Cosmic Rhythms

By J. Schultz

An essential characteristic of the manifestations of life in the different kingdoms of nature is the element of rhythm. The general development as well as the individual organic functions and physiological-chemical processes in the organisms of plants, animals and human beings are connected in the most varied ways with a rhythmical course of the vital activity. The life-rhythms are in part intimately coupled with external rhythms of nature, so that organic processes, for example the growth of a plant, are released and guided directly by the external rhythm.

Also independent inner rhythms appear extensively in which the individual living body of an organism is expressed. Even these rhythmical occurrences are, however, frequently linked with the external rhythms of the earth, or at least show by their periodicity the original connection with the earthly and cosmic rhythms. The most important nature-rhythms of day, year and month are, of course, cosmically conditioned by the relation of position and movement of the earth to the sun and moon. Longer periods must also be considered, such as the eleven-year sun-spot period and the various planet periods.

Daily rhythmic changes in the life processes of plants can clearly be observed and a few examples will now follow:

The sap of plants shows daily fluctuations in its electrical conductibility, with a minimum in the early morning and a maximum in the forenoon.

The assimilating activity of the plant, though on the whole dependent on the presence of external light, has besides this a definite daily rhythm. The main assimilation takes place in the morning and forenoon, followed during mid-day by a period of rest, and not until the late afternoon is assimilation again considerably increased.

Growth in the individual organs and also in the whole plant follows the daily rhythm in a certain way. Embryonic growth (cell division) of individual organs does not occur regularly during the different hours of the day, even when external conditions are constant. The roots show a maximum growth between 9 a.m. and 11 a.m., the sprouts between 3 a.m. and 5 a.m. In the case of numerous algae (spirogyra) cell division occurs only at night. Examination of the growth in height of trees likewise reveals a daily periodicity. Here we have a retarding of growth during the hours from 3 a.m. to 9 a.m. and a maximum growth between noon and 6 p.m.

Familiar examples of day-periodicity are the movements of growth and the variation in the leaves of many plants. These movements happen concurrently with the daily changes of light, especially in the case of leguminosae and oxalidaceae. At night such leaves adopt a pronounced attitude of sleep. Tropical leguminosae in the Philippines, for example Gliricidia Sepium, Leucana Glauca and Bauhinia, are so sensitive to light in this respect that on

warm nights the light of the full moon will cause them to open up from their sleep.

The opening and closing movements of the blossoms of many plants, which occur during certain hours of the day, are a related phenomenon. Linné was, accordingly, able to construct a timepiece of flowers. In the case of numerous compositae, as for instance the dandelion and the hawk-weeds, the blossoms open in the early morning hours and are tightly closed in the afternoon. Water lilies (Lymphaea) and numerous cacti also open up in the light. In contrast to this, many kinds of tobacco, such as Victoria Regia and Silene Noctiflora, are night blooming and open their blossoms only in the dark.

It has been observed that numerous honey flowers follow a day-periodicity in their production of nectar, both in regard to quantity and sugar content. Maximum production occurs in the morning hours, until about 9 a.m.. The bees, therefore, increase their visits to this kind of blossom at certain hours of the day.

In other plants there are noticeable fluctuations in the content of aromatic substances, etheric oils or alkaloids. The glucose content of the potato plant reaches its minimum between 4 a.m. and 8 a.m., its maximum between 12 noon and 4 p.m.. Tobacco has its highest nicotine content during the night. The etheric oil content of peppermint and lavender attains a maximum between 8 a.m. and 10 a.m., and of the camomile between 7 a.m. and 8 a.m..

The growth substances of plants are likewise subject to a daily rhythm. Maximum concentration occurs from 4 to 6 a.m..

These are revealed in manifold ways. A. Jores says: "Today we may state that there is hardly a quantity in the human organism measurable by laboratory methods, which is not subject to daily fluctuations. These do not occur arbitrarily but reveal a certain parallelism. There are two critical times for the reversal from maximum to minimum, or vice versa, namely the hours from 4 p.m. to 6 p.m. and from 2 a.m. to 4 a.m.. It has been possible to establish the independence by all individual rhythmic processes of any external factors and to demonstrate that these phenomena appear with absolute compulsion yet without being rigidly fixed."

Thus certain changes in the blood in the pulse and in respiration reach a maximum from midnight until towards morning which is true even if a person remains awake throughout the night.

The temperature rhythm attains its maximum between 5 p.m. and 8 p.m., its minimum between 2 a.m. and 6 a.m..

Oxygen consumption reaches its maximum at 5 p.m., its minimum from 2 a.m. to 4 a.m..

The content of white blood corpuscles reveals a maximum between 4 p.m. and 8 p.m., and a minimum from 4 a.m. to 8 a.m..

The blood sugar content of the blood is at its maximum towards the hours from 2 a.m. to 4 a.m. and its minimum between 4 p.m. and 8 p.m..

Examination of the leucocytes, which are present in the blood and fulfill important physiological functions for protection against infectious-toxic proc-

esses, reveals that the viscosity of these corpuscles in the living organism is subject to numerous fluctuations which vary with health and illness, with female menstruations, with atmospheric changes and with similar influences. A daily rhythm is also present, which attains its maximum at 7 p.m.

The maximum storing of glycogen in the liver occurs between 12 midnight and 4 a.m., the maximum storing of gall from 12 noon to 4 p.m.

The maximum evacuation of salt and water takes place between 7 a.m. and 10 a.m.

The adrenalin content of the suprarenal glands reaches its minimum between 2 a.m. and 4 a.m.

The functions of other glands of internal secretion depend likewise on the daily rhythm, as established by means of experiments with certain animals.

Daily periodical laws are also followed by the events of birth and death. Thus death curves reveal a maximum between 4 a.m. and 6 a.m.

The longer rhythms of the month and the year are also essential for human life. Numerous illnesses show a yearly periodicity, or appear more disastrously in seasonal fluctuations. Criminology and the statistics of mental disorders show an increased number of cases at certain times of the year (mid-summer).

Year-periodical rhythms play a part in numerous events and processes that are important for agriculture and forestry. The entire biological soil activity thus displays a close connection with the seasons of the year.

The degree of acidity of arable land is at its minimum during the autumn months and at its maximum during the winter months. Very acid soils show a minimum acidity in June and a maximum in March, while neutral soils have their minimum acidity in May and October, their maximum in February and August.

Year-periodical fluctuations can also be observed in humus content and nitrogen content. There is a minimum solubility of phosphoric acid in forest soil in the summer, a maximum in autumn and winter.

The activity of bacteria in soil reaches its maximum in the late spring and early autumn, with a rest in mid-summer and mid-winter.

Trees show varying content of certain substances in their individual organs and parts of wood according to the time of the year. Thus the outer part of the trunk has a maximum content of magnesium in April and a minimum in August, while the inner part reaches a maximum in August. The iron and chalk content of perennial plants undergoes periodical fluctuations in the course of each year.

The content of aromatic substances, active substances, etheric oils and alkaloids in aromatic, poisonous and medicinal plants is likewise subject to a yearly rhythm.

Especially manifold observations are at hand concerning the approximate eleven-year rhythm which is noticeable in the course of many natural phenomena. This periodicity comes to light cosmically in the varying activity of the sun and the increasing or decreasing formation of sun spots.

Geologically this eleven-year periodicity is manifest in the movement of various glaciers and their alternating progression and retrogression, in peri-

odical fluctuations in the level of inland lakes (Caspian Sea), and also in the varying thickness of mud deposits in rivers and lakes, such as those observed in Russia and North America.

Meteorologically, there are eleven-year fluctuations in the average amount of rainfall. A greater fall of rain occurs in those years which coincide with the sun spot maxima. Such curves have been clearly manifest in California and South Africa, among other places.

The geophysical aspect is familiar in connection with the eleven-year fluctuations of the northern lights and the earth-magnetic disturbances which occur along with them.

Biologically, the growth in thickness of trees and the attendant width of the annual rings show variations that correspond rhythmically to the dry and wet years and follow clearly a periodicity of about eleven years. The study of these laws could be pursued by means of the wealth of material available in the Sequoias of California as well as in European trees and, of late, also in South African trees.

The appearance of important insect pests likewise follows an eleven-year periodicity. Reports that are at hand of the years 1800-1825, describing the damage done by large forest pests, show that pest epidemics recur every eleven or twelve years and increase decidedly after approximately thirty years. With few exceptions the dates show a definite conformity with the sun spot maxima.

Higher animals such as birds of passage follow eleven-year periods in their migrations, as for example the Siberian prairie hen, or the jay which comes in augmented swarms from Asia to Russia and all the way to Central Europe at the time of the sun spot minima.

The influence of the moon forces were for a long time scientifically contested, but observations have now established the connection between monthly (twenty-eight-day) rhythms in organic life and the course of the moon.

Arrhenius was the first to discover the notable effect of the moon on the northern lights and the formation of thunderstorms. Here the maximum takes place when the moon passes through its lowest point in the zodiac. Arrhenius and also, later, Schuster, established that a considerably greater number of thunderstorms occur during the waxing phase of the moon than during the waning phase.

According to observations in the tropics the phases of the moon should be taken into consideration when timber is to be felled. These observations reveal that timber felled at the time of the waxing moon is too full of sap and invites the death-watch beetle, so that it is more quickly eaten away. In South America and on the South Sea Islands contracts frequently stipulate that wood is to be cut only when the moon is waning.

As has already been mentioned, the light of the full moon is capable of causing the leaves of certain trees and shrubs to unfold on warm, tropical nights (Philippines).

The phase and position of the moon at the time of sowing are significant as regards germination and growth. Today, already, the results of observa-

tions and experiments are at hand which show plainly this effect of the moon on plant growth.

Certain Crustacea change their shell with the change of the moon.

Investigations of certain English scientists disclosed that a particular kind of sea-urchin of the Red Sea spawns only when the moon is full.

We know that the Palolo-Worm, of the South Seas comes to the surface of the water to swarm in the same month each year and during the same moon phase. The Polynesian species appears in the night prior to the last quarter of the moon, in October or November, and the species of the North Atlantic acts likewise at the end of June or the beginning of July.

According to the results of observations on the coast of the North Sea and in Holland, the birth of cattle parallels the ebb and flow of the tide, which, as we know, is itself dependent on the daily lunar cycle. Births take place chiefly with the incoming tide.

According to Kirchhoff and Guenther the upper and lower daily culmination of the moon, which is reflected in the daily double tidal wave, calls forth a birth maximum of human beings. Dr. W. Buehler investigated 33,000 births, from the years 1927 to 1935, in the city of Freiburg in Bavaria and established the existence of a 29.5-day wave of births which parallels the phases of the moon. There is an increase in male births during the waxing phase and an increase of female births during the waning phase.