CONTACT ECZEMA CAUSED BY TRUE TEAK (*TECTONA GRANDIS*)

AN EPIDEMIOLOGICAL INVESTIGATION IN A FURNITURE FACTORY

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An epidemiological study of occupational contact eczema in a furniture factory is presented. The localization, distribution, and clinical features of the skin lesions were characteristic of contact eczema caused by a sensitizing or irritating dust. True teak—*Tectona grandis*—was the cause of the skin condition.

That teak is a fairly potent sensitizer and also contains primary irritants is fully confirmed by the present study. About half the employees who were heavily exposed to teak dust suffered from eczema and/or severe itching. Only 8% of those with slight exposure to teak dust experienced skin symptoms.

Patch tests with native teak dust moistened with water were applied on 10 "controls" and 112 workers who were exposed to teak in various working procedures. Moistened teak dust produced toxic reactions in 20.5%, while native teak dust did not have primary irritant effects and was, therefore, considered to be the substance of choice for patch testing; 18.7% of the workers showed an allergic skin reaction to native teak dust. The diagnosis of allergic contact eczema was made in 12.5%, and 6.2% were considered to have latent allergy. Primary irritant (contact) eczema was considered to be present in four individuals who had experienced acute, transitory, eczematous eruptions during the hot part of the summer when they perspired freely. In these cases the patch test to native teak dust was negative. Desensitization or "hardening" was observed in four workers. In most cases the skin lesions were not severe enough to cause sickness absence.

The cause of the relatively high percentage of sensitization to teak among the workers in the factory is discussed. The importance of suitable prophylactic measures is stressed.

Occupational contact eczema caused by true teak is well known. The first report of skin eruption attributed to teak appeared in England (Evans, 1905). Later the Germans became interested in this problem (Hoffmann, 1926, 1928; Touton, 1929), and extensive investigations were reported by Hoffmann. In the published work there has been considerable confusion concerning the designation of the different wood species. This makes it difficult to compare the various reports. Botanically quite different wood species may go by the same name owing to resemblance in general appearance, hardness, and other similar qualities. On the other hand, botanically identical wood species may have different trade names derived from place of growth, harbour of shipment, and so forth (Touton, 1929; Schulz, 1957). The designation "teak" is no exception in this respect (Table 1).

TABLE 1

Trade Name	Botanical Species	Botanical Family
Burma-teak Moulmain-teak Rangoon-teak Siam-teak Bangkok-teak Java-teak, djati	<i>Tectona Grandis</i> (True-teak)	Verbenaceae
Other so-called "teak" woods		
African teak African teak Kambala, Iroko Australian teak Brazilian teak or vacapou-wood Tropic teak or maria-teak Peroba de campo Goomar-teak Native teak Moah-wood Dua-teak	<i>Oldfieldia Africana</i> <i>Pterocarpus Erinaceus</i> <i>Chlorophora Excelsa</i> <i>Endiandra Glauca</i> <i>Andira Excelsa</i> <i>Aspidosperma Macrocarpon</i> <i>Aspidosperma peroba</i> <i>Gmelina Arborea</i> <i>Flidersia Australis</i> <i>Afrormosia Elata</i>	Euphorbiaceae Leguminosae Moraceae Lauraceae Leguminosae Apocynaceae Apocynaceae Verbenaceae Rutaceae

Abstract from Bergquist and Rundberg (1942).

True teak—*Tectona grandis*—comes from Siam, Burma, and neighbouring countries, while the other so-called “teaks” come from various places in Africa, Australia, and South America. For example, “Dua-teak”—*Afrormosia elata*—is a West-African timber commonly used in place of true teak, but it is of a quite different botanical species. The actual wood involved should therefore be botanically classified when considering these problems. Extracts of true teak have been examined by a number of workers to determine the causes of its resistance to wood rot, fungi, and termites; they have been shown to contain a complex mixture of substances including tectoquinone (2-methylanthraquinone) and two, possibly three, related anthraquinones, lapachol, 2-methoxytoluene, 2-iodobenzoic acid, n-heptylamine, butyric acid, tectol, dehydrotectol, and a *cis* 1-4 polyisoprene (Kafuku and Sebe, 1932; Dhamachari, 1957; Pavanaram and Row, 1957; Sandermann and Dietrichs, 1957; Rudman, Da Costa, Gay, and Wetherly, 1958; Rudman and Da Costa, 1959; Sandermann and Dietrichs, 1959; Rudman, 1960).

The problem of which substance or substances in teak have the sensitizing or irritating properties has not yet been fully investigated. Schulz (1961) applied patch tests with some of the known constituents of true teak (tectoquinone, lapachol, tectol, and dehydrotectol), isolated by Sandermann and Dietrichs (1959), on four individuals who were sensitized to true teak. He found an allergic reaction in three cases when lapachol was used as the test substance. Further investigations are needed to confirm these results. There is no reason to believe that lapachol is the only substance that may act as a sensitizer. It is also interesting to note that members of the *Tabebuia* genus, such as “green-heart” also contain lapachol (Sandermann and Dietrichs, 1957; Rudman, 1961, personal communication).

During the past decade teak has come more and more into fashion in the Scandinavian countries as the wood of choice in the furniture trade, resulting in an increasing number of occupational dermatoses.

Method

The investigation was undertaken at the request of the management of a furniture factory. Skin complaints which were believed to be occupational had occurred among the employees. The occurrence of skin diseases was discussed with the factory superintendent and the industrial medical officer. A list of the raw materials used and the products manufactured was obtained. The workers who were thought to have occupational skin disease were examined and questioned to check and evaluate the criteria of the diagnosis. Accompanied by a foreman who was familiar with the processes undertaken, the

working conditions of the employees were inspected. Production takes place in a large, well-ventilated set of rooms with exhaust ventilation on the wood-working machinery that creates dust. Particularly dusty processes were carried out in separate rooms. Daily cleaning and regular thorough cleaning had been carried out at frequent intervals as a routine for a long time. No properly designed protective clothing was in use. There were no wash-hand basins in the workrooms, but shower baths were available for use after work. During the past four to five years two tropical wood species—“Siam-teak” and “Dua-teak”—had been used increasingly in the factory. “Siam-teak” was botanically determined as true teak—*Tectona grandis*—while “Dua-teak” was found to be an entirely different wood species—*Afrormosia elata*. A pilot study revealed that the cause of the skin complaints was the so-called “Siam-teak”, from here on named *teak* only. Other possible primary irritants or potent sensitizers such as other wood species, lacquers, and glues were excluded by patch testing.

Material

There were 156 employees, all males, of whom 112 were to a varying extent exposed to teak during different working procedures. The workers had been employed in the factory for an average of 18 years, varying from one to 40 years. The average age of the workers was 44 years. All the workers who presented skin manifestations or who had previously experienced skin complaints had been employed in the factory during the past four to five years, *i.e.* as long as teak had been increasingly in use. The duration of exposure from the first occupational contact with teak until skin complaints became manifest varied from one week to two years. All the 112 workers were examined for skin lesions, and were interviewed about previous skin complaints. Patch tests were applied both with fresh native teak dust and dust moistened with water. The patch tests were carried out in the usual way and applied on the volar side of the left forearm. The teak dust was collected in a small container directly from the machines. The container was immediately sealed to avoid evaporation of possibly volatile substances.

Results

Table 2 is based on the history and clinical examination. Six workers presented with erythematous, papular, desquamating eruptions on the face, especially around the eyelids, and also on the hands, forearms, wrists, around the beltline, and in the groins. All cases had the appearance and dis-

tribution of a contact eczema resulting from dust. During the previous week the workers had been operating machines producing teak dust. Twenty-five workers who had previously been exposed to teak dust experienced eczematous eruptions with much the same location and distribution and/or severe itching. None of these cases was severe enough to cause sickness absence. Four workers had previously experienced severe attacks of vesicular and weeping eczematous flare-ups, especially marked on the backs of the hands, on the forearms, and on the face, whenever they were exposed to teak dust. The flare-ups had gradually become worse, necessitating complete avoidance of teak. They have since remained free of skin complaints. The remaining 77 workers had never suffered from any skin complaint attributable to their occupation. Non-occupational dermatoses due to varicose ulcers and seborrhoeic eczema were observed in four cases.

Table 3 illustrates the relation between the different industrial processes and the frequency of skin complaints. The highest incidence of skin conditions was found among workers exposed to dust consisting of minute particles of teak. The machines that hurled teak particles with great force towards the worker seemed to be particularly involved. About half the workers (31 out of 60) who were occupied in sandpapering either by hand or with special machines, in sawing, in turning and the like, had some skin complaint attributable to teak. Workers

TABLE 2
RESULT OF EXAMINATION AND HISTORY-TAKING OF
112 WORKERS EXPOSED TO TEAK

	Number
Contact eczema on clinical examination	6
History of previous eczematous eruption and/or severe itching on exposure to teak dust	25
History of previous severe flare-ups whenever they were exposed to teak dust; changed jobs	4
Subtotal	35
Workers without skin complaints	77
Total	112

Four workers had non-occupational dermatoses

who had only slight contact with teak dust were much less affected. Only four out of 52 workers in this group presented symptoms or signs which could have been caused by teak. This is in agreement with the findings of others who have studied this problem.

The results of the patch testing are given in Table 4. All cases recorded as contact eczema were considered to be occupational, resulting from exposure to teak. In these cases there had been close correspondence between the presence of the eruptions and the exposure to teak. Except for the six men who had contact eczema when examined, the diagnosis was made on a retrospective analysis of the cutaneous lesions and the history; hence no differentiation has been made between allergic and primary-irritant contact eczema. The patch tests

TABLE 3

RELATION BETWEEN DIFFERENT WORKING PROCEDURES AND FREQUENCY OF SKIN COMPLAINTS

Working Procedures	Eczematous Eruptions	Itching	Sub-total	No Skin Complaints	Total
Sandpapering (hands, machines)	7	10	17	11	28
Machine work: sawing, turning, etc.	9	5	14	18	32
Sub-total	16	15	31	29	60
Joining, finishing, packing, shipment	2	2	4	48	52
Total	18	17	35	77	112

Four workers with eczema had conjunctivitis simultaneously

TABLE 4

RESULT OF PATCH TESTS WITH NATIVE DUST AND TEAK DUST MOISTENED WITH WATER

Clinical Category of Workers	Number	Moistened Teak Dust			Native Teak Dust		
		Allergic	Toxic	Negative	Allergic	Toxic	Negative
Contact eczema	18	12?	6	0	14	0	4
Severe itching	17	1?	5	11	2	0	15
Sub-total	35	13?	11	11	16	0	19
No skin complaints	77	5?	12	60	5	0	72
Total	112	18?	23	71	21	0	91

TABLE 5

RESULT OF PATCH TESTS AND RETESTING ON 10 NURSES AFTER FOUR WEEKS WITH NATIVE TEAK DUST AND TEAK DUST MOISTENED WITH WATER

Control Number	First Application		Re-application Four Weeks Later	
	Fresh Moistened Teak Dust	Fresh Native Teak Dust	Four-week-old Moistened Teak Dust	Four-week-old Native Teak Dust
1	Toxic (IV)	Negative	Toxic (II-III)	Allergic
2	Toxic (IV)	Negative	Toxic (I)	Negative
3	Toxic (IV)	Negative	Toxic (III)	Negative
4	Toxic (IV)	Negative	Toxic (II)	Allergic
5	Toxic (II)	Negative	Negative	Negative
6	Toxic (I-II)	Negative	Negative	Negative
7	Toxic (I-II)	Negative	Negative	Negative
8, 9, 10	Negative	Negative	Negative	Negative
Sum: 10	7 Toxic	10 Negative	4 Toxic	2 Allergic

were applied for 24 hours and read at the end of this period and read again after 48 and 72 hours. The interpretation of the patch tests was based on the usual criteria, and was recorded as allergic, toxic, or negative. Precautions were taken to avoid false positives and false negatives. False positives were observed in five cases, probably due to a pressure effect. These are not recorded in the Table.

In patch tests with native teak dust no toxic reaction was recorded. In 14 workers who presented, or who had previously suffered from eczematous eruptions, allergic reactions were observed, indicating allergic contact eczema. The remaining four individuals in the contact eczema group gave negative reactions to native teak dust. These workers had previously experienced eczematous flare-ups on exposure to teak. They volunteered the information that, in spite of continued exposure, their skin lesions had gradually diminished, and they were now able to work with teak without inconvenience. Allergic reactions to native teak dust were also observed in two cases with severe itching as the only symptom on exposure, and in five workers without any skin complaint at all. These workers were considered to have a latent allergy. In the remaining 15 workers who suffered from severe itching the symptom may perhaps be ascribed to the mechanical effects of the dust.

The evaluation of the patch tests applied with moistened teak dust was complicated by the fact that the test substance in this state behaved both as an allergen and as a primary irritant. Hence, the results have no validity for hypersensitivity to teak. The allergic reactions in this group are recorded in Table 4 with an interrogation mark indicating the difficulty in interpretation. Several of these reactions were considered to be a combined toxic-allergic reaction type. Nevertheless, the results are recorded in the Table in order to show the number of definite toxic reactions. The results

are of some interest, from a practical point of view. Toxic reactions were registered in 23 cases. This total represents a minimum of the possible toxic reactions. Four workers in this group had suffered acute, transitory, eczematous eruptions during the hot part of the summer when they perspired freely. The history in these cases, together with the negative reaction to native teak dust, may indicate contact eczema due to primary irritant(s) in teak.

A definite allergic reaction when tested with native teak dust, indicating sensitization to teak, was recorded in 21 (18.8%) of the workers tested. Nearly 50% of the workers with skin complaints (eczema and/or itching) were sensitized. A diagnosis of allergic contact eczema was made in 14 cases (12.5%). Seven (6.3%) were considered to have a latent allergy and these workers were little exposed to teak dust. Probably a more massive exposure might provoke some allergic manifestation.

Table 5 illustrates the result of patch testing by the same technique on 10 nurses used as "controls". The testing was repeated after four weeks using teak dust which had been kept unsealed. The grading I-IV was used to make quantitative comparisons possible. The patch tests with native teak dust were all negative at the first application. An allergic reaction was recorded in two cases when retested. Using moistened teak dust, toxic reactions were registered in seven cases, and four of these were of the bullous type. On repetition four weeks later, the toxic reactions had diminished, and in three cases they had disappeared. No bullous reaction was recorded.

Discussion

Teak is one of the tropical wood species that causes occupational contact eczema. Workers heavily exposed to teak dust become sensitized. The wood as such and the manufactured furniture are not important in this respect. The different skin complaints among the workers who are exposed to

teak dust may be ascribed to the following factors: 1. The mechanical effect of the dust; 2. the primary irritant (toxic) effect, especially when in moistened condition, and 3. sensitization eruptions.

The fact that teak may act as a fairly potent sensitizer is most important, and is fully confirmed by the present study.

The fractionation and extraction of the different constituents in teak are difficult and complicated and must be performed by specialists in this field. The author has received samples of some of the chemical compounds extracted from teak. The sensitizing and irritating properties of these substances are now being studied, and the results will be reported later.

The only previous epidemiological investigations on occupational contact eczema due to teak, which I have been able to trace, are those of Hoffmann (1926, 1928). This author applied patch tests with teak dust, shavings, and various extracts. No differentiation was made between allergic and toxic reactions. There is reason to believe that in most cases the reactions observed might have been toxic. Thus Hoffmann reported that 62% of his controls gave positive reactions, indicating a high proportion. It, therefore, seems impossible to compare my findings with those of Hoffmann. My investigation strongly suggests that native teak dust is the test substance of choice in order to establish a causal relation and consequently the diagnosis of allergic contact eczema. If moistened with water, teak dust may act as a primary irritant, presumably due to water-soluble substances which render it useless as a test substance.

The control group is small and selected. In addition, the toxic reactions may vary considerably when repeated at intervals in the same person. The results in the control group do, however, suggest the presence in teak of volatile irritants.

Experience shows that desensitization as well as sensitization can occur in industry. Development of immunity or "hardening" from industrial exposure has been reported (Witkowski, Fischer, and Murdock, 1942; Schwartz, 1944; Peck, Gant, and Schwartz, 1945; Tolmach, 1947; Schwartz, Tulipan, and Birmingham, 1957), but some investigators do not believe that such a phenomenon occurs (Hall, 1944; Osborne, 1954). In the present study four workers appeared to have become "hardened". "Hardening" may be dependent on several factors, such as the degree of sensitization in relation to the degree and duration of exposure. Each case must be considered individually before deciding whether the worker should be kept on his work, with the hope that immunity will develop, or whether he should be taken off his job immediately.

Recommendations

The management of the factory was informed of the general principles of protection against dust. Because of the relatively high percentage of sensitization to teak in the factory, certain specific improvements were recommended. Attention was called to the exhaust ventilation system which, during the past few years, had been overloaded. New machinery had been installed without increasing the capacity of the exhaust ventilation system. Suitable protective clothing was recommended, and the importance of cleanliness was stressed. The workers generally had omitted daily shower baths after work because there were too few showers to permit bathing in reasonable time. It was recommended that sufficient shower baths should be provided and that the workers should be compelled to use them. In future, new applicants for work will be carefully examined and questioned, and those having predisposing skin conditions will not be employed. The worker will be instructed in detail regarding the nature of his work and its hazards, and the importance of the different prophylactic measures will be explained to him.

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REFERENCES

- Bergquist, G., and Rundberg, G. (1942). *Nord. Hyg. T.*, **22**, 205.
 Dhamachari, B. (1957). *Vanasarn*, **15**, 27, cited by P. Rudman (1960).
Chem. and Ind., **44**, 1356.
 Evans, W. (1905). *Brit. J. Derm.*, **17**, 447.
 Hall, A. F. (1944). *J. Amer. med. Ass.*, **125**, 179.
 Hoffmann, H. (1926). *Med. Klin.*, **22**, 352.
 — (1928). *Derm. Z.*, **53**, 293.
 Kafuku, K. and Sebe, K. (1932). *Bull. chem. Soc. Japan*, **7**, 114.
 Osborne, E. D. (1954). Cited by Goldsmith, W. N. and Hellier, F. F.
Recent Advances in Dermatology, 2nd ed. Churchill, London.
 Pavanaram, S. K. and Row, L. Ramachandra (1957). *J. sci. industr. Res. (India)*, **16 B**, 409.
 Peck, S. M., Gant, J. Q., Jr., and Schwartz, L. (1945). *Industr. Med.*, **14**, 214.
 Rudman, P. (1960). *Chem. and Ind.*, **44**, 1356.
 —, and Da Costa, E. W. B. (1959). *J. Inst. Wood Sci.*, **3**, 33.
 —, Gay, F. J., and Wetherly, A. H. (1958). *Nature (Lond.)*, **181**, 721.
 Sandermann, W., and Dietrichs, H.-H., (1957). *Holz a. Roh-u Werkst.* **15**, 281.
 —, —, (1959). *Holzforschung*, **13**, 137.
 Schulz, K. H. (1957). *Berufsdermatosen*, **5**, 238.
 — (1961). Personal communication.
 Schwartz, L. (1944). *Ann. Allergy*, **2**, 387.
 —, Tulipan, L., and Birmingham, D. J. (1957). *Occupational Diseases of the Skin*, 3rd ed. Lea and Febiger, Philadelphia.
 Tolmach, J. A. (1947). *J. Allergy*, **18**, 179.
 Touton, K. (1929). *Naturwissenschaften*, **17**, 371.
 Witkowski, L. J., Fischer, C. N., and Murdock, H. D. (1942). *J. Amer. med. Ass.*, **119**, 1406.