Journal of Epidemiology and Community Health, 1981, **35**, 1–4

Mulberry tussock moth dermatitis
A study of an epidemic of unknown origin*

SU DE-LONG
From Shanghai First Medical College, People's Republic of China

In July 1972, clinics of rural communes and factories on the south-eastern outskirts of Shanghai city and in suburban counties suddenly became overcrowded with dermatitis patients. The main symptoms and signs of the disease were sudden onset of eruptions (chiefly papules) with almost unbearable itching, but no pain, over the uncovered part of the body surface and sometimes also those parts covered by the underwear or diaper. The face was usually free. No fever was noticed. Most of the rash subsided gradually in three or four days or longer. Apparently the skin lesions did not respond to any available remedy, including antihistamine preparations. The whole course of this epidemic, which waxed and waned, lasted for about three and a half months. The total number of victims was estimated to be no less than 500 000 people. So it was not a minor problem.

The clinicians were greatly puzzled at the sudden and simultaneous appearance of an enormous number of similar cases of unknown origin, distributed over vast areas inhabited by no less than 2 000 000 people. They were also frustrated in the attempt to treat them one by one. They wondered if they could get to know the cause of the disease.

An ad hoc study group was soon organised by the municipal health authorities, composed of internists, dermatologists, parasitologists, entomologists, and epidemiologists. The combined multidisciplinary effort showed remarkable effect in this study. The 16 members of the study group worked as one.

The first problem was how to get the investigation started. At the beginning, we carefully took a medical history of each case. However, we soon discovered that this 'routine' clinical procedure could not possibly lead to the solution of the problem. We performed a biopsy of the skin lesion in only one case, a member of our study group. It offered us not the slightest idea of the cause of the disease. We then decided to start with a survey of the workers of a shipbuilding plant, because the dermatitis was quite a problem there, and the population and subpopulations of the plant were well-defined. Furthermore, the factory workers were well-organised and disciplined. Sampling surveys and follow-up work would thus be facilitated. One thousand and eighty-eight persons were selected at random from different workshops. The attack rate of dermatitis was 51·1%: 52·8% among the men and 45·6% among the women. The attack rates of the men and women welders and blowtorch operators were significantly lower than those of the other workers (men $\chi^2 = 10{\cdot}433$; $p < 0{\cdot}01$; women $\chi^2 = 5{\cdot}52$; $p < 0{\cdot}02$), while the attack rates between the welders and the blowtorch operators were quite close.

Since we noticed the significant difference in attack rates between different groups of people, we did not lose sight of this fact but took advantage of it, pursuing the cause of the difference. We immediately made a spot coverage and observed carefully. We found that the only difference in condition between the welders and blowtorch operators and the other workers was that the former wore thick overalls which covered them almost completely. This fact started us considering that the aetiologic agent of this dermatitis could be airborne, transmitting the condition to persons by direct contact.

In order to prove this speculation, we selected many residential areas with different degrees of windiness in the city and suburbs to study the connections between the amount of wind and the prevalence of this dermatitis. The prevalence was expressed in term of attack rates of the whole of the villagers or random samples of them. The identification of the dermatitis cases in the outbreak presented little difficulty.

The data obtained showed that there was a weak correlation between the amount of wind and the prevalence of dermatitis, but further studies in many different circumstances did not uniformly confirm this conclusion. The prevalence of dermatitis was not always higher in regions with stronger wind and might be markedly different in regions with similar amounts of wind.

Although the aetiologic agent of dermatitis was apparently airborne, the pursuit of the necessary cause was of paramount importance.

*Paper presented to an International Workshop in Clinical Epidemiology, Churchill College, Cambridge, 21 September to 10 October 1980.

What, then, was the necessary causal agent of this dermatitis? It should be approached from an ecological perspective. 'Contact dermatitis' is a loose term and can be caused by many agents, some of which can, however, be ruled out without much difficulty. At the beginning of the study, there were many conjectures, which were soon excluded after careful examinations. One supposition was that the dermatitis might be caused by hair or pollen of vegetable origin. However, the biology department of Fu Dan University gave a negative conclusion after their studies. There were few nettle plants in Shanghai.

Clinically it couldn't be excluded that this dermatitis was induced by insect bites or irritation. Therefore we made many studies along these lines.

However, in areas where the dermatitis was prevalent, there was no extraordinary occurrence of the biting insects such as bedbugs, fleas, mosquitoes, midges, or black gnats; besides, the harm, if any, caused by these biting insects had no relation to the degree of wind.

We also examined the mites recovered from a large sample of bedding in these areas and found that they did not bite man, nor did they produce any experimental dermatitis. Moreover, the presence or absence of mites in beds did not correspond to the occurrence or absence of the dermatitis.

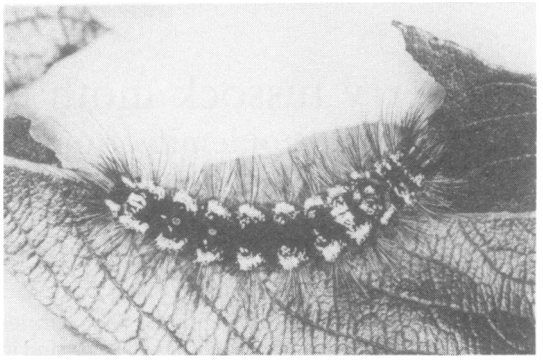
Since it had long been known that the larvae of many kinds of moths could cause dermatitis in man, we paid special attention to them.

We surveyed a number of moths notorious for being able to cause dermatitis in man, such as *Cnidocampa flavescens, Euproctis flava* Bremer, *E. pseudoconspersa* Strand, *E. chrysorrhoea* Linnacus, *E. similis* Fuessly, and its ecological subspecies *E. Xanthocampa*. With the single exception of *E. similis*, all were disregarded, both because of the dissimilarity between the clinical picture of the skin lesions produced and those with which we were concerned, and because of their scarcity in Shanghai.

Then we tracked down one of the most suspicious insects, *Euproctis similis* Fuessly, by following clues. We went a step further.

According to our survey, there was a great increase in the *E. similis* population in Shanghai in 1972. In all 25 residential foci visited by us, the majority of the trees were infested with these larvae. Hence, we concentrated upon *E. similis* larvae to study the factors involved in causing dermatitis and resulting in an epidemic.

How did the *E. similis* larvae in the tree produce skin lesions in men and women on the ground? From an old report[1] we know that a pruritic rash can be produced by the sting of the hair of a certain type of caterpillar. The larva of *E. similis* has several kinds of



Larva of Euproctis similis Fuessly.

Reproduced by permission of the Trustees of the British Museum (Natural History).

hair. Is there any specific type of hair which causes dermatitis? This problem can be solved only by experimentation. A good epidemiologist is always a good designer and performer of experiments. We repeatedly tried each kind of hair one by one, by rubbing it to the skin at the inner side of our forearms. Eventually, we found that only the fine, short hair (45–315 μm) produced skin reactions in a few minutes to a few hours in most cases. The first and most distressing complaint of our victims was the almost unbearable itching, but no pain. The eruptions were mainly papules. The experimentally induced clinical picture was indistinguishable from that seen in the field. At this moment we called out in happy astonishment. Everyone in the study group was overjoyed at his almost unbearable itching, successfully produced by himself with the poisonous hair of the larvae. In epidemiological studies observation and experimentation often go hand in hand in order to enlighten and to confirm each other.

Experiments repeated on rabbits showed the same type of lesions.

Besides the demonstrations on ourselves and laboratory animals, we still needed to prove further that the poisonous hair of the *E. similis* larvae was the agent causing this epidemic.

We set up a number of criteria, of course, before observation, to see whether the data of observation tallied with the criteria. These were:

(1) The infestation of trees with the *E. similis* larvae should be present in areas where the dermatitis occurred.

(2) The trees in areas where no dermatitis was found should not be infested, or have very few *E. similis* larvae.

(3) In areas where dermatitis was prevalent, people who had infested trees by their houses should contract the disease more frequently than those who did not have infested trees by their houses.

(4) The rise in number of clinical cases should run concurrently with the appearance of large numbers of the *E. similis* larvae at older instars and vice versa.

(5) In places where pest eradication had taken place, a decrease in prevalence should follow.

(6) The poisonous hairs of *E. similis* larvae should be found on the infested skin.

These criteria were all satisfied and some of the details were as follows.

In the rural areas and also in some areas within the city limit, it was found that wherever the dermatitis was prevalent, the trees there were always infested, without exception, with the *E. similis* larvae. A small lane in Southern District of Shanghai city, where not a single case of dermatitis was found, did not have any trees: a nearby building with many dermatitis cases had several infested trees around it.

The wards of the Shanghai Mental Hospital were surrounded by many infested trees. Among 431 medical personnel and orderlies 158 persons (36·7%) suffered from the dermatitis, but among 404 mental patients, only 44 (10·9%) had it. The difference was highly significant. The mental patients were not allowed to go about freely; also, the doors and windows of the wards were specially constructed. As a result, the patients had very little chance to come into contact with the poisonous hairs of the moth larvae, and consequently the prevalence of dermatitis was comparatively low.

At 10 residential foci, investigations were carried out to ascertain the existence of infested trees by each house and the presence of dermatitis cases in the house. The results were analysed statistically to compare the relative risk of contracting dermatitis for the residents who had infested trees near their houses, which was more than twice that of those who did not have infested trees nearby.

Dermatitis was especially rampant from early July to early August when *E. similis* larvae were also at their highest number with most of them at the older instars. By late August cases decreased sharply and the larvae of older instars were rarely seen, the mid-instar larvae began to reappear by the middle of September, then the ratio of older-instar larvae had a steep rise in late September until October with a corresponding rise in dermatitis cases, forming a residual peak. The occurrence of whole lots of dermatitis cases corresponded closely with the appearance of large numbers of older-instar *E. similis* larvae.

The relationship between pest eradication measures and the prevalence rate of dermatitis was also clearly shown from this investigation. Trees along sidewalks and in parks in the municipal area were also infested with the *E. similis* larvae, but effective pest eradication measures were taken regularly, so only sporadic cases of dermatitis were reported. The Orchard Commune in Nan Hui County had also taken relatively effective measures, hence the rate there was comparatively low (20·6%); while the Heng Tong Brigade (in Zhou Pu) did not carry out effective eradication measures and the attack rate was much higher (62·9%). On the contrary, the degree of wind in the latter was less than that in the former.

Now, let's reveal the biological facts which linked up the larvae in the tree and human beings on the ground. The poisonous hairs of *E. similis* larvae were found on the newly affected skin and in the fingernail dirt from persons who had scratched the affected area. In Chuan Sha and Bao Shan Counties we witnessed the occurrence of dermatitis in 22 persons among 32 workers soon after they finished fruit picking, and we found poisonous hairs in the affected skin of six persons. On examination of the dirt under the fingernails of 61 affected persons, poisonous hairs were found in six. Meantime glass slides smeared with glue were placed under the fruit trees and hairs were also found trapped on them.

From the clinical and experimental evidence gathered, it was ascertained that this epidemic dermatitis was caused by the poisonous hairs of the *E. similis* larvae, thence it was termed '*Euproctis similis* dermatitis' or 'mulberry tussock moth larvae dermatitis'.

All the above-mentioned facts logically support the establishment of the causal association between the poisonous hair of the larvae and the dermatitis of man. Nevertheless, the poisonous hairs alone could not cause so many cases in a short period of time. There should be conditions under which the illness flared up as a mass phenomenon. As this disease was not communicable, an epidemic could occur only when the following conditions were present:

(1) Within the area concerned the larval hairs of *E. similis* must be of a great quantity and dispersed from many foci simultaneously.

(2) A large quantity of poisonous hairs must have a chance to contact large numbers of people within a short period of time through effective means of transport.

(3) Potential receptors must be in such a condition that they are easily attacked by the larval hairs of *E. similis*.

Studies were carried out in accord with the above points, with the following results:

In the suburbs of Shanghai, *E. similis* larva was the only caterpillar which had an extraordinary rise in number in 1972. According to the data collected by the Biological Department of Fu Dan University, the number of *E. similis* moths collected from June to

September was 23 times more than that of the year before, and the population of *E. similis* moths was many times in excess of other kinds of moths. In the epidemic areas trees were heavily infested everywhere with *E. similis* larvae. As each old-instar larva carried as many as roughly 2 000 000 poisonous hairs, the number of dispersed hairs in the epidemic area in 1972 was astronomical.

The climatic conditions during the epidemic greatly facilitated the dispersal of the poisonous hairs. All through the peak periods of the epidemic, Shanghai was constantly at the border area of typhoons, so the larval hairs could be more easily blown off by the strong wind and also carried further. The poisonous hairs were trapped on adhesive tape we placed on the windows and bed-mats of the local residents. During that period there were no heavy rainfalls; the weather was dry. The climatic conditions facilitated the contact between the airborne poisonous hairs and the human skin.

Furthermore, during the peak period of the dermatitis epidemic, as the days were hot, people wore short-sleeved shirts or blouses and short pants of very thin material with the maximum exposed body area. Underwear and diapers, hung out to dry in the air near an infested tree, readily collected the dispersed poisonous hairs. This logically explained some cases in which the rash was distributed in areas closely coinciding in area and outline with the part covered by underwear or diaper. The welders and blowtorch operators, because of heavy clothing, protected themselves more than other workers, and suffered from the dermatitis much less too.

The above analyses showed that this dermatitis epidemic was the result of the presence of the necessary cause and the auxiliary conditions which played a combined role.

The study group accomplished its task in three weeks in revealing the inside story of the epidemic. The Chinese medical profession has accepted 'mulberry tussock moth larva dermatitis', suggested by the study group, as an official medical term.

Nevertheless, the trouble had not ended, there were still repercussions. *E. similis,* or the mulberry tussock moth, is mainly parasitic to mulberries in addition to many other bushes. The ordinary pesticides which kill the mulberry tussock moth larva kill silkworm as well so that the sericulture farmers objected to using ordinary pesticides on their mulberry trees.

This problem was studied by K. K. Chu and his colleagues.[2] They found that many larvae of the mulberry tussock moth died from a viral disease and they succeeded in isolating polyhedral bodies containing many virus particles. This virus was found to be specifically pathogenic to the larva of mulberry tussock moth. They squeezed juice out of the moth larvae which died from the viral infection; they then sprayed the juice, after it had been highly diluted with water, onto the moth larvae on the mulberry trees. The larvae died from the infection in a week or so. But the silk worms showed not the slightest harm.

The epidemic of dermatitis of man by mulberry tussock moth larvae was thus controlled by a man-made epidemic of a viral infection of the moth larvae themselves, in addition to the ordinary pesticide spray.

Conclusion

We can learn quite a lot from the whole process of investigation of this unusual epidemic. Clinicians are required to break through the restrictions of the microcosm—clinic or hospital—and deal with both the sick and the non-sick in the community.

The epidemic under discussion is a good example to show that the use of the concept of epidemiology, which is a set of simple principles, is not limited to infectious diseases, nor to degenerative diseases.

Epidemiology, together with its twin brother biostatistics, is an indispensable tool in the study of medicine and many other areas. Epidemiology underpins clinical medicine.

In the study of epidemiology, data should be properly collected and logically handled. Sufficiency of evidence is required in drawing a conclusion.

Reprints from Professor Su De-Long, Shanghai First Medical College, Shanghai, People's Republic of China.

References

[1] Tyzzer EE. The pathology of the brown-tail moth dermatitis. *J Med Res* 1907; **16:** 43–64.

[2] Chu Kuo-Kai, Hsieh Yung-Tung, Chang Hui-chuan, Yao Yen-er, Fang Chao-chi. Nuclear polyhydrosis of mulberry tussock moth, *Euproctis similis* Fuessly (Lepidoptera: Lymantriidae) and field test for the moth control. *Acta Microbiologica Sinica* 1975; **15**(2): 93–100.