and other factors. Nevertheless, it has shown these associations with the lipid concentrations and would seem to give similar information to these lipid measurements. These strong correlations between the lipoprotein values and the triglyceride and cholesterol concentrations were reflected in their common correlations with other factors examined—for example, body weight, fasting blood sugar, and age.

An interesting observation is the association of body weight and fasting blood sugar with triglycerides and pre-beta-lipoproteins (Tables I and II). The data are consistent with the recognized trend towards obesity and impaired glucose tolerance found in Fredrickson's type IV hyperlipoproteinaemia (increased endogenous triglyceride with raised pre-beta-lipoprotein) (Fredrickson *et al.*, 1967).

Lipoprotein electrophoresis may be of value in the identification of a raised triglyceride as being due to chylomicrons or endogenous triglyceride, or being due to the abnormal very-low-density lipoproteins with beta mobility ("broad beta," Fredrickson's type III), but in terms of discriminating subjects having coronary heart disease from those without, the determination of the lipoprotein pattern does not have any value over the determination of triglyceride and cholesterol. Furthermore, it has the disadvantages of not being amenable at present to automation and requiring greater time and effort in its performance.

Ostrander *et al.* (1967) examined the lipoprotein electrophoretic patterns in subjects with and without coronary heart disease and found that the presence of a pre-beta-lipoprotein did not discriminate between the groups. The study of Hatch *et al.* (1966) of a more thoroughly diagnosed group of young men with and without coronary heart disease suggested that the pre-beta-lipoprotein band was significantly correlated with the presence of coronary heart disease. We would conclude that lipoprotein electrophoresis need not be used in screening of the general population directed towards the detection of coronary heart disease.

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High Altitude and House-dust Mites

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Summary

House dust from high mountainous areas of Switzerland contains very few house-dust mites. In contrast to lower-lying regions, only very small quantities of house-dust allergen are found at high altitudes.

The cause of this phenomenon seems likely to be the climatic conditions in the high mountains of Europe, where cold air leads to extremely low humidity levels indoors. The soil conditions and a type of construction providing good protection against the penetration of water also contribute to dry conditions in houses. These factors prevent the development of large populations of allergen-producing house-dust mites.

The beneficial effect of a stay at high altitudes on patients with atopic asthma is probably due to the low concentrations of house-dust allergen.

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Introduction

For almost a hundred years physicians in Switzerland and elsewhere have noticed that some patients with asthma lose their symptoms during a stay in high mountainous regions. The beneficial effect has been ascribed to the thin air, low oxygen pressure, solar radiation, temperature, and other often vaguely indicated properties of the mountainous air. Only after allergy had been recognized as an important aetiological factor in the development of asthma was any other explanation of the favourable effect of the mountain climate seriously considered—namely, the absence of harmful substances capable of causing attacks of asthma in persons oversensitive to them.

Storm van Leeuwen *et al.* (1924) studied the response of asthmatics to residence in mountainous areas and found that the improvement in the patients' condition started at an altitude of 1,200 m and became maximal above 1,600 m. The beneficial effects were found, however, to be only temporary.

Recent work has done much to provide a scientific explanation for the success of high-altitude treatment of asthma. The discovery of the house-dust mite *Dermatophagoides pteronyssinus* as the producer of house-dust allergen (Voorhorst *et al.*, 1964, 1967) and its prevalence in damp and moderately damp climates have suggested that it is the most important cause of allergic asthma in low-lying districts. At high altitudes the prevalence of house-dust mites may be less, and this may account for the improvement which occurs in many asthmatic children sent to the high mountains. These observations have formed the basis for a recently concluded study of house-dust mites and house-dust allergen in various places in Switzerland.

Numbers of Mites in House-dust Samples

SEPTEMBER COUNTS

The number of mites were determined in 5-g samples of dust from three sources (Fig. 1). Each total represents the combined counts of *D. pteronyssinus*, *D. farinae* (=*D. culinae*), and *Euroglyphus maynei*. In 1965 house dust was collected from 150 houses in Leiden and its vicinity in the month of September (the period with the highest numbers of mites in dust). These houses were classified in five groups of 30 houses with different degrees of dampness. The results showed a positive relationship between the degree of dampness of houses and the number of mites in dust (Spieksma, 1967; Spieksma and Spieksma-Boezeman, 1967). Dust was also collected from 40 houses in Switzerland (five houses in each of eight places at various heights above sea-level). The results showed a negative relationship between the altitude and the number of mites (Voorhorst *et al.*, 1969). Because of the relatively small number of houses (five) per place, and because some houses (four) yielded very little dust (<1 g), the results presented in Fig. 1 are the combined observations of the four places in the mountains and the four lower-lying places. Fig. 1 also gives the numbers of house-dust mites in dust from two groups of dry and damp houses in the Netherlands.

YEAR-LONG COUNTS

Observations on the mite fauna in the Leiden house dust in 1962 and in 1964-5 had indicated that the numbers of mites undergo a periodic increase during September and October and decrease in February and March (Spieksma, 1967; Voorhorst *et al.*, 1967). The results of similar observations

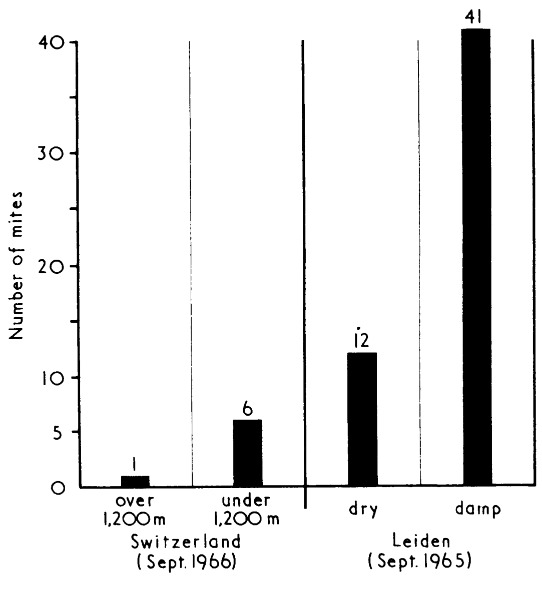

FIG. 1—Geometrical means of numbers of house-dust mites (*D. pteronyssinus*, *D. farinae*, and *E. maynei*) in dust from 36 houses in Switzerland (September 1966), including 17 in places over 1,200 m above sea-level (Klosters, 1,400 m; Davos, 1,500 m; Arosa, 1,700 m; St. Moritz, 1,800 m), and 19 in places under 1,200 m above sea-level (Basle, 250 m; Lucerne, 450 m; Berne, 550 m; Heiligenschwendi, 1,050 m); and from 120 houses in Leiden (September 1965) including 60 dry and 60 damp houses.

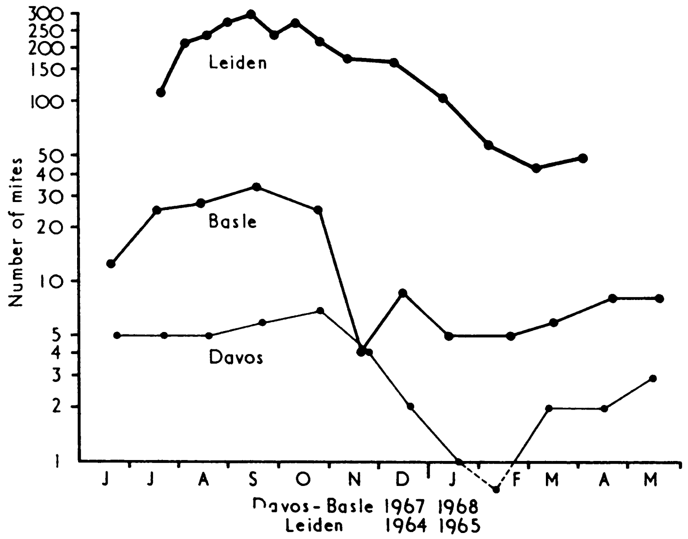

FIG. 2—Geometrical means of numbers of house-dust mites over a one-year period in dust from four houses in Davos (1967-8), three houses in Basle (1967-8), and three houses in Leiden (1964-5). Mean values are plotted logarithmically.

done in 1967-8 on dust collected from three houses in Basle and four houses in Davos are shown in Fig. 2 in comparison with those of three houses in Leiden.

Like the findings in Leiden, the Basle observations show a seasonal periodicity in the numbers of mites, with a maximum in the autumn. This periodicity is evident even in the very small numbers of mites from Davos, but it is not certain that it is caused by seasonal influences in Davos itself. The small autumnal peak in Davos could conceivably be the result of import from lower-lying regions—for example, in the luggage and clothes of travellers.

Allergen content of house-dust samples

Extracts of house-dust samples from different sources were tested in patients allergic to house dust. The reactions to these extracts were compared with those to a standard house-dust extract. (The standard extract was prepared in our laboratory from a mixture of dust samples collected from the floor of living-rooms in 25 houses in Leiden in September 1965. The stability of its potency is controlled every year by comparing the skin reactions of 20 patients with the strongest reactions—that is, patients with maximal reagin titre—visiting our outpatient department in September and October (Voorhorst *et al.*, 1969).) The allergen content was calculated and expressed in Noon-equivalent units. A Noon-equivalent unit is the amount of allergen that in a group of patients with maximal reagin titres gives skin reactions of equal strength to that given by a Noon unit in a group of hayfever patients also with maximal reagin titres (Voorhorst *et al.*, 1969).

The Table shows the allergen contents of a number of dust samples collected in Leiden and in Basle and Davos and the numbers of house-dust mites in the samples. It must be borne in mind that the allergen content need not be directly correlated with the numbers of mites at the moment of sampling. The allergenic potency of the dust is due to material from dead mites and excretions in addition to the live mites. The results confirmed the old observations of Storm van Leeuwen *et al.* (1924), Varekamp (1925), and van Geuns (1956) that there are very small amounts of house-dust allergen in the high mountains.

Voorhorst (1962) had shown that in the Netherlands there is a seasonal periodicity in allergen content of dust. More recent studies demonstrated a relationship between the allergen content and the number of house-dust mites, both showing a similar periodic increase and decrease (Spieksma 1967; Voorhorst *et al.*, 1967; Voorhorst *et al.*, 1969). From the data in the Table it can be seen that these relationships also hold

Allergen content (expressed in Noon-equivalent Units/g) and number of mites (per 5 g) of dust samples collected in Davos, Basle, and Leiden

Place and Year of Collection		Allergen Content (Noon-eq U/g)	No. of House-dust Mites (per 5 g)
Davos (Netherlands Sanatorium) 1962		200	Not done
Davos (Netherlands Sanatorium) 1964 (Spieksma, 1967)		250	5
Davos (4 houses*)	Feb. 1968	240	0
	Oct. 1967	370	7
Basle (3 houses*)	Feb. 1968	480	5
	Oct. 1967	1,470	25
Leiden (groups*) 1965 (Varekamp et al., 1966)		190	<3
		470	3–8
		770	9–26
		1,170	27–80
		1,520	81–242
		2,070	>242
Leiden, 1964 (Spieksma, 1967)		600	35
		1,400	240
		10,000	1,330
		15,500	2,450

*For groups of samples averages are given of the allergen content, and either geometrical means or a logarithmic classification are given for the numbers of mites.

for the dust collected in Basle, but at Davos the differences in allergen content between spring and autumn were very small.

Discussion

The three species of the mite family Pyroglyphidae that occur most commonly in house dust—*D. pteronyssinus*, *D. farinae*, and *E. maynei*—have been shown to produce similar allergens, whereas species of other families occasionally found in dust are sources of different allergens (Pepys *et al.*, 1968; Miyamoto *et al.*, 1969; Spieksma and Voorhorst, 1969; Voorhorst *et al.*, 1969). Our findings confirm that the climatic conditions in the high mountains of Switzerland inhibit the development of mite populations in house dust. A temperature of about 25°C and a relative humidity of the air of 70-80% are optimal for the development of a population of house-dust mites (Spieksma, 1967; Larson, *et al.*, 1969). The mites are not very temperature sensitive, and at 15°C they still multiply to some extent. They are, however, very sensitive to humidity, and at a relative humidity of the air of 60% or lower the population stops growing and dies out. Humidity is therefore the primary factor controlling the occurrence of mites; this holds for most species of mites in general and for house-dust mites in particular.

An analysis of the climatic conditions in Davos indicates that throughout the year the relative humidity of the air in the houses is so low (maximally about 50%) that the development of large populations of mites is inhibited. These low-humidity levels occur in Dutch houses only in heated rooms in the winter, the period during which the size of mite population decreases.

The low level of the relative humidity of the air in the Davos houses is caused by the low temperature of the outdoor air, which under such conditions can contain only small amounts of water vapour. When this cold outdoor air enters the house via ventilation routes and is then heated to about 20°C the relative humidity level is lowered considerably. From data of the Davos weather station on temperature and water-vapour content of the outdoor air it can be calculated that the relative humidity of the indoor air, at temperatures of 18-20°C, will normally never exceed 50%. A number of our incidental observations confirm these calculated values. In the winter the relative humidity of the indoor air in Davos will range between 20 and 35% and in the summer from 35 to 50%. For houses in the Netherlands the corresponding calculated values are 40 and 60%, and 60 and 80%, respectively.

The relative humidity of the indoor air is not the only humidity factor affecting the growth of mite populations. Another and very important contribution to the humidity conditions in houses can be made by the moisture content of the building, determined by its construction and by other materials in the house (Leupen and Varekamp, 1966). In the Netherlands this moisture content of the materials is mainly determined by free water in the superficial soil layers and by inadequate prevention of the penetration of water into the structure.

These two causes of dampness of houses are much less frequently seen in high mountainous regions. In these sloping areas water flows off more rapidly and is not retained in the superficial soil layers. Moreover, the Swiss house construction offers much better isolation not only against cooling but also against the penetration of water.

Between the extreme situations of the high mountains on the one hand and those of the low-lying parts of the Netherlands on the other, Basle probably takes an intermediate position. The conditions of temperature and humidity of the air in Basle do not differ greatly from those in the Netherlands, except that in Basle the summers are a little warmer and the winters a little colder, but soil conditions and construction methods in Basle provide for better protection against the penetration of water.

Conclusion

This study does not solve all the problems associated with the favourable influence of a high-mountain climate on patients with atopic house-dust asthma. It is, however, more and more generally accepted that the absence of large amounts of house-dust allergen is one of the most important factors. The absence of house-dust allergen in houses in Switzerland is related to the low outdoor temperatures and low humidity which prevent the development of large populations of house-dust mites. Patients with atopic asthma probably would not benefit from a stay in tropical high mountainous areas, where climatic conditions are moderate.

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