeins of silk on the winding rolls, they spread the skein by putting it over the hands and stretching it out in the manner shown by the illustration. This brings the moist silk in forcible contact with the back of the hands where the dermatitis occurs. Very few cases of dermatitis were found among the girls handling the silk after winding. A few cases occurred among the spinners (the next operation), and none occurred among the girls handling the silk after it was spun.

Silk-Soaking Process

In the factory where the largest percentage of dermatitis occurred, two wetting solutions are used—one for weaving silk and one for knitting silk. The silk destined for weaving is immersed in a solution consisting of 3 percent olive oil soap, 7 percent neats-foot oil, 0.5 percent of an antimildew, and a fugitive dye. The latter is used to identify batches of silk belonging to different owners. The silk for knitting is immersed in a wetting solution consisting of 10 percent sulphonated olive oil, sulphonated coconut oil 1 percent, potassium carbonate 0.7 percent, antimildew, and fugitive dye, as in the other solution. The antimildew consists of 45 percent cresylic acid, and 35 percent sulphonated olive oil in water.

After wetting, the silk is put in an extractor and the excess moisture, removed. It is then hung up to dry so as to remove the moisture, until the moisture content is about 25 percent, and it is then wound by the winders as described above.

After winding, the silk is spun into threads of various thicknesses on spinning machines, and the girls attending to this operation are called "spinners."

After spinning the thread is wound on cones, spools, or bobbins. The spinners and redrawers handle the silk very little, and by this time there is comparatively little moisture in it.

In order to determine what ingredient or ingredients in the wetting solution caused the dermatitis, a series of patch tests were performed with the various ingredients of the two wetting solutions on 22 of the cases of dermatitis found in the plant who volunteered for this experiment. These patches were as follows:

Patch no. 1 consisted of a piece of silk which had been wetted in a knitting solution and allowed to dry for 3 days.

Patch no. 2 was a piece of silk that had been wetted in a weaving solution and allowed to dry for 3 days.

Patch no. 3 consisted of a mixture of all the dyes used in the plant. These dyes were:

Bright green	Light red
Lavender	Yellow
Emerald	Maroon
Light blue	Salmon
Orchid	Gray
Henna	Green
Raspberry	Canary
Copenhagen	Turquoise
Mahogany	Sky blue
Gold	Bronze
Tan	Russet
Endive	Jade
Orange	

Patch no. 4 consisted of potassium carbonate 0.7 percent.

Patch no. 5 consisted of sulphonated olive oil in water 10 percent.

Patch no. 6 consisted of patch no. 5 with the addition of 1 percent of sulphonated coconut oil.

Patch no. 7 consisted of patch no. 6 with the addition of 0.7 percent potassium carbonate.

Patch no. 8—the same as patch no. 7— with the addition of 0.5 percent of an antimildew. This solution is the final wetting solution for knitting silk.

Patch no. 9 consisted of a 3 percent olive oil soap plus 7 percent of neatsfoot oil.

Patch no. 10 is the same as patch no. 9 with the addition of 0.5 percent of an antimildew. Patch no. 10 is the final wetting solution for weaving silk.

The results of these tests are shown in table no. 1.

There were no positive reactions to patches nos. 1, 2, and 3. Three girls out of 16 tested gave faintly positive reactions to patch no. 4. Two girls out of 4 patched with no. 5 gave positive reactions, and the same 2 girls gave positive reactions to patch no. 6. Only one of these girls gave a positive reaction to patch no. 7, and this girl had a polysensitivity, because she gave positive reactions to each of the 8 patches applied. It may be that the reason that the other girl who gave positive reactions to patches nos. 5 and 6 did not give a positive reaction to patch no. 7 was because the acids of the sulphonated oils contained in patches nos. 5 and 6 were neutralized by the addition of 0.7 percent of potassium carbonate in patch no. 7.

The final wetting solution for knitting silk was positive on 2 of the 11 girls tested. One of the girls was the polysensitive one.

Patch no. 9 gave positive reactions on 3 out of 4 girls tested, and patch no. 10, which is the final solution used for weaving, gave 12 positive reactions out of 16 girls tested.

It seemed from these results that most of the dermatitis in the factory was due to the solution used for the wetting of the weaving silk. A recheck was then made of the kind of silk handled by the

FIGURE 3.—POSITIVE PATCH TEST WITH WETTING SOLUTION CONTAINING SOAP AND ANTIMILDEW.

girls affected with dermatitis, and it was found that all the winders who had dermatitis wound mostly the weaving silk.

In order to determine what caused the dermatitis in the solution used for wetting the weaving silk, 10 girls who gave the positive reaction to patches of this solution consented to be tested with the ingredients that go to make it up. In addition to these 10, two girls, one of whom gave a negative reaction to patch no. 10, and one girl on whom it was not applied, were used as controls. Five patches were applied on each girl. Patch no. 1 consisted of a 12½-percent solution of the brand of olive oil soap used in the factory. Patch no. 2 consisted of sulphonated olive oil. Patch no. 3 consisted of sulphonated coconut oil. Patch no. 4 consisted of neatsfoot oil, and Patch no. 5 consisted of a 2 percent solution of antimildew in distilled water.

A stronger solution of olive oil soap than was actually used in the wetting solution was used in patch no. 1 because the patch was to be left on for only 24 hours, whereas there was a much longer exposure to the wetting solution under working conditions; and a 2-percent solution of antimildew was used instead of 1 percent because a 2-percent solution was sometimes actually used.

All the girls including the two controls gave positive reactions to patch no. 1. One of these controls had not been subject to the test of the soap solution, and the other had been tested with patch no. 10, to which she gave a negative reaction, but patch no. 10 contained only a 3-percent solution of olive oil soap.

Three girls gave positive reactions to patch no. 2.

There were no positive reactions to patches nos. 3 and 4, and six gave positive reactions to patch no. 5.

As stated before, patch no. 5 contained a stronger solution of antimildew than was usually used in the wetting solutions.

In table no. 1 it will be seen that when a weaker solution of antimildew was used only 2 out of 11 girls were sensitive to it.

Of the 6 girls who gave a positive reaction to the 2 percent solution of antimildew, 4 had been previously tested with patch no. 8, which contained 0.5 percent, but did not contain olive oil soap, and they gave no reaction.

These tests seem to show that although the antimildew was irritating to a few of the girls, sensitivity to the olive oil soap was the chief cause of dermatitis in this factory.

In order to determine whether these girls were sensitive to the particular brand of olive oil soap used in this factory, or whether they were sensitive to any soap, the 6 girls who gave positive reactions to the 12½ percent solution of olive oil soap were tested with 12½ percent solutions of three other brands of soap. All the

girls gave positive reactions to soap A. One girl developed +++ reaction and two girls ++ reactions. Soap B gave reactions on all the girls, and soap C also gave reactions on all the girls, but on two of the girls the reactions were rather faint. These tests showed that while all the soap solutions of 12½ percent strength were irritating to the skin of 3 girls, the brand of soap used in this factory was more irritating than the other soaps tested. This may mean that the sensitivity of the girls was more specific to the soap to which they were exposed in their occupation than to soaps to which they were not exposed.

NOTE.—The three brands of commercial soaps tested will be discussed as A, B, and C.

In order to determine whether there was any fault in the manufacture of the soap used in the factory, a visit was made to the plant where the soap used in the factory was manufactured. The soap was made in the ordinary manner from sulphur olive oil foots, and caustic soda, and an analysis is as follows:

	Percent
Moisture	11.75
Free caustic	trace
Sodium carbonate	0.40
Anhydrous soap	84.16
Unsaponifiable fat	1.10
Salt	2.20
	99.61

The sulphur olive oil foots used in manufacturing this soap is imported from Portugal, Spain, Italy, and Algiers, and comes up to the specifications required by the Government. Sulphur olive oil foots is extracted from the pulp of the olive with carbon bisulphide. It is of a dark green color and has an unpleasant odor of sulphur. It is slightly acid in reaction. The soap is made by saponifying olive oil foots with sodium hydroxide, to which is added about 2 percent of salt. The mixture is boiled and evaporated to a semisolid state and then dried. No denaturants, such as oil of Rosemary or nitro benzene, are used, because they are not neccessary, as the sulphur olive oil foots could not be used as a food on account of its unpleasant taste and odor.

Three girls working as winders in the silk factory, who gave positive reactions to olive oil soap, were patched with Portuguese olive oil foots obtained from the manufacturers of the olive oil soap, and two of them gave positive reactions to it. One of the two girls who gave a positive reaction to the olive oil foots was tested with an edible olive oil solution and gave no reaction. These same three girls were patched with a 12½ percent solution of brand D soap, which is made

mostly of tallow, and all three gave positive reaction, showing that they were sensitive to the brand D soap as well as olive oil soap.

In order to determine what percentage of the girls working in the silk factory were sensitive to the solutions used, patch tests were made on 20 volunteers who never had any dermatitis, and who did not handle the wet weaving silk. Six solutions were used for patching as follows:

Patch no. 1 was the final dipping solution for knitting silk.
Patch no. 2 was the final solution for weaving silk.
Patch no. 3 was a 12½-percent solution of the olive oil soap used in the plant.
Patch no. 4 was a 2-percent solution of the antimildew.
Patch no. 5 was sulphur olive oil foots.
Patch no. 6 was a 12½-percent solution of brand D soap.

All of the girls gave positive reactions to patches nos. 2, 3, and 6. This shows that a 12½-percent solution of olive oil soap or brand D soap is irritating to the normal skin if the patch is left on for a period of 24 hours, and that a 3-percent solution of soap made from olive oil foots plus a 0.5-percent solution of the antimildew is also irritating to the normal skin if left on for 24 hours.

Nine girls reacted positively to the final dipping solution for knitting silk, which contains 0.5 percent of the antimildew. Eleven girls gave positive reactions to the 2-percent solution of antimildew. Among these 11 were the same 9 who reacted to 0.5 percent of the antimildew. Five girls, or 25 percent of those tested, gave positive reactions to sulphur olive oil foots.

In order to determine whether olive oil soap made from edible olive oil was less irritating than that made from sulphur olive oil foots, a sample of soap was specially made from an edible olive oil in the following manner:

Three ounces olive oil was mixed with an equal amount of water in a beaker.

One and one-half ounces of sodium hydrate 38° B. was then added and the mixture was boiled again; then ½ ounce of sodium hydrate was added to this mixture, making a total of 2 ounces of sodium hydrate used, and the mixture boiled again.

A small amount of salt was added to salt out the soap, and after standing a while the fluid was drawn from the bottom of the beaker. Water was added again and the mixture boiled. (This process is called graining.) The fluid was again drawn from the bottom of the beaker and the soap was allowed to cool. It separated into two layers. The top layer was white and the lower layer was dark (the lower layer is called the niger).

The soap thus prepared contained 30 percent of water and had a free alkali content of 0.3 percent. On standing, the water content gradually diminishes and the free alkali decreases.

A 16-percent solution of this specially prepared soap was made, to correspond in solid content to the 12½-percent solution of olive

chip soap used in the silk throwing factory, because the freshly prepared soap had a higher moisture content than the older olive chip soap. A sample of this was diluted to an 8-percent solution and another sample to a 4-percent solution. A 6-percent solution and a 3-percent solution of ordinary olive chip soap were also made. Ten workers in the soap factory agreed to be patched with these five solutions. Three were females and seven were males. Two gave positive reactions to the 16-percent solution of the virgin olive oil soap. One of these reactions was very faint, and both occurred in girls. The same two girls gave very faint reactions to the 4-percent solution of the virgin olive oil soap. The 3 girls and 2 men gave positive reactions to a 6-percent solution of sulphur olive oil soap, and 2 girls and 1 man gave reactions to the 3-percent solution of sulphur olive oil soap. One of the men who gave a positive reaction to the 6-percent solution of sulphur olive oil soap did not react to the 3-percent solution of the same soap; the other man did. These tests show that soap made from sulphur olive oil foots is more irritating than soap made from virgin olive oil. The 10 individuals who submitted to this patch test had been working for some years in this factory and had never had any skin irritations as a result of their occupations. These tests also showed that a 3-percent solution of soap made from virgin olive oil can be left on the skin for 24 hours in the form of a patch test without resulting in any reaction in normal individuals.

These tests show that dermatitis in the silk factory examined was caused principally by sensitivity of the girls to soap made from sulphur olive oil foots and also in a lesser degree to sensitivity to cresylic acid used in the anti-mildew solution. They also showed that the soap made from sulphur olive oil foots was more irritating to the skin than soap made from virgin olive oil.

In order to check the findings in this factory, another factory employing 1,400 people in the manufacture of silk goods was visited. In this plant only one wetting solution is used for all grades of silk, and it consists of a 3-percent solution of sesqui carbonate of soda, called "snow-flake crystal", to which is added 1 percent of glycerine, 1 percent of mineral oil, 1 percent of Neatsfoot oil, and 0.5 percent of olive oil soap, and fugitive dyes. The sickness records of the plant showed that occupational dermatitis was rare among the workers, and that when it did occur it occurred among the hangers and winders only.

Ninety-six hangers and winders were examined. In this plant the silk after being wetted and extracted is hung for 24 hours before it is wound. Nine girls among the 96 hangers and winders examined were found to have or have had a dermatitis on the hands

and on the forearms which they attributed to the wet silk. Ninety-one spinners and coners were examined and no cases of dermatitis were found among them.

Sixteen girls were examined who worked in the laboratory of the plant and only one case of dermatitis was found. This was an erythematous vesicular sharply circumscribed patch occurring in the web between the forefinger and thumb. An examination of her feet showed the presence of tinea between the toes and the case was probably epidermophytosis.

Of the 9 girls found to have had dermatitis, 3 were hangers, out of a total of 7 hangers examined. The other six were winders. Six of these nine girls volunteered for patch tests and they were patched with the following solutions:

Patch no. 1—the wetting solution used in this factory.

Patch no. 2—3 percent solution of the olive chip soap used in the first factory examined.

Patch no. 3—3 percent solution of soap made from edible olive oil.

The patches were left on for 24 hours. One girl did not return to have the patch removed. Three girls out of five gave faint reactions to patch no. 1. The same 3 girls gave marked positive reactions to patch no. 2, and 1 additional girl gave a faint reaction to this solution. Only one girl showed a very doubtful reaction to patch no. 3. One girl gave no reaction to any of the solutions. This girl's dermatitis proved to be due to scabies.

In this factory only 0.5 percent of soap is used in the wetting solution, and no antimildew (because the silk is worked soon after it is prepared, so that the mildew has no chance to develop). This may account for the diminished incidence of dermatitis among the winders, as the patch tests performed showed positive reactions in 4 out of 5 girls to the 3 percent solution of the sulphur olive oil soap, which is used in the wetting solution in factory no. 1.

The histories of all the girls in this study who had an occupational dermatitis showed that they worked from a period of a few months to a few years in the factory before they developed dermatitis. This seems to indicate that the sensitivity to the soap was acquired while working.

Prevention

1. To prevent dermatitis in the handling of wet silk, it seems advisable to use a wetting solution which contains a minimum amount of soap, and antimildew.

2. To supply the girls who hang the silk and wind it, with fresh white gloves to wear each day, and underneath these gloves have some water impervious material, such as cellophane, to prevent the wetting solution from touching the skin. A bland ointment can be

rubbed into the skin of the hands and forearms before putting on the cellophane and gloves.

3. Olive oil soaps could be made from edible olive oil. This renders them less irritating than soaps made from sulphur olive oil foots.

4. Detergents other than soaps may be tried. Such detergents are now on the market.

TABLE No. 1

Solutions numbers	1	2	3	4	5	6	7	8	9	10
1. Winder	−	−	0	0	0	0	0	0	0	0
2. Winder	−	−	−	−	0	0	0	0	0	−
3. Winder	0	0	−	−	−	−	−	(1)	−	−
4. Winder	0	0	−	−	0	0	0	−	0	+
5. Winder	0	0	0	−	0	0	0	−	0	(1)
6. Winder	0	0	0	0	+	+	−	−	0	+
7. Winder	0	0	−	0	−	−	−	−	0	(1)
8. Winder	−	−	0	(1)	0	0	0	0	0	−
9. Winder	−	−	0	−	0	0	0	0	0	+
10. Winder	−	−	0	−	0	0	0	0	0	+
11. Winder	0	0	−	−	0	0	0	0	0	+
12. Winder	−	−	0	−	0	0	0	0	0	(1)
13. Winder	0	0	0	−	0	0	0	0	+	+
14. Winder	0	0	−	−	+	+	+	+	+	+
15. Spinner	0	0	0	0	0	0	0	−	0	0
16. Spinner	0	0	−	(1)	0	0	0	−	0	0
17. Spinner	0	0	−	(1)	0	0	0	−	0	0
18. Spinner	0	0	0	0	0	0	0	−	0	0
19. Spinner	−	−	0	−	0	0	0	0	0	+
20. Redrawer	−	−	−	0	0	0	0	−	0	0
21. Redrawer	0	0	0	−	0	0	0	0	+	+
22. Chemist	0	0	0	−	0	0	0	0	0	−
Total:										
Negative	8	8	9	13	2	2	3	9	1	4
Positive	0	0	0	3	2	2	1	2	3	12

[1] Faintly +.

NOTE.—Zero indicates that patch test was not performed.

DERMATITIS IN THE MANUFACTURE OF LINSEED OIL

This study was prompted by a request from an insurance company for advice as to the cause and prevention of dermatitis occurring in men working in a linseed oil plant.

In a linseed oil manufacturing plant employing 64 men there occurred during a 2-year period 8 cases of pus infections of the fingers and 1 case of dermatitis severe enough to be reported to the insurance company. Seven of these men had to stop work for varying periods of time and receive compensation.

There is no record of the number of cases of dermatitis and infection that occurred during this period which were not severe enough to require a lay-off from work, but according to the statement of the superintendent there were many such cases and most of them left the plant when they found that they could not tolerate the dermatitis resulting from their work.

The compensation paid to workers with skin diseases in this plant far exceeded the total paid for all other conditions.

An examination of the 64 workers in the plant was made and 8 new cases of dermatitis were found. These 8 cases occurred among 39 men who were in contact with linseed meal. Among 25 men who did not handle the linseed meal or cake, no cases of dermatitis were found at the time of the inspection.

An examination of the labor turnover for the past 2 years showed that 190 different men were employed in this plant who worked with linseed oil and cake, and it was among these workers that the 8 cases of infections of the fingers and the 1 case of occupational eczema which the insurance company reported occurred.

The linseed used in this plant comes mostly from South America, and the crew of the vessels carrying it, as well as the stevedores and lightermen who unload the barges, and the men who weigh, screen, and store the seed, suffer at times, especially in the summer, with dermatitis. These occupations are all very dusty and the clothes of the workers become filled with dust and linseed.

From the storage bins the seed runs into grinding rolls to be ground into linseed meal. The meal is carried to steel jacketed steam cookers, mixed with a small amount of water and cooked. The meal is taken out from the bottom of these cookers by means of a small chute, and is wrapped by hand in a feltlike cloth woven from human hair imported from China. The mass is put into a press and

pressed into a soft mold. These soft molds are then placed into large hydraulic filter presses which press the oil from the seed. The residue is called the "cake" and the haircloth is stripped from this cake by hand. The edges of the cake are trimmed because the oil has not been thoroughly pressed from them, and the trimmings are returned to the press. The rest of the cake is used as cattle feed.

An examination of various samples of the linseed showed all of them to contain bettlelike parasites. Specimens of these parasites were sent to the Bureau of Agriculture for indentification, and they reported as follows: "The insects were of two different species—the flour beetle *Triboleum ferrugineum*, and the saw-tooth grain beetle *Oryzaephilis surinamensis*. The extremely small-mouthed parts of these insects make their attack on man a very uncommon thing. In fact we do not see how it would be possible for them to annoy man in any way whatever. We are inclined to think that the trouble may be caused by the pediculoides in the linseed. These are small mites which attack soft-bodied insects in linseed, straw, etc., and when they come in contact with man attack the skin and sometimes set up a rather severe dermatitis."

The men handling the linseed state that their clothes often become infested with these parasites and the skin is irritated by their crawling, and that they are also bitten by them.

The samples also show contamination with a considerable percentage of mustard and rape seed. The seed from South America contained more of the mustard and the rape than did the seeds from North America and from India. The superintendent of the factory stated that when Indian seeds were handled there was more irritation of the skin and mucous membrane of the workers from the dust than from either the South or North American seeds.

The men working in the storage bins and on the screening chutes wear gloves, respirators, and goggles to protect them from the irritating dust.

The men working in the section of the factory where the cooked meal is placed in the haircloth mats and then placed into the presses, and the men who take the cake out of the presses and strip the haircloth from it often suffer from dermatitis. The superintendent stated that it is not unusual to find that a new man at these jobs develops a dermatitis which persists as long as he is in the factory, and that it sometimes becomes so severe that he must leave the work.

The men who strip the haircloth from the cake often receive cuts and friction burns on the ends of their fingers from gripping and pulling on the hot haircloth, and these cuts and burns may become infected. New men at this occupation wear gloves for a period of about 2 weeks until the ends of their fingers are toughened and

FIGURE 1.—LINSEED OIL DERMATITIS.

calloused from the continuous friction. Most of the cases of cuts and infections have occurred among new workers before the skin had become hardened. Haircloth mats are used in the presses because they withstand wear and tear better than other materials, and Chinese hair is used because it is cheaper than camel's hair.

The 8 cases of dermatitis found among the 30 pressmen and 9 trimmers examined consisted of an erythematous macular and deep-seated papular rash on the backs of the hands and the inner surfaces of the forearms, extending from the wrists to above the elbows, and marked in the ante-cubital spaces by scratch marks and crusts. One of the men had a generalized eruption; he had been transferred from his job as a pressman on account of the eruption, and was placed in another part of the plant. While there the condition improved, but when he was placed back on the job of pressman the eruption again appeared.

The pressmen handle the meal after it has been heated and after it comes out of the presses. They are not subjected to dust or parasites. They come in contact only with the meal, the oil, the cake, and the haircloth. Three of the cases of dermatitis found among the pressmen were patched with linseed oil and linseed meal. The patches were left on for 72 hours, at the end of which time there were positive reactions under all of them, showing that the men were hypersensitive to the oil and the meal.

In an abstract from the "Retail Credit Company Report of August 1931" it is stated that there is a chemical contained in cottonseed called "gossypol" which may be harmful through skin contact. This may be the irritant in the linseed, but the contamination of the linseed oil with the oil of mustard and the oil of rape may also be a factor in the cause of the eruption.

The cases of dermatitis which were found at the time of inspection were unknown to the superintendent. Although they had a severe dermatitis they continued to work without complaint, for fear of losing their positions. It was comparatively easy to pick them from among the other workers, because everyone of them wore long sleeves to protect his arms, whereas the men who did not have dermatitis worked with bare arms.

The skin hazards in this industry are: (1) Irritation of the skin and the mucous membranes from the sharp edges of the linseed, as well as from the dust. (2) Bites and irritation from the parasites which infest the linseed. These two causes are only operating among those workers who handle the linseed before it is pressed. (3) Dermatitis due to hypersensitivity to linseed oil and perhaps to the contaminators—mustard and rape oils. (4) Cuts and friction burns (which often become infected) from pulling the hair mats off the

pressed cake. Only the workers who handle the linseed meal, the linseed oil, and the cake are subjected to hazards (3) and (4).

Prevention

Allaying of dust and elimination of parasites will tend to lessen dermatitis occurring among the handlers of the linseed.

Cleanliness should be enforced among the workers.

Clean towels should be supplied daily to wipe the oil and the mash from the hands instead of the dirty, coarse burlap aprons which are now used.

The workers should be compelled to take shower baths and change to fresh clothes after work.

Clean cotton gloves should be furnished daily to pressmen and those stripping the haircloth from the cake.

Whenever a worker shows hypersensitivity to the oil he should be transferred to work where he will not come in contact with it.

There should be frequent medical examinations of the workers to discover cases of dermatitis.

Literature

Cases of dermatitis occurring among workers in linseed and linseed oil have been previously reported.

(1) Prosser White states that in England lightermen and others handling linseed and flaxseed have been found to be affected with a folliculitis. In America it has been noted among the extractors of linseed oil. The rash is intermittent and is found on the hands, the forearms, and occasionally on the upper arm and face, and even on the legs.

(2) Frank S. Pedley, assistant professor, Columbia University, investigated the condition in a factory and found that it was confined to the department where the ground flaxseed is cooked and then subjected to hydraulic pressure. In Pedley's report it was a South American linseed that was at fault. He suspected the burlap sugar bags in which the linseed was shipped as the cause of the trouble, but patch tests which he performed with the linseed meal and with the linseed oil, and with a piece of burlap from the sugar bags on the excoriated skin were negative.

(3) F. J. Vokoun reports in the Journal of the American Medical Association, July 2, 1927, and the Ohio State Medical Journal, March 1927, that he noted many workers in a linseed-oil plant who suffered from dermatitis, usually in a mild form. However, he reports three severe cases. He sent out inquiries to physicians in charge of linseed-oil plants and found that they have had hundreds of cases of dermatitis among their linseed workers. He states that seeds from South America seem to be more irritating than the seeds from Canada or northwestern United States, but that the Indian seed is the most irritating of all. Eruptions are usually on the forearm and the hands, occasionally on the body, neck, and shoulders. If the worker is laid off for 3 or 4 days the eruption disappears. It was found that the use of burlap to wipe oil and meal from the hands and forearms between pressings caused skin irritation. The use of sterile rags or towels in place of the burlap helped to prevent many

cases of dematitis. A thorough cleansing with soap after the work period helped to prevent dermatitis. Difficulty in making the men obey the rules of cleanliness was observed. In the treatment of these cases a mild sulphur ointment with balsam of Peru was used.

(4) Dr. Barnett Kooperman states that the dermatitis is not caused by the flaxseed oil but by the dust from the ground and unground seed. He states that blondes are more susceptible than brunettes, and that colored people are also attacked. The characteristics of the eruption are: That it occurs on the anterior aspects of the arms and thighs; that it is symmetrical and discrete, with deep macules, papules, scratch marks, and crusts; and that there is itching and burning, especially after bathing. Scabies must be ruled out of the diagnosis. Treatment with drugs is only palliative. A few days' vacation usually clears up the condition. The exact nature of the irritating substance is undetermined. Dr. Kooperman rubbed linseed oil on the freshly shaven skin of a rabbit and produced a severe dermatitis.

(4) Ullmann, Oppenheim & Rille, "Die Schädigungen der Haut," vol. 2, pp. 216 to 225, state that oil dermatitis occurs among handlers of animal as well as vegetable oils. The dermatitis may take many forms, but the most common are folliculitis, acne, and pustules. They divide dermatitis occurring from all oils into three kinds:

"The first is after working a short time—erythema of the whole body that can become a moist dermatitis; the second after a longer period of work—acne on the face and over the body with pigmentation; and the third after longer work—an extensive pigmentation of the skin—melano dermatitis."

It is also stated that it seems as if a certain idiosyncrasy must exist before dermatitis arises from any of these apparently harmless fats and oils, and that men with hairy arms and dry skins are more apt to get these conditions. Personal uncleanliness also predisposes. Microorganisms gain entrance into the skin through scratching and set up a secondary infection. Fresh and clean oils and fat do not affect a skin that is not wounded and has no predisposition to skin disease. The utmost importance is absolute personal cleanliness; cleaning the hands and arms with soap and warm water before and after beginning the work, and before and after eating. Individual towels should be used. Oil-saturated clothes should be changed. People with skin diseases should not work at such occupations.

(5) Hope, Hanna, and Stallybrass, in "Industrial Hygiene and Medicine," London, 1923, p. 403, state that the trouble is confined to workers in Calcutta linseed, and they suspect a parasite is the cause of it.

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DERMATITIS DUE TO PERFUME

In a factory manufacturing perfume there occurred two cases of dermatitis sufficiently severe to necessitate the girls stopping their work. These cases occurred among 12 girls working at the operation of bottling and capping perfume. One of the girls affected had worked in the factory for 1 month, and the other for 2 months. An examination of the remaining 10 girls employed at this operation revealed 3 additional cases of dermatitis that were not severe enough to cause a cessation of work. These 3 girls had worked at the operation for more than 1 year. The eruption in these 3 cases was confined to the inner surfaces of the forearms and consisted of slighty erythematous areas and scattered papules and scratch marks.

Process

Two kinds of perfume are made in the factory, and the essential oils used are bought from an outside manufacturer. They are mixed with nine parts of denatured alcohol (denatured with brucin and iso-propyl alcohol) in large metal tanks. One man attends to this mixing. The resultant mixture is piped from the tanks to a table where a girl is employed filling bottles. Other girls then place gelatine caps over the filled bottles which are covered with large caps of bakelite. The perfume is a 10-percent solution of the essential oil in denatured alcohol.

About 60 workers are employed in the whole establishment, and no cases of dermatitis have occurred among any group except the group of girls bottling and capping the perfume.

In order to determine what irritant was in the perfume the two severe cases of dermatitis were patched with five substances.

(1) Denatured alcohol.
(2) Essential oil A diluted with nine parts of Nujol.
(3) Essential oil B diluted with nine parts of Nujol.
(4) Perfume A.
(5) Perfume B.

The girl who fills the bottles with the perfume and who is splashed with it more than any other girl, but whose skin was not affected, consented to act as a control, and she was also patched with the five substances.

The patches were placed on the back, alongside of the spine, and were left on for 24 hours, at the end of which time there was no

reaction under any of the patches. The more severe of the 2 cases stayed away from work for 2 weeks; the other only a few days. While the more severe case was away from work the other patient and the control were patched with the gelatin cover of the bottles, and with the bakelite cap ground into a powder. The patches were left on for 48 hours, at the end of which time they were removed, but there was no reaction under the patches. Two weeks after the first observation the less severe case of dermatitis had entirely cleared up. The three mild cases continued at their work although the eruption remained about the same. The most severe case returned to work 19 days after she was first seen, at which time the eruption had practically cleared up. After working for 2 days the eruption reappeared and became so severe that she again had to stop work. The eruption of the first attack was confined mostly to the forearms, with only a few patches on the exposed portions of the chest, while in the second attack the face and the legs also became involved. Two days after she stopped work she was patched again with perfume A and perfume B and with the denatured alcohol, but this time the patches were placed on the inner surfaces of the upper arm, on areas of the skin which were not involved in the eruption. Under the perfume A patch there was a reaction which consisted of an erythema; under the perfume B patch there was a reaction which consisted of an erythema, oedema, and vesicles. There was no reaction under the denatured alcohol patch. These tests showed that she was markedly sensitive to perfume B and less so to perfume A, and it was recommended that when she became well she should not return to her occupation. After staying away from work for 2 weeks her condition improved and she obtained a position as a chocolate dipper, and when seen after working 1 week as a chocolate dipper the skin eruption had entirely disappeared.

Because this employee did not react to the first series of patches placed on her back and did react to the second series of patches placed on her arm, an attempt was made to find out whether the skin on her arm was more sensitive to the perfume than the skin on her back. She was therefore patched with perfume B, the one to which she was most sensitive; one patch being placed on the inner surface of her right upper arm; and the other patch was placed over the right scapula. After 24 hours the itching underneath the patch on the arm became intolerable and she insisted that the patch be removed. Underneath it there was found an area much larger than the patch (about 1½ inches in diameter) of erythema and oedema covered with vesicles. The patch on her back was removed at the same time and underneath it there was only a very slight area of erythema (about ¼ inch in diameter) hardly sufficient to call

a reaction. It seemed from these tests that the sensitivity of the skin on her arm was much greater than the skin on her back.

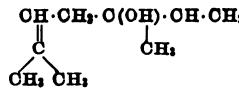
The manufacturer of the essential oils used in these perfumes was visited and their composition was obtained.

Essential oil B consisted of 46 different compounds and essential oil A consisted of 22 different compounds. Among the 46 compounds contained in essential oil B there were 15 which, after consulation with the chemist of the plant, were considered to be possible skin irritants. Among the 22 compounds contained in essential oil A, 5 were considered as possible skin irritants. These five:

Linalool
Oil of Bergamot
Di ethyl phthalate
Ylang Ylang
Kananga

were common constitutents to both essential oils. It was possible that any or all of these substances were the causes of the dermatitis, but the chemist of the plant thought that if any one substance was particularly to blame for the irritating properties of the two oils, it was linalool. Linalool was contained in three times greater strength in essential oil B than in essential oil A.

Linalool $C_{10}H_{18}O$ has a graphic formula:



It is classed by some as a terpene alcohol and by others as an olefin terpene, having a boiling point between 197° and 199° F., specific gravity of 0.8702 at 20°. It is made of Mexican oil of linaloe, from which it is distilled in impure form but can be purified. It is contained in:

Oil of lavender	Geraniol
Bergamot	Neroli oil
Origanum	Spearmint oil
Coriander	Ylang Ylang

The best grades are made from the oil of female rosewood distilled in British and French Guiana.

Prosser White states that Indian rosewood is intensely irritating to the skin. (R. Prosser White, "The Dermatergoses or Occupational Affections of the Skin", p. 450.)

Linalool belongs to a group of compounds of which geraniol and nerol, citral and neral, rhodinol and rhodinal, citronellol and citronellal are members. It is extensively used in the manufacture of perfume and is contained in about a strength of 7 percent as pure linalool in essential oil B and about 2 percent in essential oil

A. However, in both essential oil B and essential oil A, there are many other substances containing linalool or other members of the group of terpene alcohols, so that 10 percent of linalool is not too much an estimate for the content of essential oil B. The perfume itself is made up of 1 part of essential oil to 9 parts of denatured alcohol, and contains on a conservative estimate at least 1 percent of linalool. The fact that the other essential oils in the perfume may also have irritating properties cannot be overlooked. (Glaser in "Die Schädigungen der Haut", Ullmann, Openheim & Rille, vol. 2, 1926, pp. 216 to 225, calls attention to the fact that some of the essential oils cause skin irritations in hypersensitive people.)

The patient, although entirely recovered since working at another occupation, consented to be further patched in order to find out what there was in the perfume to which she was sensitive. Accordingly, a 1 percent solution of linalool in denatured alcohol was made and a patch put on her left arm. After 24 hours the patch was removed and showed an area of skin about 1½ inches in diameter to be erythematous and oedematous, the reaction being slightly less marked than that which was obtained on the inner surface of the right upper arm while she still had the eruption.

Discussion

Among 12 girls employed in bottling perfume, 5 cases of dermatitis were found. Three of these occurred in girls who had worked in the plant for 1 year. These cases were mild and were confined to the inner surfaces of the forearms, but did not cause sufficient inconvenience for them to make a complaint. The 2 severe cases occurred in girls who were only recently employed and 1 of them was so severe that she was compelled to give up her occupation. In the less severe of these 2 cases the eruption disappeared entirely about 2 weeks after she was first observed, despite the fact that she continued at her occupation. The more severe of the 2 cases had the eruption cleared up after about 2 weeks' cessation from her work, only to have it reappear 2 days after again resuming work. It took 2 weeks' cessation from work for it again to disappear, and she had to give up her occupation. Patch tests showed that the two essential oils were the causes of the dermatitis, and that the skin on the inner surface of the upper arm which was near the eruption was more sensitive than the skin on her back which was farther away from the eruption.

Perfume B gave the more severe reaction to the patch test than did perfume A, and it contained a much larger percentage of linalool than did perfume A. A patch test with linalool performed about 1 month after the patient had recovered and was at another occupa-

tion showed a reaction only slightly less than that obtained with perfume B while the attack of dermatitis was at its height.

Conclusion

Hypersensity to the essential oils caused the dermatitis described in this article. This hypersensity was acquired after working with the perfume for a period of about 1 month.

One of the cases acquired a relative immunity while continuing work; the other case became more sensitive. Linalool, a terpene alcohol contained in the perfume, was probably the principal skin irritant.

DERMATITIS DUE TO PYRETHRUM CONTAINED IN AN INSECTICIDE

Twenty cases of dermatatis occurred during a period of 2 years in a factory manufacturing 2 products, 1 an insecticide, and the other a fly repellant used as a cattle spray.

The factory employs about 100 men and women.

One of these cases was so severe and persistent as to compel the man to give up his work. Other workers became so sensitive to the insecticide that they developed a dermatitis if they merely worked in the room where the product is bottled.

The insecticide depends principally upon the action of an extract of a flower resembling the ordinary daisy, and is called chrysanthemum pyrethrum, or pyrethrum cinerariaefolium, which grows in various parts of Europe, Asia, Australia, and America. It is cultivated for its insecticidal properties in Dalmatia, Montenegro, Croatia, Austria, Persia, Japan, and in California. This flower should not be confused with the pyrethrum of the Pharmacopeia, which is obtained from the root of a plant grown in Algiers, Morocco, Tunis, and Arabia, called the anacyclus pyrethrum, the extract of which is used as a sialogogue and an antineuralgic.

The pure powdered flowers are used, or they can be mixed with other substances, and the action of the insecticide on the insects is to paralyze the neuro-muscular system. The entire pyrethrum plant contains the toxic principle, but the flowers contain many times more of it than do the leaves and the stems. The active principles, according to Erwin Ott and Otto Behr, are pyrethrin I and undecadienic isobutylamide (formula $C_{10}H_{17}CONHCH_2CHMe_2$) and pyrethrin II. Pyrethrin I is more active than pyrethrin II. The amount of pyrethrin extracted from the pyrethrum flower ranges from 0.4 percent to 1.21 percent. According to McCord three varieties of the flower are used:

Chrysanthemum cinarariaefolium
Chrysanthemum roseum
Chrysanthemum marshallii

This author reports 18 cases of dermatitis occurring among 85 workers in the months of April, May, and June.

J. Chevalier states that 10 grams of pyrethrum powder as a gummy emulsion, or two-tenths of a milligram of pyrethrin when injected into the lymphatic sack of a frog will first cause excitement, then tetanus, and paralysis, and death within 3 hours. The symp-

toms resemble those of strychnine poisoning, except that there is an absence of tetany with permanent rigidity. He also states that when 2 milligrams of pyrethrin per kilogram of body weight are injected intravenously into a dog it will produce the symptoms of pyrethrum poisoning, and 6 to 8 milligrams per kilogram of body weight causes death.

Pyrethrum is used in destroying the parasites of plants as well as moths, vermin, fleas, and other insects on men and animals. J. Chevalier states that he has used it to kill ascaris lumbricoides in hogs, and tenia in dogs. He recommends doses of 10 milligrams of pyrethrin for children and 20 milligrams for adults given every 3 hours against tricocephalis, tenia, and ascarides. The eggs of these parasites are not destroyed.

Ginsburg (Journal of Agricultural Research, vol. 40, pp. 1053 to 1057, 1930) states that the essential oils of pyrethrum are harmless to insects. It is only the nonvolatile substances, pyrethrin I and II which are active. The chemical activity of pyrethrum is determined by its action on insects such as aphids, caterpillars, fleas, bugs, ants, beetles, flies, and cockroaches.

The flowers used in the factory examined are grown in Japan, and are commonly known as Japanese insect flowers. They are dried and pressed into bales in Japan and shipped to the factory. Here they are ground and extracted with a petroleum distillate in totally enclosed machinery so as to minimize contact with the workers. To this distillate extract are added: "camphor-sassafrassy", methyl-salicylate, and traces of other compounds, the result being a powerful insecticide, the strength of which is standardized by testing on insects. A similar extract of pyrethrum flowers made with a heavier petroleum distillate, and di-ethyl phthalate is made to use as a cattle spray to repel flies.

When the plant first began to manufacture these substances, there were a comparatively large number of cases of dermatitis occurring among the workers handling it, 20 cases seeking relief in the dispensary in the first 2 years. The method of handling has since been improved so that now only those who fill the cans and put tops on them are exposed to splashings from the liquid.

In the present examination of the workers in the plant, two new cases of dermatitis were found. Patch tests were done on both, and one was found to be negative when patched with the ingredients of the insecticide, and the skin condition which she had was diagnosed as acne vulgaris of the face and back. The other case was found to react to patches of the insecticide and the cattle spray. Further patching with the ingredients of the insecticide and the cattle spray showed that he was markedly sensitive to the Japanese insect flower,

and only mildly sensitive to kerosene and the heavier petroleum distillate, but not sensitive to the other ingredients. The history of this case is as follows:

The man, 43 years of age, has worked in the plant for 2 years, the last year as a foreman. Five months ago, after handling various solvents, the insecticide, and the cattle spray, he developed an erythematous, vesicular, scaly, crusting eruption on his fingers and his hands, which later spread to his arms, his face, and his legs. It was accompanied by severe itching and burning. He was given various soothing applications with no improvement, and was finally taken away from contact with the chemicals, and from that time began to improve. At the time he was seen he still had an erythematous, scaly eruption on his hands and his face which he stated became worse when he went near the insecticide and the cattle spray.

Patch tests were made on the skin of his back with six substances which he handled: (1) the insecticide, (2) the cattle spray, (3) alcotate, (4) kerosene, (5) methyl-salicylate, (6) antifreeze. The patches were left on for 72 hours, at the end of which time there were marked reactions consisting of erythema, oedema, and vesicles under the insecticide, and cattle spray patches. There were no reactions under the other patches, but 48 hours after their removal there developed an erythema at the sites of the alcotate and kerosene.

In order to determine which of the ingredients of the insecticide and the cattle spray were the causes of the reaction, he was patched a few days later on clear portions of the skin with: (1) Japanese insect flower, (2) oil of sassafrassy, (3) isopropyl alcohol, (4) heavy petroleum distillate, and (5) di-ethyl-phthalate. The patches were on for 48 hours, at the end of which time there was an area of erythema, oedema, and vesiculation under the patch of the Japanese insect flower, an erythema under the heavy petroleum distillate patch, and no reaction under the other patches. This man was markedly hypersensitive to the Japanese insect flower and mildly hypersensitive to petroleum distillate. It is worthy of note that during the period of conducting the patch test the eruption on the hands and face spread and became more severe.

There probably occurred more than the 20 cases of dermatitis that reported for treatment to the dispensary during the 2 years, because many mild cases do not report for dispensary treatment. On the other hand it is a fact that whenever a chemical, which is found to be irritating to the skin of some workers, is used in a plant, there is a tendency to attribute to the action of that chemical all of the skin eruptions occurring among the workers. That this happened in some of the cases in this plant is shown by the negative results

of the patch tests in the first case mentioned, where a girl thought that her skin eruption was due to contact with the insecticide, whereas it was acne vulgaris.

Eighteen workers who had dermatitis are still working in the factories in contact with the insecticide. Some of them are no longer troubled with dermatitis, showing that they have developed an immunity to the insecticide, or that the original diagnosis of dermatitis due to the contact with the insecticide was wrong. The others are only occasionally bothered by a mild recurrence of the dermatitis. Two of the girls who had dermatitis and are still working in the factory have been removed to other parts of the building, because, whenever they work in the room in which the insecticide is prepared they develop a dermatitis.