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An investigation into the health of kapok workers

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ABSTRACT Kapok is a cotton-like fibre obtained from the fruits of *Ceiba pentandra*, a tree grown in tropical countries. In Sri Lanka ginning of kapok is usually done by machine in poorly ventilated buildings where workers are exposed to a great deal of dust. Forty-one workers in five ginneries in Colombo were examined. Mill fever occurred in 28 (77·8%) of the 36 workers who were able to give a history. Chronic bronchitis, which is an uncommon condition in Sri Lanka, was detected in seven workers with an average of 20·9 years' service in the industry. It is suggested that chronic bronchitis is an occupational hazard of workers who are exposed to kapok dust for long periods. Byssinosis was not found in any of the workers studied.

Kapok is the fibre obtained from the fruits of the tree *Ceiba pentandra*. It is a commercially important vegetable fibre but its effects on those who work with it have not been well documented. In the only reference that could be traced, Egtabaeng (1971) attributes a wide range of pulmonary diseases to kapok, namely asthma, acute and chronic bronchitis, emphysema, bronchopneumonia, fibrosis and bronchiectasis, but no evidence is presented in support of this assertion. The present investigation was undertaken in order to elucidate the pathogenicity if any, of kapok dust.

Kapok is rather like cotton in appearance but is yellowish rather than white, and is lustrous. The fibres are very light, only a sixth of the weight of cotton. Their ability to repel water is attributable at least in part to the waxy cutinous covering of the fibres. They retain their buoyancy even when left in water for weeks. These qualities make kapok suitable for use in life saving equipment such as life belts and life jackets (Kirby, 1963).

Kapok is widely used for stuffing pillows, mattresses and cushions. In recent years synthetic material has been increasingly used for this purpose, and therefore the demand for kapok in the world market has declined. Nevertheless, kapok has the advantage over other filling materials that a lesser weight of kapok is sufficient for the same purpose.

The low thermal conductivity of kapok makes it useful for insulation. It is one of the best sound absorbers per unit weight and is used for this purpose in aircraft where its lightness is an added advantage.

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Ceiba pentandra grows in tropical countries such as Thailand, the Philippines, Indonesia, India, Sri Lanka and East and West Africa. In Sri Lanka it thrives chiefly in the central hills up to an altitude of 1000 metres. The green pods turn black on ripening. At this stage if the pods are allowed to remain on the trees the husks burst and the fibre is dispersed by the wind. Such a loss of fibre is forestalled by plucking the pods before they burst, and then drying them. Pickers who climb trees for this purpose are exposed to the risk of accidental falls because the branches are very fragile.

The spindle-shaped pods are about 15 cm in length and 5 cm in diameter at the centre. When the outer husk is removed balls of fibre, each arranged around a central pepper-like seed, are exposed. These fluffy balls are disposed around a central fibrinous core.

Fruits mature at different times, and therefore the harvesting season is spread over many months. The pods are husked manually and delivered to dealers at collecting centres in the kapok-growing areas. The husked kapok is then packed in bags and transported to ginneries in Colombo.

GINNING

Ginning may be manual or mechanical. The proportion of impurities in hand-cleaned kapok may be as high as 5% and therefore the demand for it is negligible and ginning by machine is preferred, where impurities do not exceed 2%. During ginning only a third of the material is realised as clean kapok, the remainder comprising seed and core. It is estimated that 100 pods yield 0·5 kg of cleaned fibre.

There are five ginneries in Colombo, each equipped with one or two machines. Each electrically powered machine is capable of ginning 275-550 kg of kapok a day, depending on its size. A machine consists essentially of a large cylindrical cage mounted over a pit a metre deep in the ground. The wall of the cage is constructed either of metal sheet or closely knit wire mesh. On a central vertical metal axis running lengthwise through the cage are mounted a pair of horizontal iron rods at the bottom, and above them a series of three to six pairs of fan-like blades equidistant to each other.

The kapok that is to be cleaned is fed into the machine through a vent on its side. When the axis rotates at high speed the steel rods at the bottom break up the pods; the fluff that separates is propelled upwards by the action of the fans into a wide duct at the top of the machine, which conveys the cleaned kapok into an enclosed cubicle. Kapok seeds, unlike cotton seeds, are not attached to the fibre and therefore their separation from the fibre is easier than with cotton. The seeds and cores fall into the pit in the ground through perforations at the base of the machine. These are removed at intervals from the pit via an approach trench. The seeds, from which an oil is extracted, are subsequently separated from the core by passing the mixture through a sieve. The cores are collected and stored in bags to be reginned later.

The machine is stopped from time to time and the cleaned kapok collected from the cubicle. In order to conserve shipping space the fibre is then mechanically compressed into rectangular bales. Excessive pressure during this process may adversely affect the elasticity and other properties of kapok. Each bale which should weigh either 1·25 or 1·5 cwt (64 or 76 kg) is wrapped in jute cloth and fastened with hoop iron prior to export. In 1975 Sri Lanka exported 340 900 kg of kapok chiefly to Japan, Australia and the United Kingdom.

The ginneries are situated in a very congested commercial sector of Colombo. They are located in old buildings without any special provision for ventilation. A ginnery may consist of one large hall which provides common space for all the activities concerned with the trade. The machine is at one corner, while considerable space is allocated for storage of bags of both cleaned and uncleaned kapok. In a couple of ginneries the storage space may be separate from the ginning area but there is free communication between the two.

Each ginnery employs six to 15 workers each of whom is expected to perform any type of work connected with ginning, namely feeding the machine with kapok pods, collecting and bagging cleaned kapok, sifting the seeds from the cores, and bagging and storing them. All the workers are therefore equally exposed to kapok dust. Hardly any dust escapes from the machine itself, but during the other processes much fibre is released into the atmosphere of the ginnery which is visibly laden with it.

The workers are expected to work for eight hours daily from Monday to Friday, while Saturday afternoon and Sunday are free. The work in the ginneries usually starts with the beginning of the harvesting season in April. There is sufficient work for about nine months after which most of the workers in the industry are laid off. When the harvesting season is over and there is a dearth of pods, the stored cores to which some residual fibres adhere are run through the machine again in order to obtain a coarse and cheap fibre. This fibre, which is not fit for export, is brownish and contains large amounts of fine dust derived from the fibrinous core. Although the workers are kept occupied well beyond the close of the harvesting season they are exposed to more dust than with the standard kapok.

Subjects and methods

Forty-one workers who comprised the entire labour force of the five ginneries in Colombo were admitted to the study. Thirty-eight were labourers who handled kapok while the remaining three were a supervisor, a clerk and a machine operator respectively. The latter were included in the study as they worked with the others in the same building and were therefore subject to the same environmental conditions. An occupational history was obtained from each of them and was checked with the management as regards the period of employment. Each worker was questioned according to a questionnaire on respiratory symptoms based on that of the Medical Research Council (1960), modified to suit the local conditions and extended to include questions on byssinosis and mill fever. A clinical examination with emphasis on the respiratory system was carried out. A standard-sized postero-anterior radiograph of the chest was taken. Sputum examination by direct smear and culture for tubercle bacilli, white blood cell and differential counts and erythrocyte sedimentation rate determination were also done if necessary.

The first 21 workers were skin-tested with an antigen prepared from kapok and kindly supplied by Professor J. Pepys of the Cardiothoracic Institute, London. The prick test was carried out on the left forearm with two strengths of the antigen, namely 1 mg and 10 mg/ml in Coca's fluid. Sera from 14 workers were obtained at the same time for serological tests.

The symptomatic workers were recalled after one year and examined again.

Results

The majority of the workers were women (Table 1), their average age was 34·5 years, and their average period of service in the kapok industry 10·7 years. The eight workers with less than one year's service (Table 2) were the new recruits for the current season and represent a feature of the industry where an appreciable number constitute casual labour. Fourteen workers had over 10 years' service.

None of the workers had been employed in any other industry prior to joining the present one. The clinical picture was therefore not complicated by exposure to other noxious dusts.

Twenty-eight workers gave a history of mill fever which was defined as a trivial, self-limiting illness characterised by sore eyes, sneezing, mild pyrexia, muscular pains, cough or headache on initial exposure to dust. The frequency of these symptoms is shown in Table 3. They occurred either singly or in combination in the 28 workers who comprised 77·8% of the 36 subjects who were able to give a history. Four workers with long periods of service were unable to recall any symptoms they experienced at the beginning of their career, while another was deaf and therefore it was not possible to elicit a proper history.

These symptoms, the commonest of which involved the eyes, were self-limiting and mild except in the case of two workers who at the time sought outpatient treatment for eye symptoms and fever respectively. In all cases the symptoms occurred on the very first day of work and lasted for one to 14 days, the average being four days. In 12 workers the symptoms lasted only one day. None of the workers lost any working days on account of these symptoms.

Loss of weight was another initial symptom complained of by five (12%) of the workers. One of them was unable to give the actual extent of her weight loss but the remaining four had lost from one to nine kg. They regained their weight after a few months.

Chronic bronchitis was considered to be present when there was a history of cough and phlegm during most days for at least three months of at least one year. This condition was diagnosed in seven workers, six of whom were women. Bilateral rhonchi were heard over the chest in six workers. The average age of these workers was 49·4 years. At the time of the onset of symptoms they had worked in the kapok industry from 12 to 33 years, the average being 20·9 years. In two of the workers the symptoms were mild and did not interfere with their normal work, but the other five had to take days off because of illness. All those with chronic bronchitis were from one ginnery.

Table 1 *Age and sex distribution of the kapok workers*

Age group (years)	*Male*	*Female*	*Total*
10-19	0	5	5
20-29	1	8	9
30-39	2	13	15
40-49	1	3	4
50-59	1	6	7
60-69	1	0	1
Total	6	35	41

Table 2 *Period of service in the kapok industry*

Years of service	*No. of workers*	*Percentage of Total*
<1	8	19·5
1- 5	12	29·3
6-10	7	17·1
11-20	5	12·2
21-30	6	14·6
31-40	3	7·3
Total	41	100·0

Table 3 *Symptoms of mill fever and their frequency*

Symptoms	*No. of workers*	*Percentage of total*
Eye symptoms	20	48·8
Irritation	16	39·0
Redness	15	36·6
Lachrymation	13	31·7
Sneezing	16	39·0
Muscular pains	16	39·0
Fever or malaise	15	36·6
Cough	6	14·6
Headache	4	9·9

Three workers showed radiographical evidence of pulmonary tuberculosis but the lesions were found to be inactive clinically and bacteriologically. Two of them were known cases of pulmonary tuberculosis and had been treated at the chest clinic a few years previously. When the disease was first diagnosed they had already worked in the industry for 35 and 18 years respectively.

One worker was subject to asthmatic attacks but these had no apparent relationship to her work.

When the symptomatic workers were re-examined a year later there was no significant change in their clinical, radiographical and bacteriological status.

The prick test was negative in the 21 workers tested. The 14 samples of sera on which precipitin tests were carried out in Professor Pepys' laboratory did not show any reactions to extracts of raw and crude kapok or *Aspergillus fumigatus*. Seven samples reacted to *Micropolyspora faeni* antigen.

Discussion

The kapok industry in Sri Lanka engages a considerable number of workers in various processes ranging from cultivation to the point of its local utilisation or export, but the subjects who are most exposed to the dust are the ginnery workers. The very nature of their work as well as the poor ventilation in the ginneries render them a group which, though small in number, is most likely to exhibit adverse effects, if any, of exposure to kapok dust.

MILL FEVER

Mill fever is an acute, transient and trivial illness that occurs in new workers who are exposed to a variety of vegetable dusts such as cotton, hemp, flax, jute and grain (Doig, 1949). It is known as comber's fever in hemp mills, while in other industries it is called flax fever, grain fever and malt fever according to the type of material the workers handle. The incidence of mill fever in the kapok industry is perhaps higher than that in most of the other industries. Doig estimates that 25-50% of new workers in the flax industry suffer from mill fever.

Hunter (1975) stresses that mill fever in the cotton industry should not be confused with Monday feeling which is the first stage of byssinosis that occurs after more than 10 years' exposure to cotton dust. The symptoms of kapok fever, if one were to adapt the nomenclature used in other industries, are almost identical with those described by Gill (1947) in the cotton industry, namely sore eyes, sneezing, cough, mild pyrexia and headache.

Referring to mill fever in general, Hunter (1975) states that the symptoms may reappear following a period of absence from work which may be as short as two to four weeks. However, the symptoms of kapok fever did not recur when workers resumed work after being laid off during the off-season. Whether the initial attack of kapok fever confers immunity when the break in service is considerably longer is not clear, for in the present series there were no cases with such a long interruption. Hunter says that the aetiology of mill fever is not known. However, Davenport and Paton (1962) relate mill fever in cotton workers to pyrogenic substances found in cotton dust.

The symptoms of kapok fever are well recognised by both management and workers as an inevitable experience of workers on being initiated into the industry. It is usual for the senior hands to apprise new recruits of the likelihood of development of these symptoms, and to recommend treatment with aspirin.

CHRONIC BRONCHITIS

Chronic bronchitis is an uncommon condition in the general population in Sri Lanka. According to official statistics for the whole country the rate of hospital admissions for chronic bronchitis for 1974 was only 493 per 100 000 population. Its infrequency has been related to the low consumption of tobacco by smoking, as well as the relative freedom from atmospheric pollution in the country. The per capita consumption of tobacco in 1974 was as low as 1·79 lb (814 g). The occurrence of seven cases (17·1%) of chronic bronchitis in a small group of 41 workers is therefore epidemiologically significant.

Non-smoking is almost a cultural characteristic of women in Sri Lanka. A random survey showed that only 1·6% of 579 women were smokers (Uragoda and Senewiratne, 1971). The six women with chronic bronchitis were also non-smokers. The fact that these six non-smokers with long occupational histories should have developed chronic bronchitis enhances the probability of a causal relationship between exposure to kapok dust and chronic bronchitis.

It is relevant to inquire into the incidence of chronic bronchitis in other local spheres of employment where conditions of work are comparable. In a survey of 779 coir workers in Colombo only three cases (0·3%) of chronic bronchitis were detected (Uragoda, 1975). These workers lived under similar social conditions to the kapok workers and their average age and period of service in the coir industry were similar to those of kapok workers, 30·1 and 11·2 years respectively. The difference in the incidence of chronic bronchitis between kapok and coir workers is statistically significant ($\chi^2 = 89·9$).

In the present study all the cases of chronic bronchitis came from one ginnery which provided continuous employment to its workers by stocking sufficient kapok to last through the off-season. Uninterrupted employment was obviously an incentive to the workers to stay in the industry, for 11 of the 14 with over 10 years' service were employed in this ginnery. On the other hand the policy of the other ginneries in discontinuing workers during the off-season, though economically detrimental to them, apparently has the salutary effect of protecting them from chronic bronchitis.

A feature that was common to all workers with chronic bronchitis was their long service. The finding that 50% of the workers who had worked for a decade had developed chronic bronchitis suggests that it is a common occupational hazard of those who work for long periods in the very dusty atmosphere of the kapok ginneries. Lack of protective measures undoubtedly has a hand in this high incidence of chronic bronchitis. There is much room for improvement of ventilation at the ginneries.

Though masks are usually provided by the management workers are averse to wearing them.

TUBERCULOSIS

The incidence of pulmonary tuberculosis is known to be high in certain occupational groups, especially in those inhaling silica-containing dust. The presence of two known cases in a small group of 41 workers is more than would be expected in the general population. In the case of a comparable occupational group, coir workers, there were only nine such cases among 779 workers (Uragoda, 1975). The number of cases among kapok workers is too small to draw any conclusions, but a high incidence among them would not be surprising in view of the poorly ventilated conditions in which they work.

BYSSINOSIS

In view of the occurrence of byssinosis in workers handling some of the other vegetable fibres such as cotton, flax and soft hemp, and the similarity in appearance between cotton and kapok, it is pertinent to inquire whether the condition occurs among kapok workers too. However, close questioning failed to reveal its presence in these workers. All of them came under Group O of the classification of Roach and Schilling (1960) in that they had no symptoms of chest tightness or breathlessness on Mondays.

Reports from different countries and dealing with various categories of workers show a wide variation in the prevalence of byssinosis. Lammers *et al.* (1964) found a higher prevalence in English than in Dutch cotton workers, the probable reason being the higher level of atmospheric pollution in Lancashire. Kondakis and Pournaras (1965) did not find a single case of classical byssinosis in a study of cotton ginnery workers in Greece though they detected the condition in other categories of cotton workers. On the other hand, El Batawi (1962) found a prevalence of 38·4% in cotton ginnery workers in Egypt. In the light of such variation in its prevalence under different conditions, the failure to detect a case of byssinosis in a small group of kapok workers cannot be taken as conclusive evidence that kapok workers in general are free from the disease.

FARMER'S LUNG

It has been shown that farmer's lung is due to a reaction mediated by precipitating antibodies to *Micropolyspora* antigens. Although 50% of the sera tested showed precipitating antibodies to *M. faeni*, none of the workers concerned had symptoms of farmer's lung. The only symptoms they had in relation to their occupation were those of mill fever. Such a history was obtained not only from these seven workers, but also from the other seven whose sera did not show precipitating antibodies to *M. faeni* antigen.

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References

Davenport, A., and Paton W. D. M. (1962). The pharmacological activity of extracts of cotton dust. *British Journal of Industrial Medicine*, **19**, 19-32.

Doig, A. T. (1949). Other lung diseases due to dust. *Postgraduate Medical Journal*, **25**, 639-649.

Egtabaeng, U. (1971). In *Encyclopaedia of Occupational Health and Safety*, vol. 1, p. 749. International Labour Office: Geneva.

El Batawi, M. A. (1962). Byssinosis in the cotton industry of Egypt. *British Journal of Industrial Medicine*, **19**, 126-130.

Gill. C. I. C. (1947). Byssinosis in the cotton trade. *British Journal of Industrial Medicine*, **4**, 48-55.

Hunter, D. (1975). *The Diseases of Occupations*, 5th edition, p. 1024. English Universities Press: London.

Kirby, R. H. (1963). *Vegetable Fibres—Botany, Cultivation and Utilization*, p. 381. Leonard Hill (Books): London, and Interscience Publishers: New York.

Kondakis, X. G., and Pournaras, N. (1965). Byssinosis in cotton ginneries in Greece. *British Journal of Industrial Medicine*, **22**, 291-294.

Lammers, B., Schilling, R. S. F., and Walford, J. (1964). A study of byssinosis, chronic respiratory symptoms and vital capacity in English and Dutch cotton workers, with special reference to atmospheric pollution. *British Journal of Industrial Medicine*, **21**, 124-134.

Medical Research Council (1960). Standardised questionaires on respiratory symptoms. *British Medical Journal*, **2**, 1665.

Roach, S. A., and Schilling, R. S. F. (1960). A clinical and environmental study of byssinosis in the Lancashire cotton industry. *British Journal of Industrial Medicine*, **17**, 1-9.

Uragoda, C. G. (1975). A clinical and radiographic study of coir workers. *British Journal of Industrial Medicine*, **32**, 66-71.

Uragoda, C. G., and Senewiratne, B. (1971). Tobacco smoking in Ceylon. *Journal of Tropical Medicine and Hygiene*, **74**, 145-147.