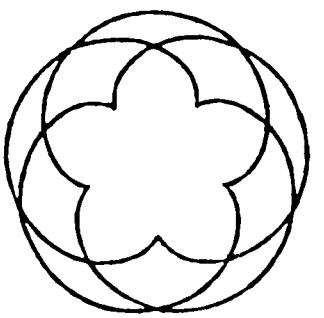
SCIENCE FORUM



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The editors would be pleased to receive such items for consideration (typed, preferably in double-spacing).

Please address all communications to: Science Forum, c/o Rudolf Steiner House, 35 Park Road, London NW1 6XT

Anthroposophy is the name that Rudolf Steiner (1861-1925) gave to his Science of the Spirit. This has given birth to new perspectives and practical activities in the arts and sciences, in medicine, agriculture and education. Information on Anthroposophy and the Anthroposophical Society can be obtained from Rudolf Steiner House.

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S C I E N C E F O R U M No. 8
(SPRING 1989)

C O N T E N T S

E D I T O R I A L

In this issue of Science Forum John Wilkes describes practical and theoretical aspects of one of the latest developments in Flowform research - the Sevenfold Cascade. Graham Calderwood investigates the cosmic rhythms which may lie behind the variations in the shapes of plant buds observed by Lawrence Edwards and reported in Science Forum Nos. 5 and 7 - using Fourier Analysis to reveal possible hidden or inhibitory factors influencing the observations. Also in the field of botany, Margaret Colquhoun describes a comprehensive Goethean approach to the classification, characteristics and properties of plants, with special reference to the Ranunculaceae.

Several aspects of modern physics are discussed - including quantum mechanics, relativity and the philosophy of science, while Howard Smith describes an approach to chemistry from the vitally important, though often neglected, standpoint of macroscopic phenomena and direct experience.

CAPILLARY DYNAMOLYSIS

The discussion on capillary dynamolysis continues, but we are unable to include a further report in this issue. The method, with its general, medical and scientific associations, has a special place in the Anthroposophical Movement. The work has also been reported more widely, in general and professional publications. Reference to the work of L. Kolisko, M. Engqvist and A. Fyfe has been made in Science Forum Nos. 4 and 7: this work together with the experimental observations of W. Steffen reported in Science Forum No. 4 is of great value but some co-ordination is needed before its significance in relation to the fundamentals of Anthroposophical science can be determined. Contributions to the discussion will be welcome.

THE BENVENISTE AFFAIR

Experiments carried out by Jacques Benveniste at the University of Paris South claim to show that homoeopathic solutions, at astonishingly high dilutions, are able to produce biological effects. The results were published in Nature, Vol. 333, p. 816. However, the Editor of Nature was not convinced and the journal sent a team of investigators to Benveniste's laboratory. They came to the conclusion that the experiments were a delusion. The details of the story have to be read to be believed (see New Scientist, 14 July 1988 and 4 August 1988). Some interesting points arise from the ensuing discussion:

What is meant by 'an independent researcher'? If one with an enthusiasm for homoeopathy is to be regarded as biased, does the same apply to one with an enthusiasm for allopathic medicine?

If repetition of an experiment fails to confirm the original result, it does not mean that the first result was necessarily at fault; additional factors as yet unrecognised may be involved.

"Benveniste speculates that water can somehow retain a memory of the anti-body's shape, even though the molecule itself is no longer present at high dilutions. Water could act as a 'template' for the molecule..." (New Scientist, 14 July, 1988, p39).
[See also 'News from the Goetheanum, Vol. 9, No. 6, p.5]

Dr. BOCKEMÜHL'S WORK ON HEREDITY

Progress on the new approach to heredity initiated by Dr. Bockemühl (see Science Forum No. 5) is currently being made at the Goetheanum, Dornach. A report will be included in the next issue of Science Forum.

THE COMMITTEE OF THE SCIENCE GROUP

We welcome two new members to the committee: Stuart Brown as an additional member, and Bruce Jackson to succeed Robert Kersey Green as Treasurer. Robert had been our treasurer since the Group started in 1979 and we are very grateful for his services and loyal support over this period.

NOTE. June Woodger's address given on page 1 of Science Forum No. 7 has now changed to: 1 Riverside Cottage, Deepway, Sidbury, Sidmouth, Devon EX10 0SA.

ERRATUM

The attention of readers is drawn to a correction required on page 20 of Science Forum 7:

The Figure designations *"Fig. 8 (Freely after Schwenk)"* and *"Fig. 9 (After AJW)"* should be transposed.

CHEMISTRY WITHOUT ATOMS ?

HOWARD SMITH

THE PROBLEM

It is with some hesitation that I write this article; as a professional chemist living in the age of atomic power, quantum pharmacology, X-ray diffraction, ion-emission microscopy and so-forth, to place a question mark against the whole atomistic way of thinking is perhaps straining the good will of the scientific community. How could anyone doubt the fruitfulness - and hence the implied validity - of the atomic theory today? As Nobel Prize-winning physicist Richard Feynman puts it:

"If, in some cataclysm, all of scientific knowledge were to be destroyed, and only one sentence passed on to the next generations of creatures, what statement would contain the most information in the fewest words? I believe it is the atomic hypothesis (or the atomic fact, or whatever you wish to call it) that *all things are made of atoms - little particles that move around in perpetual motion, attracting each other when they are a little distance apart, but repelling upon being squeezed into one another.* In that one sentence, you will see, there is an enormous amount of information about the world, if just a little imagination and thinking are applied." (1)

despite such enthusiastic endorsement, I would like to place the atomic theory in the witness box and examine it from two main viewpoints. Firstly, its ***use.*** Is the use of the theory in education always as helpful as we imagine? Does it clarify and sharpen the mind and senses? Does it really encourage logical thinking?

In elementary chemical education, the atomic theory is introduced more or less in the form given it by Dalton in the 19th century, and used to explain simple phenomena such as diffusion, chemical formulae, and the fixed ratios in which elements combine. Perhaps there is nothing wrong with this, but it has to be said that such phenomena do not by any means require the atomic theory to explain them, as I hope to show. And it is always painful to see a complex theory whittled down to slightly less than bare essentials, clumsily handled by chemistry and physics pupils to "explain" straightforward observations which don't really require it.

Such a method of education leads to a confusion of observation with theories, evident in much school science. For example, in one school physics textbook we read, in connection with Brownian motion:

"When the extremely small and evenly-sized particles of a suspension are viewed under a high powered microscope, the particles are observed to be knocked about in a haphazard manner by the water molecules."

Do we REALLY observe water molecules? Young pupils can be forgiven for believing so. Such statements abound in school science books, but occasionaly the true cart-and-horse order is recognised, and the phenomenon is taken as merely indicating the theory as a possibility. The dangers of confusion are recognised in the introduction to the Nuffield A-level physics course, where we read:

"Facts in physics are pretty well always loaded with theoretical interpretations."

My objections to the atomic theory on the grounds that a simplified form of it is spuriously employed (or misapplied) in basic education must seem, I admit, rather thin. But could it be that, educated to think in this way, the spurious use of atomic theory ad nauseum becomes habit-forming, and carries over into more advanced science? Is there a point at which the theory is REALLY indispensible?

My second main objection comes from the standpoint of a spiritual view of life, i.e. a view of the Universe in which everything that we can become aware of - including physical matter and the laws which govern it - ultimately derives from the activity of conscious (or perhaps one should say super-conscious) spiritual beings. This contrasts with the materialist/reductionist mode of thought, which attempts to explain all phenomena in terms of simpler phenomena, and finds the explanation for all things in an irreducible world of minute particles, invisible to man, moving according to immutable laws. No values, purpose or consciousness here - merely blind chance and chaos.

Thus, for me, the second main question arises: what is the reality of the atomic theory in all its ramifications? Is it merely the product of the reductionist habit of thought, or is it - despite its origins - a true representation of reality? In recent years there have been numerous attempts to show that the two views are not incompatible; that purpose and moral value overlies molecular chaos. I remain unconvinced; can we REALLY see the workings of a Divine mind by contemplating the theories derived by a mode of thought which aims in the opposite direction? The particle approach to nature has been of little or no use in all those practical human endeavours in which a holistic and spiritual approach is essential.

For example, orthodox science has so far been at a loss to elucidate the working of homoeopathic medicine, whereas it has greatly helped orthodox medicine, which concentrates much more on the physical organism. Theory only supports practice of the same genre.

ORIGINS OF ATOMISM

Let us now see how the atomic theory was introduced into chemistry, and what its contribution has been. The father of the modern atomistic viewpoint was John Dalton, who, from around 1800 onwards, achieved great success in applying ancient Greek ideas to the interpretation of experimental data accrued over the previous century. Starting from an assumption that has its origins in Epicurean metaphysics, namely that matter is made of tiny indivisible chunks ("atoms"), he assigned properties to these in order to explain the properties of bulk matter.

Thus, since matter has mass, atoms must have mass; since the total mass appears to be conserved in chemical changes, we must presume that atoms, likewise, can be neither created nor destroyed; since a pure element is chemically the same, no matter what its source, and different from all other chemical elements, we must assume the constituent atoms to be likewise identical, yet unique for each element; since elements combine in fixed proportions to give unique compounds, we presume that the molecules of such compounds are, rather like the atoms of elements, identical, but different from molecules of all other compounds. Moreover, the fixed proportions can be explained by assuming the atoms combine in small whole-number ratios.

Hence, the study of matter enabled Dalton and others to deduce the properties of the inferred entities, simply by transferring observed macroscopic properties into the supposed unobserved microscopic realm. This achieved very little; instead of thinking directly in terms of phenomena (i.e. the empirically-discovered laws of chemistry), an extra, hypothetical entity was introduced: the atom, with its unique mass for each element.

ARE INFERRED ENTITIES NECESSARY?

From vast quantities of experimental evidence, one can abstract the unit masses of elements which react together: their "reacting masses".The scale on which these masses are placed is purely arbitrary, the main thing being the ratios. At one time, the unit was taken as one gram of hydrogen but the current standard is 12g of carbon. However, for the purpose of practical calculation, it is not necessary to view these masses as relative masses of atoms (hence giving the table of "Atomic Weights", or more accurately, "relative atomic masses"). It is quite possible to deal directly in the reacting masses.

As an example, consider the practical problem of working out the ratios in which carbon and oxygen combine to make carbon monoxide. The reacting masses are 12 and 16 respectively, hence 12g of carbon (or more generally, 12 of ANY mass units) combines with 16g (or whatever units are taken) of oxygen.

This very simple process becomes more complicated if we view the empirically-derived values as relative masses of atoms. To make carbon monoxide, we require a 1:1 ratio of carbon and oxygen atoms. But their masses are in the ratio 12:16. Hence we must weigh out the elements in a 12:16 ratio to ensure the correct number of atoms. We achieve the same result, but via a longer route involving inferred entities.

The whole concept of the "mole" (the S.I. unit of "amount of substance") as the mass containing an agreed standard number of particles (e.g. 12g of carbon) can, for practical purposes, be replaced by the concept of the unit reacting mass of an element. It is a simple matter to extend this to compounds; the sum of the reacting masses of elements in a compound can be called the compound's unit reacting mass, rather than its "molecular weight". For example carbon monoxide in the above example would have a "reacting mass" of 12 + 16 = 28.

As we know, carbon and oxygen form a second compound, in which the elements combine in a 12:32 ratio. The chemist explains this by assuming that 1 atom of carbon may combine with either 1 or 2 atoms of oxygen, giving carbon monoxide or dioxide respectively, as shown by the formulae CO and CO_2. But such assumptions are not necessary; chamical formulae may be interpreted more directly as the ratio of reacting masses present in a compound. For example, CO_2 contains 2 reacting masses of oxygen, whilst CO contains only one. There is no reason, in principle, why the numerical relations between masses should not be grasped *directly*, rather than by attaching them to supposed particles.

Such simple considerations can be extended - with suitable refinements - to cover all chemical formulae and equations.

GASES

Where gases are involved, it has been found that the "reacting mass" (or one "mole") of any gas occupies approximately the same volume, namely. 22.4 litres at standard temperature and pressure (stp). The study of gases has historically contributed much to chemical theory, through the work ofsuch giants as Avogadro and Cannizzaro. Indeed, "Avogadro's Hypothesis" - that equal volumes of gases contain the same number of particles - was

regarded as a great cornerstone leading to the consolidation and further advance of the atomic theory in the 19th Century. And yet it is quite possible to develop chemical theory without Avogadro's interpretation which really adds nothing of value to the phenomenon.

For example, it is a matter of experimental fact that the standard volume of 22.4 litres of, say, oxygen at stp contains *two* reacting masses of the element. The atomistic interpretation - that oxygen consists of diatomic molecules, formula O_2 - adds little to the experimentally-deduced fact that oxygen gas behaves more like a "compound" with itself, in that it can be split up into irreducible elemental oxygen.

NUMERICAL RELATIONSHIPS AND INFERRED ENTITIES

These few primitive examples can be refined and extended to apply to more complex phenomena. Ultimately, it is a question of how we regard the numerical relationships between masses and between gas volumes, which we find in all chemical reactions. Can we grasp them ***directly*** as "primary phenomena" (to use Goethe's term), enshrined in the laws of chemistry? Or must we attach them to inferred entities? The latter is rather as if a mathematician could only grasp, say, the number "five" by seeing 5 beads on an abacus.

Similar conclusions to these have been reached by Tricker (2) who says that, as an "explanation" of basic chemical phenomena, inferred entities contribute nothing, and one can more conveniently construct concepts directly out of sense-data. Indeed, Tricker goes on:

> "The synthesis of the theory of chemistry directly out of sense-data has the advantage of rendering it independent of inferred entities, the existence of which is bound to remain associated with a certain amount of doubt. Should evidence accrue from some other brance of science, for example, which led to the questioning of the reality of these entities, the theory of chemistry would remain unaffected. It would be capable of being constructed without reference to such entities at all. The theory of chemistry would then be directly verifiable by the senses and would be quite unaffected even if the names of atoms and molecules could never be mentioned at all....The formula for sulphuric acid will remain H_2SO_4 whatever explanation is put forward to account for it."

INFERRED ENTITIES AND SCIENTIFIC PROGRESS

What, then, is the justification for including such inferred entities in scientific theory? Tricker says the only justification is that they may lead to further knowledge..."but in the end, like the scaffolding by which a building has been erected, it becomes unnecessary as soon as the building has been completed". By contrast, the logical constructs out of experimental data contain nothing beyond themselves, and cannot lead to further predictions and new knowledge.

As an example, Tricker cites the kinetic theory of gases, developed in the 1860's - a purely theoretical treatment which relates the observable properties of gases (pressure, volume and temperature) to the chaotic movement of the constituent atoms. However, while it is true that this theory did unify all the gas laws, it did not, as Tricker seems to suggest, lead to any new laws. The most that could be said is that if any gas laws had *not* been discovered at that time, then the kinetic theory would certainly have predicted them.

As soon as inferred entities are injected into an otherwise empirical construction of sense-data, one is adding properties, some of which may not be given by the data. These extra properties can lead to predictions, some of which may be verified, and thus new knowledge can arise. However, as Tricker notes, "It is impossible to say whether predictions are frequently confirmed or not; failures are rarely recorded." However, through this process, science has advanced.

This raises an important question of methodology: Is it possible to stick to logical constructions, not confusing phenomena with superfluous concepts, and yet develop a system which could fruitfully lead to new areas of knowledge? This, of course, is what the Goethean approach attempts to do, but that is not my purpose here.

MORE COMPLEX PHENOMENA

Returning to the main question of this article, what IS the reality of the atomic realm? Elementary chemistry can certainly be developed without recourse to inferred entities, but what about more sophisticated phenomena, especially those involving radioactivity? This is not the place for a systematic and thorough evaluation of these. But suffice it to say that the results of some such experiments are much more strongly suggestive of there being an ultimate limit to the size of a chunk of matter (or is this the result of our addiction to atomism?!). One has only to consider the various methods designed to find the number of particles in one mole (or unit reacting mass, as described in this article). The methods are entirely different, yet all give the same answer!

AN ANTHROPOSOPHICAL PERSPECTIVE

What does anthroposophy have to contribute to this question? One approach has been well-expressed by Frits Julius (3). He des-

cribes a phenomenological approach to elementary chemistry (for use in Waldorf Schools), in which inferred entities play no role. But this, he says, is not an attack on the atom; rather a defence against it. Very few experiments actually point to such entities, yet they are used quite unnecessarily to "explain" the whole range of observed phenomena. Hence, a consciousness schooled on interpreting all phenomena in terms of "centric forces" (the point-centred forces of the atomic realm) will of necessity be blind to the role played in some phenomena by "universal forces" approaching matter from outside. In understanding living organisms especially, these latter forces must be taken into account.

An example would be the role of light (a "universal force") in plant growth - not just in providing energy to activate certain molecular processes, but in exerting a formative and directing effect on the life processes of the plant. These latter forces are described by Rudolf Steiner as etheric formative forces (4), the main one in chemistry being the "chemical ether" (which has also been called the "number ether"), the principle which orders according to numerical relations. The intrusion of the atomic realm into all areas prevents us from forming a true concept of these number-ordering and other forces. Julius says the atoms should be relegated to the realm where they belong, i.e. as phenomena (possibly!) which need to be understood in the experimental context in which they arise, rather than as a way of thinking to explain all things.

An objection to invoking "formative forces" in an attempt to understand natural processes is that we are simply switching from one set of inferred entities to another. It is certainly true that one can infer the existence of, for example, a numerical ordering principle, but we must also consider the claim that these forces can be perceived **directly** by the higher faculties of which Steiner and others speak. They are thus discoveries, rather than inferences, though admittedly not many have made the discovery.

In concluding this article, I am aware of the questions raised, yet incompletely, if at all, answered. Moreover, there are other aspects to the central question, which I hope will be aired in future debate. The whole exercise is intended to stimulate serious thought and questioning of our most dearly cherished theories. It is a faltering start, not an end, and I hope some will feel moved to take it much further.

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(1) R.P. Feynman,Lectures on Physics, Volume 1, (Addisonn-Wesley Publishing Company, 1963).

(2) R.A.R. Tricker, The Assessment of Scientific Speculation, Chapter XV, (Mills and Boon, 1965).

(3) Frits H. Julius, Grundlagen Einer Phaenomenologischen Chemie, (Verlag Freies Geistesleben, Stuttgart, 1965).

(4) See, for example, Ernst Marti, The Four Ethers, (Schaumburg Publications, Illinois, 1984).

SEVENFOLD FLOWFORM CASCADES

A. JOHN WILKES

In this article will be discussed the most recent developments with the Flow Design Research Group in response to my initial question from 1970:

> "Can we create an organ for water which will enable it to manifest its potential for metamorphosis?"

This question was framed in the context of the prevailing attitude of "making water work" where water is almost exclusively considered as a transporting or energy producing medium. These uses entirely ignore the infinitely subtle veil-like forms that fill a body of unadulterated water in harmonic movement. Water's ability to move in this rich way is related to its capacity to support living processes.

The rhythmical metamorphic potential hidden within fluid processes in Nature is clearly demonstrated by Theodor Schwenk in the 'Wirbelstrasse' (see 'Sensitive Chaos', Rudolf Steiner Press). These metamorphic processes are manifest as a fundamental aspect of the organic world. (Science Forum No. 3)

INTRODUCTION

Flow Design Research has to do with the investigation of rhythmical processes in water which are generated by means of specifically shaped and proportioned vessels. These rhythms and their effects upon living processes relate inevitably to the overall rhythmical content of the whole natural environment. The field of experimentation is wide open and manifold, so choices have to be made and particular directions followed. One such direction is the Sevenfold metamorphic sequence which is the particular subject of this article. There exist a number of associated facilities around the world in which such themes have been taken up. The Flow Design Research Institute at Emerson College attempts to coordinate and promote work together with these facilities so than an understanding and application of the results may be furthered.

Three aspects of water movement are apparent (Fig. 1). In different circumstances these manifest in something like linear, harmonic and turbulent phenomena (P. Schneider, Elemente der Naturwissenschaft No. 19). For instance a movement itself, within a volume of water, will dominate momentarily only to be gradually resisted; a condition of reciprocating harmony is reached where rhythms can appear, after which the original impulse loses power and forms disappear into complexity and eventual amorphousness. This harmonic realm is of great interest. It is where form appears as the result of a delicate balance between force and resistance.

When considering any process of development or evolution it is possible to imagine a phase of entry and then one of withdrawal, between which a meeting takes place. There can be an impulse out of the past being transformed and given on as an impulse for the future. The natural water cycle itself can be considered as a 'taking in', 'utilisation or digestion', and a 'passing on'. An overall picture of contraction and expansion is revealed. From the water vapour in the atmosphere, clouds condense, rain falls and a confluence of tributaries eventually builds the meandering river which can be considered the heart of the system. When the flatness of the coast is reached, the water spreads out into the arms of the delta and expands into the ocean from which it again evaporates. The threefold nature of the process manifests at every stage in all conditions of condensation and evaporation while movement mediates. Water is the 'element' of movement. This aspect of the earth's organism is external to us but there is also a complementary process within living organisms. Fluid is taken in through an orifice and as it circulates it expands throughout the organism and contracts again as it is discharged. An expansion is followed by a contraction.

A Flowform is a vessel - a kind of organ - with a narrow entrance and exit, through which water is allowed to flow. Between the entrance and exit are two laterally placed cavities. The carefully proportioned exit creates a resistance which brings about a swinging of the stream alternately to the left and right, round the cavities. The vortical flow path describes a figure-of-eight or lemniscate with a lobe in each cavity. The frequency of the rhythm varies with size of Flowform while the character of the movement depends on its shape. Behind the visible reciprocating movement, longer term rhythms can exist; their periodicity is measurable only by means of instrumentation amd Fast Fourier analysis. (Science Forum No. 4)

Fig. 1 Linear, harmonic and turbulent movement resulting from a stream entering still water through an orifice.

Rhythmical patterns are evident in every life process and they reveal, within its fluid body, the particular signature of an individual organism. If this process is interfered with in a disruptive way the very existence of the organism in question can be threatened. fluid is taken into the organism in order to mediate these rhythms which in turn carry life. Increasingly water's more subtle capacity to move is now degenerating and is in need of healing. Quite apart from the necessity to cleanse (the removal and not addition of foreign substances), the quality of movement is directly related to water's ability to influence and sustain life processes. We have repeatedly observed through experimentation that organisms respond differently to water which has been moved in different ways. Our aim is to establish which specific rhythms will bring about a healing and revitalising process when applied to given organisms and under what circumstances this must take place.

FLOWFORM CASCADES

If the same Flowform design is repeated in series (Fig. 2), like rhythms compound to form an increasingly complex rhythmical pattern as the water proceeds through the cascades. Nevertheless this pattern maintains the signature of the single Flowform. Individual Flowforms in such a cascade can be observed to fill up and empty out over a longer period. A more vigorous period of movement when the form is full is followed by a calmer period when it is empty, but the frequency tends to remain constant.

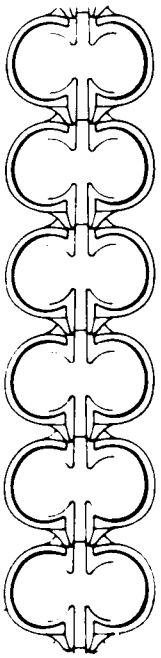


Fig. 2

A sequence of 'Järna' Flowforms.

Flowforms of varying size (Fig. 3) and identical flowrate generate a larger range of movement within the cascade. Smaller forms generate vigorous, fast, more spherically contained and three-dimensional movements, while larger forms can generate slower, calmer, more two-dimensional movements. The cumulative effect can be very complex.

With varying size and also changing quality of lemniscatory movement further enriching of rhythmical patterns is achieved (Fig. 4). Asymmetrical cavities generating fast and slow movements in a single Flowform introduce other types of flow pattern (Fig. 5).

Fig. 3 The 'Akalla' Flowform in three sizes, 55cm, 90cm, 180cm.

Fig. 4 A diagram of the lemniscatory movement changing its axis in the direction of flow.

Fig. 5 Original flow design for the 'Olympia' Flowform complex.

Fig. 6 Plan of the 'Olympia' complex as prototype.

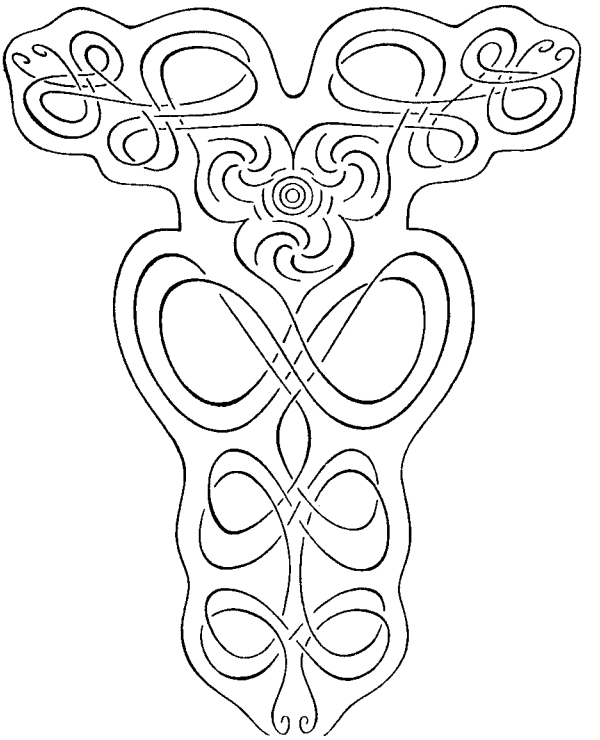


Fig. 5

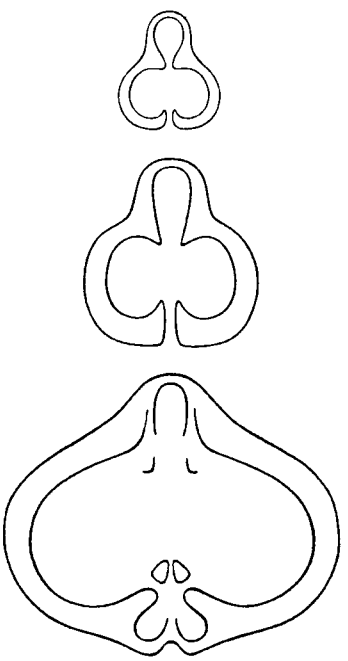


Fig. 3

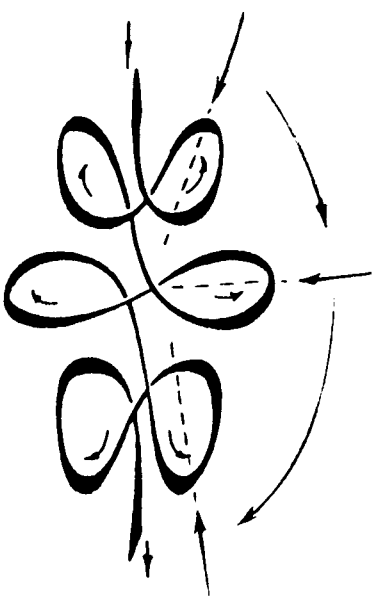


Fig. 4

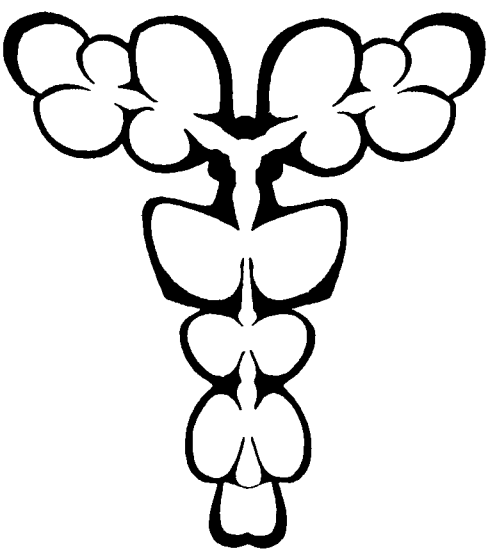


Fig. 6

SEVENFOLD METAMORPHIC CASCADES

The experience which originally inspired the sevenfold developments came from observing the metamorphosis implicit in a composite leaf (Fig. 7). The artichoke is one example of such a leaf (Fig. 8). Its small lower rounded forms expand towards the middle part and stretch, pointed, to the periphery at the end. Such a single leaf anticipates the leaf development process of the whole plant (further discussed by J. Bockemühl, Elemente der Naturwissenschaft, No. 6).

The fish skeleton shown in Science Forum No. 7, page 19, which should have been shown 'hanging by the tail' in a vertical position, reminds us also of the patterns of a composite leaf. We can see how the angle of the bone processes sweeps round, from one end to the other, indicating the movement described in the changing lemniscatory axis. From the leaf via the fish to the mammal spine we experience the gradual definition of the sevenfold. An expansion or increase in complexity followed by a return to simplicity in the end, which is nevertheless of another quality. This can occur in many different ways but we see basically a threefold entry and threefold exit with the mediating fourth condition.

The first sevenfold experimental model of about 2 metres length was made in 1970 shortly after the work with Flowforms began (Fig. 9). The diagram (Fig.10) shows the actual plan of the model, which was constructed with lead strip walling on a flat metal sheet. Thus the whole channel lay on a continuous slope. The range of axial movement in the lemniscatory process was indicated but not yet with the greatest expansion at the fourth stage. The rhythms were timed and noted (Fig. 11). These values related directly to the overall dimensions of the Flowforms and it is just these proportions which still demand much investigation in order that some specific harmonic set of relationships be found for such a sequence. The first adjustments were made as in Fig. 12.

Over a period of fifteen years many attempts were made to carry out the project. Thorough investigations were carried out by the author with Nigel Wells, Paul van Dyke, Patrick Stolfo, Philip Marchand and others in various directions. Small scale models were made in an attempt to solve some of the many questions posed, not least the use of the Archimedian screw for circulating the water.

Already in the mid 70's scale models had been made leading to a Flowform sequence about four metres long. By means of this, progress was made on the idea of the 'rhythm enhancement effect' for which another large detail model was constructed. This 'effect' has to do with a positive build-up of movement in a series of Flowforms over a longer duration due among other factors to changes in frequency of active rhythms.

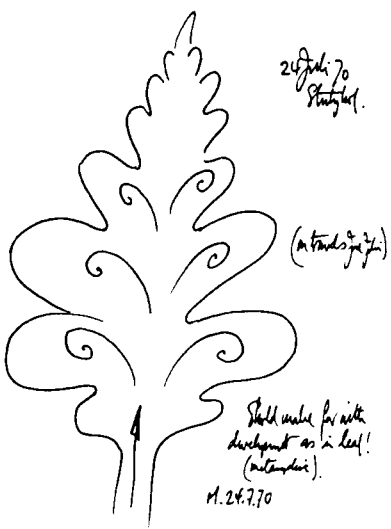


Fig. 7
Original sketch leading to sevenfold sequence 1970.

Fig. 8
A complete artichoke leaf and one side of it placed to show similarity with normal leaf development in the whole plant.

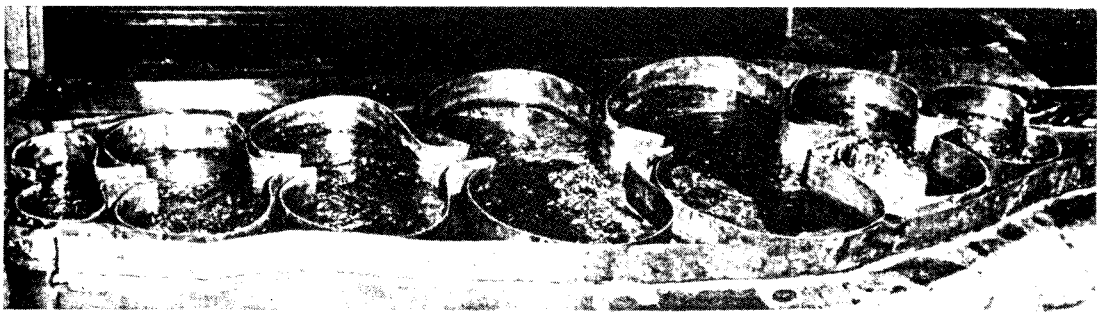


Fig. 9 Photograph of original sevenfold sequence 1970.

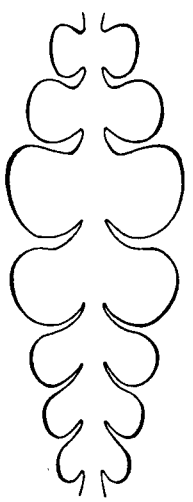
It became feasible to carry through a first complete project with Nigel Wells in 1985, albeit on a scale smaller than anticipated and in very simplified terms (Fig. 13). This created a basis from which further developments could emanate. During 1986-7 new funding enabled further work to be carried out with the collaboration of Hansjörg Palm, transforming the first composition stage by stage. The generous help given for these two projects by the Cultura Fond, Heidenheim, and the Mercury Arts Fund, London, is gratefuly acknowledged.

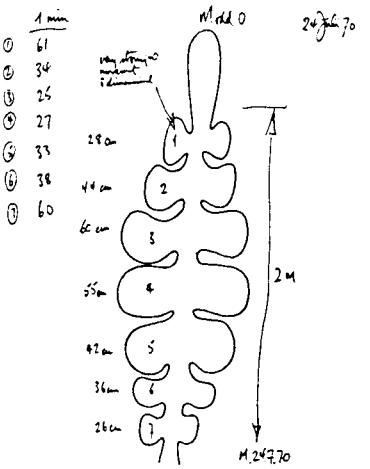
This is where we stand today. With these working installations we are able to look back at the whole process and consider a number of ideas that have not yet been fully manifest. We can also study in detail what has been achieved in the rhythmical structures of the two completed Sevenfold Cascades and test for the effects upon plant growth and other biological processes.

MOVEMENT QUALITIES

In the initial three stages of a cascade one can consider three qualities of movement; the polar opposites of fast and slow with an harmonious combination in between. We can ask, is there an ideal Flowform, of specific size and shape, which will provide an optimal quality for water with its particular viscosity? This would lie between these two opposites, generating on the one hand a nervous, fast movement in a smaller vessel, and on the other a more ponderous slow movement in the larger vessel. This last one would in turn be 'digesting' all the preceding movements. The central of the three Flowforms would thus determine the size of the whole sequence.

Tha answer to this might be that there would be a range of 'ideal' size and that probably the relative proportions of the vessels would be of major significance. The enhancement effect would be also part of the digesting process indicated.





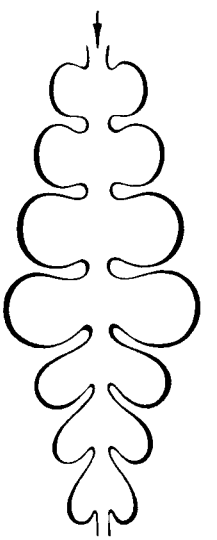
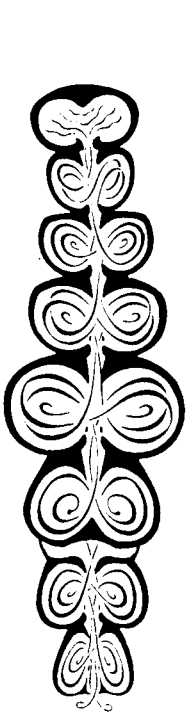


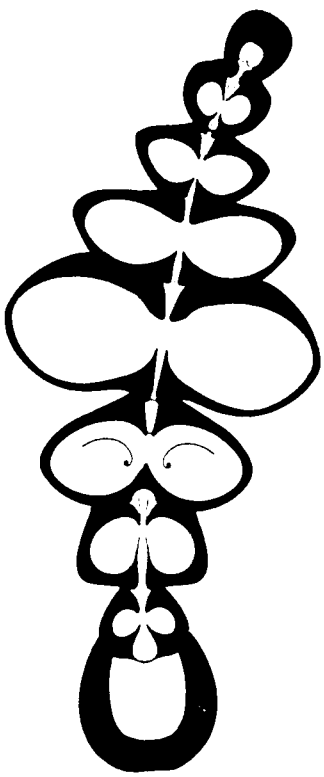
Fig. 10 [left] Diagram of original sequence 1970.
Fig. 11 [centre] Note of rhythmic frequencies form initial experiment.
Fig. 12 [right] Original sketch design for the sevenfold metamorphic cascade

In any sequence of Flowforms, movements in succeeding forms are influenced by preceeding ones. With changes in size and thus also in movement frequency, influences shift over a period of time supporting or inhibiting rhythms in subsequent forms (Fig. 16). Consequently a rhythm can periodically be cancelled out, only to recover after a momentary collapse. Conversely a cumulative effect in a positive sense can occur so that a strong high wave can be achieved, also periodically. (This reminds us of the observation that, after a given number of waves have reached the coast, said to be the seventh, one is larger).

These permutations are complex but through careful design of the Flowforms they can be quite specifically chosen. A moving pattern of more or less preplanned rhythms can appear. It seems feasible to assume that this is similar to what happens in any living organism. An existing combination of rhythms and forms, catalysed by the seed, is instrumental in building an organism which then itself behaves as mediator for these rhythms - especially through its fluid organisation. Rhythms are the vehicle for the living processes.

In the human organisation two strong rhythms among many gentler ones are evident in the breathing and blood circulation. These relate with each other in ever minutely fluctuating proportions.





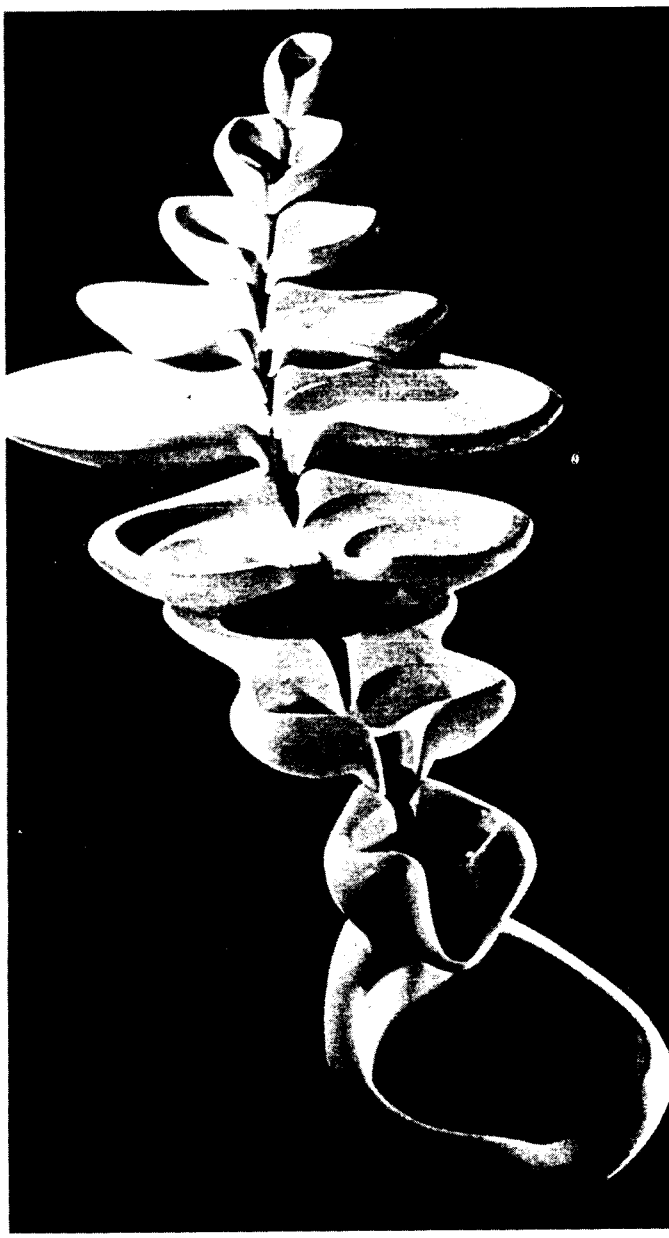


Fig. 13 [far left] Flow diagram with plan of Sevenfold I. (AJW, NW)
Fig. 14 [left] Plan of Sevenfold II as prototyped. (AJW, HP)
Fig. 15 [above] Sevenfold II (AJW, HP)

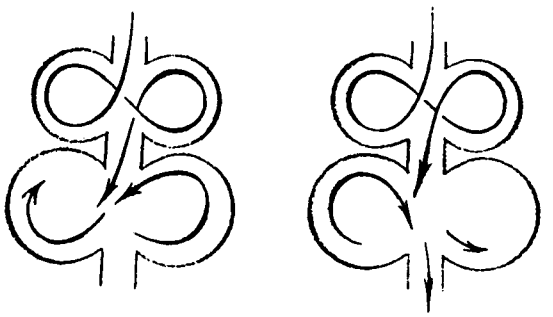


Fig. 16 Diagram showing two stages of interference, one supportive the other inhibitive, due to shift of faster, in relationship to slower movements.

LIFE PROCESSES

If we are thinking about organism, then we should consider the so-called life processes described by Rudolf Steiner (12.8.1916). Every organism **takes in** substances which are, generally, **accepted** and **digested.** The orgasnism responds with certain **secretive** processes, is **nourished, grows** and eventually **reproduces** itself. In creating an organ for water we can also venture to think of it in terms of such life processes. The organ itself is of course in this instance totally passive. The intention is that the water is taken into it and is encouraged to relate to the surfaces in an intimate way, so that rhythmical, pulsing movements are generated. These movements may open up the water in its innermost structure to the influences of the environment; not only the gases are absorbed, but also more subtle planetary influences via Moon for instance. Reference has been made at the beginning to this innermost structure, manifest in veil-like forms which are dramatically changed and also receptive in their movement to outside events (see Bewegungsformen des Wassers, by Theodor Schwenk). Whatever changes occur within the water, these are carried on into the environment and influence regenerative biological processes. (See the Table)

It is becoming increasingly evident - through the work of many investigators - that we must think of the watery body of the earth as maintaining a mediating function which conveys the 'information' of the total environment to all living things. It is this embedding of everything living into the totality that is of paramount importance to the continued existence of life on the planet.

FUTURE DEVELOPMENTS

A more complex approach to the design of the first three Flowforms, abandoned for various reasons to date but probably constituting the next major development, is as follows. With each of the first three stages, an additional, adjustable water input is arranged. The second and third Flowforms increase in size but with the increasing flowrate exhibit stronger rhythms although these at the same time become slower. The fourth and largest stage would receive the accumulated flow with all its rhythmical structure. Flowforms five, six and seven progressively decrease in size but nevertheless accommodate the flowrate. Due to this contracting process the rhythms increase in frequency and vigour manifesting a very dramatic enhancement as the metamorphic process culminates.

It is the intention that this sequence would be repeated, to give an overall cascade of fourteen Flowforms. This advice, from a Swedish consultant based on his investigations, supports our intention to work with a sequence long enough to allow intensive penetrating of rhythms to take place. It also does not influence the initial design development. We are looking for financial support to carry out this project which would be Sevenfold III.

LIFE PROCESSES RELATED TO QUALITIES THAT MIGHT BE DEVELOPED IN THE SEVENFOLD CASCADE SEQUENCE.

LIFE PROCESSES	EQUIVALENT, RELATING TO CASCADE
Taking in (breathing)	Entering
Acceptance (warming)	Relating to surfaces
Digestion (nutrition)	Rhythms
Secretion	Receptivity of the water's innermost structure
Nourishment	Oxygenation and planetary influences
Growth	Subsequent support of growth processes
Reproduction	Subsequent plant regeneration; enhancement

Sevenfold I was carried out for reproduction in three pieces on a continuous sloping gradient. The entry, with numbers one and two constitutes the first piece. Three, four and five are combined in the second piece, butt-jointed with the first piece, in a fixed position. The catch basin under five, with Flowforms six and seven are in the third piece. The whole plan describes a very slight 'S' curve. The fifth Flowform seemed to be an appropriate position to introduce the theme of holes in the base through which continuous oscillating vortices are developed in the foci of the lemniscate. It has been possible since the completion of the prototype, to design separate ball and socket joints for each of the Flowforms. This allows for adequate flexibility in overall plan design for a left or right-handed curve. These prototypes, providing a whole range of small Flowforms, have still to be completed before reproduction of them is possible.

Sevenfold II was developed stage by stage from Sevenfold I as described. The whole process could develop organically. For the first time in the design process, we decided to ignore the difficulties and complexity of reproduction connected with smaller spherical type forms which have re-entrant cavities. So the first and the last Flowforms could be made more in keeping with function. Vigorous, three-dimensional movements, of about 75 oscillations to the minute generated in a more enclosed cavity, also demands more gradient. The beginning and the end of the cascade therefore now have an increased gradient while the middle region remains more horizontal, with the fourth Flowform generating about 18 oscillations to the minute. So the range of rhythms lies between these two values.

A further stage of development might be to work with planetary influences, not only from the point of view of rhythm but also of formative gestures. Starting with the basic idea we have been able to work in such a way that each new step has shown itself as a real organic development. We hope to continue in this vein to create a true 'organ of metamorphosis' for water, which will provide a home and revitilisation for Elementary Beings, traditionally associated with nature's processes but now largely ignored and thus in desperate need (see Science Forum No. 3, p 14, and also many references by Rudolf Steiner).

All illustrations by John Wilkes

The author is grateful for Stuart Brown's help in revising the manuscript.

RELATIVITY AND THE ETHER

BRIAN STOCKWELL

Yet another attempt to discredit Einstein's Relativity has come from Italy. Marco Todeschini (1) constructed a series of equations from optical experiments designed to unify the gravitational and electromagnetic forces. He believes that space - far from being Einstein's ether-less void in which relatively moving observers experience time dilation and all measure the same speed of light - consists of a tenuous fluid 10^{20} times less dense than water. The course of light through this fluid deviates from the expected path just enough to explain all the astronomical and particle phenomena generally regarded as evidence for Special Relativity.

The Michelson-Morley experiment of 1887 which failed to detect the "luminiferous ether" believed by physicists at that time to provide the medium for Maxwell's electromagnetic waves, led Fitzgerald, Larmor and Lorentz to hypothesise contraction of length and slowing of clocks to explain away the negative result. Einstein took over the Lorentz transformation equations but declared the ether unnecessary. Todeschini believes the Michelson-Morley result was in fact consistent with his own conclusions; that the interferometers used were not sufficiently sensitive, and that in similar experiments in the 1920's Miller found small fringe displacements very near to his own results.

Todeschini applied his theory to the whole of universal space, from the stars to atoms. The astronomical aberration of light, discovered by Bradley in 1727 and still held by some to discount Relativity, was seen as due not merely to the movement of the Earth in its orbit but to deviation caused by the flow of fluid space.

The Sun was at the centre of a spherical field of rotating space having an average speed of 60 km/sec, and the Earth in a smaller field, which was being dragged round the Sun at a speed of 30 km/sec; while the planetary field at the Earth's surface spins at an average speed of 9.335 km/sec.

Todeschini's "three decisive experiments" were: to detect and measure a stream of fluid space which turns round the Earth and forms its own particular planetary fields; to check whether Doppler's effect and Fizeau's effect were in agreement with Galileo's relativity or with Einstein's; to check whether or not a light ray undergoes an angular deviation when passing through a fluid stream.

Believing that all his findings were compatible with classical theory, he stigmatised Einstein's "pseudo-relativity" as "the greatest anti-scientific delusion, which has prevented a unified physics that would explain and enormously simplify the whole structure of science". He went on to define matter as consisting of the same substance as its surrounding field, "both being movements of spherical layers of fluid space rotating on themselves at great speed relative to the motionless fluid space ambient".

The orthodox view is that Relativity is now so buttressed by experiment and practice as to be unassailable. It still has a few critics among physicists; and philosophers of science are not all uncritical of the metaphysics which, against Einstein's own wish, has grown up around it. There are also developments, particularly in quantum theory, which call some aspects of Relativity into question.

The first experimental proof of the slowing of clock-measurements at high velocity came from the American physicist Herbert Ives (2) in 1938. He accelerated hydrogen canal rays through a cathode tube and measured a decrease in the hydrogen atoms' frequency of vibration. This effect was later confirmed by the slowing of an atomic clock carried by a jet aircraft; and by the extended life - about 30 micro-seconds - of muon particles reaching the Earth at near the velocity of light, compared with their laboratory life of about 2 microseconds.

However, Ives himself regarded these results as confirmation, not of Special Relativity, but of the Fitzgerald-Lorentz contraction and dilation effect. They were not due to the apparent mutual slowing-down of clocks and shrinkage of length and distance between frames of reference in uniform relative motion. Ives developed a theory (3) to reconcile Galilean and Newton's relativity with Maxwell's electromagnetic laws.

Ives, following Lorentz, Poincare and others, believed that the Newtonian absolutes do provide the standard frame of reference for motion which Einstein rejected. The difficulty here, as Ives conceded, is that this can never be measured. Einstein's constant speed of light is justified by the fact that measurements by differently moving observers will always show that speed as c, rather than, e.g., c plus v where the source of the light is moving at its own relative velocity v. Nevertheless, for Ives this was an appearance only, and he developed some complex mathematics to demonstrate it (4).

Since the earth itself is moving, and no experiment has been able to discover the ether drag, the truth of the matter rests on interpretation. Ives reproduced the Lorentz transformations in a form compatible with Newton's theory. He believed that Einstein's solution of the problem, combining the apparently contradictory postulates of Relativity and the constant velocity of light, not only violated common sense - which relativists admit - but led to wrong physical predictions and wrong philosophy.

The famous clock paradox of Special Relativity (two space travellers moving at uniform relative velocities each see the other's clock going slower than his own) was explained by Ives as due to misinterpretation of the normal time dilation effect of motion. There has sometimes been confusion among relativists as to whether time dilation is apparent or "real", and they have given different explanations of the paradox.

According to Ives and to other critics, notably Professor Herbert Dingle (5), an astrophysicist and sometime President of the Royal Astronomical Society, there has also been confusion over the use and meaning of "time". One of the reasons for Einstein's popular acclaim in the 1920's was the widespread belief that there was some deep mystical significance about Special Relativity. H.G. Wells and other early science fiction writers had already fascinated their readers with stories of time travel. The mathematician Minkowsky was responsible for introducing the idea of space-time as an objective reality. Einstein adopted Minkowsky's mathematics for his General theory. Space-time appeared to have metaphysical implications, although for Einstein himself the "fourth dimension" remained a purely mathematical term (6). In fact as Dingle argued, Einstein's theory dealt always with instants of time and their recording and measurement, not with time as a concept.

Einstein was concerned with what can actualy be measured. When he abolished the concept of simultaneity, using the plain fact that the clock-instant of an event depends on the recording clock's distance from it, he meant that the only way to measure the time of a distant event was by light signals. The common-sense conviction that at our "now" there must be something happening at all other physical locations, was outside physics since it could not be measured. Another aspect of time confusion was noted by Ives. The slowing-down of clocks happened because the rate of vibration of atoms changed with

velocity. Thus it was strictly the interval-recording function of clocks which slowed down, not time as a concept.

Quantum theory and Relativity theory, the two corner-stones of modern physics, are not regarded at present as fully compatible. Many physicists, e.g. David Bohm (7), believe modifications are needed to bring them together. Einstein himself never thought quantum theory was complete, because he believed its indeterminacy, expressed in Heisenberg's uncertainty principle, did not give a true picture of reality. He preferred strict laws of cause and effect. Bohm's school of thought seeks hidden variables as the underlying cause of quantum randomness. These have not so far been discovered. But he sees weaknesses in Relativity also. For instance, Relativity is based on the concept of light as a signal, though this notion does not fit with quantum theory; and it treats particles as extensionless points. This leads to infinities in certain field calculations, which has meant introducing mathematical "renormalisation" techniques to achieve practical results.

A fundamental of quantum mechanics, recently proved experimentally by Alain Aspect in Paris, is that measurement of one of two particles originally associated but now flying apart, will affect the alignment of the other particle even though it has travelled beyond the reach of a light signal. This is thought by some to breach Einstein's principle that nothing can travel faster than light. The second particle appears to "know" what is happening to the first, and to react accordingly. Known as non-locality or action at a distance, this was argued over by Bohr and Einstein. Einstein did not believe it would be proved.

John Bell, author of the famous test theorem known as Bell's inequality, is ready to consider the possibility of "something like going back to Relativity as it was before Einstein" (8). In aradio interview he told Paul Davies that the pre-Einstein position of Lorentz, Larmor and Fitzgerald on the ether was perfectly coherent and not inconsistent with Relativity theory; and that he would be prepared to go back to the ether in view of the result of the Aspect experiment. Controversy continues as to whether non-locality does in fact violate Relativity.

Physicists are naturally reluctant to jettison any part of a theory in practical use for more than 80 years. Other sources of doubt discovered from time to time are either explained away or shelved pending further exploration. Radio astronomers have found quasars and radio galaxies apparently ejecting material into space at superluminal velocities, as measured from Earth by the new technique of long baseline interferometry. But this is regarded as an illusion. A basic asumption of Relativity, that it is impossible to detect absolute motion, also appears to have been breached, in theory, by the discovery in 1965 of the universal background microwave radiation of around 3K. A space traveller could position himself so that the radiation measures exactly 3K in every direction; that would tell him that he was at rest in space (9). It would also be possible to measure a steady speed in relation to the Universe.

Rudolf Steiner's opinion of Relativity was that it was "brilliant nonsense", but that we would not be able to evade it (11). It meant in effect that natural science was unable to break through to any reality; and thereby showed the need for a spiritual science. He regarded the total abstraction of the illustrations and arguments Einstein used as demonstrating its absurdity: people in boxes suspended in space so that they could experience the equivalence of gravity and acceleration; travellers racing at near the speed of light towards the stars; light signals from Arcturus or Betelgeuse to show that there was no simultaneity of events. It was not just that Relativity theory was distant from life because its effect could be observed only at very high velocities; its provenance and justification did not belong to the real world.

Ernst Lehrs (12) described a 1921 seminar with scientists in which Steiner declared that Relativity theory operates with "thoughts one cannot really think". When someone put the argument that it was impossible to find any fixed point against which to determine planetary motion, Steiner instanced two people sitting together, one breathing normally and the other flushed and panting. Science would one day develop, he said, a way of observing phenomena on planetary bodies from which it would be possible to read their absolute state of motion.

The increasing abstraction of science is illustrated best in cosmology, where new and abstruse mathematical models have led to questions about origins and about God - although an increasingly abstract God. Recent books by Paul Davies ("God and the New Physics", "The Cosmic Blueprint") and Stephen Hawking ("A Brief History of Time") consider how creation relates to the laws of physics. From another aspect, the "strong anthropic principle" asks whether the constants of nature have just the values to make conscious life possible (10).

Another casualty of the Einstein epoch has been the application of "common sense" to physics. Relativists take pride in the repeated statement that Special Relativity is difficult to grasp only because it violated common sense. Einstein's method was to welcome contradictions and treat them as paradoxes. His combination of two fundamental postulates which in logic were contradictory was a brilliant stroke which he proceeded brilliantly to justify. Recent research continues to produce proposals

difficult to fit into his scheme, such as the possibility that space is in fact a sea of particles.

To return to Todeschini: having, as he believed, established his physical theory by laboratory experiment, he extended it to define and explain the human soul and spirit. The fluid ether, he said, impinges on the sense organs at varying frequencies, oscillations and pressures, setting up nerve currents which are translated by the psyche into all the different forces and qualities we perceive. Not just the so-called secondary qualities of colour, sound, taste and smell, but all sensations including force, electricity and magnetism are brought about by contact with this single universal substance. Moreover, he believed this to be an exact science, and produced 10 "psychophysical equations" to demonstrate an exact correspondence between matter striking the body and the sensations stirred in the psyche.

Since matter can only transmit pressures, the argument goes, the soul where sensations are born must be immaterial, and therefore of a spiritual nature. The sense organs are all transformers of mechanical impulses, themselves sensationless. In the physical brain only these currents are found, and it is the soul which responds with sensations. In the reverse direction, the soul activates currents through the nervous system to bring about our own movements. This conception proved, Todeschini argues, the existence of God and a spiritual world. Since man's own nervous force was insufficient to use more electrical energy than is concentrated within the body, by analogy it followed that the forces needed to move the fluid masses of the universe come directly from the spiritual world.

This brief discussion has served to highlight how controversy over Relativity has turned on the nature of space. The Michelson-Morley experiment failed to demonstrate the "luminiferous ether" then expected by physicists. Fitzgerald, Lorentz and Ives saved the appearances with theories allowing an ether which could not be directly detected. For Einstein, the whole idea of an ether in space was unnecessary.

The 19th century ether could be regarded as a last remnant of imaginative realism in physics. It was not entirely abstract; its content was unknown, and after Michelson-Morley, unknowable, but it was substance of some kind. Einstein moved science on into a new age in this respect, though as we have seen the idea still lingers, and it remained in the text-books until the 1930's. Its removal even as a concept heralds and symbolises the new physics. With it went many other relics of an older science, including the last possibility of conceiving a spiritual creation which needed a transition point from ethereal to physical space and substance. Steiner's conception of an ether of formative forces, with warmth mediating between spiritual and physical, could find no ground here.

Those few scientists who still feel the need for a universal frame of reference may be grasping after a less abstract ether, and even a spiritual reality. It is tempting to see in Todeschini's fluid another attempt to find such a reality, especially as he goes on to postulate a spiritual causation. But there is no conceptual link here with a formative forces ether. The frontier between spiritual and physical, with spiritual forces "pushing" a physical ether fluid, still looks like a Cartesian divide. Whether his experiments are convincing depends on confirmation in the laboratory. We have not been able to discover how far this has been attempted. That they are apparently unknown to orthodox physics is perhaps not necessarily decisive.

"Don't Bring Back the Ether" was the anguished headline above the editorial article in "Nature" which condemned Dingle's challenge to Special Relativity. No doubt the idea of an ether had to go through this attenuation, before there could be any possibility of bringing it to life in a different form.

[Our attention was drawn to the work of Marco Todeschini by a reader in Italy. Very little information about Todeschini and his work appears to be available in this country. - Ed.]

NOTES

1. "Decisive Experiments in Modern Physics". Marco Todeschini, Professor of theoretical mechanics and electronics. Hon. Vice-president of the Theatine Academy of Sciences. Bergamo 1966.

2. Re-published in full in "The Einstein Myth and the Ives Papers". 1979. Edited by Richard Hazelett and Dean Turner. The Devin-Adair Company, U.S.A.

3. Titled the Theory of Absolute Space and Time, by Dean Turner, in "The Einstein Myth and the Ives papers".

4. See Dean Turner's "The Einstein Myth", Ch. 7.

5. "Science at the Crossroads". Herbert Dingle. Martin Brian and O'Keefe, 1972.

6. See "Einstein", biography by Ronald W. Clark. Hodder and Stoughton, 1979.

7. "Wholeness and the Implicate Order", Part 5. David Bohm. Routledge and Keegan Paul, 1980.

8. "The Ghost in the Atom", Ch. 3. Edited by Paul Davies and J. R. Brown. Cambridge University Press, 1986.

9. "Einstein's Universe", Ch. 17. Nigel Calder. BBC, 1979.

10. See "The Anthropic Cosmological Principle". John Barrow and Frank Tipler. Oxford University Press, 1987.

11. "Karma of Materialism", Lecture 2. Rudolf Steiner.

12. Ernst Lehrs. "The Rising Generation" in "Rudolf Steiner: by his Pupils". 1958.

N E W S A N D C O M M E N T

COLLOQUIUM AT THE GOETHEANUM: APPROACHING QUANTUM MECHANICS PHENOMENOLOGICALLY

GEORG MAIER, GEORG UNGER, TOMASZ MAZURKIEWICZ, & HENRY SAPHIR

[Translated by Charles Lawrie from "Das Goetheanum Nachrichten", 26 April 1987.]

During the first quarter of this century, a tempestuous revolution took place within the then predominant science, physics, which can provide the impulse to overcome the "bodily" thought-forms against which Goethe so radically contended. It was Rudolf Steiner's "Fundamentals of a Theory of Knowledge for the Goethean World-Outlook" which laid the necessary methodical basis for this direction, in 1886. In the event, rather little mutual contact arose between the two streams: those of a science of the inorganic questing for the "Inner" of outer Nature, and of a germinally self-unfolding science of Nature on Anthroposophical ground.

Out of the need to be able to stand knowingly within contemporary physics, the plan arose to approach thoroughly "key experiments" of the time when quantum mechanics emerged, by means of the methods presented in the "Fundamentals" [Grundlinien]. So the Mathematical-Astronomical and Natural Science Sections (of the School for Spiritual Science at the Goetheanum) arranged a colloquium with a distinctly international attendance from 14-21 February 1987. The ages of the eleven collaborating ranged from about 21 to 78, thus providing a real picture of scientific development since the establishment of Quantum Mechanics.

Each day began with concentration on the aforesaid methodical "Fundamentals". The intense exchange of thought between Goethe and Schiller in January 1798 proved especially valuable and stimulating here. The method appropriate for inorganic Nature is then, in its thought-structure, one eminently mathematical. Such a patient thought-procedure was exercised - in constructing and varying experiments, in surveying the conditions which were demonstrably interactive, and finally in the initial construction of the statements which lead back to Axioms (Ur-Phenomena), as well as the requisite definitions. A good variety of equipment was to hand for the experiments: shining flames, refraction and imaging, photoelectric effect, electricity passed through thinned air, Franck-Hertz experiment, electrical resistance sound-phenomena. Each day also participants took it in turn to make extensive contributions. These included for example the aims of the development of physics since Galileo, the provenance of mathematical and physical concepts in the human organisation, or the details of scientific occurrences in the first quarter of the century.

We viewed the whole gathering as an experiment. The underlying question was: "Does the problem of the reality of a realm fall away, which no longer permits definite mental pictures concerning material processes in space underlying it, when an attempt to explain its phenomena by means of external models is rigorously refrained from?" By the end, participants could regard the outcome of this experiment as positive. It is possible to enter into the world-picture of physics so that it becomes an "active grasping of reality", and hence to give full weight to the revolution at the beginning of this century. In other words: the more recent physics need not present any obstacle to a knowing open to the spirit. Naturally, a thorough penetration of the classical as well as the newer conceptualizations already to hand, is essential, and must be tackled again at every succeeding colloquium.

Conversation in a coffee-pause turned to the intimate parallels between the historical evolution of physics and art. As Kandinsky was confining himself to the "concrete" elements in painting, renouncing any external motif, a physics emerged, which was to free itself of the supports which outwardly conceived materiality had offered. When human beings hold back from the supports, which bodily objects have afforded them, then they are open for the question of real encounters with beings in the spirit.

This can work to encourage future efforts in shaping physics teaching in the Upper School. In this gathering we were still ready to let the questions pose themselves through the history of physics itself. It is a task of Anthroposophical natural science to propose directions which can entrust healthy elements for future cultural activity. We consider that this presupposes the process already set in motion, of freeing ourselves from the thought-forms of the 19th. Century.

1) THE PHENOMENOLOGICAL BASIS OF QUANTUM THEORY

NOTES OF A MEETING WITH Dr. UNGER

A one-day conference for members of the Science Group on the above subject, led by Dr. Unger, was held at Rudolf Steiner House, London, on 10 October 1987. Dr. Unger had previously participated in a conference on the same subject at the Goetheanum, Dornach, in February 1987 (see p). Dr. Unger spoke on many aspects of quantum mechanics and the general situation in physics today, and there was much discussion. The following notes indicate some of the main points.

Early in this century, new phenomena were found which did not fit into the scheme of classical physics: a new approach in science had to be developed. Some of the key phenomena were: spark delay, black body radiation, specific heats of gases, the photo-electric effect, and line spectra.

It is of interest to note the characters and motivation of some of the key personalities. Einstein had a philosophical side to his nature: Balmer was an artist as well as a mathematician, he sought 'the harmony of the light': Planck described, in 1925, how he felt that destiny had led him to be the one to bring different ideas together.

On closer examination, we find that what we are accustomed to regard as simple phenomena often consist of more than pure observation. When we observe light, heat may be present as well, even when there is no infra-red element. This leads to the concept of energy. Spectral lines only become significant when a thought-element is added to them. (An alternative approach might be to regard **processes** as basic, from which physical elements are products or 'spin-offs'.)

The concept of 'action' in physics may be difficult to grasp. The Principle of Least Action has been described as a case of 'God's laziness'. Light always takes the shortest path - but how does light <u>know</u>, at the outset, which **is** the shortest path?

Schrödinger's wave function (ψ) has played a vital role in the development of quantum mechanics. How can a function collapse as supposed when a measurement is made, and what does this really mean? Dr. Unger described this as essentially of the nature of thought. (See comment by Nick Thomas, 'Schrodinger's Wave Function', page 21)

Steiner warned of the use of mathematics: by, for example, solving differential equations one may think one has found facts, whereas one has only hypotheses. During the last few decades the use of mathematics has become increasingly complex and intense, in certain directions: we have to ask, What is the nature of the thought-processes involved and in what conditions are they being applied? It is possible to experience the spiritual nature or quality of specific mathematical processes through conscious effort.

COMPUTERS

Computers have been developed around new materials, new components and new techniques. Design changes have been necessary as technology advances. The computers of today are 'sewn together', the product of 'patchy' knowledge rather than of steadily developing concepts. 'Chips' are already unbelievably small, yet great efforts are being made to make them even smaller. Where does the motivation for this come from? Often, in the first place, from military sources.

Computer technology and programming are becoming more and more complicated. Malfunctions may arise for no apparent reason; the term 'computer viruses' has been coined. Programs and technologies originate in the human mind: there is interaction between human intelligence and machine intelligence. When an elusive 'computer virus' is encountered, does it exist in the machine or in the mind? If there is interaction between man and machine, will this take different forms according to the individual's state of mind on a particular day?

It has been said that in, for example, gardening or cooking one should seek to establish a relationship with the elemental beings, but what sort of beings are attracted to the sphere of computers and artificial intelligence? We know from experience that unless care is taken the use of computers may have a de-humanizing, or de-personalizing, influence.

THE EVOLUTION OF PHYSICS

In 1904 Steiner stated that the atom consists of the same substance as thought and that this knowledge could be used for harmful purposes (see 'On Nuclear Energy and the Occult Atom', G. Unger, 1982). In 1905 Einstein published his article on the relationship between energy and mass, $E = mc^2$ - a first step towards the release of atomic energy. The ψ function exemplifies the concept of thought-substance in modern physics.

In the 19th century, the atom was conceived as having material existence. The 20th century atom was a theoretical model: because it is not real it is an Imagination. Modern physicists have entered the realms of Imagination and Inspiration - but they do not know it. Electric and magnetic fields were earlier regarded as real, but today they, too, have more the nature of thought-substance.

The problem of simultaneity can be overcome if one thinks in terms of space and counterspace. Point and plane are opposites but in some circumstances their inter-relationship may lead to a borderline between the physical and the non-physical. G. Adams developed a geometrical approach to etheric (polar-Euclidean) space. "Our real world swims in the ether world like ice in water". (See also 'Grundbegriffe der modernen Physik - Quanten, Teilchen, Relativität', G. Unger 1967.)

A science of information was initiated in 1940. Information is the restriction of chance. Could information, as measured by information science, interact with the thought-substance of sub-atomic physics? This might account for some of the anomalous effects, in physics, reported recently - see, for example, the work of Brandt carried out in USA and in Russia. However, information as encountered in information theory is a very restricted concept compared to the term as applied to life in general. We are familiar with the idea of etheric forces or qualities being drawn down into the sphere of sub-nature. This process has often been described in relation to light ether and chemical ether but the sub-natural counterpart of life ether is problematical. It is possible that information theory, as used in modern science, is connected with the negative counterpart of life ether, known also as 'meaning ether'. This might be compatible with the idea that the 'third force' has some connection with nuclear energy.

It should be noted that although scientists assume that man **processes** information, the truth is that man is the only **source** of information, by virtue of his sensory/supersensory nature.

Science may be leading in the direction where it may become possible for human thought-substance to be transmitted to a machine. In the past, several general suggestions about the possibility of machines making use of hitherto unknown forces have been made. If this comes to pass, the moral quality of thought will be of great importance.

Comments by Nick Thomas and Hedley Gange on specific points arising from the conference are given below. One general comment was that it would be beneficial to the Anthroposophical Movement as a whole if members had a clearer appreciation of the contribution that science has made to intellectual and general cultural development during the last hundred years.

(These notes were prepared by Hedley Gange, Nick Thomas and June Woodger)

2) SCHRODINGER'S WAVE FUNCTION

NICK THOMAS

Quantum theory points to the need to incorporate a genuine concept of wholeness. For the psi function always relates to the whole assemblage of particles and barriers (potential wells etc.) present, which is why it is generally unsolvable for all but the simplest situations. The probability distributions calculated depend in detail on the psi function and therefore on the whole situation, although the difference made is often slight.

It is not inconceivable that in some circumstances that difference need not be slight. The effect of three polaroid filters on a beam of light is an example of a macroscopic phenomenon which physics can only account for on the basis of quantum theory. Photons are not themselves polarised (which is in accord with Rudolf Steiner's indication that it is not the light which is affected in polarisation phenomena) for that would imply a reduction in their energy, and hence their frequency, and hence the observed colour. Therefore the probability of a photon passing through two filters is discussed. If their transmission axes are at an angle theta then the probability of transmission through both is the square of cosine theta, which agrees with classical theory. If theta is 90 degrees it is zero, but if then an intermediate filter is inserted the probability is the product of the squares of the cosines of the two resulting angles, which need not be zero even though the angles sum to 90 degrees.

What does it mean to say that the wave function "collapses"? Max Born's interpretation, at variance with Schrodinger's original intention, is that the psi function does not relate to real physical waves but relates to a probability distribution describing where the associated physical particle may be found. This is why "renormalisation" problems arise, for the integral of the square of the function must then be unity, assuming that the particle is in fact somewhere. In some circumstances that can involve singularities which are evaded by renormalisation, but the success of that evasion challenges the probabilistic interpretation. When an experiment is performed which locates the particle, the psi function cannot remain after the experiment as it was before because the experiment has drastically altered the probabilities, and so the wave function is said to "collapse". This could indicate a momentary dissociation from the wholeness of the situation represented by the psi function. For example the psi function may describe the etheric aspect, which would be why Born was led to deny it any direct physical significance. An experiment brings in a "death" element which (momentarily?) particularises whatever is meant by a "particle" into one eigen state (position or momentum, or energy or time etc.). Does this bring the physical to the fore, or the mineral? We could also see the psi function as related to the physical in Steiner's sense, as condition of form, while the particle is related to the mineral as condition of life. Or are there two aspects of the psi function, one physical and the other etheric? Could *this* be what is expressed by the fact that the psi function is complex, not real in the mathematical sense? The problem with that is that Steiner refers imaginary numbers to the astral, not the etheric. Or are the physical/etheric and living/mineral polarities related to the alternative eigen state polarities position/momentum and energy/time? What about spin? Steiner relates rectilinear motion to the physical and rotation to the etheric.

3) QUANTUM MECHANICS AND THE PHILOSOPHY OF SCIENCE

HEDLEY GANGE

We have examined quantum mechanics with special reference to its historical development and the nature of the key phenomena. A complementary approach may be made by considering the place of quantum theory within the whole scheme of science, in the conditions of today.

One recent trend has been for some scientists to become increasingly concerned with the human and social implications of science whilst regarding atomic theory as a tool, having limited capabilities, to be used for specific purposes: "...for all the power of quantum theory, the goal of predicting 'upwards' from the properties of subatomic particles to the properties of molecules has not been achieved even for such simple substances as H_2O." ("Science and Beyond". Ed. S. Rose and L. Appignanesi, Basil Blackwell 1986, p 7). Another recent development is a blend of

history, philosophy, psychology and technology ("Mind in Science", R.L. Gregory, Peregrine Books, 1984). The acceptance of parapsychology as a recognized subject for university study (Edinburgh 1986) may have implications for the philosophy of science (see, for example, Philosophy of Science and the Occult, P. Grim (Ed.), Albany: State University of New York Press 1982).

It would perhaps make a useful contribution to the contemporary scene if Steiner's basic philosophy, as given in The Philosophy of Freedom and elsewhere, could be extended step-by-step so as to embrace the concepts, realities, laws and relationships of modern science.

THE MARGARET WILKINSON RESEARCH FUND

HOWARD SMITH

Since 1981 the members of the Science Group Committee have administered the Margaret Wilkinson fund. which supports research *"based on Rudolf Steiner's information by members of the [Anthroposophical] Society."* Although in practice most grants have ben given for scientific research, other deserving areas qualify; several grants have supported educational research.

Currently, the Fund is assisting in the following areas:

1) Lawrence Edwards' research into morphology (especially of buds) has been aided by the purchase of a "Microsight System". This is a scanner which has been adapted to measure the relevant parameters of buds automatically, eliminating much tedious photography and hand measurement. [See Science Forum 5 and 7 for earlier reports on this research. See also Graham Calderwood's report in the present issue.]

2) John Wilkes' research into Flowforms continues to be supported by the Fund. [See the report in this issue.]

3) Martin Hardiman is conducting a project on reading and writing in Waldorf Schools, and is receiving help from the Fund.

REPORTS RECEIVED

Dr. Margaret Colquhoun has written a report of her researches into the morphology of the Buttercup family (supported in part by the Margaret Wilkinson Fund), which is included in this issue of Science Forum.

Audrey McAllen has for many years researched learning difficulties in Waldorf School pupils, and has received some help from the Margaret Wilkinson Fund. A report of this work has been submitted to the Trustees. The following is a brief outline of the research, prepared for Science Forum.

From the 1960's Waldorf Schools have had an increasing number of children with writing and reading problems. Because of our approach to these subjects the fact that these pupils were in real difficulties did not come to light until late in the Class Teaching period and even on into the Upper School. Parents were more alert to their child's problem due to media publicity and, not obtaining satisfactory replies from the teachers, our schools found that many children were being assessed and receiving outside help in these learning areas.

Those responsible for Teacher Training and remedial work at Rudolf Steiner College, California, asked if I could find a method of diagnosis that would pick out earlier the children with these problems, as few schools had a remedial teacher and if each child was to be assessed that teacher would be fully occupied and not have time to "teach".

From experience I had already discovered that primary difficulties showed themselves in children's drawings. Assisted by Monica Ellis, visits to schools in U.S.A., the U.K. and Europe have been made. There we have done "Class spot checks" in Class Two to Class Eight. The results have been correlated with their Class Teachers.

In this way we have found out those children with evident motor problems, incomplete developmental stages etc. who were definitely at risk and needed detailed assessment. It has also come to light that children without learning problems have delayed development stages which are not "made up" during the Class Teaching period. There is evidence to show that children are entering Class One at too early an age. Also we are finding that among children requiring full assessment there are some with structural problems caused from birth difficulties, unexpected falls and other accidents in the home. Treatment by cranial osteopaths has confirmed our "query" in the drawings and helped the child to make better progress in his motor organisation.

Audrey McAllen

[Further information on the Margaret Wilkinson Fund can be obtained from the Editor.]

SOCIETY FOR THE EVOLUTION OF SCIENCE

A society for the advancement of Anthroposophical/Goethean science has been formed in the United States. It has a nationwide membership and issues a Newsletter two or three times a year. The first (tentative) Newsletter was produced in January 1985: in subsequent issues the scope and aims of the society, as well as the choice of a suitable name, were discussed. There was wide agreement that the organization should seek to appeal to many scientists rather than be directed primarily to those who were already "interested in Goethe, Steiner or Anthroposophy": the name provisionally agreed was 'The Society for the Evolution of Science'.

The July 1987 Newsletter contains an interesting 8-page Report on the results of a survey carried out among members to obtain a general picture of the present state of Anthroposophical Science and Technology in North America and possible lines of future development. A conference was arranged to be held in Chicago in June 1988 for the purpose of discussing this report and also presenting scientific papers. Further information will be given in the next issue of Science Forum. The Newsletter is edited by Bruce K. Kirchoff, Route 4, Box 1081, Hillsborough, NC 27278, U.S.A., and production is by Michael Wisniewski.

ANTHROPOSOPHY AT THE UNIVERSITY

HEDLEY GANGE

When Manchester University Extra-Mural Department arranged a course on 'Rudolf Steiner: Scientist and Visionary', in collaboration with the Manchester Group of the Anthroposophical Society in Great Britain, a meeting-ground was provided for Steiner's Spiritual Science, the life of the University and those members of the general public who enrolled for the course, numbering 70 in all. Lectures were given on one evening per week for eight weeks, from 28 April to 9 June 1988, as follows:

Steiner - The Man	*Dr. Rudi Lissau*
Steiner & the Philosophy of Science	*Nick Thomas*
Steiner and Education	*Brien Masters*
Steiner and Medicine	*Dr. Michael Evans*
Steiner & the Philosophy of Freedom	*Rev. Evelyn Capel*
Steiner & the picture of the Human Being out of Biology	*Graham Kennish*
Steiner and Psychology	*John Lees*
Steiner and the Christian Spirit	*Dr. Andrew Welburn*

All the lectures ware warmly received and gave rise to wide-ranging questions. The special conditions of the course made it of interest to both newcomers and long-standing students of Anthroposophy. The following comments are concerned with one particular aspect of the course, namely the insight which it provides into the present state of knowledge in the area where spiritual (or holistic) approaches meet the orthodox sphere.

The question arose early in the course, "Is spiritual science, as it exists today, scientific?" The answer should, perhaps, be, "Yes, the basic scientific spirit should be fundamental in Anthroposophy, but this does not mean that all the theories and hypotheses of modern science are compatible with Anthroposophy." However, students of Rudolf Steiner attach varying significance to this question: in connection with, for example, artistic activities it may appear unimportant but in the present context, where biology, psychology and philosophy are being discussed, a clear understanding of the situation, as it exists today, is desirable. This is a question that merits further attention - especially in regard to its public presentation.

Steiner's message to modern philosophers is that they should train ***all*** their faculties by following a path of patient development. By so doing, reality can be grasped and the apparent division between subject and object overcome. The Philosophy of Freedom is invaluable in this respect, but it is not an easy book, and Steiner remarked in 1894 that it could have been written in a hundred different ways. It would perhaps be useful if a shorter book could be written, with a more limited objective, introducing Steiner's approach to modern students of philosophy: the Philosophy of Freedom could then be studied later.

A recent publication, Introduction to Contemporary Epistemology by Jonathan Dancy (Basil Blackwell 1985), is intended for use by undergraduates in their second or third year of a philosophy degree course and gives a good indication of the modern approach. The subject is treated clearly and systematically but the whole remains at the level of logic and argument. Perhaps some means can be found of bringing a wider 'theory of knowledge' to the notice of students - based on a comprehensive understanding of the nature of man and of the potentialities of his faculties?

The Philosophy of Science may be approached by applying Steiner's basic philosophy in the specific sphere of science. Changes have taken place in the scientific outlook during the last 30 years and these have been reflected in differing approaches to the philosophy of science, which today appears in varying forms. Concepts such as 'falsification' or 'justification' have useful applications within certain limits but all existing approaches have associated problems, either inherently or in relation to life in general. Spiritual science can throw much light on the present situation but, as Nick Thomas remarked, it would be very helpful if an Anthroposophically-oriented Philosophy of Science could be produced, referring specifically to the concepts and processes of present-day science. Some features of such an approach would be: an enhanced role for concepts or groups of concepts derived from experience; ethical and qualitative values associated with the forces and processes of science; different categories of phenomena and their relation to Reality.

The subject of education aroused much interest and the time for questions was all too short. The principles of Steiner education were described and the reasons for some special features explained. One question was, "Has the time arrived for Steiner's educational impulse to be implemented more widely, beyond the dedicated schools and institutions?" There is today a wide interest in education at all stages of life and the educational scene, as it exists today, has developed out of many impulses and initiatives. Possible advantages of a wider application of Steiner's educational ideas are (a) more people from a wider range of the population would be likely to benefit and (b) there would be less likelihood of the Schools appearing 'separate' in a social sense.

Dr. Michael Evans outlined the principles of Anthroposophical Medicine, based on the concept of man as a being of body, soul and spirit. He also referred to progress being made in Anthroposophical medicine in Britain, involving increased facilities and wider recognition. There are today many different schools of alternative, or complementary, medicine, and it is important that the distinctive characteristics of Anthroposophical medicine should be widely known - especially by the authorities responsible for public health and welfare. Anthroposophical doctors are required, first, to undergo a normal medical training. Anthroposophical medicine has been practised and developed for more than fifty years, especially in Switzerland and Germany where there are clinics, research institutions and Anthroposophical hospitals. Activities in Britain include private/NHS practices, eurythmy therapy, artistic therapy, counselling, massage and training courses for nurses and medical students. The public impression appears to be one of remarkable medical insight by Rudolf Steiner, the fruits of which have been further developed by Anthroposophical doctors during the last fifty years. Views on the scientific (or spiritual-scientific) basis of Anthroposophical medicine are necessarily influenced by, for instance, the impression created by the eight lectures of this course taken together.

Graham Kennish gave a sensitive and artistic introduction to the Anthroposophical study of biology, evolution and the relationship between man and animal. His approach served to illustrate how a more limited approach, consisting of, for example, the setting up and refuting of hypotheses, would fail to achieve a true understanding of these fields. Many debates are currently taking place in, and around, the sphere of biology, involving social, ethical and aesthetic factors. There is today more general interest in, for example, the concept of *form* than is perhaps realized within Anthroposophical circles (see Organic Form - with bibliography - ed. G. S. Rousseau, Routledge and Kegan Paul, 1972). It would be of value if an up-to-date study of organic form, drawing on both Anthroposophical and orthodox sources, could be produced.

The field of psychology is of particular interest because of the many developments that have taken place since 1925. John Lees outlined an approach to psycho-therapy in which different methods and techniques (Anthroposophical and orthodox) are employed according to needs and circumstances. In the past there has been some reluctance to introduce Anthroposophical ideas into contemporary life because of possible misunderstandings and terminological difficulties but there seems now to be a general feeling that the time has come for such difficulties to be faced and dealt with.

Dr. Andrew Welburn gave a fascinating account of some recent archaeological discoveries in the Middle East, relating to the Gospels, the results of which have only become available during the last two years. These confirm Rudolf Steiner's spiritual insights of more than sixty years ago.

Anthroposophy can be described and systematically developed as a path of knowledge and activity: the situation becomes more complex, however, for various reasons, where matters of a religious nature are involved. Newcomers will have been impressed by the abilities and

personal qualities of all the lecturers on this course - and by their common commitment to Anthroposophy, which includes, in some way, a religious element (specific references to the role of Christianity in the life of Rudolf Steiner were made by Rudi Lissau, Evelyn Capel and Andrew Welburn). In the modern world, individual commitments may take various forms - religious, humanist, compassionate: the questions arise, now that Anthroposophy is being disseminated more widely, "Does the pursuit of spiritual science, in a social context, require a personal commitment, and if so, what is the nature of this commitment?"

A further course on Rudolf Steiner and spiritual science has been arranged at the University for April-June 1989.

FOURIER STUDIES OF MORPHIC RHYTHMS BETWEEN BUD AND PLANET

GRAHAM CALDERWOOD

In what follows I have made use of some of the data published by Mr. Lawrence Edwards in Science Forum 7, for which I would like to thank him. I was curious to know what further light Fourier Analysis might throw on the phenomena he so interestingly describes. A number of things emerged which I thought interesting enough to pass on, not only because they deepen the insight to some extent, but because they prompt what I believe to be rather fundamental questions about things like 'formative energy', and give pointers to new research. First, a little background may be in order for those unfamiliar with what Fourier analysis accomplishes, which is to reveal simple rhythms present in periodic phenomena.

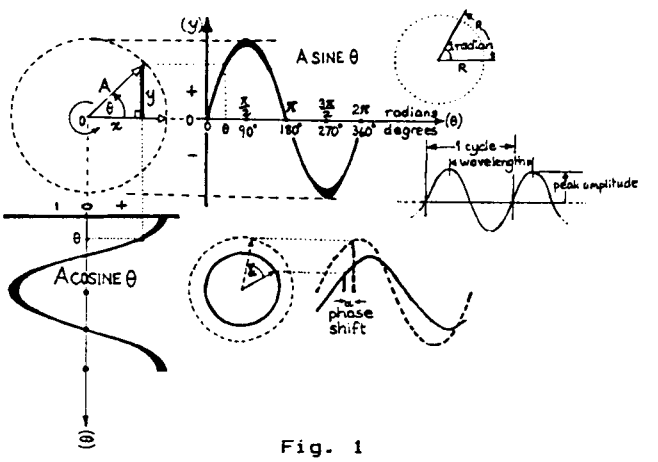


Fig. 1

SIMPLE RHYTHM

The simplest rhythm is a Sinusoid, named for its snake-like shape, and derived from the rotating radius of a circle, like the spoke of a wheel. We chart the height of the rim end of the spoke above the hub against the angle through which the spoke turns - by convention, anticlockwise. We note the curve repeats exactly for each cycle of the wheel, so this is indeed a rhythm. Frequency is the repetition rate, so it will be given in cycles per second, nowadays called Hertz (Hz). The main features of such waves are summarised in Fig. 1.

Note the right-angled triangle 0Ax. From it, and trigonometry, we have

$$y = A.sin\ \theta$$

but also

$$x = A.cos\ \theta$$

The latter gives the horizontal distance from the hub to the spoke end, and an identical wave, except that, because

$$cos\ \theta = sin(\theta + 90) \quad ,$$

there is a 90 degree phase difference between the sine and cosine waves.

FOURIER

Baron Jean Baptiste Joseph Fourier, 1786 - 1830, assumed that a periodic function of any shape, $f(\theta)$, is the sum (Σ) of a suitable mix of simple rhythms $A_k.cos(k.\theta)$ and $B_k.sin(k.\theta)$, so that he could write

$$f(\theta) = A_0/2 + \sum_{k=1}^{k=\infty} (A_k.cos(k\theta) + (B_k.sin(k\theta)),$$

$(k = 0,1,2,3,...)$

and, genius that he was, went on to show that

$$A_k = (2/T) \int_{\theta_1}^{\theta_2} f(\theta).cos(2\pi k.\theta/T).d\theta ,$$

and that

$$B_k = (2/T) \int_{\theta_1}^{\theta_2} f(\theta).sin(2\pi k.\theta/T).d\theta ,$$

provided that T is always $(\theta_2 - \theta_1)$.

A_k and B_k are the Fourier co-efficients, and are the peak amplitudes of the component simple rhythms of $f(\theta)$, called "harmonics.

This is a marvel. If we can solve these two integrals, we have the component rhythms we want. Now integrals are lovely but notorious things. They are nearly always difficult to solve exactly, and sometimes impossible. It's a bit like the game of patience - you never know in advance if it will come out! Fortunately, approximate solutions can always be found, and although these will not be perfect, they can be made as exact as we wish, or have time to compute. And suppose an exact solution happened to be an irrational number - the sort that wrecked pre-Pythagorean cosmology - such as π or $\sqrt{2}$, we would need to take some decision about the precision with which we represent this number in practical usage of it, and if we must use an approximation for such a case, we might as well for all, and apply the same decision to the lot! So, at small cost, we kill all the birds with one stone. Such methods do tend to be labour-intensive, but with computer assistance, they can be reasonably painless. I use 'Simpson's Approximation' in my programs.

THE FIELD

The phenomenon of interest to us now is the variation of λ with time of the various species of bud, which has strongly periodic features, as Mr. Edwards has shown. He indicates that the period of a particular bud type matches that of the alignments of a particular planet. At the start of his investigations, he found that the major changes in λ "clocked in" more or less together with the alignments. There appeared to be synchrony. Were I a believer in chance, I would call this a happy one, for as the years, and the investigation, went on, he detected a drift from synchrony - but matches of bud to planet periodicity seem to be preserved.

Were we dealing here with simple rhythms only, we would say their frequencies remain unaltered and equal, but there is a phase shift between them which seems to be increasing. Though Mr Edwards says the evidence is frail, the rate of phase shift seems such as eventually to restore synchrony in a time consistent with the period of nutation of the moon nodes, some eighteen years.

However, the phenomenon is richer even than this, and of course does not consist of a single simple rhythm. In fact, the λ wave shape is quite complex; for example, there is a variation, apparently seasonal, of "peak amplitude", which Mr Edwards calls the "winter sleep", and at least once a "dip" is missing from one of the records. Clearly, it would be of value and interest to discover just which rhythms are present in the whole phenomenon, and how they vary, in order that we might find out what ought to be correlated with what. For this, Fourier analysis is really the only tool, and I for one am most grateful to M'sieu le Baron that it is to hand!

SPECTRA, SYNTHESIS AND FILTERING

When an analysis is performed, a set of Fourier coefficients is obtained, referred to as a "spectrum", in rather more than analogy with the colour spectrum yielded by a prism or diffraction grating - that spectrum is a natural Fourier analysis performed before our eyes! If we have a complete set, we can perform the inverse process, and synthesise the original waveform exactly as it was, or is.

This might seem an unnecessary thing to do, since we already *have* the original wave!

But in fact we may not quite have it. Inevitably, in any process of observation a certain amount of what we observe has scantly to do with the phenomenon per se - this may come from imprecision of measurement, or from disturbances of one sort or another, summed up in the term "noise". We can exercise the sometimes pious hope that these disturbances are small, rapid and random, which in Fourier terms means harmonics above, we hope, some frequency not too near to those which "really" make up the phenomenon. Provided we judge the cut-off correctly, we can simply synthesise our wave without these higher harmonics! The result will be closer to the truth, and clearer. Sometimes we do this even to relatively noise-free but complex observations, the better to see trends. This process is one instance of "filtering", with which too, Fourier synthesis can be an excellent smoother and interpolator of "scattered" data.

DOMINANTS, MISSING DIPS AND ROGUE WAVES

Fig. 2a gives the spectra corresponding to Mr. Edward's diagram 11 of Science Forum 7, on Beech, and Fig. 2b those graphs reproduced by my plotter. Both are in two parts, 1984 and 1985. Superimposed on the graphs are the

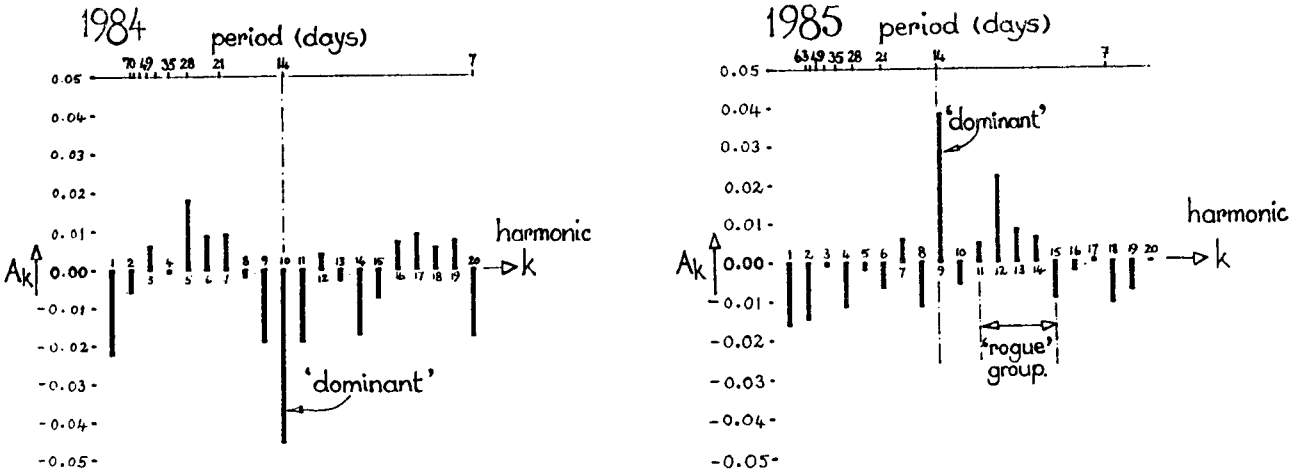

1984
period (days)
70 49 35 28 21 14 7
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
Ak
harmonic
k
'dominant'
1985
period (days)
63 49 35 28 21 14 7
'dominant'
harmonic
k
'rogue' group.

Fig. 2(a)

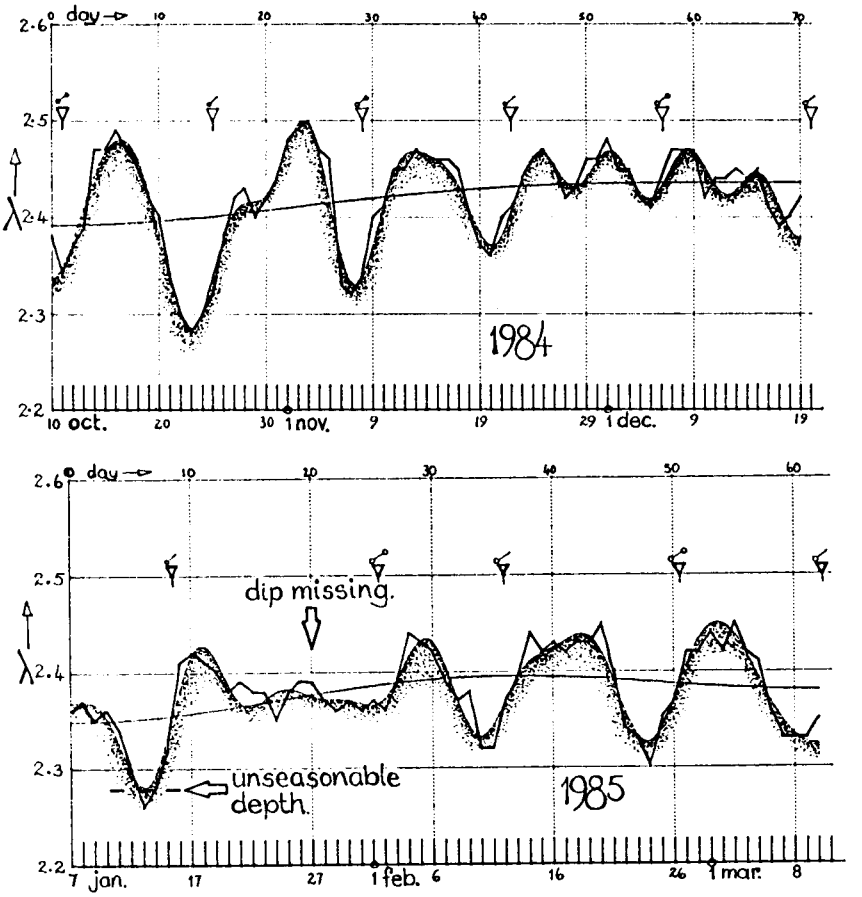

day
0 10 20 30 40 50 60 70
2·6
2·5
2·4
2·3
2·2
λ
1984
10 oct. 20 30 1 nov. 9 19 29 1 dec. 9 19
day
0 10 20 30 40 50 60
2.6
2.5
2.4
2.3
2.2
λ
dip missing.
unseasonable depth.
1985
7 jan. 17 27 1 feb. 6 16 26 1 mar. 8

Fig. 2(b)

syntheses from all harmonics up to the 20th, which fairly powerfully smooths the graphs - perhaps too powerfully. Some baby may be going out with the bath water, but the dips are there, and it is likely that they are better identified and timed in the synthesis than in the original.

Note especially that the 14 day rhythm is dominant in both spectra; it is the most emphatic rhythm present, but by no means the only one.

But note also that the data for 1985 is odd, in two ways. firstly there is a dip (the second) very obviously missing; secondly the first dip is unseasonably exaggerated in depth. The bud is here just emerging from its "winter sleep", and experience suggests that this dip ought to be shallower than most. But the fact that the 14 day rhythm is still dominant in the 1985 spectrum as in that of 1984 must mean that the second dip is not missing. Something must be overlaying it and nullifying it in some way. If we scrutinise the 1985 spectrum more closely we see there, but not in the 1984 spectrum, a fairly strong group of harmonics around number 12. It is a reasonable bet that these represent whatever is suppressing the dip.

Fig. 3 is the result of synthesis with that group filtered out. We see the occluded dip reinstated, which is very nice, but just as interestingly the first dip now has a more seemly depth!

Synthesis of the "rogue" group of harmonics by itself (Fig. 4) yields the reason for both of these things in detail.

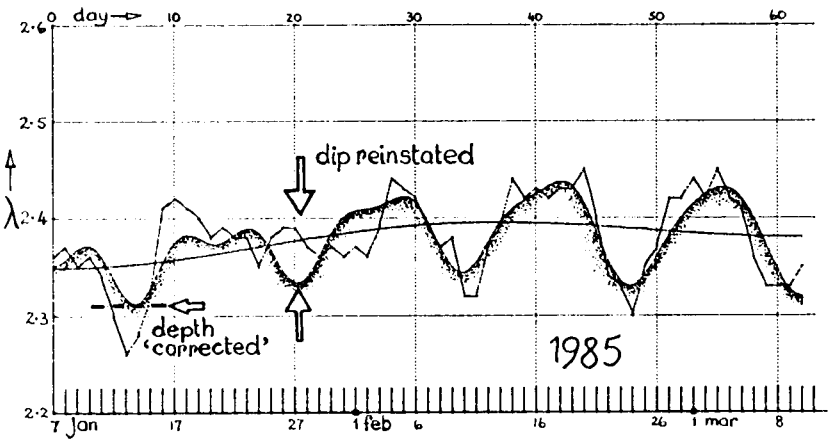


Fig. 3

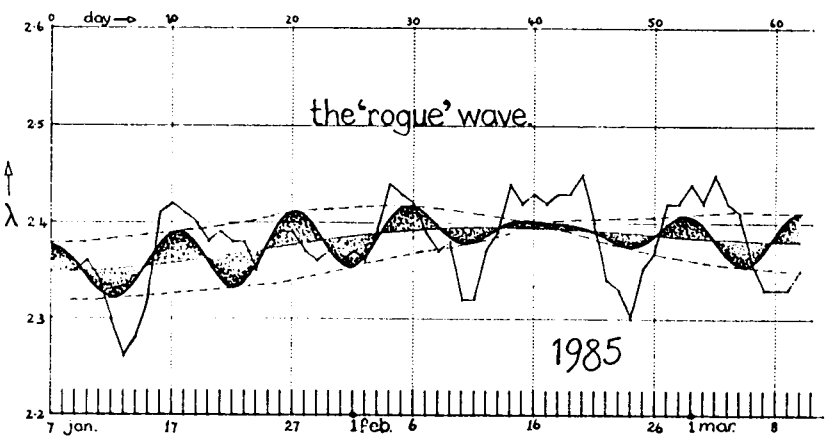


Fig. 4

The disturbance is a waxing and waning wave train with a basic period of around ten days. A peak of it lies in anti-phase with the second lambda dip, and sums with it to near zero, while a trough is in phase with the first lambda dip, and nearly doubles its depth. Other dips are little affected because the rogue wave has diminished considerably by the time they fall due. So both oddities have the same origin.

But the source of the disturbance is anyone's guess! What has a period of 10 days? I do not know, but there is little doubt in my mind that the disturbance is real. Just possibly, some confluence with an adverse planet might be responsible. Mr Edwards mentions his suspicions about inhibitory planets. This could be a case.

THE WINTER SLEEP

I was reminded of my radio designing days by the harmonics immediately flanking the dominant. A radio wave may go far, but conveys nothing just by itself. One must alter it in some way consistent with what one wants to transmit, for which it then becomes the "carrier wave" (CW). One option is to vary the peak amplitude of the CW in accordance with the instantaneous amplitude of the music or speech, or whatever. This is "amplitude modulation" (AM). Let the modulating signal be a simple rhythm, say $B.cospt$, and the unmodulated carrier another, $A.cos\omega t$. On modulation, the peak A becomes

$$A + B.cospt \ ,$$

so that the radio signal becomes

$$(A + B.cospt).cos\omega t \ ,$$

which multiplies out to

$$A.cos\omega t + B.cos\omega t.cospt \ .$$

Note that the left hand term is just the carrier. The right hand term expands, by a well known trigonometrical identity, so that we obtain

$$A.cos\omega t + (B/2)\{cos(\omega+p)t + cos(\omega-p)t\}$$

or, in full

$$Acos\omega t + (B/2)cos(\omega+p)t + (B/2)cos(\omega-p)t$$

which is the sum of three simple rhythms. There is the unmodified carrier, and two "sidebands", each at half the modulating peak amplitude, spaced by the modulating frequency equally above and below the carrier frequency. The spectrum would be something on the lines of Fig. 5. Looking at the discrete spectra for Beech 84/85, we find approximately this situation for the dominants and their immediately flanking components. It was of interest to synthesise from just these alone. Fig. 6 is the result.

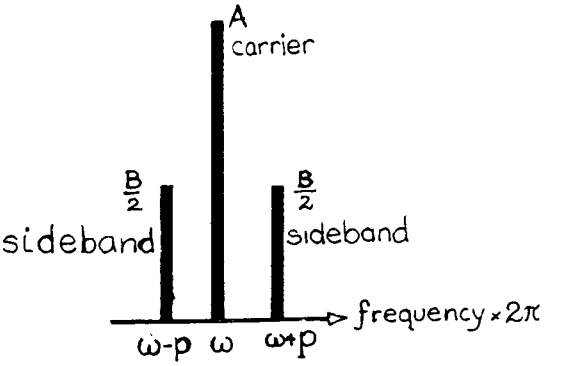


Fig. 5

I believe we capture in these graphs the essence of what Mr Edwards calls the "winter sleep".

On programming the computer to extract the "envelope" waveform of these filtered graphs in much tha same way as a receiver does it when it recovers the "message" - full wave rectification, low pass filtering, and so on - I found that the results also enveloped the original, unfiltered data surprisingly accurately, considering the rather savage exclusion of rhythms that had gone on.

Thus we may be led to speculate that we have generally to do with a modulated phenomenon. If so, there will be a modulator. Of what sort is it? It may be that Mr Edwards' charming description of the dying and resurgence as the winter sleep reflects more than metaphorical insight, and that the effect is indeed seasonal, in which case it will have to do with the tree's position on the earth's surface, with the earth's inclination and with its position in its solar orbit. How I would like a set of measurements from the beech trees of Australia! I am at the moment inclined to think it probable that the modulation is only of a bud's sensitivity to its planet, and not the manner of it, as muffling the ear dulls hearing, but leaves the understanding of whatever speech remains to be heard largely intact. Future work may settle these matters.

Remaining with radio for a moment, it is worth noting that a receiver is made selective by a process of tuning which depends on **resonance.** (Hoot loudly - but privately - at a piano. Some strings will resound, others will remain silent: a piano is not a bad fourier analyser! Strings sharing frequencies with the hoot will re-son-ate - sound again.) Now, whenever we have it so that a quantity of energy can be regularly swapped between potential and kinetic forms, we have the conditions for resonance. In a receiver, this is obtained by some combination of inductance and capacitance in a "tuned circuit", which allows it to respond to just one transmission and more or less ignore the rest.

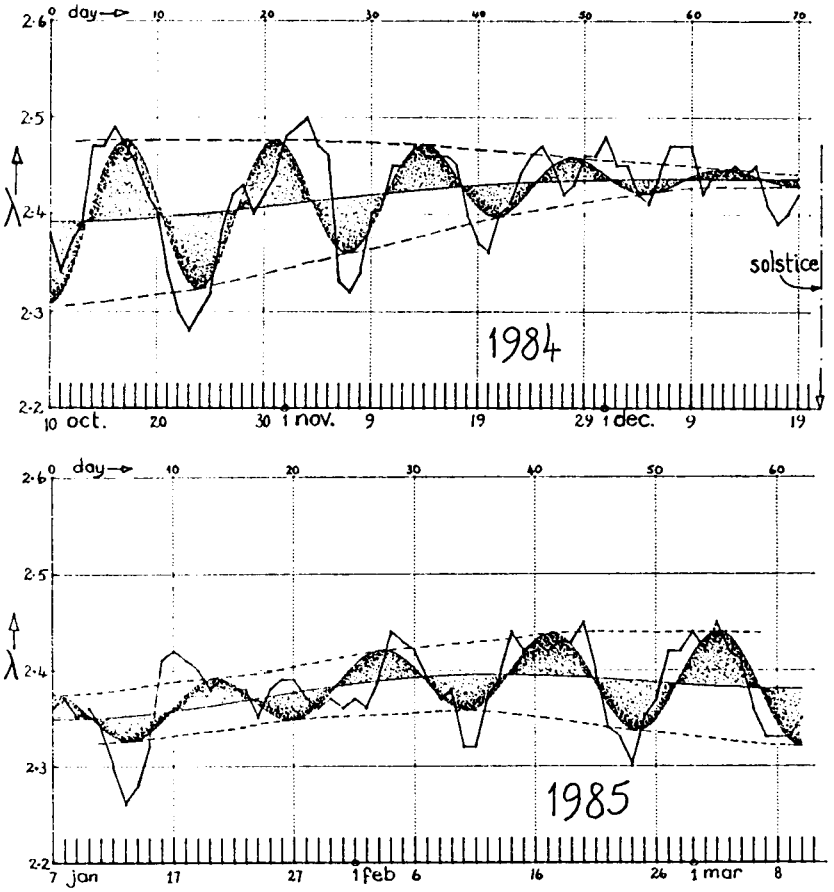


Fig. 6

Now I am not about to insist that the formative agencies which may be at work in plants are physical, but when it comes to it, we have been dealing with rhythms, and Mr Edwards has shown that the buds are selective. We may find the analogue in morphic terms of the tuned circuit.

All this implies a good deal, and the path is strewn with pitfalls! It is tempting to think that if physical energy is the capacity to do work, morphic energy must be the capacity to create form. Is it possible to formulate a theoretical relationship between 'formative force' and 'created form'? We need the equivalent of mass, m, and acceleration, a, in the classical mechanical situation f = ma, if we are to speak **equivalently** of 'formative force'. We might succeed in this were we able to put a value on 'quantity of form', but this presents severe difficulties. We can say by example what a form is, sometimes, but not how much there is of it. Until we can manage the latter, we cannot define formative 'force' as ordinary force is defined. Are there alternative definitions, and if not, do we do best not to speak of force at all?

There are other very interesting questions arising from bud/planet selectivity, if it is in actual fact a "tuned" type, each of which would lead to a whole chapter of research! For example, whatever morphic enregy turns out to be, it must come in two interchangeable kinds **and be conserved**, or the resonance, and hence the tuning, will not work. One of the two kinds will be static and the other to do with flow, presumably of form itself. And there is the intriguing question of how the planets "generate" the rhythms to which the buds selectively respond, and how the moon "mediates" them, as it rather apparently must be doing. I have begun work on the latter questions, starting with Kepler's three laws. There is great encouragement in the fact that the graphs of some features of orbital motion, notably acceleration, rather resemble Mr Edwards' lambda graphs after they have been Fourier-smoothed, but things are still highly tentative, and I won't go off at half cock by reporting on them now!

There is another rather important thing. So far, I have dwelt upon the notion that a bud

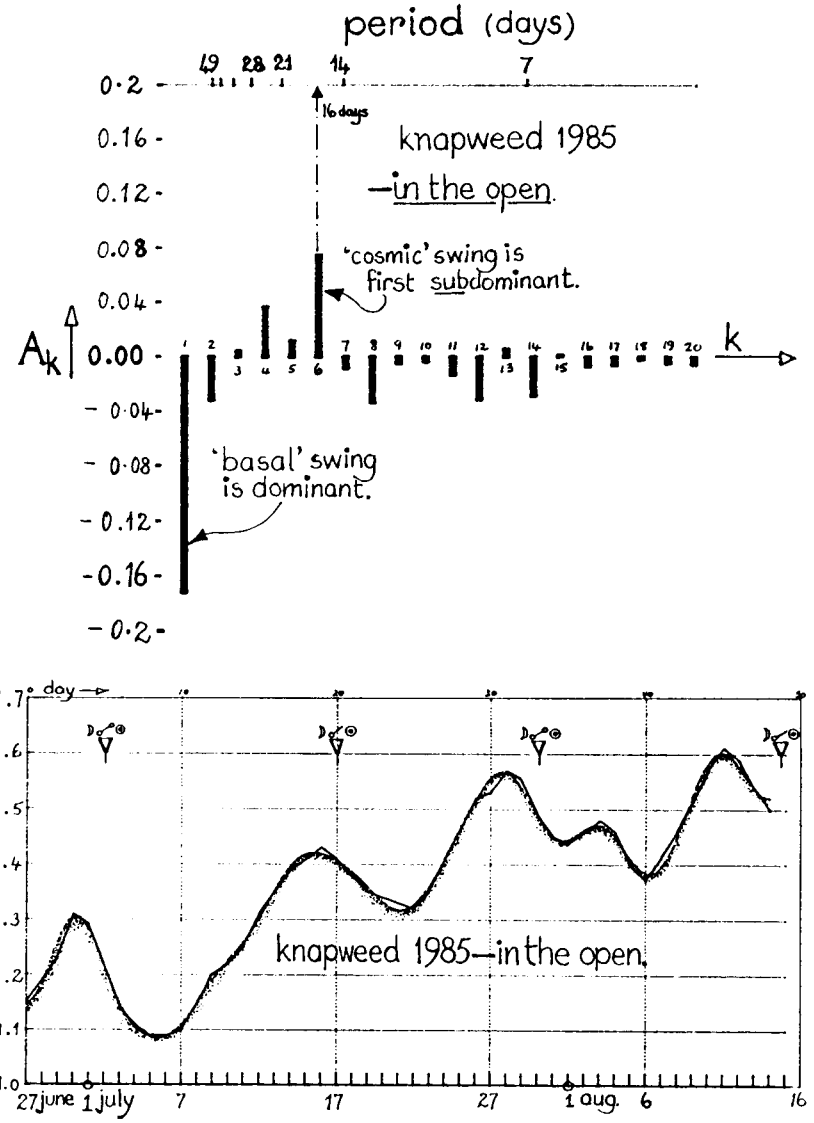


Fig. 7

responds to something in the nature of a signal. this may be completely incorrect. All known signals propagate at finite velocity, and none which involves physical energy (so far they all do) can ever outstrip the relativistic limiting velocity – that of light. Indeed, radio waves altogether exist only because this is true. Now it could be that planets instantaneously modify their buds, because neither form nor its production is necessarily under physical constraint.

This implies infinite velocity of propagation, which is the same thing as saying that there is no propagation, and that the morphic field of a planet moves bodily with it, with what is tantamount to perfect rigidity! Though I personally will not rush to believe that this is the case, it surely could be. And then we might not really need notions of resonance or tuning, because the bud would simply be embedded in the morphic field, and respond at once. In fact, even the word 'respond' could be misapplied, since there would be no re-doing anything. I regard it as urgent that some means be found to settle this question of propagation velocity, and I wish I could think of what that means might be! As I write, it dawns on me that this is the ancient problem of "action at a distance" all over again, and there! I had thought it long resolved.

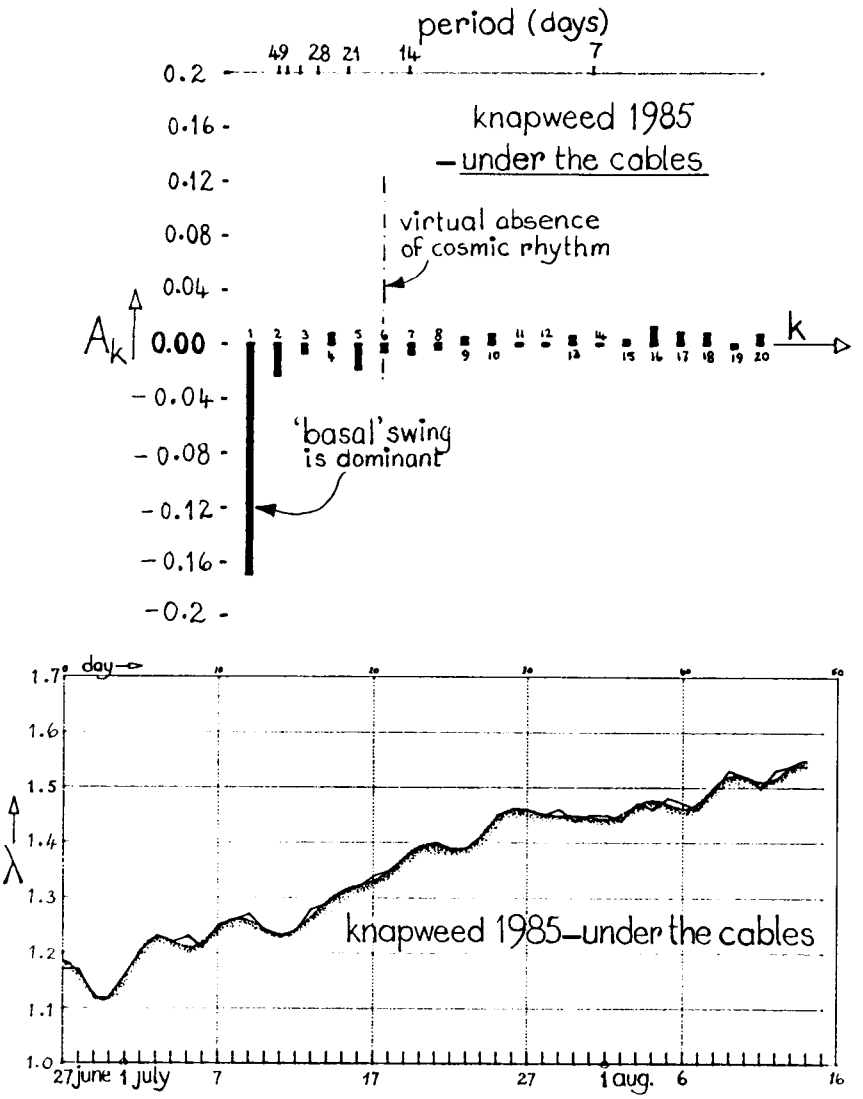


Fig. 8

Let me come back, literally, to earth, and finish with something for which, thanks to Mr Edwards once again, we have some firm data!

BASAL LAMBDA, AND THE EARTHY SIDE

Mr Edwards' Knapweed graphs (Science Forum 7, diagrams 13 and 14) are especially interesting from a Fourier point of view.

If synthesis is done from fewer and fewer harmonics, omitting from the top down, progressively smoother curves are obtained, each following the original wave's deviation less vigorously, until in the limit the synthesis is just the average of the original, and a straight line. This was the prelude to a basic question: is there a frequency limit below which the "cosmic" influence ceases, so that any residue can be seen as entirely terrestrial in origin? The knapweeds help towards an answer.

Mr Edwards gives two graphs in diagram 14, Science Forum 7, which are reproduced here as Figs. 7 and 8 along with their spectra. One is from knapweed in the open, the other from knapweed under high-tension cables. He says of the under-cable graph that it is just what would be expected in the absence of cosmic influence. (One assumes that it is supressed by the electromagnetic (EM) field of the cables, but it would be interesting to place a "faraday cage" – a box made of chicken mesh, within which there would be almost no EM field – over some of the knapweed both in the open,

and under the cables, just to see! Perhaps the metal alone is enough to cut the buds from the planets.)

Some rhythm, however, remains to the under-cable plants, which I tend to think of as the strictly earth-bound contribution to the bud's shaping. Fig. 9 shows the synthesis of just the first three harmonics from the buds in the open, graphed together with Mr Edwards' under-cable result. It will be seen that the filtered curve matches well with the under-cable curve. It seems from this that the effect of the cables is to suppress rhythms above the first three, or perhaps four.

Thus there is a rough answer to the question: harmonics below and including the fourth or so may provisionally be taken as terrestrial. I call the synthesis from these "**basal lambda**", and have assumed for the moment that the limit-figure for knapweed applies to other species too. The basal curve is also on the beech graphs above.

As always, the end comes on a rising inflection, a questioning note. It seems that anything we do as scientists to paper over a patch of ignorance only exposes further great tracts of the stuff. Excellent! How can we know we are ignorant unless we have found a brace of reasonably well-defined questions? I wish to be protected from the man who knows it all, or who thinks he knows enough!

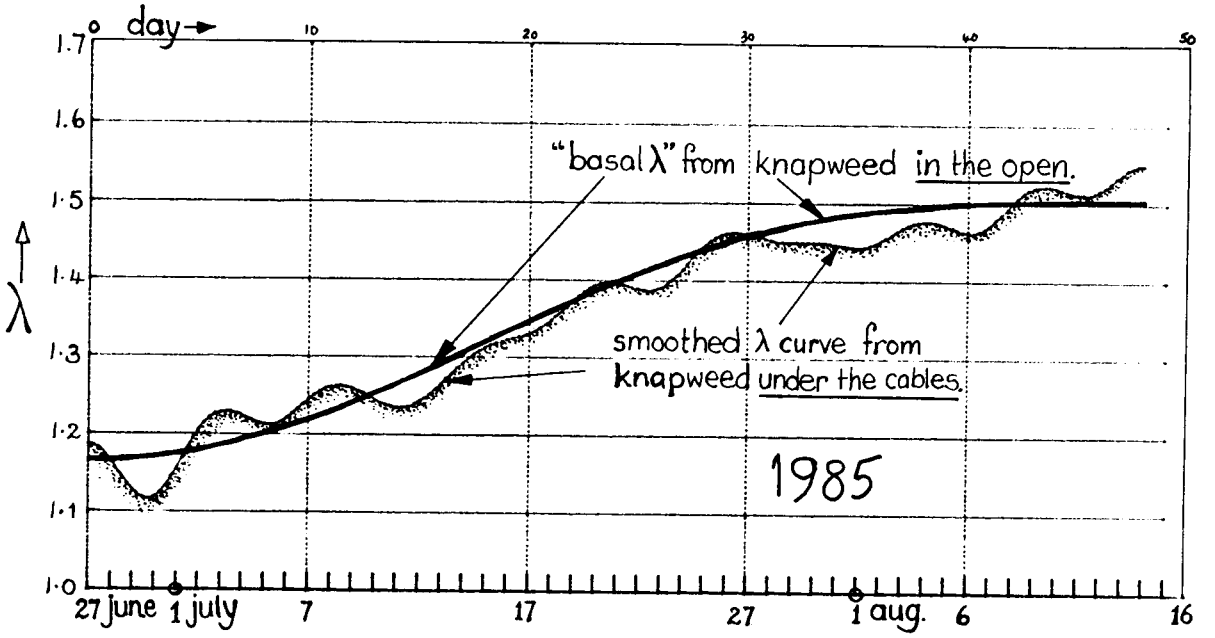


Fig. 9

MEETING THE BUTTERCUP FAMILY

MARGARET COLQUHOUN

INTRODUCTION

"Confused may you be my beloved,
by the thousandfold mixture of flowers in the garden..."

Goethe's words at the beginning of his poem on "The Metamorphosis of Plants" are a highly appropriate description of the initial experience of anyone embarking on a journey of "encounter of the other", the essence of the rather modern scientific method known as Goethean Science. This method of approaching natural phenomena has only been developed in the last 100 years since Rudolf Steiner edited Goethe's scientific works. Realizing the importance of Goethe's contribution to the world of science (Goethe himself considered his scientific work more important than all his literary endeavours!), Rudolf Steiner took up Goethe's way of experiencing nature and initiated a path of scientific investigation which involves the subjective participation of the scientist in a conscious way and even necessarily entails a transformation of the investigator's soul, as well as the so-called objectivity of conventional modern science.

Goethe goes on in the poem to say how, although among the thousandfold mixture "...all their forms are alike, yet there's none like the other. The whole choir is pointing to a secret law." Towards the end of the poem he says that once one has learned to unravel the manifoldness and wonder of confusion thus finding order therein, "the many-coloured hosts" appear "no longer confusing before your mind's eye... Each plant bears witness of an eternal law" - a law of order not only within each plant but manifest right across the plant kingdom. Learning to read this script or "to decipher the letters" in Goethe's words is the aim of the scientific method which bears his name. My own introduction to the Goethean Scientific Method involved an excursion (or non-violent incursion) into the Buttercup Family, the Ranunculaceae. The task, "to order them Goetheanistically", was given to me by Thomas Goebel, head of the Carl Gustav Carus Institute in Oeschelbronn, West Germany, when I went there in January 1983 to do three years of research.

The Buttercup family consists of over 4,000 brothers and sisters (species) mainly confined to the temperate zones of the world. They are rare in the tropics and polar regions. There are small plants with yellow, wide open, upturned flowers like the winter aconite (Eranthis hyemalis), the lesser celandine (Ficaria verna) flowering in the spring and, of course, the Ranunculus genus containing somewhere between 400 and 800 species of true buttercup (both yellow and white) adorning our fields and hedgerows in late spring and throughout the summer.*

Anemones and Pasque flowers (Pulsatilla) belong to the spring-flowering members, Clematis, Thalictrum or meadow rue, Delphinium, Aquilegia (the columbine) and Aconitum or Monkshood to those larger, more complicated late summer and autumn-flowering plants. The Christmas Rose, Helleborus niger and its very close relatives flower from mid-winter on through to Easter. Not only are the many members of this family represented throughout the year in their flowering pattern, but the individual groups (genera) show a marvellous spread of diversity in their habitat requirements, size, growth habit, colour and shape of flowers.

Among the Ranunculus species alone we find different examples from the tops of mountains, by the glacier edge, down through mountain passes and pastures, open hillsides, thick woods to the valley bottoms, on moors, water meadows, in and beside lakes and rivers and even on the sea shore. Clematis can grow up to 60 metres climbing around trees and leaving a woody skeleton over the winter, while Eranthis is only a few centimetres tall, its flowers and leaves disappearing after a few weeks. We find such sunny bright yellow flowers as Eranthis or the buttercups, through the pale yellow-whites and greens of Helleborus, pale blue of Nigella, to the deeper hues of Aquilegia, dark blues of Delphinium and blue-violet of Aconitum, not forgetting the scarlet red Adonis or pheasant's eye.

In flower shape they vary from the open saucer-shaped buttercups to the yellow globes of the globe flower, Trollius, the spherical nodding heads of stamens of Thalictrum and the animal-like two-sided symmetry of Delphinium or Aconitum, not to mention the complicated showy nectaries in Aquilegia and Nigella or the shy simplicity of the wood Anemone. Confronted with this "thousandfold mixture of flowers" in one plant family alone where does one begin? How did anyone recognize in the first place that all these tremendously diverse plants "belong together" and why?

[* The reader is invited to read this together with a European Plant picture book.]

LINNAEUS

It was Linnaeus, now just over 200 years ago, who first described and named the many members of the buttercup family, although the name Ranunculaceae, as a single taxonomic unit (plant family), was given by de Jussieu in 1789. Linnaeus was able to identify and describe all these individuals out of an intuitive ability to recognize what we would now call "Ranunculus Archetype" or "Typus" - a belonging-togetherness - combined with a very fine faculty of describing exactly what he saw. He was not, however, able to describe the process through which he went in arriving at such a recognition. His main life's work entailed a reduction of what was undoubtedly profound spiritual knowledge and a deep subjective experience of familial relatedness, to exact details which anyone could subsequently use in order to identify the same plants. This left modern science with an exact and objective description of the phenomena of the organic world but with no means (for the individual today) of consciously recreating the experience, quite naturally present to some degree or another in all of us, out of which Linnaeus was able to do his describing.

GOETHE'S PLANT STUDIES

It was some 30 years later that Goethe, after many years of poring over Linnaeus' works (he rated Linnaeus, along with Shakespeare and Spinoza, as one of the profoundest influences in his life) began, through the careful recording of his own personal development during his study of the plant world, to become more conscious of the principles out of which an Archetype is recognized, and to describe something of the inner process involved. He was, through his very mobile inner constitution, able to experience and describe to a certain extent the developmental processes inherent (but ignored) in Linnaeus' work and thereby open the doors for others to tread this path of "coming to a recognition of the other", be it a single plant, plant family or fellow human being; also to lay the foundation for the theory of evolution developed in the following century by Darwin and Fischer among others.

Later in the 19th century Rudolf Steiner was given the task of editing Goethe's scientific works. Recognizing their importance he developed Goethe's method into a conscious scientific path which anyone can follow without necessarily being in possession of the remarkable gifts which Goethe undoubtedly had.

"URPFLANZE" & "URORGAN"

In 1787 Goethe had travelled from Germany over the Alps into Italy. Throughout this journey he noticed many familiar plants expressing themselves in quite different ways in the various climatic conditions in which they grew. Out of this experience of "one expressed as many" and "many belonging to one" he first saw and described what he called the Archetypal Plant or Urpflanze. He saw too that not only is every plant a particular manifestation of *the* Plant Archetype in general (and of Family, Genus and Species Archetypes) but also that every organ of every plant is a manifestation of an archetypal organ (Urorgan). "In the organ of the plant which we ordinarily designate as ***leaf***, the true Proteus lies hidden... Forward and backward is the plant ever only leaf", he wrote to his friend Herder in May 1787. It was, in fact, Cesalpino in Italy in the 16th century who first put down the idea that all organs of the plant were of leaf origin, and this was again noted by Linnaeus in his Metamorphosis Plantarum.

For Goethe, this process of transformation or metamorphosis of the leaves into organs of the flower and fruit (he left out the roots because he did not like them!) was a reality which he "saw" with his own "eyes". Inside the manifold transformation of "leaf" organs he recognized and described waves of expansion and contraction in the growth of the plant in leaf, flower and fruit regions where, with each expansion the plant enters into fullness of expression for that part of its development and, with each contraction, becomes finer, "more perfect", before moving on to a higher, more developed level of existence and then expanding again. This is a rhythmical movement inherent in all developmental processes in the organic world.

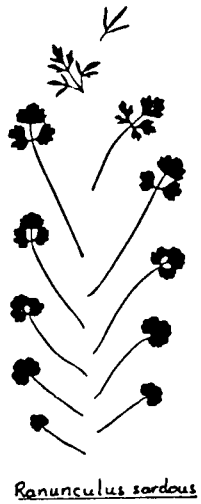
Rudolf Steiner described this in a lecture in Bern in 1920: "When we enter with feeling into the developmental impulse, we proceed at first from simpler to more complex forms; but then we reach the most complicated stage in the middle of the development after which it becomes simpler again while also becoming more perfect."

LAWS OF DEVELOPMENT IN THE LEAF SERIES

Let us look at this process in the development of the leaves of a buttercup as they spiral up the stem from root to flower. Fig. 1 shows a leaf series (all the leaves on the main stem) from Ranunculus sardous, the hairy buttercup. At first the leaves are long-stemmed with simple, rounded blades and their centre of gravity pushed out far from the stem of the plant. The blades then expand in surface area as the leaves climb up the stem, the leaf stems reduce proportionately in length and, towards the middle of the series the blades increase in complexity as well as in size. These are the leaves we call "typical" for the species.

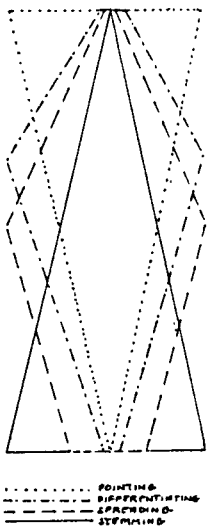
After the fully expanded phase of development there is a decrease in size and complexity, the leaf stem is completely reduced and disappears

Fig. 1



Ranunculus sardous

Fig. 2



inside the now simplified blade until the topmost leaf under the flower is a simple "more perfect" triad of spear-like bracts. The architectural laws of the forces producing this transformation were described by Bockemühl in the 1960's and can be read about in English in more detail in "Towards a Phenomenology of the Etheric World" (Anthroposophic Press, 1977) and "In Partnership with Nature" (Biodynamic Literature, 1981).

In brief, the activity at the beginning of the series, which predominates nearest the root and produces long-stemmed, peripherally heavy leaves with a movement away from the main stem, is known as STEMMING. This is followed rapidly by SPREADING as the leaf blade expands or spreads into the horizontal. The next activity to predominate, DIFFERENTIATING, seems to be in tension with spreading as the rounded forms become differentiated and divided as if from without. There then follows POINTING where the leaf stem is swallowed up in a blade which has become simple and pointed and which clasps with its bulk the main stem of the plant under the flower. Fig. 2 shows the interpenetration of these formative activities diagramatically to demonstrate their differential predominance (by width of triangle) beside the leaf series of Ranunculus sardous.

THE LEAF, THE WHOLE PLANT & THE PLANT FAMILY

If the plant is a whole and all plant parts are of leaf origin, would one then expect to find these formative force laws expressed in some way in other parts of the plant, e.g. in flower, fruit and root? And, if all parts are a reflection of the whole, and the buttercup family is a recognizable whole in its belonging-togetherness, would one not expect to find something of the single plant wholeness and its particular laws reflected in the family as a whole?

CLEMATIS VITALBA

Fig. 3 portrays a leaf from Clematis vitalba, Traveller's joy, a plant which grows in warm, sunny, dry corners of woodland edge and hedges primarily in limestone country. It climbs up, around, between trees and shrubs, intertwining its neighbours quite indiscriminately, often to a height of up to 60 metres. Although it cannot stand alone and bear its own weight, the stems are woody (up to 3 cm thick) and the habit somewhat tree-like. The leaves are shed in winter leaving curtains of woody skeletons festooning the trees. It has a tree-like potential for longevity, small non-showy flowers and an immense capacity for continuous vegetative growth. The leaves grow on the woody stem in opposite pairs, each axil bearing one or more buds which may or may not develop and add on sideways to the repetitive rhythmic growth. This growth habit is reflected in the form of the individual leaf, where leaflets are added on progressively pairwise as the leaf stem seems to push through and penetrate into the leaf blade.

Fig. 3

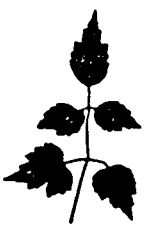


Fig. 4

In August we find loose clusters of very small greenish-white, individually rather insignificant flowers in the axils of some leaves. (They are occasionally terminal). The single-membered corolla consists of petal-like sepals (or sepal-like petals) which bend back and then fall off as the flower develops its mass of thick, cream-coloured stamens. These give off a fine, sickly-sweet smell (and in some other Clematis species exude nectar from their bases), a function usually attributed to the petals. They are visited by pollen-collecting flies and beetles which pollinate the pistils. These bear receptive stigmas before the anthers are ripe, thus avoiding self-pollination. They may also be pollinated by the wind. Then the fruit takes up the same gesture of light, upward and outward movement. The styles go on growing, as the carpels ripen, into long

feathery awns which often persist over the winter glistening like silvery flowers in the slanting light before the winter winds blow them abroad. Fig. 4 depicts flower and fruit of Clematis vitalba. (Drawings not to scale).

Let us hold this picture of rhythmic branching repetition from a stem which grows ever upwards vegetatively and persists over winter above the ground; paired leaves with a stemming activity which has penetrated the leaf blade, leaf divisions being added on behind this stretching forward; the emphasis of stamens as the organs of floral expression and a fruit which continues the gesture of upward and outward movement - a gesture thus found in the plant as a whole, in its growth habit as well as in flower, fruit and leaf form.

ACONITUM NAPELLUS

Now we go on to consider quite a different member of the buttercup family. Fig. 5 displays leaf, flower and fruit of Aconitum napellus, the Monkshood or Wolfsbane. This plant grows in large numbers of the same species in moist pastures, thickets and waste places, often on high mountains, usually on granite, sometimes in partially shady places such as the north side of high cliffs, around springs or streams. It is highly poisonous, the most concentrated poison being developed under the ground in the swollen white tubers built up in the summer and autumn months at the same time as the plant is flowering. There is a heavy, dark presence about this plant - one experiences awe in the face of the mass of deep, blue-violet upright beings, and certainly there is no rush to go and pick them in armfulls! The flowers are a dark, heavy, purple colour and are oriented downward towards the earth, the "hood" of each flower closing it off from the sun. They grow in a stiff raceme terminally on strong, erect, hollow stems around which the dark green leathery leaves form a concentrated spiral. The leaf stems themselves are strong and compact, ending abruptly at the base of the blade which has numerous divisions produced off to the sides in a rather compressed way. One gets the feeling that something is dammed up or held back here, especially if one compares the leaves with those of the stretching Clematis. Fig. 6 shows the leaf-types of both plants diagramatically to demonstrate the mode of division.

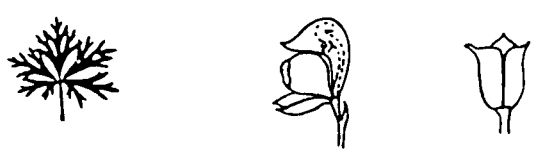


Fig. 5

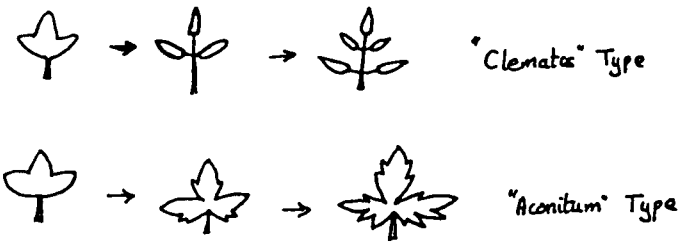


Fig. 6

In Aconitum leaves the "pointing" formative movement is strongly emphasized right from the beginning of the development; from the early leaves right up into the flower region where each flower on its short stem sits in the axil of a tiny, spear-like bract. One could say that "pointing" has sunk into the "differentiating" movement of the leaf series. Likewise in Clematis one might say "differentiation" has arisen by the prolongation of "stemming" into the "spreading" and "dividing" stages.

The dark blue-violet flowers of the monkshood are zygomorphic (display 2-sided symmetry) and the spiralling of the 5-membered perianth so common in this family is here almost undetectable. One "leaf" of the calyx (a sepal) becomes a huge helmet creating an inner space which contains a highly complex pair of nectaries. Two side sepals expand to form the wings of the enclosure and the lower two act as a kind of landing stage for the visiting bumble-bees which exactly fit the shape of the monkshood flower. Note that it is here the calyx, the outermost flower organ, which forms the "organ of show" in this flower, i.e. the calyx has taken on the role of corolla. At first a green bud, it changes in time into a coloured corolla-like expression. In Clematis the stamens, the innermost flower organs, had taken on the role of corolla.

In the Aconitum flower there are no true petals; instead we find a pair of highly-specialised convoluted nectar-secreting vessels which seem to have evolved together with the insect's proboscis, the fit is so good! Apart from displaying this special connection to one particular insect, the flower itself is almost animal-like in its 2-sided symmetrical form - something more often found in the animal than in the plant world. Even the active movement of the stamens is not very plant-like! They ripen in rows, standing up from the front to the back, bearing their pollen in exactly the right place to touch the bee's abdomen. The spent stamens then fall forward and, when all have moved through, the by-now-receptive pistils stand ready to encounter the visiting insect, thus avoiding self-pollination. The resulting fruit is a pod (usually three), dark brown, long and dry, containing many tiny dark seeds. When the pod bursts the seeds simply fall to the ground not far from the parent plant, and need frost in order to germinate.

CLEMATIS AND ACONITUM AS POLAR OPPOSITES

In Clematis we saw how the plant was predominantly vegetative in its additive repetitive growth habit, bearing the generative part, the flowering stem, almost "in passing" on its rampant vegetative way. In Aconitum we find quite the opposite gesture. The whole of the plant which meets the eye is its generative part, the flowering stem carrying its thick spiral of leaves. The vegetative part was only visible above the ground in the rosette of the first year's growth. Thereafter this plant demonstrates vegetative growth and reproduction predominantly underground, creeping sideways very slowly through the production of its soft, fleshy, white, sometimes hollow daughter tubers by means of which it overwinters underground. Quite the opposite to Clematis!

One could say here that the whole Aconitum plant is so heavily gripped by a powerful flowering impulse that the equally powerful vegetative potential is held back, dammed up in the tubers which, as well as growing sideways, develop one of the most powerful known plant poisons (a unique group of alkaloids). Thus we find that the whole plant in its form and growth habit demonstrates the gesture we first saw in the leaf with its dammed-up expression and sideways, downwards-dividing leaflets, which is again echoed in the enclosing, dark, downward-directed form of the flower, the dry, hollow fruit and in the held-back tubers and their poison production. (Compare with Clematis.)

Let us dwell for a moment on the polar opposite gestures discovered so far in these two very extreme examples of the buttercup family. Remembering the earlier example of Ranunculus sardous and the four formative movements depicted in Fig. 2, and considering our other two examples, we find (perhaps surprisingly) that one plant, Clematis, seems to emphasize the legginess of the stemming principle belonging to the beginning of the individual plant leaf series, while in the other, Aconitum, pointing, belonging to the flower end of the general leaf metamorphic sequence, predominates. Both plants have leaves that are very divided but in quite different ways (Fig. 6). In Clematis dividedness is produced by stemming penetrating into the blade; in Aconitum by pointing taking over the blade, taking on a differentiating role so to speak. In the Clematis flowers the stamens take over the role of corolla and in Aconitum the calyx becomes the corolla.

LEAF MOVEMENTS AND FLOWER FORM

Perhaps this gives the beginning of an answer to our earlier questions concerning the relationship between formative movements and other (in this case flower) organs, and the relationship between the whole plant and a plant family. There seems to be a very definite relationship between the stemming movement in the leaves and the emphasis on stamens in the flower as well as between pointing in the leaves and the calyx of the flower. The latter relationship is further substantiated by those rather rare plants which display a continuous movement from upper leaves to calyx. They reveal one of the "universal open holy secrets" which Goethe refers to in Epirrhema, a short poem accompanying the "Metamorphosis of Plants".

Helleborus is one of these very special plants within the buttercup family. Fig. 7 shows the continuous step-wise transformation from upper leaves into flower in Helleborus foetidus, the Stinking Hellebore. Helleborus is a very close relative of Aconitum and, as well as demonstrating the calyx-becoming-corolla story to an extreme degree (in Helleborus niger the pink/white petalloid sepals become green later on while the fruit is ripening and can even photosynthesize), the Helleborus leaves show the sideways way of dividing also taken to an extreme. The leaf outlines are no longer rounded but even indented in the centre and spread out like a hand (Fig. 8).

The reciprocity between the two middle leaf movements, spreading and dividing, is obvious (the more divided a surface is, the less rounded it can be and vice versa), and in the tension between them we find the species-specific leaves of the expanded part of the leaf series. Within the flower the petals and nectaries produce that species-specific colour, form, scent and nectar by which each plant is recognized. These organs also form the expanded part of the flower and are, like the two middle leaf movements, mutually exclusive, i.e. never found as separate organs together in any one plant. In Clematis flowers the stamens have "taken over" petal function, and in the leaves the dividedness is "taken over" by the stemming activity. In Aconitum, leaf dividedness is created by pointing predominating, and in the flower petal function is taken over by the calyx. The leaf retains a rounded outline all the way through its development, i.e. roundedness is present but only hinted at. Nectaries are present in the flower. In Caltha, the marsh marigold, one of the same group of plants as Aconitum, roundedness is fully present in the leaves (they are undivided). There are no nectaries in the flower.

CLEMATIS RELATIVES

The group of plants closely related to Clematis all have strongly branching stems with a similar pattern of leaf division. We also find a plant in this group which takes to an extreme both the penetration of stemming into the leaf blade (creating second and third order divisions) and the building of stamens into a corolla-substitute. This is the genus Thalictrum where the flowers are yellow, white

Fig. 7

or lilac globes of dangling, sweet-smelling stamens, and the leaf region is a bushy mass of large much-divided leaves on strong branching stems. Fig. 9 depicts a single leaf and flower of Thalictrum aquilegifolium.

This group of plants, the Thalictrinae, shows remarkable conservatism in the form of the flower but demonstrates a wonderful metamorphosis of fruit and also stem formation from the above described Clematis with its woody, liane-like branching stems and feathery achenes on the fruit, through bushy Thalictrum with lightly-winged achenes as fruit, to a firmer erectness in the stem and pods for fruit in Cimicifuga, and an almost Aconitum-like rigidity combined with considerable poison and a berry for fruit in Actaea, the baneberry.

Fig. 8

ACONITUM RELATIVES

On the other hand the close relatives of Aconitum and Helleborus in the Helleborinae show considerable conservatism in their fruit form. They all have usually 3-5 pods containing many seeds. But they do demonstrate a wonderful polymorphism, and thus metamorphosis, between genera across the group in their flower gesture, colour, form, and in the development of the nectaries. The various Delphinium species show many similarities with Aconitum in their zygomorphic flowers, complicated (this time partially-hidden) nectaries, growth habit and leaf form - even to the production of poison in some species and overwintering underground through a sideways expanded hypocotyl.

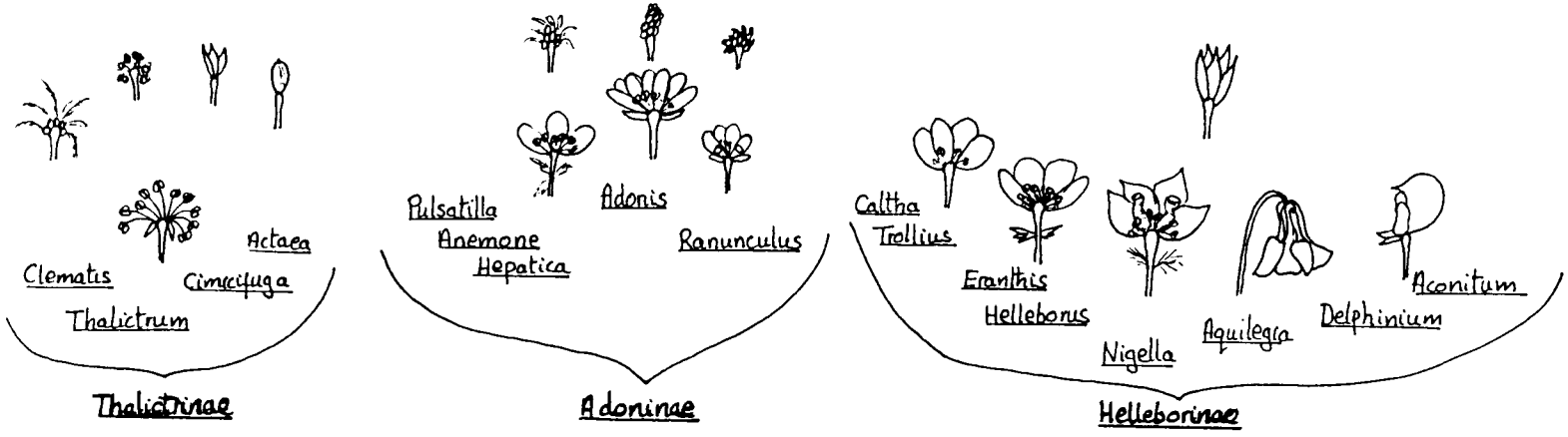
Aquilegia, the columbine, takes the complicated flower form a stage nearer actinomorphy (radial symmetry) with its pleiomorphic, downward-facing blue-violet flowers still with convoluted nectaries which are here more than half exposed and petal-like. Nigella (love-in-a-mist), Helleborus and Eranthis all have separate, well-developed nectaries, more petal-like in Nigella, small and cup-like in the others.

The other two members of this group of plants characterised by the calyx taking on the role of corolla are Trollius, the globe flower, and Caltha, the marsh marigold. Trollius has very pointed, sharply sideways-divided leaves and inside the bright yellow globe of coloured calyx often produces a series of organs revealing the transformation from calyx through petal-like organs, the inner ones with nectar-secreting pockets at the base, to stamens, but builds no circle of separate nectaries. This plant and Caltha, with its full, rounded leaves and bright yellow simple upturned flowers without nectaries, build the bridge to the true buttercups (Ranunculus spp.), Adonis, and the Anemone group, all of which together form the third distinct group of plants within the family. Unfortunately, through limited space, these metamorphoses cannot be more than hinted at here. Schematic summaries are depicted in Figs. 10a and 10b.

ADONIS

The Adoninae, or middle group of plants, of which we will consider Adonis as an example, have achenes or nuts as fruit, each hardened fruit bearing a single seed. Their flowers are all relatively simple and actinomorphic. The variability in this group is primarily revealed in the leaf realm and in growth habit, the buttercups themselves being the masters of plasticity in leaf-form transformations as demonstrated by Grohmann in his book "The Plant" (Rudolf Steiner Press, 1974).

Fig. 9



Thalictrinae

Climbing, woody plants or large plants with branching stems and many small, insignificant whitish flowers.

Stamens take on corolla function.

Nectaries rarely present.

Leaves of "Clematis" type.

Polymorphism in fruit.

Predominantly vegetative growth

Adoninae

Low to medium plants often with branching stems and actinomorphic coloured flowers.

Stamens may be coloured (Pulsatilla, Anemone, Adonis)
Sometimes true calyx and corolla (Adonis)
Sometimes involucrum + petals are "calyx" (Anemone)
Sometimes nectaries become "corolla" (Ranunculus)

Leaves may be "Clematis" or "Aconitum" - type, both or neither.

Fruit always achenes.

Rhythm of vegetative / generative growth

Helleborinae

Plants with underground tubers or creeping stems, often poisonous

Often strong straight flower stems with single or few large, coloured, actino-, pleio- or zygomorphic flowers.

Calyx takes on corolla function.

Nectaries usually present (except in Caltha & Trollius) may be petal-like (Nigella, Aquilegia) or hidden (Delphinium, Aconitum)

Leaves of "Aconitum" type.

Fruit always pods.

Predominantly generative growth

Ranunculaceae (Buttercup Family)

Fig. 10b

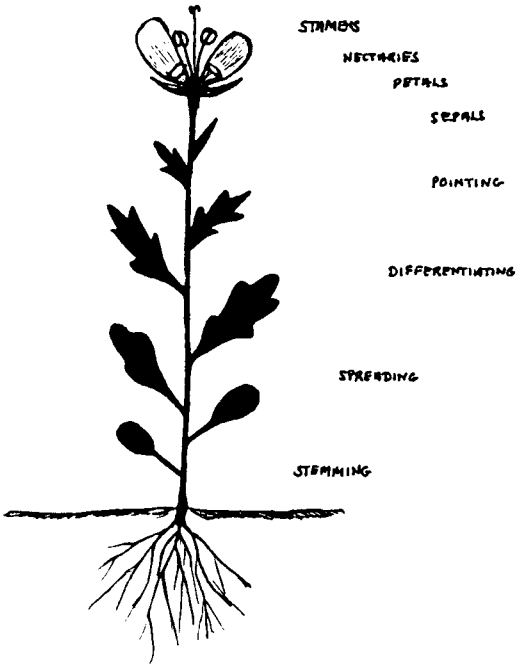


Fig. 10a

Remembering the two extremes typified by Clematis and Aconitum, imagine these two gestures combined in a single plant. Imagine a plant where stemming penetrates the leaf blade in a stretched leaf but where pointing is also emphasized and the leaves show a sideways, downwards division of leaflets. Imagine flowers with calyx and stamens both showing a hint of transformation into corolla function, but where petals form the true organ of show in the flower, and a plant which has a strong persistent root system like Clematis, but which can also divide sideways underground like Aconitum.

The various Adonis species fulfil all these descriptions. Adonis aestivalis, the pheasant's eye (Fig. 11), has bright red flowers. It is the only red species along with Adonis autumnalis among all the European Ranunculaceae. It has true green sepals (five) with an obvious spiral, and the inner members of the calyx especially take on a red colour in time and thus corolla function as the flower matures. There is a variable number of petals - bright scarlet red with a dark spot at the base, the colour of which is taken up in the unusually heavy, dark-coloured anthers. There are no nectaries. The flowers stand at the ends of tall stems with spiralling feathery leaves. Fig. 12 shows the leaf series of this summer flowering annual. The lower leaves have strong stems with opposite, paired leaflets like Clematis with the stem penetrating the leaf blades. Further up the stem we find the petiole begins to produce leaflets which branch sideways and downwards. Later on the two sorts of dividing merge until the topmost leaves are remarkably like those of some Aconitum species or Delphinium consolida.

We find, then, the two leaf-dividing gestures which typified the other groups of plants here in a harmonious balance in one plant. The Clematis type predominates at the beginning of the development and the Aconitum type towards the end. The growth habit of Adonis vernalis, the perennial Spring Adonis Rose (now extinct in Britain), demonstrates a balanced rhythmic movement of generative then vegetative growth throughout the year. The flowers of Adonis are the only ones in the European part of this family which have a true calyx, corolla and stamens which do not interchange functions! All members of the Adonis genus give one the impression in their form, expression and development, of harmony, of a rhythmic completion. There is small wonder that the leaves of the flowering spring Adonis Rose are a potent heart medicine! Perhaps one might by now expect that Aconitum, Delphinium and their close relatives, provide medicine for the human sense and nervous systems, and some Clematis species, Cimicifuga and Actaea are much used abdominal (uterus and sexual organs) medicines!

Fig. 11

CONCLUSION

Unfortunately space will not permit further exploration and more detailed description of the individuals and patterns in relationships between members of the buttercup family. I hope here, if nothing more, to have whetted the appetite of the reader to explore for him/herself the relationships of different plants and plant parts to one another, to uncover the secret laws laid out in the plant there for the reading; secret laws which show how the flower is the "inside out" of the leaf region as we have begun to see in this paper (what about the root and the fruit?); secret laws revealing how the relationship between plants within a plant family bears a kind of horizontal connectedness in the here and now to the laws of the plant as a developing vertical being (and thus to man?).

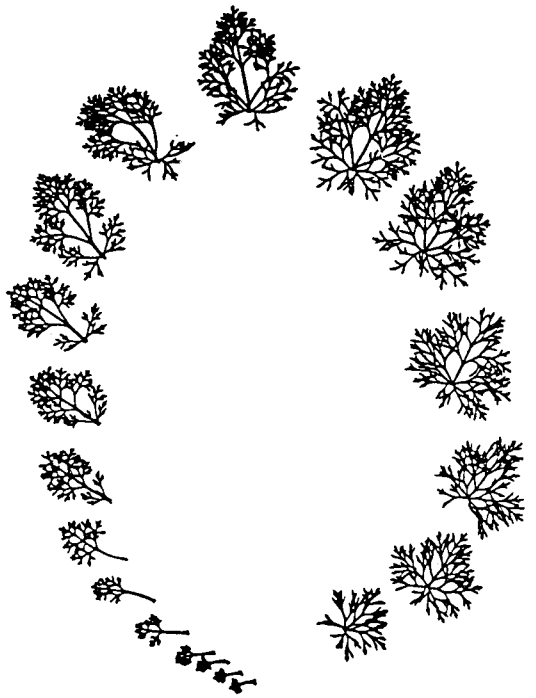


Fig. 12

"In the study of Nature you must always consider
Each single part as well as the whole;
Nothing is inside, nothing is outside;
For what is within is also without.
So hurry onward and try to grasp
The universally open Holy Secret.

Rejoice in this true illusion
As well in the serious game;
Nothing alive is ever a one
Always is it a many."

Goethe - "Epirrhema"

ACKNOWLEDGEMENTS

Finally, I would like to express my thanks to the Margaret Wilkinson Fund and the Rudolf Steiner Association in England, and the Gemeinnützige Treuhandstella, Bochum, and the Rudolf Steiner Fonds in Germany, for enabling me to do this work; and last but by no means least to my teachers, Dr. Jochen Bockemühl and Thomas Göbel and their colleagues in Dornach and Öschelbronn.

ASPECTS OF HOLISTIC SCIENCE

HEDLEY GANGE

This article continues the notes on holistic science given in Science Forum 6 p24, and 7 p31: it aims to show how the holistic approach may be progressively developed, by considering two specific aspects, (a) the etheric realm and (b) moral values in science.

THE ETHERIC REALM

The term 'etheric realm' may be interpreted in different ways. Some may regard it as a matter of direct perception, others as a vague abstraction and still others as a relic of an earlier form of knowledge. Rudolf Steiner indicated how a systematic approach to the study of the etheric realm could be developed, as an integral, and directly experienced, part of his world-concept, and this can be used as a guide for further study. In the present approach, it is assumed that the student will wish to make his or her own judgement and assessments after considering all the available information and advice. Some of the main aspects are referred to below.

● The etheric realm has been described as the lowest level of the spiritual. Myths and legends, from many lands, tell of the creation of the world: out of chaos (the primordial ether) forms begin to emerge. Light appears in the darkness, followed by the first indications of material forms. In the New Testament, light is described as the bearer of higher spiritual qualities.

Men of earlier times may have experienced the ether in a way that is not possible (or appropriate) to-day. Direct experience of spiritual influences and beings seems to have

been a feature of the life in ancient Egypt. The druids of Britain and the priests of the oriental Sun Temples experienced etheric and other qualities in the streaming sunlight.

In spiritual descriptions of the evolution of the earth, the development of substance through the gaseous, liquid and solid states is accompanied by the progressive refinement (or differentiation) of the ether, from warmth through light to 'chemical' and 'life' ethers.

● The four modifications of ether are closely related to Aristotle's Doctrine of the Four Elements. In ancient Greece, art, science and religion formed a unity: etheric influences could be observed in human nature as well as in the phenomenal world. There are similarities between this system of knowledge and those of other cultures, as described in, for example, the well-known Chinese 'Book of Changes' or I CHING, with its pervasive *yin* and *yang* tendencies.

Pythogorus linked music, astronomy and mathematics: the innermost order of the Universe came to expression in the celestial Music of the Spheres, reverberating in the cosmic ether. Numbers had an occult significance relating to etheric and higher spiritual qualities.

The principle of Polarity, embodied in the Doctrine of the Four Elements, is encountered universally in early cultures. Local polarities - Moist/Dry, Smooth/Rough - derive from the fundamental Heaven/Earth (Ether/ Gravity) polarity. Polaric concepts figure prominently, also, in medieval alchemy. All world-concepts, including that of modern science, need an opposite pole to that of gravity.

● Artists and poets cultivate a sensitivity for the etheric, as in for example, Goethe's imaginative way of observing Nature. In Wordsworth's 'Daffodills' there is a blend of etheric and 'starry' elements. The painter experiences etheric qualities in the interplay of light and shade and in the nuances of colour.

● Modern science describes man and earth without introducing the concept of ether, and this has been highly successful. However, some of the limitations of this approach are now beginning to be appreciated: some extensions, modifications and reorientations of the method are being suggested, and the relevance of moral values is being reviewed.

In holistic medicine, the term 'etheric' is sometimes applied to any forces or influences not normally recognized. Some investigators claim to have identified energy fields (O-fields, T-fields) which can be used for therapeutic purposes.

● Rudolf Steiner, in his study of the etheric realm, describes how man's perception of this realm has changed through the course of history and how the etheric forces have themselves evolved in relation to both man and Nature. This study involves almost every aspect of life, and significant progress in the development of Steiner's indications has been made in many fields during the last sixty years. Experience of the etheric is important in, for example, eurythmy, speech-training, drama, agriculture and medicine. In some fields progress has been slower than originally anticipated: G. Wachsmuth's work 'Etheric Formative Forces in Cosmos, Earth and Man' was published whilst Steiner was alive, but consolidation of the work has proved difficult.

Some detailed investigations, which have been reported in previous issues of Science Forum, are: flow design research, the experimental method of Capillary Dynamolysis, and changes in the shapes of plant buds. Etheric forces are involved in these phenomena, although further work is needed to describe their role precisely. The properties of Physical and Ethereal Spaces have been described by G. Adams. The electrification of civilization, which has taken place during the last 200 years, is directly related to the evolution of the etheric forces (see Science Forum 1, p12).

Perhaps the most difficult problems to deal with are those where social factors are prominent. The etheric element is involved when the threefold structure of the human being is related to the threefold membering of the social organism, and also when the faculties of Imagination, Inspiration and Intuition are developed in a social context.

MORAL VALUES IN SCIENCE

The moral element is part of the basic fabric of life. Questions of Good and Evil are enshrined in myths, fairy tales and primitive beliefs, as well as in the great religions. In ancient times, those who sought the path of knowledge were required to undergo a disciplined training of the moral life.

■ The relationship between the spiritual/moral and the material, or phenomenological, aspects of life has been perceived differently at different stages in history. The totems of North America and Polynesia denoted an identity of sense-impressions with spiritual entities or influences.

For the disciples of Budda, the true reality was to be found through meditation: the material world was illusion - Maya. In ancient Egypt there was great spiritual awareness but the body, too, was important and its preservation after death had special significance. A mysterious correspondence between spiritual values and material qualities underlay the alchemist's dream of transmuting base metals into gold.

■ A close relationship between moral values and the etheric realm is involved in descriptions of the Fall of Man when this event is

interpreted as a fall of the spirit of man into a denser physical existence, coincident with a change in the moral conditions of life.

In the central Christian Sacrament, the four elements of earth, water, air and fire are embodied in accordance with their special characteristics and deeper significance.

■ Architecture, painting and music all have their moral aspects. Purely functional architecture reflects the nature of the underlying thought-forms. A Greek temple and a Gothic cathedral embody different religious experiences.

The inspired painters of the Renaissance expressed their religious aspirations and experiences through the medium of colour and form. Deep spiritual truths can be conveyed through music, with its elements of melody, harmony and rhythm and with emphasis at different periods of history on different intervals - seventh, fifth, fourth and third.

■ To-day the pursuit of science is dependent upon the social basis, with its relevant moral values, provided by contemporary culture. Some recent scientific developments have emphasised the need to pay closer attention to the ethical aspects, as mentioned in the earlier article in Science Forum 6. In certain fields, such as spiritually-oriented ecology, the moral element is of major importance.

While traditional science is developing in this direction, it is being met by a variety of holistic impulses and movements, embodying ethical considerations, which are arising against a wider and more general background. The contemporary scene is complex, but there is reason to believe that progress towards an ordered study of the role of the moral element, in science and in life, is possible. A great store of information, wisdom and experience is available - from many sources. Students of Rudolf Steiner will value particularly the path of training described in ***"Knowledge of the Higher Worlds"***.

CONCLUSION

Many mutual relationships exist between the etheric and moral realms. The above notes, elaborated and co-ordinated, would perhaps provide a small glimpse of the very wide field opening up to holistic investigation. Future progress will be dependent, most of all, upon the development of the investigator's powers of perception and other faculties.

C O R R E S P O N D E N C E

ETHERIC FORCES

Dear Editor,
Hedley Gange's question in Science Forum 7, page 3, "Are Etheric Forces Formative?" disturbs me in that it arises from Ernst Marti's Four Ethers and concludes 'It is important, after sixty years of development, that the fundamentals of formative activity should be clearly understood.'

Marti Should not have fallen out with Wachsmuth's scholarly work by saying his Etheric Formative Forces had misled the Society for sixty years; he need only have read it properly and taken into account that Wachsmuth's colleague Rudolf Steiner was still alive when the book was published. For example:

p142, para 2, line 4
'Thus stream in also the cosmic formative forces...bringing forth through...the etheric forces...colour...in space and time.'

p206, para 3, final sentence
'In the spoken word the united action of the spiritually real, the etheric formative forces and substance is complete.'

p208, last para, line 4
'...the circulation of warmth...is induced by external cosmic influences, especially those of the sun.'

p209, line 7
'...that is we "blush". In this externalizing of our soul life, we begin in an individual manner to intervene in the activity of the etheric formative forces...'

As you see from these examples and many others the thorough reader will find, Wachsmuth was fully aware also of Cosmic Formative Forces but rightly stuck to his theme of Etheric Formative Forces as a supplement to Rudolf Steiner's work and in consonance with the natural science of his time.

On the other hand we must applaud Ernst Marti's extremely useful contribution to the phenomenology of the Etheric despite the redactions he has already been obliged to make, e.g. p10, footnote 21. Sadly we must accustom ourselves to unnecessary disputes of this sort, which arise from the mingling of different streams in the Anthroposophical Movement but which further the development of the ego, and Marti's argument is after all at best merely semantic.

Finally, how lovely it would be if after six, sixty or even six hundred years one did clearly understand the fundamentals of formative activity, for as one who has worked in that direction for a number of years, that is indeed something devoutly to be wished.

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[Hedley Gange writes:
My comments on the Etheric forces at the 1986 Science Conference were actually made without any knowledge of Marti's book.*]*