PHYSIOLOGY

# Working in Comfort

**Heat, but also moisture in the air, wind and your own activity contribute to summer discomfort. High pulse rate a danger signal.**

By MARTHA G. MORROW

➤ TO BE comfortable in the summer's heat, you work only about one-fifth as hard as you would if you were doing your utmost. That is science's latest finding.

People begin to feel uncomfortable, and want to slow down on the physical exertion, when they are doing only one-quarter of what they are humanly capable of doing. But if they keep on going, they will soon get their "second wind" and can continue to work without discomfort.

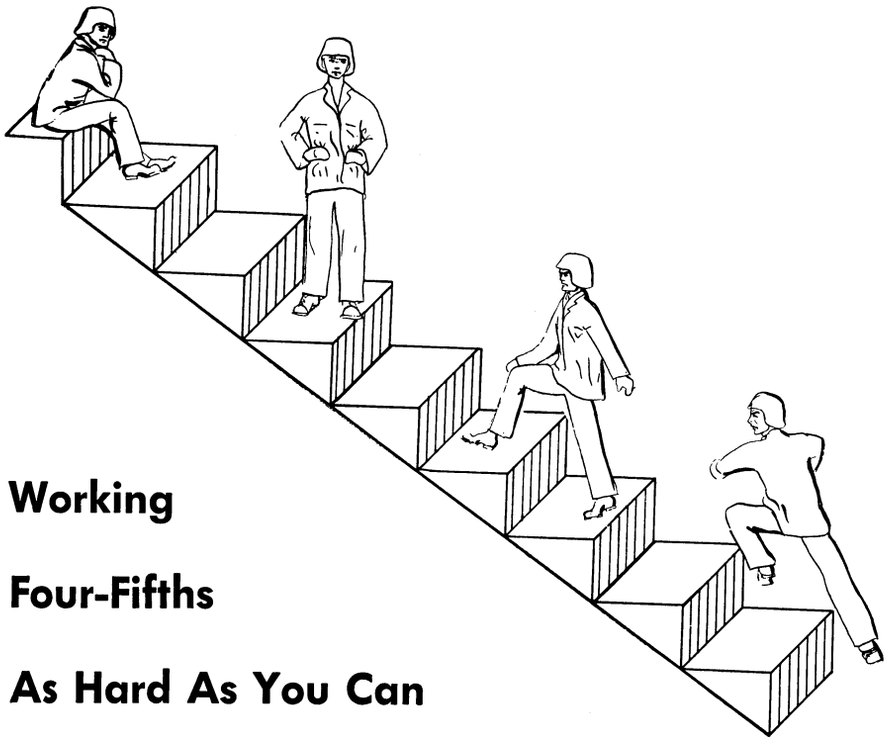
A person's comfort as far as physical activity is concerned—and comfort is very important to all of us—can actually be measured, the Quartermaster Corps of the Army found while trying to determine how much work our soldiers could safely do in different climates. They found that a person's degree of comfort is the ratio of what a man is doing in a given environment to what he can do in that same environment.

Irrespective of whether a person is taking violent exercise on a cool summer day or whether he is sitting still when the day is oppressively hot, a person's comfort increases with the amount of heat the air can take up from his body and his comfort decreases with the heat that is generated by his body.

The high relative humidity of the air, which many of us take as a signal on a hot day for complaining about the heat, may mean that it will probably rain, but has little real relation to how we feel. What is important to us is the actual amount of water vapor in the air, or absolute humidity.

It is almost twice as hard to evaporate the moisture from your body when the temperature of the atmosphere is around 90 degrees Fahrenheit as it is when the temperature is at 70 degrees, even though in both cases the relative humidity is 90%, because the absolute amount of moisture in the air is greater in the first instance than in the second.

The amount of heat created by the human body in digging a ditch, marching, driving a truck, just sitting still or sleeping must be lost into the surrounding air, or a person will suffer. If the air temperature is cooler than the body, this heat may be carried away by the convection currents of wind, by evaporation of sweat, or by radiation to cold ground or sky. If the air temperature is about that of the body, wind and sun will add heat, but evaporation is usually able to dispel it too.




*MOUNTAIN CLIMBING—Although the temperature may remain at 97 degrees Fahrenheit, as the amount of moisture in the air increases, the amount of physical labor which a man can safely do rapidly decreases, as shown in this Army chart from the office of the Quartermaster General.*

### Moisture Loss Serious

The amount of moisture that a person loses through the evaporation of sweat can be measured by his loss in weight. Under comfortable conditions, men give off about 50 grams (that's slightly less than two ounces) of moisture an hour. When they lose as much as 450 grams or about 16 ounces an hour, they begin to get uncomfortable. But if these same men can get plenty of water to drink, they can lose as much as 1500 grams or about 3½ pounds of moisture an hour without suffering any serious difficulties.

Danger points, beyond which a person should not go for safety, have been determined by a group of experts at the Quartermaster Corps as follows: When the pulse rate reaches 130 to 140 beats a minute—watch out. Even if a person is drinking plenty of water, when he is sweating away 1500 grams of moisture an hour, he should cease whatever he is doing and rest for a while. Another danger point is reached when the rectal temperature, which pretty well shows the temperature of the interior of your body, reaches 101.4 degrees Fahrenheit. Danger may be reflected in these ways or several others, but any one of them should serve as warning. A man can go above these warning regions without harm for

snort periods, but it is dangerous for him to continue there long.

These danger points may find a practical application in industry or the services. An officer on the march would know that his men must have a rest, for instance, when their pulse rate gets beyond 130 beats a minute. A steel expert might require his men to leave the heat of the steel furnace when they have sweated away more than a certain amount of their weight for that day.

Even a warm wind cools you, unless you are enduring severe desert conditions. A layer of still air is around everything, clinging close to your arm, pocketbook or table top. Wind erodes the layer of still air and takes away part of the insulation from your body. As long as the temperature of the air is cooler than that of the body, the wind cools you.

On a hot day when the temperature of the air is warmer than that of your body, eroding the layer of air would tend to make you hotter, because it brings the hot air closer to the body. But at the same time the hot wind increases the speed with which moisture is evaporated from your body, which in turn tends to cool you off. In the desert when there is a high wind, however, this is no longer true because then the wind may be demanding from the body more sweat than the body can produce and a person will get the full heating effect of the hot wind.

### Damp Clothes Cooling

Clothes reduce the amount of heat that can be transferred to the cooler surrounding atmosphere in jungle or humid heat and thus tend to make a person hotter—this is an argument in favor of the now-popular bare legs which women are enjoying as even sheer stockings trap a thin layer of air between the stockings and the legs.

If the clothing is damp, however, and sticking to the body, a person may get almost the full cooling effect of the moisture evaporation. In the full blast of desert heat, and when the man is not exercising energetically, clothes may be a positive help, as they form a resistance barrier to the flow of hot air toward the body. Don't start out without hat or shirt to drive in an open car or jeep across New Mexico or Arizona.

People who are accustomed to the climate will begin to feel uncomfortable indoors, even if they are themselves just sitting in their office, when the relative humidity is 90% if the temperature gets above 87 degrees Fahrenheit. Or if it drops to 83 degrees, with the same relative humidity, in absolutely still air, like that of a telephone booth, they will begin to feel almost unbearably hot. They will also be uncomfortable under either of these conditions if they begin to do violent exercise.

On one of these hot summer days if the temperature is 90 degrees and the relative humidity 80%, an office executive doing the usual amount of getting up from his desk, walking around and conferring with others, will be between just plain hot and oppressively so, and probably wish he could think up some excuse for leaving early.

If the thermometer continues to hover around 90 that evening, however, and the amount of moisture in the air remains the same, this same man can play a couple of sets of tennis around six o'clock with a not-too-good opponent without being any worse off, provided the sky is overcast. By running around the court, he will have increased his wind velocity enough to counterbalance for a time the added exertion. But if this same man attempted to play tennis at about two that afternoon, with the

# Do You Know?

*Sittard* in the Netherlands is supposed to have got its name from Napoleon, who upon his arrival there, according to the story, said "si tard", or "so late."

Toughness in *meat* may be due to the age of the animal when slaughtered, or to the diameter of muscle fibers and of muscle-fiber bundles, and the proportion and distribution of fat within the muscle.

When *alum* is added to raw water it forms little particles, positively charged, which attract to themselves the negatively charged dirt particles, thereby clarifying the water as they settle.

Owing principally to an increase in soda ash and chlorine production, the total output of common *salt* in the United States in 1944 exceeded 16,000,000 tons.

*Tetanus antitoxin,* used to prevent lockjaw, is an antibody obtained from the blood of horses; unless renewed it gives the human body only ten days' protection.

*Corn* grown on soil containing the proper fertilizing elements produces a higher percentage of grain to cob than corn grown where these elements are deficient.



sun beating down upon him, he would be sweltering close to the limits of safety.

A 150-pound soldier carrying a 40-pound pack and marching at three miles an hour under jungle conditions, with no wind blowing, except that created by his body, will be extremely uncomfortable at a temperature of 85 degrees, with 90% relative humidity, whereas a man without a pack would not be as uncomfortable, with the same amount of moisture in the air, until the temperature hits 95. If the GI, on the other hand, received a letter from his girl friend saying she had married someone else or if he hadn't slept well, he might have had to put down his pack before the four hours were up, or drop exhausted.

No conditions anywhere in the world are so bad that you can't walk around and do some shoveling. In the City Deep Mine (recently air-conditioned), Witwatersrand, South Africa, the relative humidity was usually 100% and the temperature about 96 degrees. Yet comparatively few natives were unable to get accustomed eventually to the conditions and work in the mine.

Climbing mountains is considered about the hardest work a person can do as the weight of the human body must actually be lifted from one place to another. When the wind is blowing five miles an hour and the relative humidity is 100%, if the temperature rose above 85 degrees, the man climbing a steep mountain without rest would drop exhausted. Should the temperature rise to 90 degrees and the relative humidity drop to less than 50%, he would have reached his upper limit of comfort and mountain climbing would have become just plain hard work.

When the temperature is around 70, if the wind is blowing at five miles an hour, the relative humidity doesn't matter much because the pressure of the vapor upon your body is low and the wind velocity is great enough to take away the body sweat.

When the wind drops to one mile an hour (such as you get indoors with a fan in the same room, but not turned directly on you), however, a man doing gymnastics in only shorts and shoes would be affected by the moisture in the air unless the temperature dropped to about 60 degrees.

A number of laboratories throughout the country have been studying the amount of work a soldier or civilian can comfortably do under special conditions, but it was at the office of the Quartermaster General in the Climatology Section where Major Paul A. Siple, Dr. Jesse H. Plummer, and Margaret Ionides brought all this information together and correlated it.

The basic information, they state, came from research conducted at the John B. Pierce Laboratory of Physiological Hygiene at New Haven, Conn., but it was necessary to correlate it with the work done by Dr. Sid Robinson, Department of Physiology, University of Indiana, and by many others before it could be used for so many different activities and temperatures.

The temperature of the air, velocity of the wind, vapor pressure (amount of moisture in the air), and the kind of activity a person is doing all influence his comfort. But other factors such as individual differences, acclimatization, dehydration and combat fatigue are also important, worthy of further study and can be analyzed by the same method, experts believe.

After more data have been secured, they state it will be possible to tell a "weak sister" from a "strong brother" and give these differences a numerical value.

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