PHYSIOLOGY

All-Season Hibernation

A select group of mammals is being induced to hibernate at any time of the year. Their laboratory sleep is contributing to man's knowledge of hibernation.

By HOWARD SIMONS

➤THIS SUMMER in Boston, a small, select group of animals will be lulled into the feeling that it is not summer at all, and be induced to hibernate.

This will not be an unusual feat for these particular animals, for they are hibernating mammals that have been experiencing induced hibernation at any time of the year in the laboratories of Dr. Charles P. Lyman of the Harvard Medical School and Museum of Comparative Zoology.

In their natural habitat, these same animals would instinctively hibernate each fall without the help of Dr. Lyman, or anyone else. Much has been learned about this unique ability of some animals to spend the long winter months in a form of exaggerated sleep. Much, however, remains a mystery, as we shall see.

A "Who's Who" of the warm-blooded hibernators is not very long. It includes among others the hedgehog, several rodents and bats, the hummingbird and the whippoorwill. There is a theoretical explanation why these animals hibernate. Winter in cold climates is hard on most animals—particularly for the insect- and plant-eating animals, which include all the hibernators.

Avoiding Winter

By trial and error animals have found ways around winter's harshness. Some go south, others store food and still others add a thick coat of fur. Finally, a few have learned over a long period of time how to curl into a tight ball and to sleep away their wintry displeasures. Winter seems no less harsh on most humans, many of whom have adapted the animals' defenses for comfort—going south, making themselves as comfortable as possible, or adding a thick coat of fur.

No human, however, has been able to curl into a tight ball and hibernate, and from present evidence it is doubtful that one will.

The definition of hibernation is important. Dr. Lyman, together with the late Dr. Paul O. Chatfield of the National Institutes of Health, Bethesda, Md., chose always to distinguish between "deep hibernators" and "deep sleepers." The former exhibit a profound drop in body temperature and concurrent decreases in breathing and heart rate. The latter do not.

This definition eliminates the black bear as a hibernator. Drs. Lyman and Chatfield explained to many disbelieving trappers and woodsmen that although the bear spends a part of the winter in a dormant state, it is not hibernating. It fails to show a striking drop in body temperature or metabolic rate.

Still incredulous, a few intrepid outdoorsmen offered to enter a bear's den in midwinter and kick an old bruin to prove it was a notch above a "deep sleeper." The offers were not accepted.

Definition is important in another area. Hibernation is often confused with hypothermia, the practice of "freezing" humans to live during surgery. The two are very different. It is interesting to note, for example, that a hibernating mammal that is subjected to artificial freezing will die a short time after its body temperature reaches five degrees centigrade (41 degrees Fahrenheit). However, the same animal can lower its body temperature to the same degree or lower through the hibernating process and live to awaken in the spring.

It is also important to note that a human heart fibrillates at body temperatures between 70 and 80 degrees Fahrenheit. Dr. Lyman and his co-workers have found evidence that some heart and muscle tissue of hibernating mammals differs from that of nonhibernators, including man.

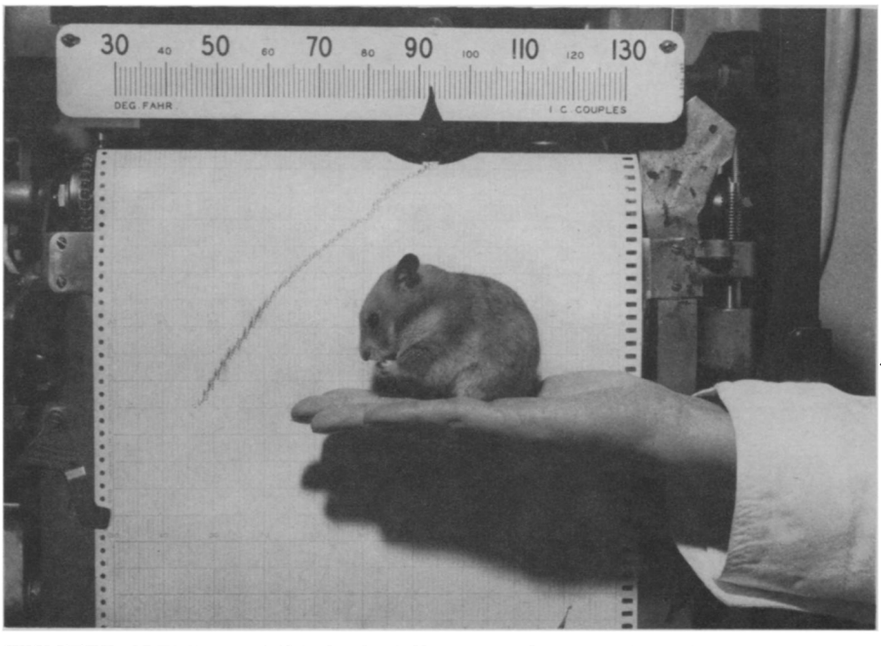
Hibernators must prepare for their long winter's sleep. Some, like the woodchuck and thirteen-lined ground squirrel, add body fat and live from it without awakening. Others, like the golden hamster, store food and awaken periodically to eat it. There are three stages in hibernation, each undergoing intensive study in Dr. Lyman's laboratories: entering the dormant state; remaining in hibernation and awakening.

As yet, no one knows what triggers hibernation. By the same token, no one fully understands what triggers awakening. Dr. Lyman suspects that the sympathetic nervous system is in some way involved in both processes. He thinks the "thermostat" of hibernating animals may be turned both up and down by the hypothalamus, an area of the brain that is connected with most vital body functions, as well as the "waking and sleeping centers." He does not rule out the possibility that a building up of waste material throughout hibernation might also contribute to the wakening process.

Descent Into Sleep

The descent from a fully awake active animal to a deep hibernator is dramatic. In some animals it is a smooth transition. In others, it is stepwise. A hamster, experimentally induced to hibernate, lowers its body temperature to near freezing, its heart rate to four to ten beats per minute (from 250 to 270), and its breathing to less than ten breaths per minute characterizing a metabolic decrease of from 1/30 to 1/100 of the normal resting rate.

The Harvard researcher and his coworkers found that the hamster's temperature remains about one degree above that of the environmental temperature and regu-



WINTER SLEEPER—This little fellow, perched on the palm of a Harvard University researcher, is a golden hamster—a hibernating mammal. He is being made to hibernate experimentally at any time of the year. The temperature gauge in the background registers the hamster's normal body temperature. The chart shows its body temperature in hibernation.

lates itself automatically as the outside temperature changes.

If the temperature is dropped below freezing (32 degrees Fahrenheit), however, the researchers found that the hamster will increase its metabolism three-fold or more and even awaken. This may account for the fact that hibernators are not found far north of the Arctic Circle.

Once in hibernation, all mammals curl into a tight ball with their heads tucked beneath their tails. Their hair remains erect effecting maximum insulation against loss of body heat. In this state all bodily processes are slowed to a minimum.

In many respects the hibernator is in a period of immunity from disease, aging and other dangers. If such an animal is subjected to a lethal dose of radiation during hibernation, for example, it does not die or show ill effects. In the same way, if a cancer is transplanted in a hibernating animal, the animal will not succumb. There is a "but," however, and it is, when the hibernator awakens it will die from radiation poisoning or cancer.

Lively Sleep

Up to the present it was thought that hibernating animals do not age in their dormant state. Recent experiments by a graduate student working with Dr. Lyman, however, indicate that some growth is taking place.

Poke a hibernator and get an arousal! This is not an immediate reaction, however. Stimulated arousal occurs in the same manner as natural arousal. In the hamster the awakening process takes about three hours. It starts with a quickening of respiration, followed by a rise in the heart rate. In less than two hours, Dr. Lyman has found, the respiratory rate is over 100, the heart rate is up to 550 beats per minute, twice its normal rate, and the body temperature is 86 degrees Fahrenheit. An hour later its breathing and heart are normal and its body temperature is 98 degrees Fahrenheit.

Commenting on the arousal process, Dr. Lyman says that "only death can stop the animal from struggling to regain its homeothermic temperature."

Hibernating mammals cannot be kept hibernating forever, even experimentally. The longest continuous period of hibernation was reported by a French researcher, C. Kayser, who recorded a 114-day dormancy for a common dormouse. The usual period of hibernation is considered to be much shorter than this.

International Study

Interest in hibernation has increased since the end of World War II. Studies are currently being undertaken in many laboratories in the United States and in France, Finland, Sweden and Russia. On May 13, hibernation experts from throughout the world gathered in Boston to compare notes and discuss their recent findings.

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PUBLIC HEALTH

Lung Cancer Total High

➤ SOME 31,000 persons in the United States will be stricken with lung cancer this year.

Of this number, 26,000 will be males and 5,000 will be women. The recovery rate for this disease is below five percent.

No one knows just what causes this disease, but one famous theory holds that smoking tobacco products produces cancer.

Within the past few years, the lung-cancer-smoking controversy has flared like the smoldering end of a cigarette at each puff.

For instance, Dr. Alton Ochsner, surgeon at the Ochsner Clinic in New Orleans, points out that the incidence of lung cancer has increased proportionately to the increase in cigarette sales in this country.

"It is my firm conviction that every heavy smoker will develop lung cancer — unless heart disease or some other sickness claims him earlier," Dr. Ochsner says in *Today's Health*, a publication of the American Medical Association. The article carries the notation that the House of Delegates of the AMA has not taken a position on the possible relationship between smoking and lung cancer, due to the considerable difference of opinion among medical authorities.

Four other lung cancer experts recently met and decided further research is required before anything definite can be said about the possible link between smoking and lung cancer. These four, three of whom are smokers, were Dr. Seymour M. Farber, chief of the University of California's Tuberculosis and Chest Service; Dr. Carlo Sirtori of Milan, Italy; Dr. Bernard Pierson, France; and Dr. Anton Sattler, Vienna, Austria.

The experts have stressed that lung cancer is becoming the number one killer among males more than 40 years of age. Lung cancer in the U. S. has increased 400 times in the past 30 years, Dr. Farber said.

However, none would attribute the increasing death rate to smoking. Dr. Farber suggests that perhaps the fact that men have to work in smoke-filled cities and factories may have a key role in the development of lung cancer.

A two to six year study of 6,000 persons who showed no symptoms of lung cancer initially was conducted by Dr. David A. Cooper of the University of Pennsylvania. At the end of the investigation period, 86 of the 6,000 had developed lung cancer. Of these victims, 85 were smokers, Dr. Cooper said.

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OCEANOGRAPHY

Renew Deep Ocean

➤ THE TIME NEEDED for deep ocean water to renew itself is at least 300 years.

Dr. Henry Stommel of Woods Hole Oceanographic Institution, Woods Hole, Mass., said his mathematical model of circulation patterns in the world's oceans gave the 300-year figure. Actual measurements, he reported to the National Academy of Sciences meeting in Washington, indicate the complete turnover of all the ocean below 6,600 feet may take as long as 1,800 years.

Dr. Stommel said the mathematical ocean model was devised with Dr. Allan Robinson of Harvard University. He reported that his theory also predicts the existence of a large northward flowing deep current over the Tonga Kermadec Trench in the western South Pacific off New Zealand. This current supplies the entire Pacific Ocean with deep water. Exploration is underway to determine whether this predicted ocean current actually exists or not.

Another deep ocean current, flowing southward under the Gulf Stream, is also indicated from the model. Dr. John C. Swallow of the National Institution of Oceanography, Sussex, England, reported his direct measurements of this deep current to the Academy symposium on the deep sea.

Dr. F. F. Koczy of the University of Miami Marine Laboratory, Coral Gables, Fla., said measurements of the distribution of radium showed that the total surface layer of the Atlantic Ocean is renewed by bottom water in about 300 years. In the Pacific, however, it takes about 1,500 years for the surface waters to be replaced completely by deep water.

Dr. Stommel reported that the mathematical model he developed with Dr. Robinson followed publication of a "pioneering study" by Dr. P. S. Lineykin of the State Oceanographical Institute in Moscow. The Russian scientist attempted to explain the full three-dimensional field of current, temperature and density in an ocean acted upon simultaneously by wind and heating.

After studying this paper, Dr. Stommel and his Woods Hole colleagues concluded the Russian model was applicable only to rather small-scale seas and lakes, like the Caspian Sea, but did not apply to the large-scale oceans. Both the Moscow and American scientists suggested in 1957 preliminary versions of a model similar to the one Dr. Stommel reported.

The new model, Dr. Stommel said, allows oceanographers to compute the vertical distribution of the currents in the ocean and the vertical temperature-density structure as a result of the combined action of wind stress and of heating and cooling. In order to make these computations, a hypothetical quantity that describes the vertical mixing of ocean water had to be introduced.

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