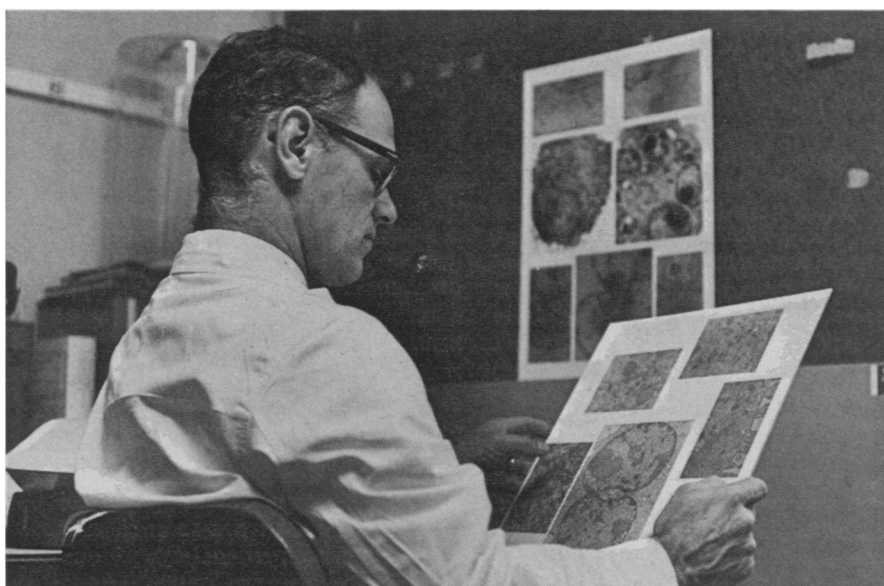


# The search for clues to the rhythms of life



Dr. Becker: Trying to find correlations with changes in electromagnetism.

## The mechanisms behind the biological clock are still not well determined

by Joan Lynn Arehart

Color alteration in autumnal leaves is related more to light than to temperature changes. Potatoes seem to anticipate barometric pressure fluctuations by two days. Fiddler crabs and oysters moved inland readjust their sleeping, eating, body temperature and hormone cycles to the solar-lunar atmospheric tides at that latitude and longitude. Schizophrenic patients' behavior, renal function, heart beat, temperature, ionic composition of the blood and other body rhythms change dramatically with solar electromagnetic storms. When an individual has been traveling transatlantic by jet, his sleep patterns seem to return to normal quicker than his daily temperature cycle. In man, more than a hundred functions and structural elements oscillate between maximum and minimum values once a day, from deep body temperature to rhythms in mood and mental performance.

Observations of biological rhythms in various plants, animals and humans have been made for several hundred years at least, but only in the past several decades have recordings of specific

biochemical, physiological and behavioral rhythms been based on elaborate scientific experiments. Even now scientists are more caught up in scientifically observing and analyzing the rhythms than with probing their final causes. Yet of those researchers boldly striking out for final answers, recent advances in physics, chemistry and molecular biology, coupled with sophisticated statistical and laboratory studies and limited space probes, have given them ample leverage.

These scientists generally view biological rhythms within the framework of a hypothetical biological clock. The hands, or gears, of the clock represent various rhythmic activities of enzymes, hormones, nerves and muscles. Yet what sets the clock in motion? What is the key or keys?

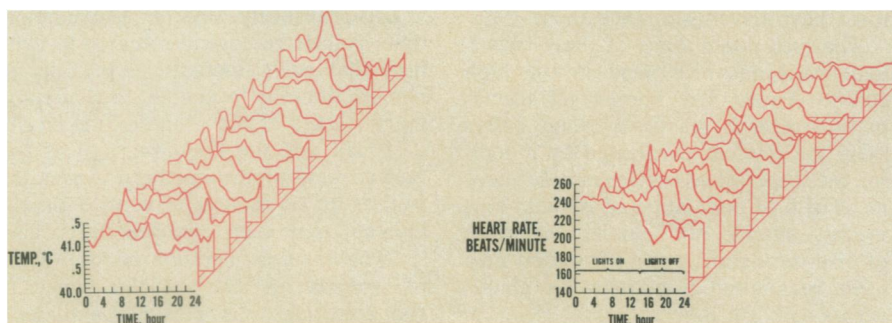
Evidence to date, culled from all kinds of biological rhythm research, has shaped two broad schools of thought. The first school holds that the key to rhythms—the biological clock—lies within an organism. Whether the key is peculiar to each organism, or

whether there are several keys within an organism that set differently synchronized rhythms going, is not known. The second school of thought holds that while there may or may not be an internal key or keys within each organism, rhythms are overwhelmingly paced by external factors such as light, temperature and electromagnetic fields.

"There is no question that the cause [of biological rhythms] is in the organism," says Dr. J. Woodward Hastings of Harvard, a major proponent of the first school. Although there may be geophysical cues, he believes they do not stop and start the biological clock. Having looked for a biochemical key to the clock for some years now, Dr. Hastings admits that what he has come up with mostly are "difficulties." Yet he claims to have detected rhythmic changes at the most intimate cell level. For example, he has found molecular changes in enzymes at different times of the day.

Dr. Frank Brown Jr. of Northwestern University, a staunch backer of the second school, disagrees. "All research to date shows the influence of geophysical factors on rhythms, yet only some research suggests an internal factor. Hence the opposition is weakening." Dr. Brown points out that a few years ago Dr. Britton Chance of the University of Pennsylvania thought he had found an internal key (SN: 10/14/67, p. 380). But it turned out that the "ticks" he had detected in yeast cultures were temperature-dependent.

Dr. Robert Becker, an orthopedic surgeon at the Veterans Administration Hospital in Syracuse, N.Y., has been looking at the effects of electromagnetic



C. M. Winget and D. H. Card

Daily oscillations of an isolated bird's vital body functions over 14 days.

forces on biological rhythms and behavior. He says he "leans toward Brown." Drs. John Pauly and Larry Scheving of the University of Arkansas Medical Center have measured over 50 different rhythms in soldiers, patients and the elderly. They adhere more to Hastings' belief that the key is internal. Dr. Karl Hamner of the University of Southern California has been observing rhythmic changes in plants when light is varied. He says he favors the internal key, but does not rule external causes out.

The question of biological clock master key aside, most scientists of either school concur that external or geophysical factors can reset the clock or throw it out of phase. Light is considered by many researchers to be the most critical external timer or *zeitgeber*. Dr. Hastings has found that even when light was blocked from animals' eyes, their body rhythms fluctuated with light-dark changes. To determine the effect of light on the menstrual cycle in women, a gynecologist-physicist team studied 19 women whose menstrual cycles varied from 20 to 44 days. A shaded 100-watt light was timed to cast a glow on the walls of their bedrooms on the 14th, 15th, 16th and 17th nights of the women's cycles. The result over the course of a hundred monthly cycles was the regularization of their cycles to 29.5 days, the synodical period of the moon.

Social habits can also influence biological rhythms. The biological clocks of two persons kept in the same room usually remain synchronized more or less to a 24-hour schedule, but if the persons are put into separate rooms, their clocks tend to get out of phase. Dr. Richard Wortman, a physician-researcher at the Massachusetts Institute

of Technology, has found that protein intake can alter rats' various metabolic rhythms, and light changes shift the rats' eating patterns. He doesn't consider the influence of light over eating habits as a *zeitgeber*, but simply as two timers—light and eating habits—getting into phase.

Perhaps the most controversial *zeitgeber* is electromagnetism. Only in the past five years has it been acceptable to entertain a hypothesis that electromagnetic forces are a cue to biological rhythms, says Dr. Becker. He strongly supports such a view. His lab has accumulated extensive evidence, slowly being accepted by other scientists, that certain cells and tissues in organisms are electrical conductors, and that changes in their electric potential can cause marked physiological changes, such as stimulating bone growth. Dr. Becker's lab studied 25,000 psychiatric admissions over five years, correlating the rates of admission with the number of magnetic storms a month. The lab made the same study again, correlating more precise statistical parameters with clinical observation of schizophrenic patients under treatment, and found the patients' biological rhythms and behavior noticeably changed with the recording of electromagnetic storms. Electromagnetic storms, Dr. Becker found, also altered the biological rhythms in normal human volunteers.

In June Dr. James Hayes of Columbia University's Lamont-Doherty Geological Observatory reported, at a conference at the observatory, that studies of rock sediment in the ocean's bottom correlate the extinction of various species with known changes in the earth's magnetic field. Dr. Becker considers this evidence to be support for the argument that electromagnetic



*Dr. Hastings: Studying light effects.*

forces affect the rhythms of life.

Dr. Brown admits that the evidence suggesting electromagnetic and other geophysical forces influence biological rhythms and behavior could conceivably be taken as a scientific basis for astrology. Yet he is quick to warn that scientists know little about earth, sun and moon coincidences and their specific effects on various organisms, and virtually nothing about the planets' effects. Even if such influences were better understood, he says, it would take "computer upon computer" to explain or predict such forces at work in human beings.

Some scientists believe that if a final answer to the internal or external key of the biological clock is ever obtained, it will probably come from experiments conducted outside the earth's gravitational and electromagnetic fields. "Spudnik" (Dr. Brown's potatoes were to have been launched around the sun, to telemeter biological rhythm data back to earth), some researchers feel, might have provided the answer. But the project was scrapped by the National Aeronautics and Space Administration. Nonetheless the forthcoming Skylab pocket mouse study, although it will take place within the earth's gravitational field, may shed further light on those forces behind biological rhythms—as did projects Biosatellite II and III. □

### Putting bio-rhythms to work

Whether or not the ultimate question—what makes the biological clock tick—is answered in the near future, biological rhythm research is beginning to offer some practical applications.

Clinical trials have shown that certain drugs can be more effective if given at certain times of the day. Charting one's biological rhythm profile and noting any slight deviations from normal could conceivably indicate sickness and allow a person to seek early diagnosis and treatment. Students in a Minneapolis high school are charting their profiles for this purpose. Lethal drug doses, extrapolated to man from animal studies, are required by the Food and Drug Administration before new drugs can be marketed. Drs. Franz Halberg and Erhard Haus of the University of Minnesota have found that lethal doses vary considerably in rats according to the time of day a drug is given. Thus time of day might eventually become a crucial yardstick in running lethal dose tests for new drugs. A better understanding of how electric forces alter biological rhythms, Dr. Robert Becker says, should lead to more effective shock treatment for psychiatric patients, more effective electric anesthesia (being tried in Russia) and possibly a scientific basis for acupuncture and electric acupuncture, being widely practiced in China (SN: 6/12/71, p. 400).