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Mediterranean climate and geriatrics

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Key words. Climate; health; human bioclimatology; meteoropathology; geriatrics; Mediterranean area.

The fascination exerted by the regions around the Mediterranean on elderly people living in western and central Europe has given rise to two forms of residence: seasonal residence, continuing the tradition of winter holidays, and permanent residence, as more and more elderly people move to these areas for their retirement[12]. This second form is still restricted to the northern shores of the Mediterranean, but the holidays of senior citizens are now often directed to North Africa, particularly Tunisia. In both cases the motives are numerous, but almost always the pleasant weather conditions and the desire to evade the harsh winters of the North are decisive. In short, everyone expects that the climate near the Mediterranean assure pleasant conditions and good health.

But is reality not sometimes quite different from the expectations and the transfer therefore accompanied by bitter disillusionment? In other words: *is the Mediterranean climate really suitable for elderly people?* The answer to this question implies a discussion of the biological peculiarities of elderly people in relation to climatic conditions. Then, three questions must be asked: 1) has the Mediterranean climate a favorable effect on the physiological stability of aging organisms? 2) has it a beneficial influence in relation to the most common diseases of people over the age of sixty? 3) does it provide a delay, however short, of the end of life? Of course, this threefold analysis will not provide a simple answer. But it might help to produce a better realization of the strong diversity of the Mediterranean area, even if we limit ourselves to the southern parts of Europe and to northern Africa, excluding thereby the Near and Middle East, to which few elderly people migrate. Other areas with climates of the Mediterranean type are also excluded. These are California, which seems to have a similar attraction for retired people, Central Chile, Southwest Australia and the Cape region in South Africa.

1. Specific physical reactions of elderly people towards climate

Though it sometimes seems otherwise, no living organism remains the same with time; time changes all that lives. The question here is whether the changes accompanying old age affect the capability to adapt to a new climate or to the variability of a present one. Surprisingly, two entirely opposite viewpoints exist in answer to this question. The first one is proposed by Nicolas[25]. He sees old age as a period of reduced susceptibility to the exterior environment. The organism defends itself better and better, as the years go by, against attacks from the outside. This is because the biological processes have a typical rhythm for each age. In children the speed of these processes is high, as the body goes through a multitude of reactions and adaptations. But the opposite happens in old age; the body processes are slow and there are few evolutionary phenomena. Therefore the difficulties of adaptation are reduced; atmospheric changes do not interfere with internal evolutions, because they have largely different frequencies.

Moreover, it is well known that the human body reacts only to exterior influences if a certain threshold of excitability has been reached. These thresholds are at a low level in children, whose biological regulatory systems are easily disturbed, but their level increases with age. Therefore, according to Nicolas[25], a climatic stress which forces the body to readjust quickly will be severely felt by young children, but will have little effect on elderly people.

Unfortunately, research during the last 25 years on the forms and mechanisms of aging has taught us that these ideas are illusory[6, 11, 32]. It is true that the physiological speed of internal processes follows the described sequence, but at the same time the body deteriorates, almost imperceptibly, and it becomes more and more vulnerable. The combination of senescence, difficulties of existence and the development of degenerative diseases causes serious and irretrievable transformations which result in a stronger submission to the exterior environment[7]. The defence mechanisms of the old body become less and less vigorous and their reactions less predictable, and the organism therefore restores itself more slowly and with greater difficulty than when it was younger. Some authors feel that the best period to adapt to new climates, or to adjust to climatic stress, is between fifteen and thirty or forty years of age[14].

Under these conditions, the constitutional fragility of elderly people makes it desirable to submit them only to

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weak climatic stimuli[20]. The appropriateness of a temporary or permanent migration of retired people to the Mediterranean regions is therefore questionable.

2. Old age and the preservation of health

As an individual advances in age, the reduced efficiency of the controlling mechanisms of the organism decreases its margin of adaptability to the exterior environment. This jeopardizes the constancy of the internal environment, known as *homeostasis,* which defines the state of health[17].

Two main organic balances are strongly influenced by climatic conditions; the caloric balance, controlled by heat exchanges between the body and the air outside, mainly through the skin, and the hydric balance through the lungs, where respiratory exchanges between blood and air take place. It is the first of these two which seems most affected by old age.

2.1 The energy balance of the aging organism

Contrary to common ideas, experiments with climatic chambers show no significant difference between young and old subjects regarding the preferred ambient temperature[16,29]. Probably the effects of a reduced interior heat production (lower basal metabolic rate) are compensated by a lower intensity of evaporative losses[21]. It is therefore not correct to consider that man prefers a warmer environment the greater his age. Only the reduced physical activity of very old people seems to increase the thermal optimum slightly. But it is undeniable that an aging organism, exposed to cold or heat, will have more difficulties in keeping its thermal balance than a younger one. The reasons are obvious: a reduced heat production hinders the fight against cold (or thermogenesis); sweat secretion becomes lower; vasodilatation of the arterioles of the skin is delayed and scarcely effective, as the 'tensing' of the muscles is weaker even at normal temperatures; the cardiovascular system becomes ineffectual in the fight against overheating (or thermolysis).

One understands therefore why mild and uniform climates, without extremes and abrupt changes of temperature, are attractive to people of advanced age. But do Mediterranean climates belong in this category?

In fact, many processes are involved in the energy balance of the human body, and it is therefore impossible to determine the answer to this question by examining temperatures only. We must include both wind chill and atmospheric humidity[2,4].

The *temperature-wind chill complex* is indicated by the index of Siple and Passel[30]: $K=(10.45+10\sqrt{v}-v)(33-t)$, where v = wind speed (m/s) and t = temperature (°C). Using this index, the optimum is between 300 and 600, when the body does not need to fight against either cold or heat. These conditions occur during about 36% of the year in Trieste, 42% in Tunis, 46% in Athens, 55% in Nice and 56% in Gibraltar, against 31% in Paris and 29% in London (fig. 1). Frequencies of occurrence along the shores of the Mediterranean are the highest, i.e. the best in the world.

The *temperature-humidity complex* can be estimated by the index of Thom[31]: $THI=t-[(0.55-0.0055\,U)(t-14.5)]$, in which U is the relative humidity in %. With this index, values between 15 and 20 leave body temperature control systems at rest. With frequencies of occurrence for these conditions between 12 and 22% of the year, the Mediterranean region has lower rates than the rest of Europe (Lyon: 22%, Metz: 26%, Dinard: 27%) (fig. 2). This is a first reason to doubt the original optimism, but there are others as well. Although the regions around the Mediterranean seem favored by a high frequency of occurrence of physiological comfort, they are not spared extreme temperature conditions, which strain the internal balance of the human body. On the cold side, these are not frequent, but they are characterized by harshness and

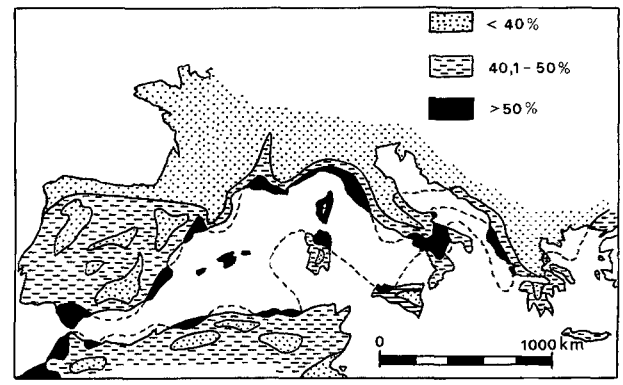

Figure 1. The temperature-wind chill complex. Frequency of occurrence of K-values[30] between 300 and 600 (in % of the year).

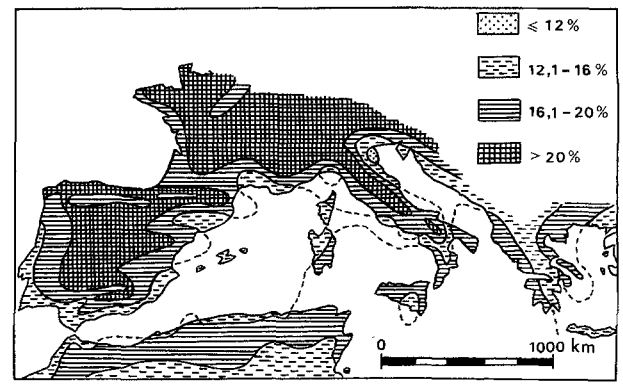

Figure 2. The temperature-humidity complex. Frequency of occurrence of THI-values[31] between 15 and 20 (in % of the year).

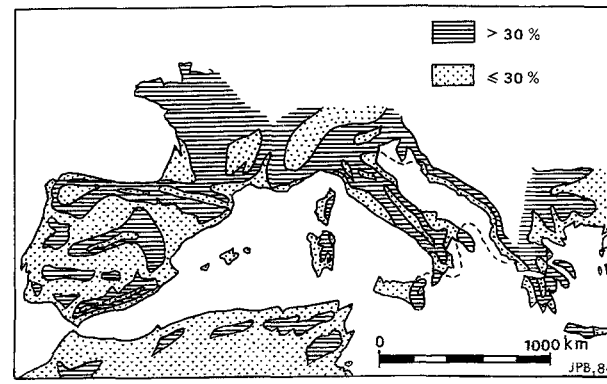

Figure 3. Water vapor exchanges in the pulmonary tract. Frequency of occurrence of vapor pressures between 7.5 and 11.6 mb (in % of the year).

suddenness; for example there was a K index of 1793 at Salonica on January 12, 1968, whereas the threshold of 1500 has never been exceeded in either Paris or Lyon. On the hot side of the scale these extremes are more frequent: 15 times more negative K values in Attica than in Central France, and 60 times more often in Djerba. The danger of THI values over 30 is a real one in most parts of the Mediterranean area, while the absolute maximum recorded in the British Isles is only 26.
Finally, rapid and sudden weather changes in the Mediterranean climates often menace the thermal balance of elderly people. Particularly the southern parts of Europe are frequently visited by extreme conditions, which, however, rarely last for long. They are often preceeded by long periods of remarkably favorable weather.

2.2 The moisture balance of the aging organism

The exchanges of moisture between blood and air, which take place in the respiratory tract, are unequally affected by age. On the one hand vapor tensions between 7.5 and 11.6 millibars are favorable for human organisms at all ages, but on the other hand it becomes more and more difficult for the aging organism to adapt to vapor pressures outside the optimum range. This is true for humidities below 7.5 mb, when the very dry inspired air may cause a real loss of moisture to the body, of which we shall describe the pathological consequences later. But it is even more so for conditions beyond 11.6 mb, when the risk of dilution of the plasma exists – a danger that is usually very well endured in the beginning, but which may cause fatigue and numerous indispositions when the water vapor pressure exceeds 20, 25 or, even more, 30 mb.
In this respect, the only advantage of the Mediterranean regions is the lower frequency of dehydrating conditions. These occur 15% of the time on the Côte d'Azur and 11% around the Gulf of Gabès, against 33% in Paris and 43% in Berlin. But this advantage disappears when optimal conditions (7.5–11.6 mb) are considered. These are systematically rarer in the Mediterranean area than in the oceanic or semi-continental climates (fig. 3). And the risk of dilution of the blood is undoubtedly the main drawback in southern Europe and North Africa, where vapor pressures over 21 mb occur during 2–18% of the year, while in Paris their frequency is 1–2%. Absolute maxima recorded in Spain may even be world records (52.4 mb in Seville on 20th August, 1962). It is clear that retired people from the mid-latitudes are not prepared to face such hardships, to which their resistance is limited and which inevitably cause an increase in the incidence of several pathological phenomena.

3. Elderly people and climatic pathology

Are there diseases, specific to aged persons, which are strongly influenced by the atmospheric environment? Rather than dealing with diseases which occur in all periods of life, but more often during old age, we shall limit ourselves here to three types of chronic affections which occupy a key place in geriatrics: heart, lung and rheumatic diseases.

3.1 Cardiac insufficiency

Heart insufficiencies are usually the result of almost all heart diseases which were not immediately fatal. These reduce the contracting power of the myocardium and thereby increase the risk of heart failure[27, 27]. The question is whether climate can constitute a factor of vulnerability in this respect.
Climatic stress, especially in warm and humid environments, is well indicated by the acceleration of the heartbeat. This indicator seems even more relevant here because the maximum frequency that is tolerable to the human body decreases by about 1 beat/min for every year of age: while a youngster may feel fine with a heart rate of 180/min, a person around 80 years old cannot stand more than 130.
The difference between the normal rhythm of 65 and the theoretical maximum is generally larger than any possible accelerations by the climatic environment. But if an elderly person is already in a state of tachycardia as a result of physical effort, emotion or any other cause, the critical level may be dangerously close. Certain combinations of temperature and humidity will cause frequencies of 95 heartbeats per min (fig. 4). Compared to Brittany, this risk is 7 times as high in Nice, 70 times in Athens, 75 times in Naples, 150 times in Monastir and more than 200 times as high in Seville. One must admit, therefore, that the Mediterranean climates are not free of this type of risks to elderly people during the summer, particularly in the more southern areas and near the coasts. However, a different picture is produced when considering bronchiopulmonary diseases.

3.2 Respiratory insufficiency and chronic bronchitis

The respiratory tract, largely open to the exterior environment, is exposed to attacks of all kinds, to infections, to fumes and dust of a polluted atmosphere, and it therefore probably bears the weight of years more than any other part of the human body. Chronic bronchitis affects about 40% of elderly people, and with any lung disease respiratory insufficiencies may break out[13, 18]. Now, many climatic elements have deleterious effects on this type of trouble and may favor infections. The so-called index of biometeorological aggression (or IBA), devised by Rivolier, Campos, Lemée and Wolfromm[28], is based on relative humidity, precipitation, temperature, wind, sunshine hours, rapid changes of atmospheric pressure and various 'special phenomena'. Negative values indicate a low aggressivity, positive ones a real climatic aggression which is particularly directed against the vulnerable broncho-pulmonary parenchyma of old people.
In this respect, lower humidity, less persistent cold spells, more sunshine and generally more stable weather give the Mediterranean areas a substantial advantage. The only drawback is the strong wind in some places. The pathogenic season, during the winter, of course, becomes shorter from north to south (fig. 5). While in Brittany the probability of positive IBA values is over 50% during six months, there are only three to four months in this category in Spain and Greece, two in Crete and only one in southern Tunisia.

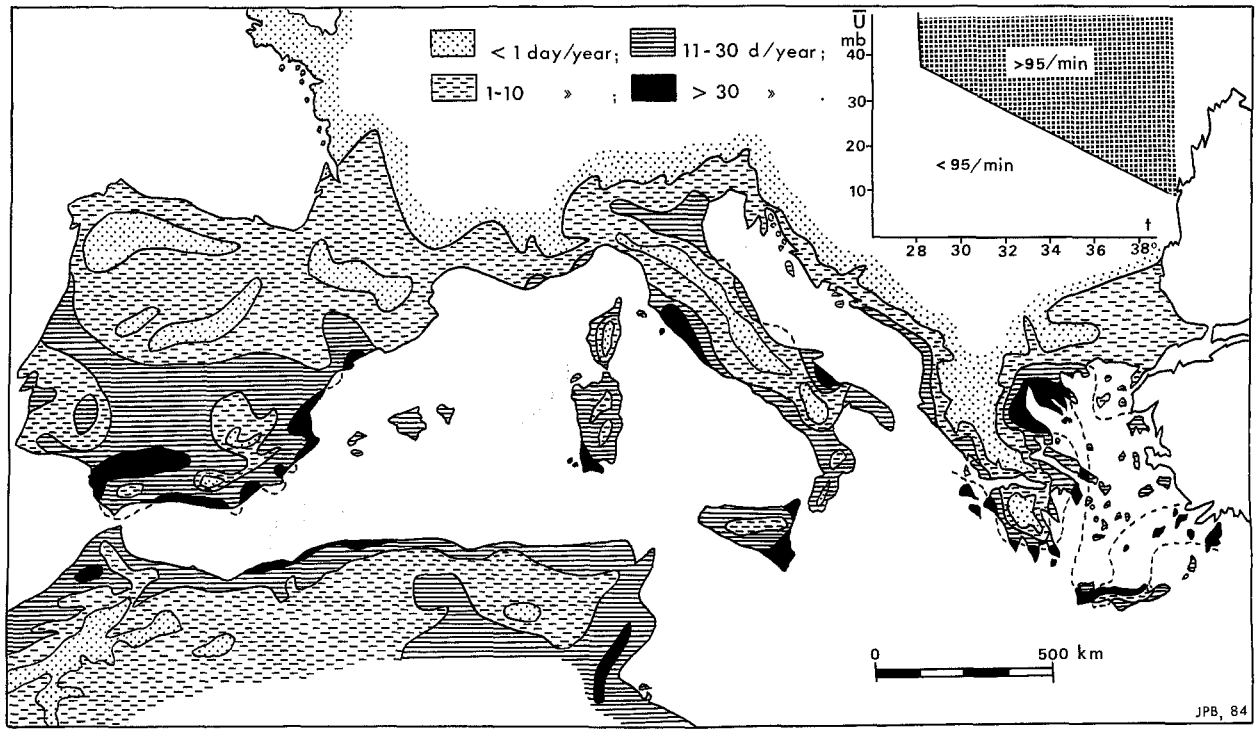

Figure 4. Climate and cardiac risks of elderly persons. Frequency of days which may cause heart rates over 95 per minute. Inset: simplified nomogram to predict heart rate as function of temperature (t) and vapor pressure ($\bar{U}$).

3.3 Rheumatism

There is nobody over 60 who does not complain, sometimes, of 'pains'[23]. Though most sufferers of rheumatism see every attack as an indication of a change of weather, research into the correlations with meteorological situations has been rather disappointing, because of the difficulty in quantifying episodes of pain. It can be said, however, that rheumatic crises are normally associated with weather types combining sudden changes of pressure, drops in temperature, increase of wind speed and a high humidity. But heat can have the same effect: as it maintains a high humidity of the skin, the slightest cooling, caused by a move into the shade or a temporarily stronger wind, resulting in evaporation at the skin surface, may have painful effects. It seems that the IBA gives a correct evaluation of the risk of rheumatic attacks. The climatic diagnosis is not much different from the one given for affections of the respiratory tract: the same general advantages of the Mediterranean areas, a similar concentration of the critical periods during the winter, an identical disadvantage of coastal regions compared to the interior, and the same danger in sectors exposed to strong winds (fig. 5).

But one must emphasize the importance of local conditions, particularly for rheumatic diseases[24]. We shall deal with this at a later stage, after studying the most serious pathological affections.

4. Mediterranean climates and the mortality of old people

This field is not well-researched[10], and many studies are still required before any definite conclusions may be drawn. We can only offer a few remarks on the subject.

In the Mediterranean regions the seasonal rhythm of mortality of elderly people seems to show two maxima (fig. 6). The winter maximum, which has been reduced strongly since the beginning of the century in areas further northwards, is still rather prominent on the Côte d'Azur as well as on the Balearic Islands. The summer maximum is clear on the southern shores of Europe and even more so in North Africa. Heat is the obvious factor here, but it is more difficult to explain why the Mediterranean winter, despite its mildness, remains relatively more lethal than in Paris or Berlin. Maybe it is the strong variability of the weather during a short period, which has serious effects on two main causes of death, namely myocardial infarctions[3] and cerebrovascular accidents[9,19]. It is also possible that the cold is not generally perceived as a real danger to health and that Mediterranean people consequently protect themselves insufficiently against it.

Certain heat waves, well supported generally by younger people, cause many deaths amongst the elderly[8]. It seems that the limited cooling at night is sometimes more detrimental than the high temperature of the early afternoon[15]. A strong increase in mortality has been observed when the THI was over 29 during at least an hour on several consecutive days, and the mean over 24 h was near 27. Such heat spells, practically unknown in oceanic temperate climates (Brittany), rare in semi-continental climates (Germany), occur almost every year in North Africa (Monastir), every two or three years on the Costa del Sol (Malaga) and every four or five years in Corsica. At the most advanced ages, many deaths are caused by dehydration[5], which may occur under two entirely dif-

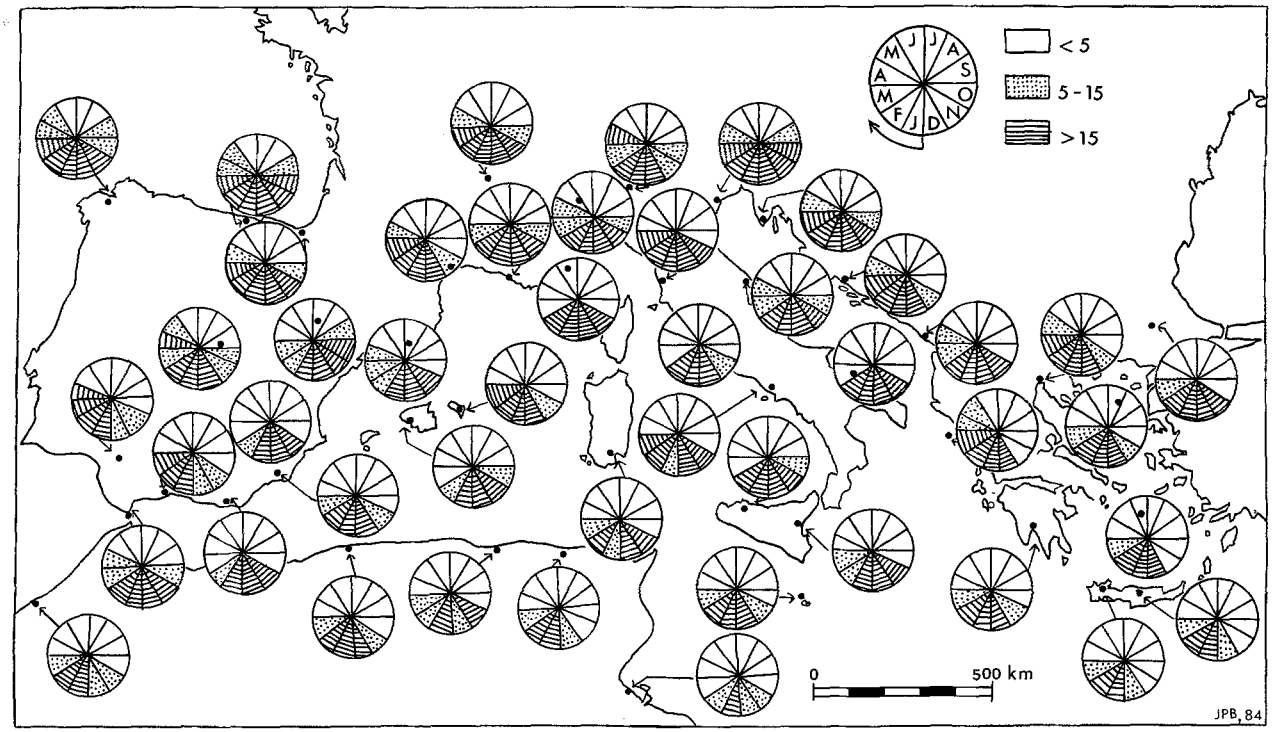

Figure 5. Climate and bronchio-pulmonary risks of elderly people. Monthly number of days when the IBA[28] is positive. This index can also be used to evaluate the risks of rheumatic crises.

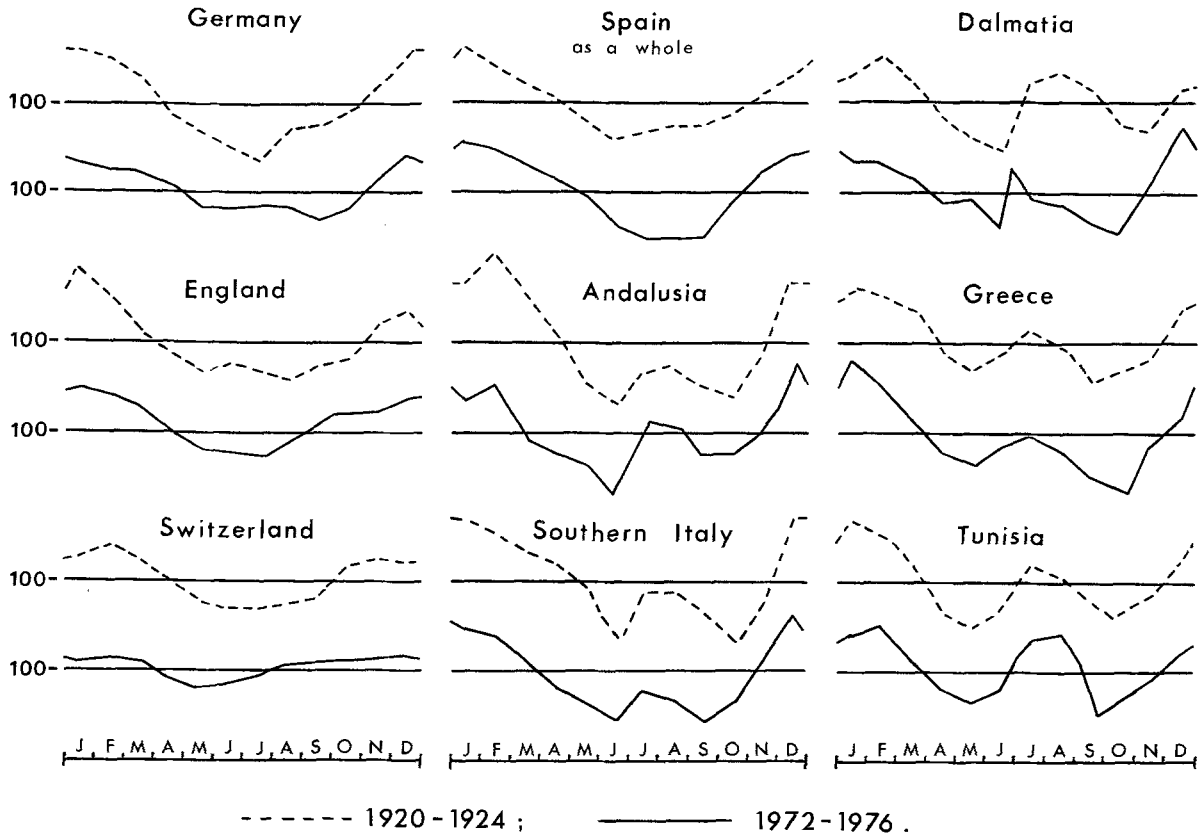

Figure 6. Seasonal variation of mortality rates of elderly people (100=annual rate).

ferent sets of circumstances. In winter the dried-out mucous membranes provide no resistance to microbial attacks, and infections of the respiratory tract are the result. An increase of 25–33% has been observed every time that the vapor pressure was below 4 mb for some time. It is true that this condition is much rarer in Nice (less than 1% of the period from December to February) than in Paris (10%) or Berlin (18%). In summer dehydration of the whole body is a danger, caused by the intense sweating whenever the diurnal minimum relative humidity is below 35%, and even more so when it decreases to 25%[22]. These conditions are common in the Mediterranean area, especially in the interior parts. And vigilance is particularly necessary because dehydration in elderly people is not always combined with a feeling of thirst.

5. *Conclusions: A difficult diagnosis and the differences over space and time within the Mediterranean area*

Common sense advises the avoidance of one-sided positions. Considering the positive aspects regarding the maintenance of homeostasis and the development of diseases in elderly people, it must be said that our judgement should be reserved, because the Mediterranean climates also present drawbacks. Moreover, the advantages are variable in both space and time: some are clearest near the coasts, others stronger in the interior; some occur mainly during the winter (heart insufficiencies), others during summer (lung diseases, rheumatic pains). All this means that the Mediterranean climates are not basically better or systematically worse than others, but *different*. They have their own characteristics, which should be outlined with some precision to obtain maximum benefits for all ages. But the judgement is made difficult by the strong diversity and variability of these climates.

Spatial diversity occurs at all scales. What a difference between the Gulf of Venice and Tunisia or Crete! But there is also a strong difference between the areas exposed to continental winds, like the mistral in Provence, the tramontane in Lower Languedoc, the bora along the Dalmatian coast and the vardaris of the Gulf of Salonica; and the Rivieras, almost perfectly protected. On that account, Barelli[1] has pointed out that a wind speed as slight as 5 m/s is sufficient to develop irritability and to impair the sociability of elderly people, and even differences on a small scale may have strong repercussions on health conditions: every locality, every coast, every valley has its own climatic characteristics, which are not necessarily found in the neighborhood. A retired person suffering from rheumatism in his residence on the Promenade des Anglais in Nice, near the coast, may find instantaneous relief by moving to the center of the town or to the surrounding hills.

Variability in time points out strong seasonal differences: *The winter* seems not to be specially favorable to elderly people, particularly the very oldest ones or those whose general status is seriously impaired. But those who can support a moderate climatic shock, and who are normally kept indoors by the cold winds and bad weather of northern European winters, can certainly profit from a winter holiday in Mediterranean climates. But they must avoid regions with strong bora-type winds and choose either the well-protected Rivieras (for instance the Côte d'Azur east of Nice) or the more southern areas, like Tunisia, Malta, Costa del Sol, Costa de la Luz, etc. And they should be aware that the Mediterranean winter, despite its heavenly appearance, may conceal real dangers. Going out on days with strong winds, and at sunset, should be avoided. But doctors know how difficult it is to respect these rules in a climate that possesses such strong powers of seduction.

The intermediate seasons, and autumn probably even more than spring, seem most capable of providing the protection needed by elderly people. The range of favorable places is wide open. But one should remain careful, because the normally moderate weather conditions during these seasons do not exclude the occasional occurrence of weather types which can be just as harmful as those of the main seasons. Thus, spring sometimes has cold spells reminiscent of winter, as trying as the cold spells of spring in the north of France. In the same way, the moist heat of October can be more oppressive and unhealthy than the hotter but drier weather of July or August.

The summer, too hot and too sultry, too humid, too exhausting for the heart, is nowhere in the Mediterranean region very suitable for elderly people. Only the mountainous areas, found almost everywhere in the region, can be considered favorable for health.

The above are, to our present knowledge and understanding, the best arguments for a rational use of the different climates of the Mediterranean region for holidays for elderly people. But the problems of retirement settlements seem more difficult to solve. People in their sixties, who are going to live in the Mediterranean regions, hoping that the attractive climate there will provide them with the chance to live the rest of their lives in the best possible physical and mental health, may be very disappointed. The months of July and August carry the risk of seriously jeopardizing their health. Escape during the summer, while certainly possible at first, will become more and more difficult with age and almost impossible for the very old, who are most vulnerable in this respect. But it would be wrong to finish in such a gloomy way. Even if the Mediterranean climate is sometimes trying for elderly people who protect themselves insufficiently, and if it does not guarantee the maintenance of prolonged youthfulness, nor a longer span of life, it often provides 'beautiful weather'. And while this cannot provide good health, it supports the morale and makes retirement easier to bear and more pleasant. If this cannot extend life itself, it at least improves its quality, provided that certain elementary precautions are taken by newcomers to the region.

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Soil properties of special interest in connection with health problems

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Key words. Soil properties; osteomalacia; geomedicine; exchangeable ions.

1. Some historical data

For as long as medical science has existed, there has been knowledge of certain human illnesses related to particular geographical districts. In this connection Hippocrates' observations have often been mentioned[2,3]. Some knowledge of the geographic distribution of sickness in domestic animals is also very old. Marco Polo noticed cases of disease in the Far East, which may now be attributed to selenium poisoning. In the nineteenth century, such toxicity was discovered in the USA. Endemic goitre due to iodine deficiency has been known for a long period of time and this is often set forth as a geomedical example. As a lesser known example the discovery of phosphorus deficiency in domestic animals in Norway may be mentioned.

In certain districts in southern Norway, osteomalacia in cattle was very common. In the seventeenth century, farmers informed an official interested in botany (Jens Bjelke, 1580–1659) about this illness and Bjelke in turn named a plant species, very common in the pastures in the afflicted districts, *Gramen ossifragum* or, 'the grass that breaks bones' (systematic name: *Narthecium ossifragum* (L.) Huds.). Thus, very early on the species came to be identified by this name[10]. More than two hundred years later, it was proved that the osteomalacia (which farmers had tried to prevent by mixing crushed bone into the cattle fodder) was related to the extremely low phosphorus content in the bedrock, soil and plants. A geologist confronting the problem had found that the content of the phosphorus mineral apatite was extremely low in districts with osteomalacia, and deduced that phosphorus deficiency could be the cause of the sickness[21].

The etiology of osteomalacia could, however, be determined only after knowledge in medicine and natural sciences had reached a certain level. While the plant species