

*The Warmth Organism of the Earth**

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The last part of this article will be of particular interest to all who are concerned with the implications of expanding technology and with the forces that can offset or heal its destructive effects. The first portion is an invaluable source for teachers and those of a natural-scientific bent. It may also be stimulating to less specialized readers, who, in any case, are urged not to miss the last pages, should the first present difficulties.

The Editor

If we want to develop a better understanding of the earth's warmth organism we do well to start by reminding ourselves of some of warmth's special qualities and of the way it interacts with matter. We know that the earth is made up of solid, liquid and gaseous elements, of land masses, bodies of water and a mantle of air. Warmth is looked upon as a further, fourth element. We rank it above the other three because of its unique ability to permeate them. In no other case can two bodies occupy the same space simultaneously. But warmth can do this. And in achieving this spatial permeation, warmth shows itself to a great extent free of spatial restrictions. Or we can put it another way and say that it makes its appearance

* Based on a lecture to Anthroposophical physicians given at the headquarters of Weleda, Inc. in June, 1974. The footnotes, referring largely to books printed in Germany, may be obtained upon request from the Editor.

at the borderline of the physical-spatial, now entering space, now withdrawing from it.

It makes three kinds of connections with the physical world:

Heat — *conduction* is a phenomenon occurring mainly in connection with solid bodies.

Heat — *convection* takes place through the agency of air and water currents; they carry heat with them in the direction of their streaming.

Heat — *radiation* is something we experience in nature at the hand of burning or glowing substances or when the sun shines on snow-covered surfaces. Indeed, snow is a very special case in point, for its heat-absorption and radiation reach almost the same radiation-maximum as do black objects.

The sun is the foremost source of heat, supplying 99.98% of the earth's total heat resources. When the air is dry the temperature in lower strata of the atmosphere falls approximately one degree Centigrade for every upward rise of one hundred meters, while it rises on an average of three degrees Centigrade for every one-hundred meter descent through the solid earth, except where there are special features like volcanoes.

Water plays a decisive role in the functioning of the earth's warmth organism, for its thermal properties make it the great climate- and weather-regulator. One thinks in this connection of water's huge capacity for storing warmth and of the anomaly of its achieving greatest density, not at the freezing point, but at four degrees Centigrade, a fact of such far-reaching importance for every phase of life on earth that life could not exist were conditions otherwise.

Thanks to the detailed descriptions made by Rudolf Steiner on the physics of heat, its true nature can be read from processes in the atmosphere, where it finds reflection.

For this atmosphere is indeed the very realm where all thermodynamic processes take place. We know them by names

like isotherms, isobars, adiabatic changes,* isochors, and so on, using these terms to denote changes that occur in the air when temperature, pressure, entropy, and volume remain constant. We have the most striking direct experience of the ever-changing play of such warmth processes as these in meteorological happenings.

Patterns in Space:

Now let us turn our attention for a moment to the spatial differentiation into continents (lithosphere), seas (hydrosphere), and air mantle (atmosphere) of the earth's organism, noting that it applies equally to warmth.

At first glance this spatial arrangement may seem purely accidental. But a closer look makes us realize that there is order in it. Quite aside from the fact that water and land masses are so distributed as to make for a water-hemisphere to southward and a land-hemisphere to northward, the shape and placement of the continents themselves cannot be looked upon as due to chance. Rudolf Steiner described the continents to us as formed by the fixed stars, and he added that they float as it were on plastic-fluid bases, — a statement borne out increasingly by recent research. This calls our attention to a fact often lost sight of: the tilting of the earth's axis in relation to the plane of its orbit, a constant through the changing seasons. Year-in, year-out it maintains its alignment with the north pole of the heavens as a still point. This can only be taken as evidence that the earth is "fixed-star" oriented.

This position, together with the earth's rotation around its axis, determines the way the continental land masses are distributed. And the possibility of their displacement, as a result of man's interference, is also being talked of these days — a displacement brought about by an irresponsible technology that is already effecting marked changes of climate all over the earth such as could lead to the melting of the polar ice caps and thus cause massive dislocations. Since these would

* Temperature changes that take place without addition or loss of heat to or from the surroundings.

take place at a rate of change so much faster than that measured by geological ages, they would lead to corresponding speedy changes in the orientation of the earth's axis, which would bring it into a different orientation to the fixed stars and the sun's path.

There is a further spatial patterning of the earth's warmth organism between the poles and the equator wherein we distinguish tropics, subtropics, temperate and polar zones. This configuration is due to the spherical form of the earth and to the tilting of its axis. One can have an experience of the same patterning in a far smaller area, vertically rather than horizontally by, for instance, climbing 6,000-meter-high Mt. Kilimanjaro in Africa. The climatic zones through which one would be passing in the 10,000-kilometer stretch from the equator to the poles are the same as those one traverses climbing to a height of only 6 kilometers. Here we see a striking heightening of vertical intensity over that of the horizontal between poles and equator.

The atmosphere in still higher zones changes to very low temperatures, which increase once more to a warmth layer of approximately 0°C. at a height of about 50 kilometers. Then the temperature falls again to circa minus 80°C., only to rise with renewed vigor at yet higher levels. The uppermost layer (at circa 80-500 kilometers) is called earth's thermosphere. Thus we find that the warmth organism of the earth is similar to that of all living creatures in that it possesses a variety of sheaths, including an outermost warmth-sheath within which life is able to develop.

The vertical and horizontal patterning encountered thus over the entire earth is repeated with a great many variations in smaller features of the landscape: in woods, fields and cropland, rivers and lakes, all of which are separate warmth organisms and have their own individual warmth differentiations. Vegetation is the creator of these smaller warmth organisms. Areas where there is none turn into deserts subject to violent extremes of temperature, with burning days and bitterly cold nights.

Patterns in Time:

After this brief glance at spatial aspects of the earth's warmth organism, let us turn our attention to warmth processes that run their course in time, for it is especially these that are bound up with our concept of all life.

All sorts of time patterns are to be found here — rhythms encompassing both the longest and the shortest time-spans. Yearly and daily rhythms are the most familiar. We know them from the standpoint of many of their qualities, such as light and darkness, windiness and stillness, dry and wet periods, rising and falling motions. But they are all warmth-related as well and may therefore also be termed warmth-rhythms. They are meteorological and geophysical rhythms, which are often synchronized in turn with astronomical rhythms. Since, as time-patterns, they are a natural part of the same picture as spatial patternings, let us go on to study the interaction of these time- and space-aspects of the earth's warmth organism:

1) The "breathing of the continents." This refers to the great stationary high- and low-pressure areas which coincide to a considerable degree with the continents and oceans and which rise and fall in seasonal rhythms. The well-known Asiatic High is a prototypal stationary high. In winter it generates the Siberian cold air masses brought over to Europe by sharp east winds. By summer it has declined and become a pronounced low-pressure area, sucking up masses of moist air that cross the Himalayas and bring India its longed-for monsoon rains. European weather is determined by the stationary high over the Azores and by the Icelandic Low.

2) The arctic continents, consisting largely of ice, pulsate in tune with an annual rhythm: in March the sea-ice of Antarctica covers a surface 2.5 million kilometers square, which grows by September to an area of 19 million square kilometers, a 760% increase.

If we enquire into the cause of this breathing, this pulsation of the continents, we find it thus in seasonal rhythms which are themselves products of the earth's tilted axis. If it were not for this tilting, if, for example, the planet's axis were

vertical to the plane of its orbit, there would be no such thing as changing seasons. The days, instead of varying in length, would all be of the same duration. Any change in the position of earth's axis would cause considerable instability in the yearly rhythms. The fact that it is "fixed-star" oriented and that the distribution of the seas and continents is fairly constant means that the rhythm of the year achieves that living balance which makes an "organism" of the yearly cycle.

3) An open mind can receive the impression that there is an underlying building plan behind these phenomena, which are in turn linked with further phenomena of a meteorological nature resembling organs and organic functions built into the earth's warmth organism. At special points in the sun's course, such as its highest and lowest position at St. Johnstide and Christmas respectively, as also at the spring and autumn equinoxes, air pressure exhibits tendencies known as "reflections" of its curves. Let us take as example the air pressure curve of a given locality a few weeks before St. John's Day and keep on observing it for the same period of weeks beyond that date. We often find that such curves reflect each other. The second curve might also be called retrograde (cf. K. Stumpff, A. Schmauss).

Reflecting movements of this kind are well-known to musicians, for they are sometimes found in compositions of the great masters, such as J.S. Bach. There they provide a structural element, built up as though out of a higher system of laws into earthly time. Rudolf Steiner often called attention to the fact that spiritual laws work in a direction counter to the earthly time-stream. Structural concepts and laws of composition of a higher order than the earthly work into our world here, and we can discover and even measure them physically in annual rhythms such as those referred to.

4) What we thus encounter, particularly in annual heat and pressure rhythms, is met with again in the smaller compass of hourly and daily rhythms and much smaller spaces. I am referring here to something for which we might use a phrase borrowed from the yearly cycle, describing it as "the breathing of a landscape" in a single day's course. This

breathing finds expression in a host of rhythms, such as, for example, the double rise and fall of atmospheric pressure, or in striking regular changes in the wind's force and direction along the seacoast or in mountain areas. We notice the wind coming from the valleys early in the day, from the peaks at evening, and speak of morning on-shore and evening off-shore breezes. Marked temperature changes often accompany these alternations.

Now what accounts for such rhythmic changes? Here again we come across large-scale causation: the rotation of the earth around its axis, which explains sunrise, high noon and sunset and includes the whole range of thermodynamic phenomena in which we ourselves and all of nature participate, into which we are woven (we refer our readers here to Guenther Wachsmuth's very complete depicting of "the breathing of the earth").*

5) Turning now to a survey of the various major and minor thermodynamic processes involved in the behavior of the weather, we will hardly be able to keep on speaking of anything as regular as a rhythm except in the sense of seeing it as the product of overarching rhythms of warmth and cold in summertime and winter. However, this very changeability in the weather is the basis upon which the constancy of the earth-planet's warmth economy is built—a constancy essential to the preservation of all life on earth, every aspect of which depends upon it. Indeed, the living earth is itself involved in what happens in the weather, in that it is a biosphere affecting such meteorological processes as take place in the interrelationship of woodlands, cloud formation and precipitation...

6) Closer attention to what is happening in the weather discovers a law-abidingness there that is related to high- and low-pressure areas passing above us. We all know about the old rules and sayings that go to make up the farmer's calendar, and we may have heard too of the "key dates," that have been recognized from centuries of observation on the part of people whose work connects them more intimately with nature. Experienced meteorologists recognize them too, though

* *Etheric Formative Forces in Cosmos, Earth and Man* by G. Wachsmuth.

they use different terms and speak of singular happenings during the year's course that occur in meteorological elements such as temperature, air pressure, moisture content, wind direction and velocity, and so on, all of which are linked in a living interplay. Many of these may be likened to processes taking place in organisms, and many a meteorologist schooled by outdoor weather observation draws such parallels. P. Raethjen, for example, says in his "Dynamics of Cyclones" that

a cyclone has a typical life history with characteristic beginning, developing and ageing phases. It reproduces itself ... like a living creature in the sense that a young 'frontal cyclone' is born out of the womb of an adult 'central cyclone' ... Cyclones have a metabolic process without which they could not exist, for they constantly draw fresh air masses into their vortices and excrete other masses in their outward spirallings.

We must not forget that this 'dying and becoming' is an absolutely basic characteristic of cyclones. ...

Since the atmosphere behaves like a living creature, we see it truly only when we regard it and treat it as a totality. Phenomena which cannot be understood separately must be looked at in context as harmonizing aspects of a single whole.

August Schmauss has discovered in the year's course certain law-abiding principles, leading to the conclusion that the earth has a regulated warmth organism. He conceives the "dynamic year" as embracing the activity of meteorological elements: air pressure, temperature, and so on — shaping weather events in such an area as that between the western extremity of Brittany and the Shetland Islands to the north of Great Britain. This area is like a door through which Europe's weather blows in from the Atlantic Ocean. Schmauss uses the daily difference in air pressure between the two points as a reliable indicator. He takes the average of many (50) years'

findings on these dynamics of the atmosphere and comes up, contrary to all expectation, not with an irregular, haphazard line, but with a characteristic curve, which he interprets as follows:

The 'dynamic year,' as we might call it, usually begins on the 29th of September with a bottom low along the pressure gradient from St. Mathieu to Lerwick and with a minimal atmospheric activity familiar to many as a phenomenon of Indian Summer. From this point on, the gradient — and the zonal circulation with it — increases in a series of waves until it reaches the winter high, falling on the average on January 9th. The waves ... are the expression of a battle between summer and winter, from which deep winter emerges victorious. But the culmination of its activity is also the turning point in the battle. Here winter begins its retreat with a series of rear-guard actions that show up in wave-forms in the meteorological curves. Activity decreases until it reaches the annual low-point, which occurs on the average during the period from May 22nd to the 6th of June. This stretch of days quite often brings the first heat wave, for there is not much movement in the air, and as the sun approaches its zenith it can therefore make its radiation fully felt.

At the beginning of June this period of especially pleasant weather often ends quite suddenly. So-called summer monsoon weather starts ... with heightening atmospheric activity. Cooler west winds pour in, frequently bringing with them along the wide front thunderstorms like those of India, classic land of monsoons. The gradient remains high, though with wave-like weakenings, until September 16th. Then there is a sudden plunge to the autumnal minimum, matching in pace the swift upward climb from the spring minimum. The calendar of events is thus by no means a matter of chance; in-

stead, it actually deserves to be called a collective timetable.

... A meteorologist familiar with these facts sees in this scheduled taking-of-turns by bodies of air something in the nature of an orchestral score that indicates where an instrument comes in — though on occasion it may miss its cue. Even so, it is a great pleasure to be familiar with the score ...

... Our knowledge is quite equal to defining the type 'low,' but that is a collective term. Single lows are individuals, evidencing variations often brought about by very slight changes in the prevailing circumstances. We might, borrowing a musical term, call them variations on a theme. We marvel at the ingenuity of a Bach or Reger who could write any number of such at will. Our atmosphere is certainly a master at this too; it need not surprise us that meteorologists marvel as they encounter ever fresh variations of a 'low.'

... Perspectives in the direction of structural research open up here; there is reason to believe that we are dealing with something very similar to musical harmony in atmospheric events.

Here we have a meteorologist talking of musical form-elements in weather such as we also came upon as we familiarized ourselves with reflecting points in the year's unfolding.

We are led here, quite without our doing, to see a "design" in this "structure of the dynamic year," that of the pre-Christian and Christian festivals: Michaelmas, falling on September 29th, the day on which the impulse toward a climbing dynamic, starting from the minimum, sets in; the Christmas festival of earlier times, celebrated on the 6th of January (in the dynamic year, January 9th); Whitsuntide, from May 22nd to the 6th of June, a "movable" feast because it depends on when Easter falls — and finally we see this same design in the reflecting points of the four chief seasonal festivals, which we have already talked about.

And now we find ourselves able to speak not merely of a design in time, but in space as well. The dynamic year "unfolds" in low- or high-pressure vortices along the physical boundaries of the climatic zones, referred to at the beginning of this essay, *between* the wind or warmth zones. These are the so-called shear-zones, "sensitive" formations such as occur everywhere in nature and are built even into the organs of all living creatures. An example is man's inner ear, where the spiral pattern of the cochlea provides a sensitive receptor for musical and speech sounds. Formations of this kind are in every case zones where the slightest impact strikes upon "sensitive membranes" where cosmic forces can take hold. For the differentiated living being, earth, needs a corresponding world around it, as all living organisms do if they are to maintain their life. This world, for the earth, is the universe in its totality. The earth's "sensitive membranes" serve as entry ports for the forces of the sun and planets, which are able to project their ordering influences through them.

The tilted angle of the earth's axis gives it its "fixed-star" orientation. And this in turn makes it a sense organ with an unchanging focus in contrast to the ever-changing play of sun and planets. We now understand what Schmauss means when he speaks of the possibility of lows which are due to make their appearance at a given moment in the dynamic year missing their cue and failing to enter. This can happen when certain planetary positions bear down too heavily on the dynamics of the year's course.

Now let us make a brief summary of the findings we have arrived at thus far:

The stationary high- and low-pressure areas are built up and dispersed again by the way land masses and oceans are distributed and by the climatic zones which form a belt around the earth with their lines of contact. They are, in last analysis, the product of the tilting and fixed-star orientation of the axis of the earth.

The dynamic year is the outcome of processes taking place where climatic zones border upon one another in contact areas that are the product of the tilted position of the earth's axis, and are also the product of the path the earth takes in a year's course and of the influence of planetary movements. (A thorough-going study of the phenomenon of the "jet-streams" of the higher atmosphere would fully confirm and supplement this statement).

Order in Space, Time and Matter:

It is clear from even so brief a summing up that the earth's warmth organism cannot be explored and characterized purely from an earthly standpoint, but must be looked at in closest possible conjunction with the solar system as a whole.

Now let us go a little more deeply into the matter of the tilted position of the earth's axis. We will take as a guideline for our own investigation a view held by Goethe and often fruitfully applied by scientists:

No amount of effort enables us to succeed in fathoming the true nature of a human being. But if we observe his actual deeds, what he is "making happen," his character is immediately obvious.

Inquiring in this sense into the nature of earth's warmth organism, into what happens as a result of the tilting of earth's axis and of earth's motion in relation to the sun, we find that just these simple facts alone are enough to demonstrate that we are dealing here with a dynamic filled with real wisdom, a dynamic without which none of these facts — including the distribution of the seas and continents — could not have become a reality. A more thorough investigation of these facts will yield still more insights into processes of the earth's organism. We can feel it to be a pressing question whether this wise dynamic is not the underlying idea at work within the three factors already mentioned: the earth's tilted axis, its fixed-star orientation, and its rotation. We must ask whether there does not have to be a composer — the creator of the "score" and the time-patterning — to account also for

the spatial ordering through which the time-pattern is realized.

The sun takes four steps as it travels its full yearly round at an angle vertical to its path through the zodiac:

From the low-point on December 21st to the Equator on March 21st	23°27'
from the Equator on March 21st to the Tropic of Cancer on June 21st	23°27'
from the Tropic of Cancer on June 21st to the Equator on September 23rd	23°27'
from the Equator on September 23rd to the Tropic of Capricorn on December 21st	23°27'

Put another way, every 90° advance along its orbit corresponds to a vertical step of 23°27'.

Thus two components are involved in its motion whose relative lengths are approximately 4:1 (90:23.5—3.84:1). Thus the 23°27' tilt of the earth's axis has a threefold outcome:

- 1) A division of the year into four seasons;
- 2) a spatial division with a 4:1 or 1:4 ratio or relationship measured by the number of degrees in the angle;
- 3) a velocity scale in the same ratio of 4:1 as the ratio between the median orbital speed and the median speed of components involved in the ascending and descending phases of motion. In other words, the median orbital speed is approximately four times that of the annual vertical rise and fall.

So in the course of a year we can see a threefold configuration in time, space and velocity, in which, according to the tilting of the earth's axis, the ratio of approximately 4:1 crops up three times.

May we take the fact that the earth oscillates in about the same basic 1:4 ratio as that governing man's rhythmic organization in the relationship of breathing to the heart-beat as evi-

dence that the earth is a living organism? Does there not seem to be a similar design underlying both — a design in the dynamic year's course that we also saw reflected in the Christian festivals celebrated at the principal points of the four seasons? We are obviously encountering here the same being that works as the ordering agency in time and space and that has been looked upon throughout the ages as the architect of the universe, the master of all harmonious proportion. For it is the degree of the angle of the earth's tilted axis that establishes the life-supporting relationship of earth and sun and has brought about the resulting arrangement of the seas and continents.

If these questions are justified and fit the case, the architectural laws involved must apply to every aspect large and small, — as holds true of every living organism. Put another way, a fact of this kind should be ascertainable right down to the level of material composition, and we will offer evidence that this is so:

The speed at which sound waves pass through water is approximately 1400 m/s (meters per second), while the speed of their passage through the air is about 340 m/s. Here again we find the same 4:1 ratio. If we take into consideration the fact that the rate at which sound waves travel through a body depends upon its density, elasticity and specific warmth, it becomes obvious that this rate of travel depends upon its material make-up and structure. Where, as in the case of the ratio between air and water, the 1:4 ratio turns up, it is an indication that this ratio also applies to the way the innermost aspects of matter are interrelated.

Almost every property of water thus shows itself, in its relationship to warmth, as maximally suited to support the life of earth and its creatures. In this respect water is unequalled, as Henderson has shown: the temperature anomaly, as a result of which water reaches its greatest density at 4°C and grows lighter again at the freezing point, is the reason why solid ice does not sink, but floats, thus keeping the earth from becoming a totally lifeless block of ice.

Water's extremely great warmth-capacity is a chief factor

in the origin of ocean currents as it is of all meteorological and biological processes. Warmth-capacity shows a dependence upon temperature as illustrated by the fact that at 37°C water requires the least amount of warmth to become one degree warmer. At the surface of the earth the sunlight is transformed into warmth. The water vapor and carbonic acid which are dissolved in the atmosphere possess a material composition that allows the sun's light rays to pass freely through them onto the earth, but keeps the warmth reflected from the earth from radiating back out into cosmic space. This characteristic has often occasioned the earth's atmosphere being likened to a "greenhouse" within whose protective sheathing (earth's air, vapor and carbonic acid) life can flourish.

Interrelationships in Man, Nature, and Cosmos:

We can scarcely fail to notice that the human organism also embodies the same numerical ratio found, on the one hand, in cosmic and planetary interrelationships, and in those of substances in nature on the other. That this is a fact can be demonstrated in numerous examples. We will present some of them here, though they are not all taken from the thermodynamic field.

The 1:4 ratio so often met with in the design of the earth's organism reappears in man in the basic relationship of breath to heart-beat. We breathe about eighteen times a minute to the heart's seventy-two pulsations. As we contemplate the fact that man's airy and fluid organizations are founded on this pair of rhythms, it strikes us that the velocity of the sound-rhythm's passage through air and water is again approximately 1:4. This relationship is based on the innermost constitution of these life-substances (compressibility, density, specific warmth). To take the case of water's specific warmth — in other words, of its warmth-capacity — we find that 37°C is its minimum — that this is the temperature at which water can most easily be heated. The correspondence here to the normal temperature of human blood — 37°C. — is obvious.

Focusing our attention for the moment on the temperature 37°C. itself, we find it occupying almost exactly the Golden

Section position on the temperature range between the freezing and the boiling points. (The Golden Section makes its cut at 38% and 62% respectively of the distance between the two ends of a line or figure.) Can it be mere chance that the human form is likewise built on the Golden Section, — that the architectural idea embodied in it manifests this ever-recurring proportion — and that man's body is composed very largely of water and in accordance with this law?

The human breathing rhythm is a reflection of a macro-cosmic rhythm, that of the "Platonic Year," which spans 25,920 earth-years. For we breathe on the average 25,920 times in a day's course, and 25,920 is the number of days in a lifetime 72 years long. If we equate one day in the life of a human being with one indrawn and expelled breath, 25,920 such breaths will be breathed in a 72-year lifetime. Taking each earth-year as a single breath in the Platonic year, again 25,920 breaths will have been drawn in that period. The Platonic year covers the number of earth-years it takes for the vernal point to make a complete circuit of the zodiac. Thus we may say that solar laws, too, are to be discovered in our breathing. The correspondence between man's and the earth-organism's design and physiological processes permits us to see that both are based upon the same idea, right down into the very make-up of the materials of which they are composed. It is clear that man and earth are both products of a condensation process out of elemental warmth. Men of earlier times were aware of this correspondence, and for that reason called the earth "Adam Cadmon."

Warmth as a Threshold Phenomenon:

Since warmth always makes its appearance coupled with matter in a solid, fluid or gaseous state, no independent being is ascribed to it. However, great quantities of heat are required to bring a solid body into the fluid or the gaseous state. This is simply to say that a "body" is the closer to pure warmth the further it progresses beyond the gaseous condition. This also means, of course, that its hardness and shape, its solidity and structure, have disappeared and "gone up" in

heat. Or we can just as well put the statement the other way around and say that a solid body is one that has gone through a condensing process out of heat, passing through gaseous and fluid stages. This is a process observable in the evolution of spiral nebulae, fixed stars and planets as stages of increasing condensation.

Warmth thus comes to be recognized as having independent being and occupying a borderline position where the realm of the as yet immaterial — subject to spiritual ordering, structure and ideas — passes over into the physically perceptible world.

The opposite obviously also holds true: Warmth, as the fourth element, stands at the transition point from the physical-material world over into the realm of ideas. And since man and world both bear the stamp of the same "structural concepts" — concepts of which man can develop awareness — the question naturally arises as to how the two relate to one another, what their effects on each other are, including modern environmental problems. The relationship and the problems it gives rise to are so obvious as to require our developing an understanding of the earth's warmth organism. As we proceed to investigate man's interaction with the world around him it will be clear that the great environmental problems can really only be solved by man's re-connecting himself with the structural idea on which both the world and he himself are built, — re-connecting himself, in other words, with that being from whom both once issued. This means acting in harmony with earth's building-plan. Then what he does in serving the earth will further his own potentiality for a healthy higher development.

Dis-ordering Tendencies in Technology:

An extremely important thermodynamic concept, one that plays a decisive role in technology's dead world, is that of "entropy." Entropy is a measurable degree or level in a condition found in irreversible thermodynamic processes, but because it has to do with the relationship of energy to temperature it is not easy to imagine. According to the second law of

thermodynamics every irreversible process is accompanied by an increase of entropy. When heat is used to generate electricity and to drive machinery, some heat is always lost; there is no such thing as 100% efficiency. Thus an increase in "waste heat" is always taking place — a situation adequately described by the term "entropy." Practically speaking, almost every technological process is accompanied by an increase in entropy. As it goes on accumulating, it approaches a final value, a state of equilibrium no longer subject to change. All technological processes, then, run at an energy gradient, and entropy characterizes the reduction of an ordered state within a system to a less ordered one. Or, as Hagen puts it,

Entropy is the accumulating of a useless by-product made in the process of converting a system's energy or material components.

We could also couch it in statistical terms and say that an increase in entropy results from progressing from an ordered to a less ordered state, from the improbable to the probable.

An example may serve to bring out the point of this discussion of entropy:

Every irreversible process, left to itself, takes place in one direction only. Everyday experience demonstrates this. Molecules of a perfume dispersed in the air never go back of their own accord into the open perfume bottle.... They are always in favor of dividing up a big estate, but they will never willingly agree to accumulate a large estate for the benefit of a single favored individual, in this case the perfume bottle. (R.W. Pohl, Thermodynamics)

Order-creating Forces in Man and Universe:

Since, nowadays, such technological-scientific concepts as these are frequently imposed on the social structure, and every realm of life receives their imprint, the laws of breakdown, in the sense of ever-increasing entropy, have made themselves widely felt within the whole social structure of mankind. We

see their life-destroying effects everywhere about us in the living environment.

And now, at this point, the opposite question immediately suggests itself: What happens when spiritual entities or human beings join forces to carry out some statistically unlikely action, — an ethical one, perhaps, one in which there is a building up of order instead of breakdown? In such cases, laws of death, decomposition processes, structure-destroying functions are overcome. The opposite of entropy sets in, negative entropy, to be termed accordingly negentropy. Is not a new kind of questioning indicated here — whether, for example, there exist realms in which lifeless laws like that of the preservation of power, energy, matter, the logical conclusion of which had to be the concept of entropy, are no longer full / valid? That such questions are being raised by biologists and researchers in the thermodynamic field is attested by the presence, in recent professional literature, of reports like those of Riedl or Hagen. They discuss especially the work of Morowitz, Forester-Meadows and Glansdorf-Prigogine. The beginnings of this work date back to the Forties, when Prigogine started concerning himself with thermodynamic questions about biological systems.

A picture very different from that obtained in the first half of the present century has come of this. Riedl says:

... The overall functioning of the biosphere promotes an increase of entropy, a quite extravagant one, at the cost of the flow into cosmic space of solar energy. However, local processes can create ordered patterns, such as are found in rotifers, in sonnets, or in Mona Lisa's smile... One can call a living system a reservoir or storage place for negative entropy of wholly unimaginable proportions.

When, nowadays, someone speaks in such connections of "the sun as the source of an in-streaming energy-flow and as the fountainhead of negative entropy," this must necessarily lead in consequence to new "revolutions in the physicists' conceiving of the world" and in the whole field of biology during

the course of the next few decades.

Let us keep firmly in mind that

Entropy indicates the degree of disorder existing in a physical system. . . . (Riedl).

Where orderly patterns are built up, entropy decreases and energy is stored, as for example in biological systems on the most varied levels. But this means finding oneself in the realm where the laws of life obtain — and on sociological terrain.

The concept of negentropy as a standard of measurement for degrees of order has been fully accepted in thermodynamics,

although for a long time it met with doubt and opposition. During the last decade, however, it finally crossed over into the field of biology, where its application is particularly important (Riedl).

Developments of this kind in modern science have yielded fruits of insight proffered by Steiner more than half a century ago as products of spiritual research. The "opposition" they met with among the scientists of the period was intense indeed. . . .

Steiner spoke in numerous published lectures of a place where the doctrine of the preservation of power, energy and matter — which gave rise to the concept of entropy — no longer applies, namely in man himself. He states that matter is destroyed in man. Nutritive substances disappear and new matter is created, coming into being again out of the warmth that took them up, and this the more decisively the more enthusiastically a person cherishes moral ideals and an ethical ordering of life. . . . Here we have the essence of negentropy, expressed in somewhat different terms. For enthusiasm and active support of ideas, of ideals — in other words, of a creative "order" — are the opposite of decline, of entropy, which rules in the dead world of machinery.

So we may say that negentropy enters the picture wherever order is created out of chaos, as in creative thinking, in man himself. Of course our *thought-content* is drawn from the

world outside us. But in the way we connect and order thoughts we are not abiding by the dead laws of physics, — we are free. Matter comes *freshly* into being in man's organism, in harmony with the formative forces of his patterning. These are characterized by Steiner as forces of buoyancy, not of a declining potential. The laws of the "sun-space" ("fountainhead of negentropy. . .") reign here, where, according to Steiner, there is no matter, only negative space, whence order-creating moral forces work out into the planetary system to make it an organism. And this is true also of earth's warmth organism as we experience it directly in the patterning and "score" of the dynamic year.

If man and earth are built on a pattern with a common basis, must there not also be places in the earth's warmth organism that harbor negative entropy? These would have to be areas governed by sun-laws, since the sun is the source of negentropy. And the answer to this question is affirmative:

1) We have such places in the earth's warmth organism plainly in view during every thunderstorm. Recent investigation of the origin of lightning has uncovered the fact that there is a place within the earth-realm ruled by sun-conditions; there is even talk of the possibility of anti-matter being generated there. We are told by the spiritual investigator that the highest hierarchies of spiritual beings are at work in the phenomenon of lightning. Here, then, is a realm of order-creating beings manifesting themselves in "cleansing and clarifying" thunderstorms. The findings of spiritual science and natural science could converge here. Even though modern thermodynamics has not as yet included man in its research, the findings and concepts of thermodynamicists and biologists are already touching upon the secret of sun-space, described by Steiner as negative contrasted with terrestrial space and regarded today as a source not only of energy but of negentropy as well.

Steiner does include man in the picture, speaking of the fact that while thoughts are being formed — in the process wherein the will rays from the warmth realm into that of thought — "lightning is really flashing on a microcosmic scale."

There are three spheres in which man creates negentropy:

in knowledge created by will's activity in the thought-realm;

in art through the creating of ordered patterns in music, painting, and so on;

in moral ideas possessing the power to create social order.

These realms are found to be those involved in the three areas of developing human culture: truth, beauty, goodness — in other words, in science, art and religion.

2) Negentropy in the biosphere: Ordering forces, called by Anthroposophy formative forces, are at work in every plant, in every organism, even in the tiniest animal. In Steiner's spiritual science these forces are not merely named, each is exhaustively described in its unique characteristics and way of working. The earth's plant cover represents a realm, a level, where negentropy reigns, and a process similar to the play of lightning in thunderstorms or to man's thought-activity takes place when plants are pollinated (Steiner).

So negentropy, a living system of laws stemming from order-creating elements in space and time, is to be found

in the warmth organism of the earth; in the year's course with its procession of Christian festivals and in the thermodynamic processes that take place in thunderstorms;

in man: in the "striking in" of ordering ideas into the forming of thoughts out of the warmth element;

in everything organic, and most especially in the plant cover and each single plant.

Perhaps we may quote a saying of Friedrich Schiller that draws its illumination from the realm we are presently discussing:

*If you seek the greatest and highest
The plant can instruct you:
What it is, will-less,
Be that yourself with a will.
That's the key!*

It is clear from the foregoing that the force at work in what takes place in these three realms is the same order-creating sun-nature that is active in the orchestration of the dynamic year and in earth's warmth organism.

As we contemplated the design of the warmth organism described above, we enquired into the spiritual being that found expression in it. It is pertinent, in view of the breakdown taking place everywhere about us nowadays, to enquire into the nature of the causative agent here as well.

To find the answer to this question is also to discover solutions to problems of planetary extent that have arisen for the first time in the history of technological developments. For despite the tremendous contributions which technology has made to human culture, man has reached a point in his advances in it which permits him both to rule over nature and to plunge it into chaos and confusion. There is no question that far-reaching changes in the earth's warmth organism have been brought about which are already showing up in drought disasters and shiftings of climate. Air pollution, extending far up into the high atmosphere, has been increasingly cutting down the amount of sunlight reaching the earth. Vapor and combustion products emitted by jet planes have built up curtains of ice particles several meters high which are hanging in the upper atmosphere over the Atlantic and probably over other regions also; they continue building up every minute of the day and night. "Civilized" areas of every continent are covered by inconceivable amounts of smog which are being added to without let-up. Rivers, lakes and oceans are being similarly befouled. And here we are witnessing the start of a new episode in the human drama: the heating of bodies of water by the waste heat discharged from nuclear power plants.

The question was, what lies behind a technology based

almost exclusively on an increase in entropy, — governed, that is, by the laws of death? What *happens* in consequence in nature and the human race? Let us listen to the comments of some of the scientists on this point:

If we apply this definition as an adequate standard of measurement for energy and entropy, the analogy to money suggests itself in relation to the concept of energy. In relation to the concept of entropy, characterized as it is by a disorganizing tendency to achieve a state of equilibrium no longer capable of change, the analogy to environmental pollution suggests itself.... (Hagen)

As we know, our power to destroy negentropy in larger complexes has been put to use thus far only experimentally, but we are constantly destroying smaller entities. Oftentimes we become aware of the existence of some orderly pattern of relationships only when it has been annihilated.... Too dense and demanding population centers are the main cause of the chaos that is being wrought in such localities by over-use of energy.... What is lost to the biosphere is not energy — more can be generated — but the never-to-be restored larger environmental entities or biotopes that have been reduced to chaos.... And the growing use of energy is sweeping this order away at a constantly accelerating pace.... (Riedl)

We see that counter-forces are at work here on the warmth organism of the earth.

After what has been said thus far on the subject of earth's warmth organism, we can take it as almost symptomatic that technology and the economy interwoven with it have brought things to a point that can perhaps be described as a zeroing in on the sensitive spot in that organism. Geologists talk of climatic changes causing such a displacement of ice masses in the polar regions as a result of technological developments and

over-use of energy that there is a distinct possibility of the earth's axis shifting in the foreseeable future. And if we take the warnings of responsible thermodynamicists and geologists quoted here as symptoms of the path which is being traveled by present-day humanity, we will have to say that the perspective Steiner saw ahead of us decades ago has unfortunately become actual fact, as he said it might when he was speaking about order being destroyed and civilization plunging into an abyss unless new spiritual impulses were taken up and put into practice, and science, technology and business reconsidered their ways.

Man, Caretaker or Destroyer of the Environment:

In providing access to the formative ideas underlying the design of man and earth, Steiner also laid the foundation for rescuing the warmth organism of the earth and of man himself — foundations which are of vital importance for our time. For it has become possible for man not only to turn nature into a dead technological device but to be so affected by the environment he has built up around himself as himself to be transformed by it, and this in line with the system of laws governing decline and the dissolution of created order. Having been given insight into the idea on which both he and the universe are founded, he is in a position to become himself the caretaker of the earth's organism. In Steiner's teaching about the formative life-forces he provided indications for a technology of order. For these forces are order-creating in the sense of negentropy, being related to the sun which is the latter's source. Steiner spoke of enthusiasm for moral ideals, which have their origin in our warmth organism and the soul — ideals related in their spiritual substance to the sun-space, for spatial separation does not apply in this realm of spiritual patterning. Steiner speaks on this theme in lectures given in December, 1920:

... Just think how our sense of responsibility is heightened by a realization that if there were no one on earth with a heart fired with enthusiasm for true morality, for spiritual ethics, we could not con-

tribute to our world's continuance. This shining light which we generate on earth radiates effects out into the universe. We do not presently perceive how human morality rays out from the earth.... This radiance goes out for a certain distance only and is then reflected back again, so that we have here on earth the reflection of what man has thus rayed out. Initiates of every period have looked upon this reflection as the sun. For as I have often said, the sun is not a physical entity. What astronomy sees as a fiery ball of gas is simply the reflection of a spiritual element that makes a physical impression....

With modern thermodynamics beginning to speak of the sun as the source of neg. entropy — in other words, as the source of order-creating forces — and with the question arising as to how thermodynamicists and biologists conceive a therapeutic approach to the present situation, let us hear what one of them is saying:

The existing order has to be protected. For order builds on a foundation of order. And we must go on vigorously creating further order. And we are well acquainted with the cultural variants of negative entropy: humaneness and social order, science and justice, the arts and research.... (Riedl)

But where will we get the forces and knowledge with which to create this new order, since — in the last analysis — the situation now confronting us was brought about by applying the science thus far available to us? Is it not high time that we dealt seriously with facts learned from the science of spiritual ordering forces? If the sun is the source of negentropy, the final step in knowledge and action should be taken with courage and consequence: it is we ourselves who make our destiny. For the enthusiasm we engender in the pursuit of art, science and religion is the same element that rays back to us reflected from the sun, the fountainhead from which man's and the earth's warmth organisms draw their nutriment.

Now that we have had an entropy-oriented technology for a century, we should turn our attention to the order-creating forces of negative entropy, of the sun's living system of laws, both out there in the universe and in our moral impulses.

There is reason indeed for enthusiasm and gratitude to Rudolf Steiner and his life-work, which becomes of ever more decisive importance. And there is reason too to be grateful to many courageous modern scientists who have turned, in the face of opposition and skepticism, to new, creative ideas for the preservation of life upon the earth. We must hope that the consequences of their insight will be drawn by many others and that the concrete contributions of spiritual science to a new order will be understood and applied. Decisions of will rather than of knowledge are what is essential now, for the knowledge is already there. So it remains for every man's free will to choose the forces with which he will ally himself — those of entropy in the sense of decline or those of redemption in the sense of negative entropy, negentropy, ascent.

Translation by Marjorie Spock

Whitsuntide 1975

Rex Raab

Everywhere a flower grows
and is seen by human eyes
— daisy, daffodil or rose —
is a part of Paradise.

It is shielded from the Snake,
it is fended from the Fall
by a secret crystal lake
and a fiery golden wall.

Heaven and earth shall pass away,
but a blossom, leaf and stem,
rooted in the light, shall stay
in the New Jerusalem.