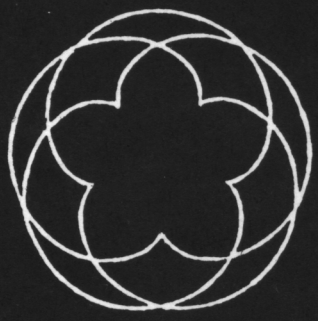
SCIENCE FORUM



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The editors would be pleased to receive such items for consideration (preferably typed 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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Editorial

We apologise for the late appearance of this issue of *Science Forum* — but, as the contents show, ideas and investigations in the field of anthroposophical science have continued to develop since our last issue.

Lawrence Edwards reports tentative findings which indicate a previously unknown correlation between changes in the shapes of buds and the movements of planets. These results are in accord with references made by Rudolf Steiner to special connections between, for example, the Oak tree and Mars, and the Beech and Saturn. It seems unlikely that such relationships will manifest only in the shapes of buds: perhaps other observers will now find more general, morphological or aesthetic, correlations between trees and planets, complementing the work of Lawrence Edwards?

Graham Calderwood, taking his start from Edwards' book *The Field of Form*, seeks to follow mathematically the shapes of leaves and buds and their mutual relationships. The use of a computer has greatly facilitated his investigations. (Is there perhaps a danger that the Spirit of the Computer, having 'got into the act', will not be content to play only a subservient role?)

Pioneering work in Flowform Research has previously been reported in *Science Forum*. We include in this issue a general account of the present position by John Wilkes and Nick Thomas. Some easily performed experiments, developing a Goethean approach to the fluid element, are described by Philip Kilner. These are intended as a basis for the understanding of future researches in the realm of organic form.

Are there similarities between Jochen Bockemühl's new approach to heredity and Rupert Sheldrake's *New Science of Life*? We give Dr. Bockemühl's comments on this suggestion.

The last Science Conference showed that differing views on the nature and use of atomic energy exist within the Group. It is sometimes difficult to separate the purely scientific from the economic and social aspects, and more discussion seems desirable. Robert Kersey Green makes a contribution to the discussion in reviewing two recent books on nuclear energy.

It is of value to both homoeopathic and anthroposophical medicine to be able to provide scientific evidence of the efficacy of potentised remedies. William Steffen is currently working in this field, at the Botton Science Laboratory, and a short report appears on page 9. A further report will appear in our next issue.

We hope to include further reference to the method of capillary dynamolysis in our next issue.

Contributions of articles, news items, reviews of books and journals and comments on any aspects of *Science Forum* continue to be welcome. We greatly appreciate the encouragement we have received, but value comment of any sort. One reader feels that the title of an article in our last issue, *Was Rudolf Steiner Right or Wrong?*, throws doubt unnecessarily on the validity of Steiner's scientific work. We appreciate his concern: one argument *in support* of such a title is that posterity does not place anyone, indefinitely, above criticism and if there *are* statements from lectures, or elsewhere, that warrant closer scrutiny, it is better for this to be done first within the movement rather than outside.

We note, in a wider context, that, as anthroposophical ideas on scientific matters penetrate further into contemporary life, the range of sincerely held viewpoints to be considered increases accordingly. This demands a flexible approach whilst maintaining the rigour of science — and underlines the need, perhaps, for a clearer understanding of the method of spiritual science (and its practice), with its blend of universality, 'objectivity' and intuition.

Contents

Variations in the Forms of Plant Buds

Lawrence Edwards

In making this report on the latest aspect of my work we must take for granted the various details of path curve geometry and its application to plant growth, especially the form of the opening bud, as described in my book *The Field of Form*. By way of recapitulation it must suffice to remember that the general form of the bud can be described by a single parameter λ, that when λ is near to unity the bud assumes a gently rounded form, that as λ increases the bud becomes more and more sharply pointed at one end and flattened at the other, and that many years of research have shown that a very large variety of species produce buds which are very accurately true to the path curve form in one or other of its metamorphoses. This is true both for flower buds and leaf buds; and the leaf buds of our great deciduous trees — Oak, Beech, Elm, etc. — make a very interesting field of study.

These buds appear on the trees in late summer, and by the end of September they are fully formed; thenceforward they hang on the branch, apparently unchanged and unchanging, for something like six months, until they are ready to start opening in the following spring; they are said to be 'dormant'. They are for the most part (the Elm being the only strong exception which springs readily to mind) very accurate path curves and their λ can be well determined. They are mostly small, hard and 'woody', and I had always supposed that during their dormant period they really are quite invariant in form. However, during the winter of 1981/82, in the course of some research which need not be detailed here, I had occasion to photograph and analyse several hundred leaf buds of the Beech tree and looking over my figures one day I was surprised to see that they offered some evidence that the buds of this tree (they were all gathered from the same tree) had been very slightly but definitely varying during the winter months, as far as their form was concerned; and it did not seem possible to correlate these variations with any changes in weather. It was of course possible that these were just random changes in the growth of the tree, due to any number of unknown factors; but something in the whole character of the phenomenon alerted me to the possibility that one might be dealing here with forces of a much more cosmic origin. I therefore made it a first priority for the following winter to study these little buds in much greater detail.

I decided that I must take a single bud for each species and photograph it daily over a long period. This immediately made considerable difficulties. My usual practice is to pick a bud, mount it on to a special piece of apparatus in my darkroom and thus get a clear and accurate profile, perfectly adapted for precise measurement. Amongst other things this means photographing the bud from a direction exactly at right angles to its long axis. To do this while the bud is still hanging on the tree means that the camera has to be held at any sort of inconvenient angle, and the resulting photograph is inevitably of inferior quality to that which my special apparatus gives. But there was a greater difficulty. If you rotate a bud, even a little, around its long axis, you get a photograph giving a slightly different λ, due to the natural irregularities in the growth of the bud. Normally the difference would be very slight; but then it would be only very slight differences which would be expected in this investigation. It was necessary that the bud should be photographed from *exactly* the same direction, day by day, and month by month.

In order to overcome this difficulty I developed a special system. I would take a small piece of clear perspex, about one inch by three, and by boring tiny holes in it at suitable places, would strap the bud down on to it by means of thin fuse wire. The perspex would then stay on the branch throughout the winter. Next I made a wooden frame, into which my camera could be placed, containing a slot which would just hold the piece of perspex. The whole thing was so arranged that when the perspex was fitted into the slot one could be sure that the bud was in the centre of the field of view, was in focus, and would be seen from exactly the same point of view from one day to the next. In the course of working with it this scheme revealed certain weaknesses, which will be described later, but it did give tolerably good photographs, although never of the same quality which I get when working wholly in my own darkroom. My work during the winter of 1982/83 was done wholly with this method, and it revealed some exceedingly interesting results.

During that winter I chose to study just five buds — a Beech, an Elm, an Oak, a Cherry and an Ash. The reasons for chosing just these species were several. Firstly, they all (with the exception of the Elm) produce buds which are very accurate path curve profiles, and whose λ can therefore be calculated with considerable precision; and even the Elm is sufficiently near to the path curve form for quite good results to be achieved. And they are species which grow strongly in the neighbourhood in which I live. But there was a further reason. At one point in his teaching, Dr. Steiner gave 'planetary rulerships' for these types of tree, as follows:

Beech — Saturn: Elm — Mercury: Oak — Mars: Cherry — Moon: Ash — Sun. If it were to prove — and at this stage of course I had no positive indication that it would — that these variations had astronomical correlations, then in the preliminary studies it would at least be helpful to know in what general direction to look.

The strapping of the buds on to their pieces of perspex had to be done with the greatest care. If the fuse-wire was twisted too tight the bud could be killed, or at least have its life forces seriously interferred with. It is just possible that this happened to a small extent with the Oak bud, although this, with all the other buds, subsequently opened apparently normally. If on the other hand the bud was too loosely fixed it could move within its bonds, and thus falsify the results. This seemed to be happening very definitely with the Ash, which, during the days and weeks, squirmed on its piece of perspex to an extent that made the results coming from it very difficult to assess or measure with certainty.

Having fixed things as well as I could, I started, first with the Beech, and then one by one with the others, with daily photographing of each bud. And it was with the Beech that the first results of interest showed themselves. I recorded a slight but definite decrease in the λ-value of the bud, whenever Saturn, the Moon and the Earth came into straight line with one another; that is to say, whenever, seen from our earth, Saturn and the Moon came into conjunction or opposition with one another. Since these two configurations appear, as far as one's knowledge and experience are concerned at the moment, to be of similar effect, I am combining them under the one term, an 'alignment' of Saturn and Moon. Subsequently a similar effect was found for the Oak and the Elm, a small but definite decrease in λ being measured when the Moon came to alignment with Mars and with Mercury respectively. With the Ash this effect was not really apparent, but the bud was seemingly moving on its piece of perspex to an extent that made accurate measurement and comparison from one day to the next very difficult indeed. And as will be seen later, subsequent work has indicated that the Ash also follows the same rule, undergoing a decrease in λ at each new and full moon.

One is tempted to make a statement of a general rule: When the ruling planet of the tree comes into alignment with the Moon, the buds undergo a slight decrease in λ — i.e. their form becomes a little more rounded, relaxed, in gesture, as though they are taking a tiny step towards opening — and then when the alignment is finished they sink back into a tighter, more closed, gesture. I believe that this formulation will turn out, in due course, to be a gross over-simplification of a very much more subtle reality, but perhaps it will serve usefully for the moment.

Diagram 1 shows the actual graph of the λ-values of the Oak bud during the winter. The arrows mark the dates of the alignments of Moon and Mars. We notice that the first three alignments, November 19, December 3 and 18 are all marked with a noticeable decrease in λ, but after this the bud seems to become more quiescent; the alignment of January 2 was only just acknowledged, and for a fortnight after this the bud became so inert that I began to suspect that I had pinned it down too hard on to its perspex and had eventually killed it. I even went to the length of looking around for another bud with which I could continue the series of measurements. Then on January 20 the bud seemed suddenly to awaken again and became quite

Diagram 1.

Oak 1 1982–83

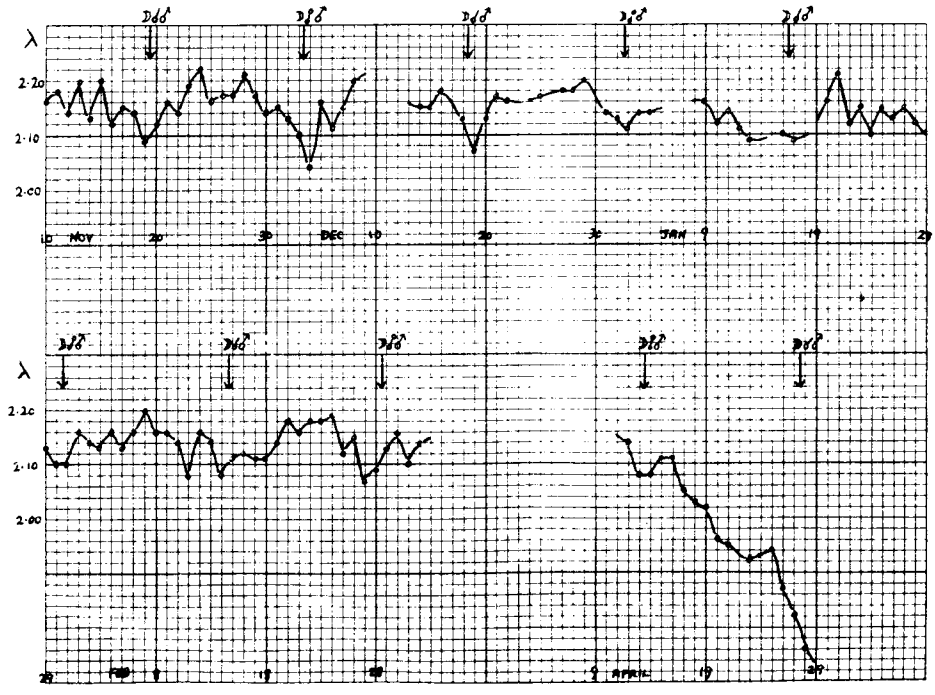


Diagram 2. **Elm 1982–83**

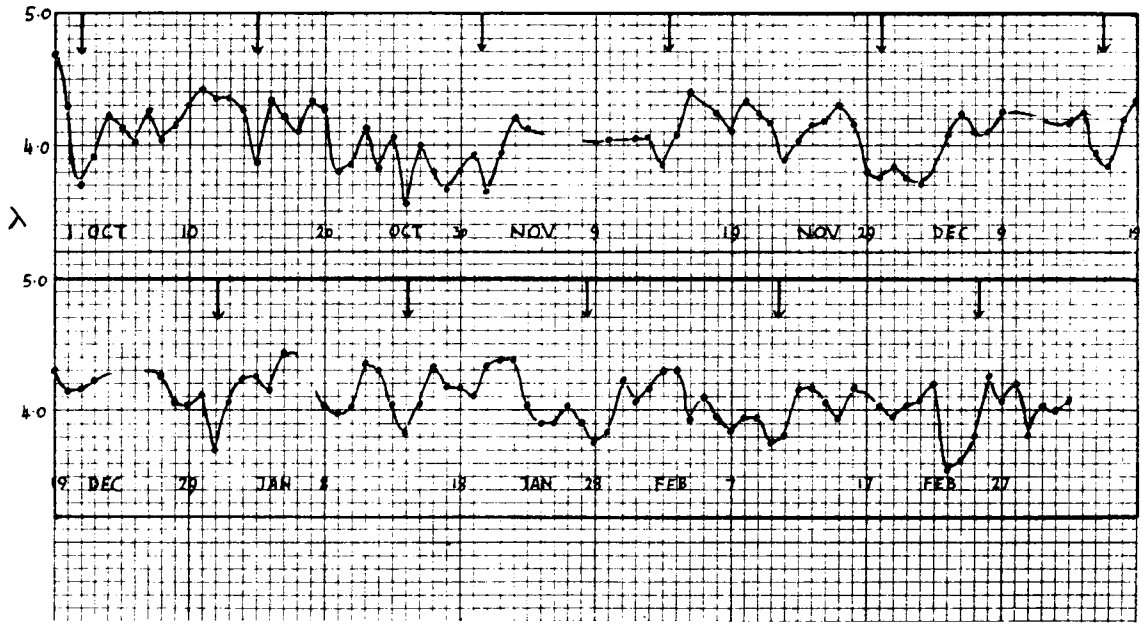
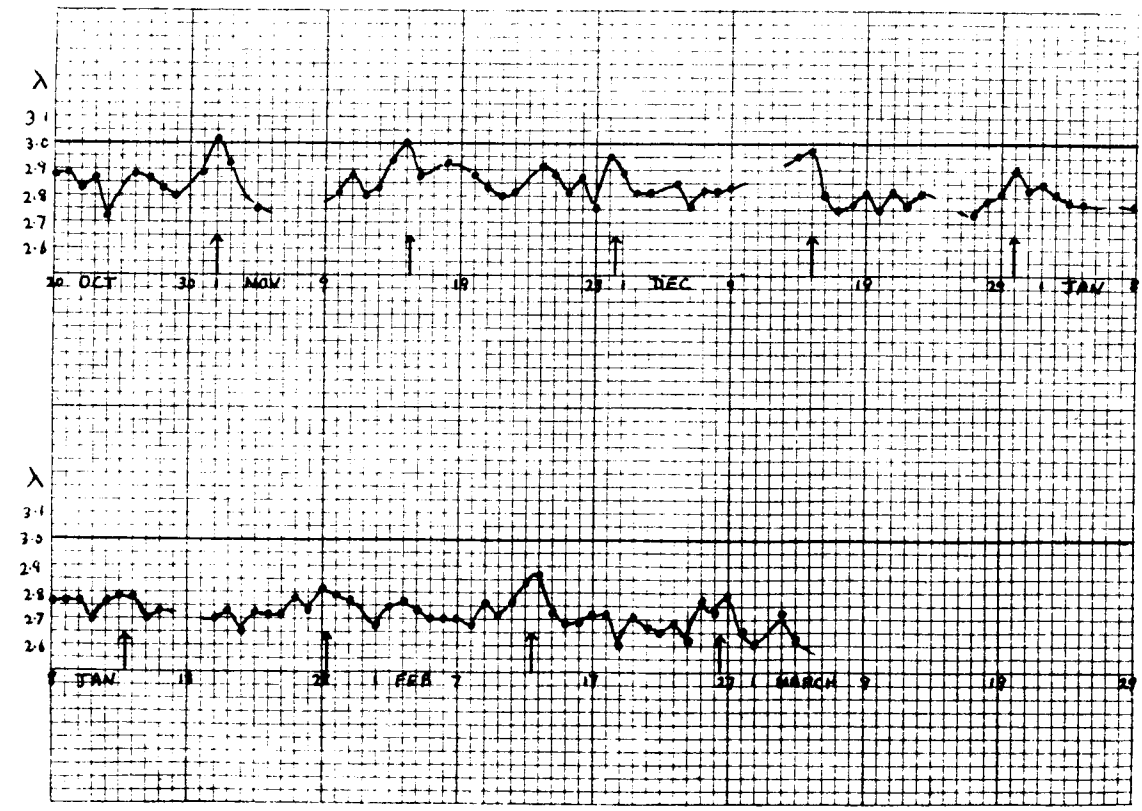


Diagram 3. **Cherry 1982–83**



lively, responding well to the alignments of January 31 and February 15, although not quite as strongly as at the beginning of the autumn. The dip in λ seemed to be about thirty-six hours early for the alignment of March 1, this being the only one that was not punctually on time. I had to be away from home during most of March but was back in time to catch a possible small dip in the curve for the alignment of April 13. Thereafter the strong decline in λ marks the beginning of the opening of the bud.

The graph for the Beech bud was similar to this, including a period of comparative quiescence in the last half of December and the beginning of January. But the dips in the curve tended to be coincident with the alignments of Moon and Saturn.

Diagram 2 shows a similar graph for the λ-values of the Elm bud, the arrows indicating the dates of the alignments of Moon and Mercury. It will be noticed that the curve stays above the line of $\lambda = 4.0$ nearly the whole time, but dips significantly below this level at nearly every lunar alignment with Mercury. Also we notice that it very rarely dips below this level at any other time, the period during the last week of October being a noticeable exception. The dip for the alignment of February 25 seems to have come about forty-eight hours early, but otherwise this little bud was mostly very punctual.

Thus we see that these three buds seem to follow pretty reliably the rule that I have stated above, whilst the photographs of the Ash were not good enough to afford worthwhile evidence either for or against the rule.

But what would be the case with the Cherry? According to Dr. Steiner the rulership of the Cherry comes under the Moon. The Moon can hardly be envisaged as coming into alignment with itself! At the same time, with its large degree of movement, it comes into alignment every day or so with one or another of the planets. Would the bud of the Cherry never be at rest? Diagram 3 shows what, in the event, was observed. The arrows mark the alignments of the Moon with the Sun, and it will be seen that the λ of the leaf bud of the Cherry seems to suffer a slight *increase* at these times. It does not seem to answer to the alignments of the Moon with any of the other planets. We notice, as with the Oak and the Beech, that this bud seemed to become quiescent during the last week of December and the first part of January.

This was the evidence which, during the winter of 1982/83 led me to envisage that these little leaf buds, which surround us in such multitudes, are all the time taking part in a great 'dance of the buds' all in tune with the mighty alignments of Moon and planets in the heavens. But before going further it is needful to say certain things. Firstly, the changes in form with which we are dealing are very small. All measurements had to be made under a powerful watchmaker's lens, on enlargements which were often not as clear as I would have wished. The tendency for the buds to move slightly within their bonds was a disturbing one, and it was not always clear whether, or to what extent, such a movement had taken place. Sometimes a dip in the curve would rely on only one, perhaps rather uncertain, measurement, at one level of the bud. It was clear to me that, at any rate part of the time, I was working dangerously close to the limits of possible error. At the end of the season I undertook a rigorous review of the winter's work, re-printing and re-measuring many of the photographs, to decide just what measure of reliability could be assumed for these graphs. The final result, reached with the greatest care, was that the graph for the Oak could certainly be held to be reliable and significant, the whole form and position of this bud being the most favourable for precise measurement and observation. The graphs for the other three buds I *believed* were significant, but I had to admit a certain amount of doubt about some of their features. I therefore resolved that during the next winter there must be the most rigorous possible testing of the rule that I have stated.

Even early during the autumn of 1982, when the planetary nature of these variations began to dawn upon me, I sensed that, if what appeared to be happening was really true, then I was dealing with something that was very big. Did this little Beech bud respond to an alignment of Moon and Saturn? But this alignment held not only for that bud, but for all the buds on that tree, and all the trees in our valley — indeed in Scotland, in Europe, in the whole world! If what I was envisaging was true, then this Dance of the Buds must be simultaneous, ubiquitous, world-wide! Could one really believe this, without some further evidence?

With this in mind I sought out two further Beech trees in our valley, which I will call Beech A and Beech B; and on certain days during the autumn I picked ten buds from each tree and photoghraphed each twice, from two different directions at right angles to one another, and found the mean from all twenty photographs. Table 1 shows the result of this little experiment, all figures being expressed as percentages of the mean λ for the tree in question. Column 1 (I.B.) gives parallel figures for the Individual Bud which had been pinned to its piece of perspex. The fact that these results ran so closely parallel with one another was very encouraging; for instance, the change in λ from October 1 to October 4 was clearly to be seen simultaneously on all three trees.

Table 1.

	I.B.	*Beech A*	*Beech B*
Sep 28	107.8	103.5	
Oct 1	103.0	103.0	102.4
Oct 4	95.8	96.5	96.0
Oct 10	99.6	101.7	101.1
Oct 16	100.3	101.7	101.1
Nov 13	93.3	94.9	

Contemplating these figures later in the year, I came to have a greater respect for those of Beech A and Beech B than for the individual bud of column 1. This was firstly because, each figure, being the mean of many buds, could be taken as an indication of what the generality of buds on that tree was doing, rather than the possible vagaries of a single bud. Secondly, the photographs, being made in the darkroom, were of much greater clarity; and thirdly, no figure relies on a single measurement, but on the mean of many.

I felt that the figures for the two right hand columns were the most reliable I would be able to get, and I resolved to work this way during the following winter.

1983/84

The task this winter was to test, with all possible rigour, the hypothesis that the λ of the bud suffers a decrease whenever the Moon comes to alignment with the ruling planet of the tree. For instance I started with a large Beech tree, offering many hundreds of buds easily accessible. This tree I called Beech 1. On October 15 the Moon was approximately at 90° from Saturn, and I picked ten buds from the tree, photographed them each twice, measured them (twenty sets of measurements) and found that their mean λ came out at 2.48. One week later, when the Moon was aligned with Saturn, on October 22, I picked a further ten buds, taking care that they should come as far as possible from the same part of the same branch. Their λ came out to be 2.22, a fall of 0.26. Yet another week later, on October 27th, when the Moon was again about 90° distant from Saturn, I repeated the experiment, finding that λ had risen to 2.35. I went on like this throughout the winter, taking weekly measurements; and the results are shown in Table 2. Column A shows the λ when the Moon was far removed from Saturn, and Column B shows the values on the days when Moon and Saturn were aligned. The third column (A-B) shows the change in λ during the intervening week. Since it is always calculated as A-B it means that a positive figure in this column is evidence in support of the hypothesis, while a zero or a negative figure would be counter-evidence.

Out of 20 figures in Column 3, (A-B), we find no less than 19 are positive. The only failure comes in the beginning of January, which, according to the previous year's work, ought to be a quiescent period anyway.

Another tree, Beech 2, was treated in exactly the same way, with results that were even more positive. In this case all twenty figures in the difference column were positive; the mean value for Column A was 2.68, and that for Column B, 2.52, giving a mean difference of .16. Throughout the whole winter there was not a single week during which the buds on this tree did not vary in the direction demanded by the hypothesis.

Table 2

	A *Moon approx. 90° from Saturn.*	**B** *Moon aligned with Saturn.*	**(A−B)** *Difference*
Oct 15	2.48		
Oct 22		2.22	+.26
Oct 27	2.35		+.13
Nov 4		2.28	+.07
Nov 11	2.43		+.15
Nov 19		2.29	+.14
Nov 25	2.44		+.15
Dec 2		2.33	+.11
Dec 9	2.50		+.17
Dec 16		2.35	+.15
Dec 23			
Dec 29			
Jan 5	2.35		
Jan 13		2.36	−.01
Jan 19	2.42		+.06
Jan 26		2.38	+.04
Feb 2	2.56		+.18
Feb 9		2.36	+.20
Feb 16	2.50		+.14
Feb 22		2.40	+.10
Mar 1	2.46		+.06
Mar 8		2.35	+.11
Mar 13	2.56		+.21
Mar 20		2.26	+.30
Mean	2.46	2.325	+.135

In Table 3 we see the results of a similar experiment using the buds of a large Oak tree growing by the side of the loch.

Of the 18 figures in the Difference column, 17 are positive, and the whole result is really remarkably consistent with those which were found for the two Beech trees.

A similar but shorter series of observations was made on the leaf buds of an Ash tree. The mean results came out as follows:

A: *Moon approx. 90° from Sun*	1.85
B: *Moon aligned with Sun*	1.57
A−B: *Difference*	+.28

Here there were only 8 figures in the Difference column (the tree did not offer very many accessible buds) but they were all strongly positive.

The buds of the Birch are very difficult to cope with, being small and

Table 3

	A *Moon approx. 90° from Saturn.*	**B** *Moon aligned with Saturn*	**(A−B)** *Difference*
Oct 25	2.17		
Nov 1		2.05	+.12
Nov 8	2.17		+.12
Nov 15		1.98	+.19
Nov 23	2.06		+.08
Nov 29		1.93	+.13
Dec 5	2.22		+.29
Dec 14		2.05	+.17
Dec 21			
Dec 28			
Jan 6	2.15		
Jan 12		2.05	+.10
Jan 19	2.24		+.19
Jan 25		1.97	+.27
Jan 31	2.11		+.14
Feb 9		2.11	.00
Feb 16	2.30		+.19
Feb 22		2.05	+.25
Mar 1	2.29		+.24
Mar 8		2.09	+.20
Mar 15	2.29		+.20
Mar 21		2.00	+.29
Mean	2.20	2.03	+.17

rather irregular. By the methods of the previous year, photographing them while they were still on the tree, it was not possible to handle them; but this year, working in the darkroom, I managed to get a short series. Rudolf Steiner gave the rulership of the Birch to Venus. The mean results came out as follows:

A: *Moon approx. 90° from Venus*	2.37
B: *Moon aligned with Venus*	2.24
A−B: *Difference*	+.13

Of the 8 figures in the Difference column, 5 were strongly positive, and two further ones, weakly so. This result is not as convincing as those already described, but seeing the difficulty of working with these tiny and rather irregular buds this is perhaps not surprising. I think this result can be taken as an indication that the Birch is probably behaving in a similar way to the other trees described; but obviously much more work is needed here before a definite statement to this effect can be made.

And a similar situation obtains for this year's work on the Elm. To sum

up the general results of this winter's work, we can say that, of the five species selected for study, not a single one failed to give positive results. I could hardly have hoped for better corroboration of the work of the previous year.

Which made the next step all the more striking, and, at the time, disappointing. Before Christmas I chose yet another Beech tree for study. My aim here was to pick my ten buds daily instead of once a week. Obviously if one is not to denude the tree of buds too heavily one cannot go on doing this through the whole winter. But I hoped to be able to follow the process through at least two minima, i.e. two alignments of Moon and Saturn, to show these two minima with a continuous curve. To my dismay the first lunar alignment passed without any significant fall in λ being recorded at all. At last I had found a tree which was not 'playing the game'! When I went back to examine the tree more carefully I realised, what I must have known all along but had not sufficiently noticed — this tree is growing in very close proximity to a powerful electric sub-station. The iron railing guarding the giant transformer is only five paces distant from the bough I had been plucking; there is a notice saying "DANGER, 30,000 volts", and the high tension cable entering the sub-station passes right over the top of the tree. Could it be the case that a plant growing in a strong magnetic field would find itself completely cut off from these cosmic connections?

I immediately put this tree down for further weekly study, in the same way as I was treating all the others. Table 4 shows the results of this series of observations.

It is instructive to compare this with Table 2, for the Beech tree growing in the open. Out of 14 figures in the Difference column, 7 are positive and 7 negative. The mean values for columns A and B do not significantly differ from one another. This is precisely the kind of result which we should expect if our hypothesis were not true, and which none of the other trees up to this moment has given us. Notice that the *amount* of the variation is more or less unchanged; the mean of the Difference column, ignoring signs, is .16; but all sense for a connection with the cosmic influences is lacking.

Table 4.

	A	B	(A–B)
	Moon approx. 90° from Saturn	*Moon aligned with Saturn*	*Difference*
Nov 25	2.46		
Dec 2		2.52	−.06
Dec 9	2.63		+.11
Dec 16		2.67	−.04
Dec 23			
Dec 29			
Jan 5	2.44		
Jan 13		2.71	−.27
Jan 20	2.46		−.25
Jan 26		2.38	+.08
Feb 2	2.46		+.08
Feb 9		2.31	+.15
Feb 16	2.66		+.35
Feb 22		2.85	−.19
Mar 1	2.75		−.10
Mar 8		2.35	+.40
Mar 13	2.37		+.02
Mar 20		2.57	−.20
Mean	2.53	2.55	−.02

Further investigation of this matter has not been very easy. Electricity sub-stations are not usually sited in dense vegetation, and the electricity company cuts a swathe through the vegetation underneath its power lines. However, after considerable searching I found a young Oak sapling growing right under the high-tension cables. It had evidently been considered too small, at the time when the cables were erected, to be worth felling. I immediately put it on the list for a similar set of bud measurements to those of Table 3, taken of course on the same dates. Table 5 shows the results of these measurements.

Here again we see a result which is similar to Table 4. The mean values for columns A and B are not significantly different from one another; and indeed what difference there is, is negative. This tree was certainly not responding to the cosmic connections in the way that the others did. A mean difference of .05 is certainly not large enough to be significant with the small number of observations which were possible on this tree. It is a pity that work had to be suspended during two weeks of January. The tree grows on a hillside several miles from home, and the blizzards had rendered access to it impossible. I hope to do more work along these lines next winter.

Table 5.

	A	B	(A–B)
	Moon approx. 90° from Mars	*Moon aligned with Mars*	*Difference*
Jan 5	2.78		
Jan 12		2.80	−.02
Jan 19			
Jan 25			
Jan 31	2.90		
Feb 9		3.01	−.11
Feb 16	3.27		+.26
Feb 22		3.40	−.13
Mar 1	3.12		−.28
Mar 8		3.39	−.27
Mar 15	3.40		+.01
Mar 21		3.10	+.30
Mean	3.09	3.14	−.05

Having experienced the work of the winter of 1982/83 the question naturally arose as to whether something of the same sort might also possibly be true for the flower buds. The way in which the λ of an individual flower bud varies as it opens had already been charted in some detail; it goes through a quite characteristic little rhythmic process which is described in Chapter 7 of *The Field of Form*. In this new work we should be asking not how an individual bud varies from day to day, but what changes, if any, a whole species undergoes during the days and weeks of its opening time. To do this we have to have a species in which it is possible to pinpoint very precisely some stage of development in the growth of the buds, and work only with buds that have just reached that stage.

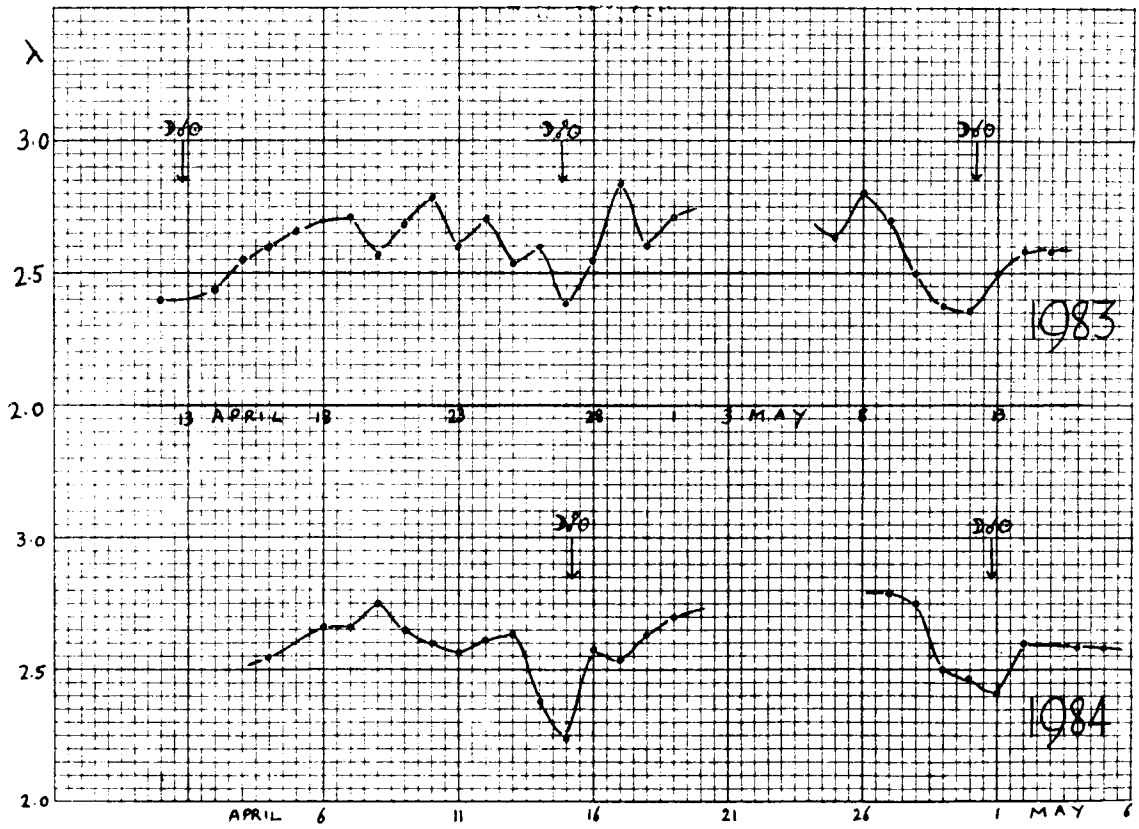
The Primrose, opening during April and May, offered just such an opportunity. The buds of this beautiful little plant start their life totally enclosed in their green sepals but during the course of their opening they burst, at a certain stage, out of their enclosing sepals, and continue their development in the open sunlight. There is thus a moment in the development of each bud when the

first hint of yellow petals can just be seen through the cracks between the green sepals, and this is a stage of development which can be easily and accurately discerned in the growth of the bud. I therefore resolved to work only with buds, picked from one corner of a particular wood, that had reached just this stage of development. Each day ten such buds were picked, photographed twice, from two directions at right angles to one another, and their mean λ calculated. This was taken as being, as near as one could come to it, the λ of the species Primrose for that day.

Of course when dealing with means of this nature there is always the possibility of some 'rogue' value occurring, due to a chance accumulation of very high, or very low, λ-values appearing in the set that is being measured, but experience has shown that in fact values obtained in this way show a remarkable degree of consistency from day to day. And the graph of the λ-values of the Primrose almost immediately began to show a clear 14-day rhythm, with minimum values coming almost exactly at full and new moon. Of course such an experiment can only be carried out over a limited period of time; after some five or six weeks there are no more buds available at the proper stage of development. One could not be sure that the correlation of these minima with the full and new Moon periods was anything more than a coincidence, so one waited with considerable eagerness to repeat the experiment the following spring. In the event the graph for spring of 1984 turned out to have almost identically the same features as that of 1983. Diagram 4 shows the curves for the two years, the time scales along the x-axes being so arranged that the times of new and full moon fall approximately above one another, for easier comparison. It will be noticed that during both these seasons the λ-values drop below the level of 2.5 at every alignment of the Moon with the Sun, and at no other time. I think we have here good preliminary evidence that this correlation is really a true and significant one.

It is too early yet to speculate much on what such a phenomenon may mean. The primary purpose of the research is to discover what **is**, and not to decide what ought to be! But it is worth noticing that this behaviour of the Primrose is similar to that which we have found for the Ash, even though the evidence in this direction, for the Ash, is at the moment very partial. If the flower buds are to be judged according to the same considerations which we assume for the leaf buds — something which is by no means established at the moment — then we would have to say that the Primrose comes under the rulership of the Sun. And perhaps this is well in accord with our feelings. When we gaze down into the heart of the plant we see a multitude of little buds, each with its golden hue,

Diagram 4. **Primrose**



radiating from the central point of the root. It is like a source of light. The poet declaims: "A primrose by the river's brim, a yellow primrose was to him, and it was nothing more". Well, what more *should* it be? Perhaps we must see a splinter of the spiritual Sun, glowing there in the early spring days, on our river bank.

Even while the Primroses are still in bud, our hedges become studded with the beautiful little white blossoms of the Greater Stitchwort. The buds of this plant also start their life totally enclosed by green sepals, and the moment when the white petals begin to break through at the tip of the bud enables one to fix a constant stage of development at which to pick them. In the late spring of 1983 I studied these in a similar way to the one I had used for the Primroses. Their λ-graph seemed to show a distinct fourteen-day rhythm, as with the Primroses, but here the minima in the curve came about twenty-four hours before the lunar alignments with Saturn. No conclusive result could be gathered from observations over such a short period, and again I had to wait until the following year for confirmation. Three possibilities could be foreseen. Either the new observations would not show any recognisable lunar rhythm, they might show a 14-day period not correlated with the movements of Saturn, or they might in all respects repeat the results of 1983. Diagram 5 shows what actually transpired. At the time of writing, the observations for the last part of this diagram are still being made, but enough has been done to make it clear that the essential features of the graph of 1983 are being faithfully repeated here. In each of four cases of alignment of Moon and Saturn, in two successive years, the λ-curve shows a pronounced dip just twenty-four hours before the moment of alignment. It is interesting to note that the buds seem definitely less 'lively' this year than last, λ never rising as high as 1.9. I do not know the reason for this. The buds were picked from the same short stretch of hedgerow, and were treated in every way the same in the two seasons. I am wondering whether the exceptionally dry weather which we have been experiencing this spring might possibly be the cause. In each set of ten there were always a few which seemed unable to reach the usual level of λ, and these tended to bring the mean values down. The rather inconsistent value for May 21, flanked by higher ones both before and after, may well be a rogue value due to a random concentration of such on that day. The real minima in the curve are shown always by two, three, or more, consecutive low values.

Another flower which was found, in 1983, to be suitable for this kind of treatment, was the Speedwell. This delightful little blue flower has buds which are very small and delicate, and it is therefore difficult to get results which are as accurate and reliable as with the larger and more

Diagram 5. **Stitchwort**

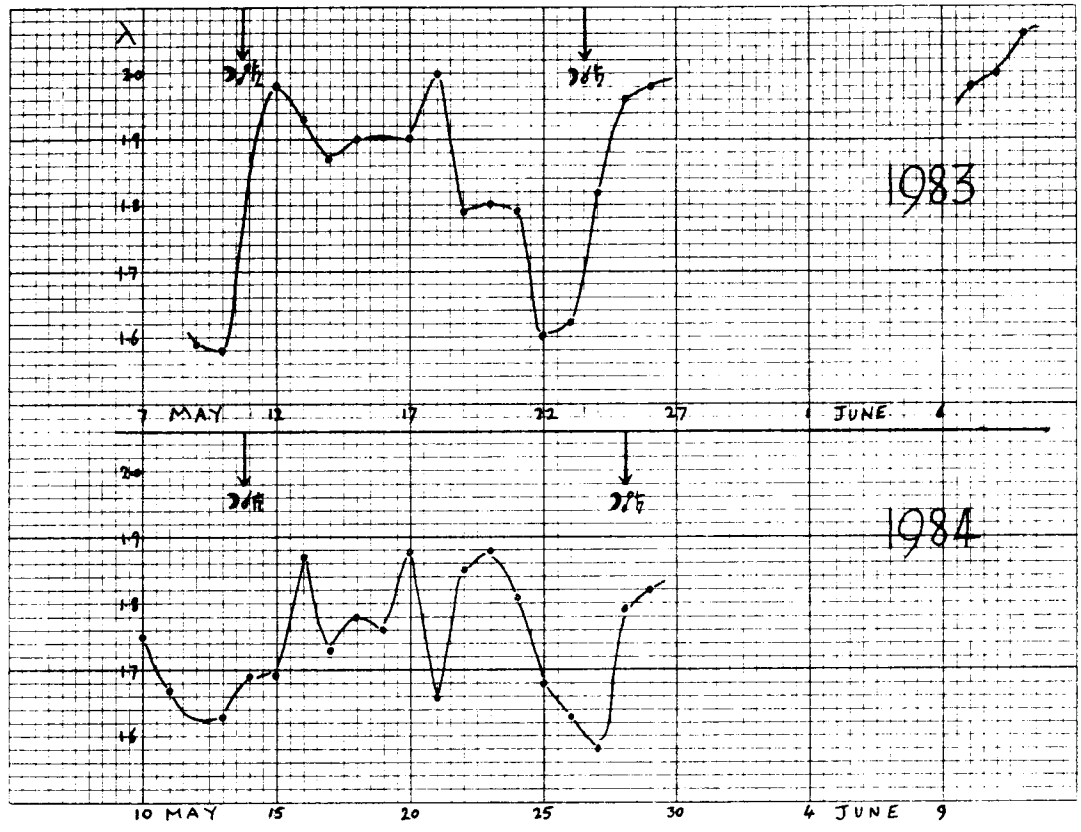


Diagram 6. **Speedwell 1983**

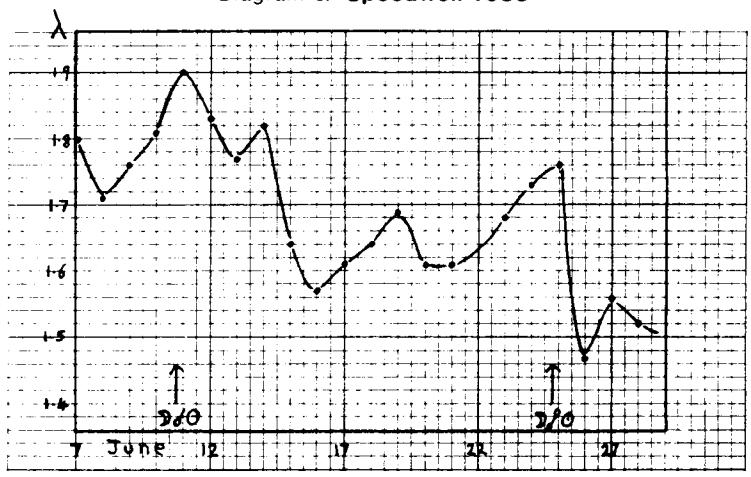
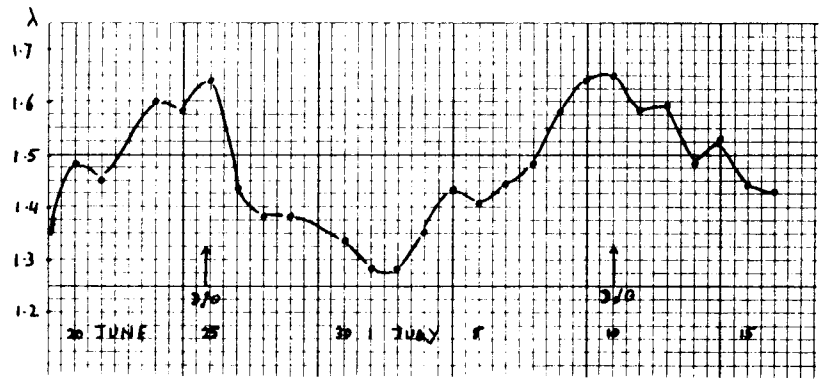


Diagram 7. **Geranium 1983**



robust buds. But the points on the λ-graph, Diagram 6, showed a good measure of consistency, and here again a 14-day rhythm seemed to establish itself fairly firmly. But the period of observation was too short for this to be considered an established fact, and careful corroboration in succeeding years will be needed. Here we notice that things seem to be going in the opposite way from that which they did with the Primrose. The alignment of Moon and Sun coincides with a maximum rather than a minimum in the curve. This reminds us of the leaf bud of the Cherry, and it might well lead us to suggest a rulership by the Moon. We notice that the general level of λ seems to be decreasing as the season progresses, and this is perhaps the reason why the second maximum in the curve is less well marked than the first.

Another bud which has had only one season's observations made on it is the wild Geranium. This lovely bud is singularly well adapted for accurate and reliable measurement, and as a result one sees the very great consistency of the points on the graph, Diagram 7. Here again there is a well-marked 14-day rhythm, the maxima co-inciding, as with the Speedwell, with alignments of Moon and Sun, and Moon and Mars, Mars and the Sun being close together at that time. However we must be alert to the possibility that here we are dealing with something subtly different. The graphs of the other buds, both leaf and flower, suggest that the general level of λ remains roughly constant most of the time, with a fairly sudden and quite short fall, or rise, in its value at about the time of the alignment. With the Geranium however the graph gives much more the impression of gradual change, very approximately like a sine curve. Much more observation is needed here; I feel that we have good evidence that we are indeed working with a lunar-solar effect, but we must guard against the easy assumption that it is necessarily functioning in the same sort of way as many of the others.

The only other species which has been treated in this way so far is the Snowdrop. Diagram 8 shows the result of observations made at the beginning of 1984. We see sudden, and quite sharp, drops in the λ-value, coinciding with alignments of Moon and Saturn. It is a remarkable fact that the early days of this graph were in fairly mild weather. This was followed by blizzards and deep snow; on many days during the middle part the buds had to be dug out of deep snow and thawed out of their icy covering before they could be photographed. Then in the last day or so the thaw had arrived. But these violent changes in weather do not seem to have had any traceable effect on the level of λ. It is only the invisible and impalpable Saturnian alignments which have been effective. When one considers the extraordinary capacity of this delicate little flower to blossom in the most rigorous conditions of snow and ice, sometimes even seeming to make a little space for itself in the deep snow, one has to ask whether perchance something of Saturnian warmth is at work here.

The amount of change is usually greater in the case of the flower buds than with the leaf buds. In the latter case the changes are to be appreciated only by exact measurement on considerably enlarged photographs. But with the flowers it is clearly visible. Diagram 9 shows two cases; the continuous curve shows the average outline of the bud at normal times, and the dotted curve

Diagram 8. **Snowdrop 1984**

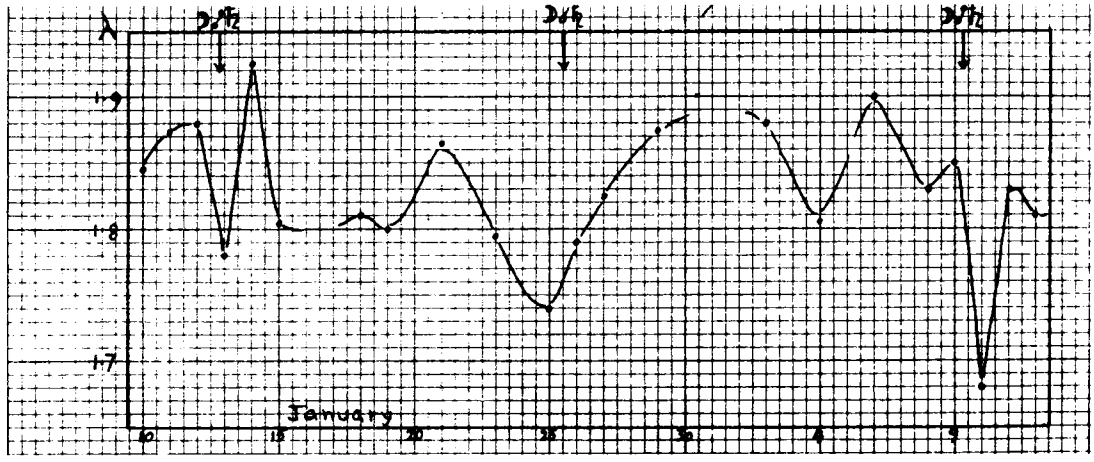
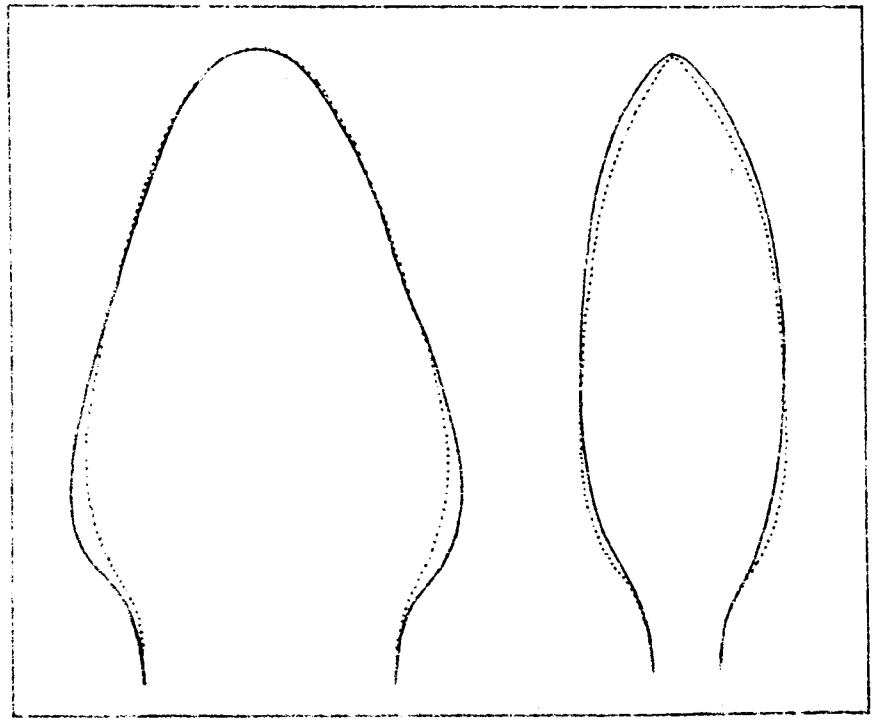


Diagram 9. **Primrose** **Geranium**



the profile when the bud is under effective alignment. On the left is the Primrose, and we see here that the change is almost wholly confined to the lower part of the bud, a characteristic which was notable both in 1983 and 1984, and which it shared with both Beeches 1 and 2. More usually however the change shows itself at both ends of the bud, a slight widening above taking place simultaneously with a narrowing below, or vice versa, as is seen in the case of the Geranium, pictured on the right.

It is in the nature of the case that this report cannot be more than a short and preliminary one, raising more questions than it can answer. The developments of greatest value must be those which lie still in future work. But I think that enough has already been done to show that the plant world is indeed sensitive to cosmic influences in this way, that these influences show themselves particularly in that most archetypal, egg-like form of the bud, and that such effects are open to exact observation and calculation. We can come to see this plant world as a field of terrestrial astronomy.

NEWS AND COMMENT

Flow Design Research Group, Emerson College.

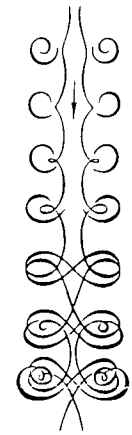
A number of research programmes have been planned over the last few years to investigate the working of Flowforms. We attempt here to give some impressions of what is going on. One aspect is design research and the other scientific research; in this particular sphere of work, however, these also interrelate very strongly.

The principal aim, stated earlier in *Science Forum 1*, is the investigation of rhythms and their effect upon the life supporting capacity of water.

Rhythmical processes are generated in streaming water by allowing it to flow through a series of vessels the proportions of which relate in a specific way to gradient and flow rate. The movements become a 'sensitive vehicle' and tool for working with life processes which are themselves rhythmical. An analysis of the parameter relationships published by Nick Thomas in the *Cultura Foundation Report 83* indicates a highly significant correlation between the proportions of the thirteen Flowforms examined. The results indicate that in morphological terms the size of the form inversely relates to the kind of Cassini curve it most resembles, small forms approaching a Cassini oval and large ones a lemniscate. In terms of the formula used a 'Cassini Index' for Flowforms may possibly be definable.

We have set out to determine more accurately the movement components within rhythms generated in any given design. The first published statement on rhythm analysis appeared in *Science Forum 4* by Nick Thomas. Through this work, data continues to be assembled on all existing Flowforms. The material constitutes basic information for further research in which attempts will be made to set up rhythmical correspondences between organisms and water.

In 1973 Flowforms were incorporated in the biological sewage system at Järna in Sweden. This functions and flourishes. The first system now has four cascades with lagunes and filter beds. A second system has been built to accommodate the growing complex of school, clinic and housing with two further cascades. Similar installations have been built elsewhere. The main one is in Warmonderhof Farm School, Holland, and was planned for the purpose of cleaning up the canal surrounding the school and for comparative investigations. Some results have been recorded and these will be briefly reported here.



The Malmö Cascade

The basic comparison is between Flowform cascades and Step cascades. The characteristic differences may be described as follows. In both cases the water moves by virtue of the overall slope. The Flowform cascade generates rhythmical swinging movements which carry the water repeatedly towards the periphery in a lemniscatory path before it falls to the next level. *(The accompanying diagram indicates the development of movement from a continuous circling motion to the swinging lemniscate.)* The Step cascade allows the water to move forward and merely fall to the next level. Three areas of research were chosen:

(a) short circuit using only holding tanks, for a number of days;
(b) long circuit via biological ponds for some months;
(c) tests on the canal into which the septic tank discharges.

Observations were carried out on: foam-production, clarity, colour, chemical/physical parameters, algae, water plants, macro-fauna and the Drop picture Method.

(a) short circuit. Indications showed a more efficient oxidation of nitrogen in the Flowform cascades. Foam-production, sediment volume of algae and the detritus were different in the two systems. However it could not be conclusively determined in short term that the differences were entirely due to the water movements.

(b) long circuit. The Step cascade and the so called Malmö Flowform cascade were connected to two separate biological lagune systems. These worked parallel from June to November.

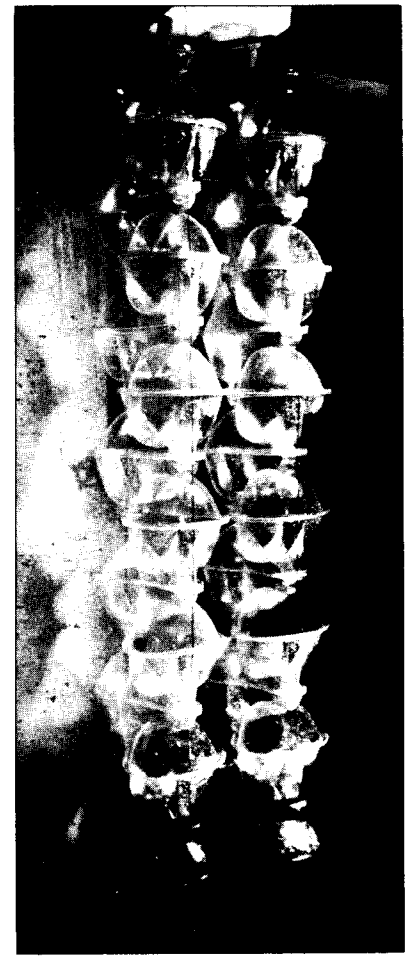
- Observations on foam-production and Drop pictures were less significant than in short term tests.
- Difference in clarity and colour was obvious in the two systems.
- The algae bloom was stronger in the Malmö cascade in June, from mid-August it was stronger in the Step cascade.
- Population of algae similar in both systems.
- Water plants showed better development in Malmö cascade from mid-August (*Sium latifolium, Alisma-plantago aquat., Nasturtium microphyllum, Lemna minor* and *Azolla filicuoides*). *Sium erectum* developed more horizontal stems in the Step cascade and showed more vertical tendency in Malmö cascade.
- Macro-fauna showed clear differences.
- In Malmö cascade more *Chironomus larvae, Lymnaea spec., Corixidae spec., Cyrnus flavidae, Tricladidae* were observed accompanied by a light green layer of duckweed. In the Step cascade more *Cloeon dipterum, Glyptotendipes spec., larvae* and *asellus* were observed accompanied by a dark green mass of algae.
- The oxidation went faster in Malmö (confirming short term observations).
- pH-values were more stable in Malmö (August, September).

Researchers' conclusions:

The process of change during the long-circuit experiments shows clear differences between the two cascade systems. These differences were quite striking by the end of the experimental period, especially in the way the higher plants developed in the Malmö cascade. In the Step cascade the growth of algae had a later start and afterwards kept predominating until the end of the period, while the higher plants were left behind. During 1982 observations showed some familiar tendencies to 1981 although weather was completely different. Results are more than enough motivation to continue the research with some improvements. Observations and study of the developing water plants, of the spontaneously developing plants and the macro fauna give the most promising perspective to obtain a broader view of the meaning of 'water quality' and to come to an understanding of the effects of different water movement treatments, by reading this out of the water itself.

For experiments on a small scale the Stackable Laboratory Flowform has been developed. Dimensions: 20cm long, 14cm wide, 11cm high, 50% gradient, flowrate 5 ltr/min. 104 osc./min.

Initial research has been carried out on germination and plant growth tests in Forest Row. Flowformed and pumped water samples were compared with an untreated control. The indications are that Flowformed water, i.e. rhythmically treated water, compared with water passed through a pump, brings an increase in harvestable material, in this case radish, with less leaf growth. This material seemed also to keep better. These results were achieved by an early morning treatment.



Stackable Flowform

When adequate facilities and researcher are available we intend to continue these investigations here. It is understood that similar work is continuing with our colleagues near Wellington, New Zealand, and in Sydney work was planned in connection with bread baking. In Wilton NH USA and in Sweden, experiments will also continue with plants under glass.

In Austria at Institut Landsmannhof investigations are proceeding under scientifically controlled conditions with the breeding of worms. This work is described as follows.

Due to the fact that worms exist in moist, dark conditions they provide convenient test organisms. Comparisons can be made on the effects of untreated and rhythmically treated water, on vitality, growth and breeding capacities of various species. Two mainly are used; *Dentrobaena Veneta* and *Eisenia Foetida* while tests can naturally be extended to include eventually other species. All conditions can be kept constant while the water treatments are varied. A report is not yet available on work during 1984.

In the curative education sector colleagues have been able to build cascades at a number of schools on the continent. This facilitates observations on the possible harmonizing effects of water movements upon conditions of imbalance. During this last year we have also begun more active work with 'Rocking Forms' as a direct therapy tool. We are indebted to Camphill and also Philpots Manor for beginning work in this field.

We are now also planning work with similar forms in connection with pharmaceutical mixing processes. We hope to provide Wala with vessels soon.

Finally it is probably worth mentioning that we would like to attempt the coordination of efforts towards the creation of 'models' which could combine various technologies connected with water treatments. For example, in connection with lagune systems used for purification or, for instance, treatment of desalinated water, with plant filter beds from which material can be harvested for different purposes, methane production, composting, slurry treatment, pisce-culture, use of wind energy etc. for circulation... We see such components combined not only for practical purposes in communities and farms but also as an educational tool for schools in the form of self-supporting miniature ecological systems.

Although we are repeatedly encouraged by results, we are not yet able to publish data on the basis of extensive scientific work. We are constantly looking for help of all kinds in this direction. At the same time we acknowledge the very generous support of the Cultura Foundation, the Margaret Wilkinson Fund and Emerson College Trust.

Our Company, Virbela Flowforms U.K. Ltd. is also generating project and development work with a view to investing proceeds in institute building and research. Artistic and scientific aspects of the work have drawn a great deal of interest but more specifically applications have been recognised by a group of friends who intend to help. Although their work has a very wide context, water is a central theme. It is expected that support will and must be forthcoming in the near future in order that some substantial contribution can be made towards a solution to today's water situation, also, from this anthroposophically orientated effort.

Nick Thomas, John Wilkes

Activity of Homoeopathic Medicines

William Steffen is currently studying the action of homoeopathic (potentised) remedies on living organisms, at the Botton Science Laboratory. His report, of May 1984, on *Growth of Yeast Cultures as in vitro Model for Investigating Homoeopathic Medicines — a Critical Assessment* describes an attempt to confirm results obtained by R. L. Jones at the Research Unit of the London Homoeopathic Hospital by repeating the experiments under similar or identical conditions. The original experiments indicated that the presence of potencies of *Pulsatilla* in the growth medium of yeast cultures led to significant modifications in the growth rate of the cultures. These results are not confirmed by Steffen's investigations. Further details will be given in the next issue of *Science Forum*.

William Steffen's report acknowledges financial assistance given by the Margaret Wilkinson Research Fund, the Research Fund of Weleda Zentralverwaltung and the Rudolf Steiner Fonds für Wissenschaftliche Forschung.

Hedley Gange

The Science Conference

30th December 1983 to 2nd January 1984

The main theme of the conference, which was held at Wynstones House, Brookthorpe, was 'Atomism — which phenomena gave birth to it, and what is its reality?' An introductory lecture on the development of atomic concepts was given by Nick Thomas and two main lectures, on 'Waves and Quanta' and 'Reality', by Dr. Georg Maier of the Research Laboratory at the Goetheanum. Some interesting, and at times spectacular, practical demonstrations were given by Howard Smith assisted by Alan Hall. Each morning began with a eurythmy session.

Subjects of short contributions included: 'Atomic Energy as seen by a reactor physicist', David Bohm's 'holistic approach to physics', 'Variations in bud forms and planetary correlations', 'Astrosophy and the history of physics', 'The Social basis of spiritual science', 'Mathematical studies of leaf and bud forms', 'Sun Space as a counterpart to Atomism', and 'an Anthroposophical view of the Periodic Table'. Two of these contributions form the basis of articles in this issue of *Science Forum* (by Lawrence Edwards and Graham Calderwood). We hope to include other items arising from the conference in our next issue.

Hedley Gange

Correspondence

Scanning the Heart

Those who have read Lawrence Edwards' *Field of Form* will be aware of his work on the heart. As he says there, the X-ray angiograms are not easy to read precisely.

In an effort to obtain accurate form-data from a set of X-ray positives Mr. Edwards was kind enough to lend me, I have been scanning them using a home-made photo-diode/lens/lamp arrangement which replaces the pen normally carried by a flat-bed XY plotter. Under computer control, this detector can be placed with precision and measure the brightness (strictly, the reflectance) of a very small element of area anywhere on an image laid on the plotter bed. In this way, a numerical analogue of the heart image may be filed by the computer.

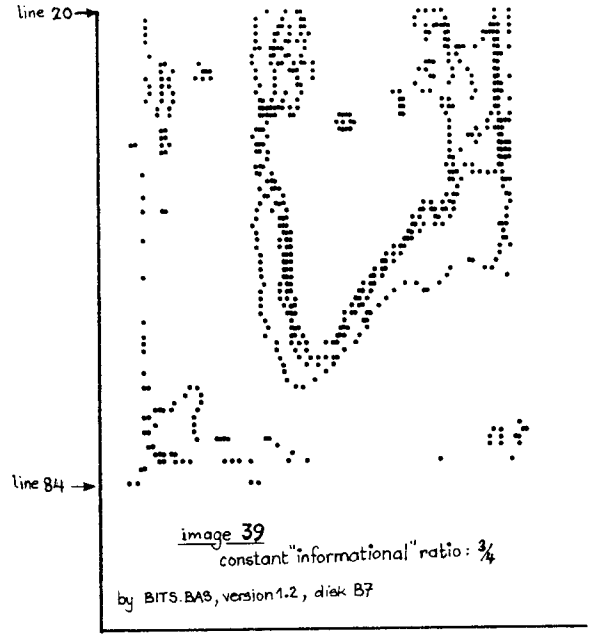
The positives are frames from a 'movie' X-ray. They are fuzzy, and of course show things besides the ventricle. My initial idea about this was that, from picture to picture, only the shape of the ventricle should change appreciably, and that by only a little, so that after positionally matching the analogues until they were as closely similar as possible, it should only be necessary to 'subtract' one picture from the other to eliminate all but the wanted differences, which should be concentrated in the region of the ventricle edge. Et Voila!

This was naive. In reality the pictures vary too greatly and non-uniformly in terms of general brightness and contrast for all such to be estimated and allowed for simultaneously, at least so far. But, this said, my thoughts went often to the fact that the eye handles these difficulties quite well; we want to do better, of course — hence the whole exercise — but it became rapidly clear that the way in which the eye finds 'edges' in a relatively turbulent visual field is as obscure as it is remarkable!

I had been trying such things as 'look for isophots' (contours of equal brightness) or for contours of equal rates of change of brightness. The latter picks up edges alright, but not necessarily the 'right' ones! Somehow the eye cancels the variations which remain to cloud things after such maneouvres are over. I formed the notion that the eye winnows the information it receives down to a very primitive residue. How?

I put it to myself that the eye finds an edge where there is a constant, detectable change in 'informational content', *of whatever kind*, and even if it does not, the computer probably could! The question was, what is informational content? What *is* 'raw' information?

Now the computer carries the brightness information as eight bit binary numbers; in decimal notation this means values from 0 to 255. A bit is either on or off, 1 or 0, and, I thought, you can scarcely get rawer than that! But the order in the binary group is significant. 1010 binary is 10 decimal, but 0101 is 5. We reach a more primitive, but non-zero, measure of information if we discard the bit-order, and merely count the bits that are set on in a given number. Is it still significant? After all, it feels slightly daft to throw away information: it quite goes against the grain!



I tried it. I asked the computer to look for changes in such content, and at once obtained scans which followed the *visible* edges more naturally than any had done before, and when I asked it to look for changes with constant ratio, it did even better. Perhaps I was on the right track at last.

This seems close, but it is not, I think, 'in the gold'. I need to understand better the meaning of 'raw' information. Sixteen or thirty-two bit representations of the brightnesses would resolve 'more' raw information, would they not? In short, I need a strong, theoretical framework to give this work better direction than intuition so far has. Can anyone help me?

Apart from the goal set with regard to the heart, we may learn something of importance about the action of the eye. Rudolf Steiner has mentioned that the eye detects form through the sense of Movement, and I am sure he has the rights of it, but something holds the eye on course in its movement, and I am just as sure that an error-correcting, negative feedback process does this (you can get the eye to oscillate), and such correction needs raw input! How does it get it?

Graham Calderwood,
Cairnlee, Bieldside, Aberdeen. AB1 9BN

The Bockemühl Approach to Heredity and the Sheldrake Hypothesis

Hedley Gange

Two new approaches to heredity have been put forward during the last few years. One, by Jochen Bockemühl, was referred to in a short article in *Science Forum No.4*, p.28 and is described in *In Partnership with Nature*, Bio-Dynamic Literature, Wyoming, Rhode Island 02898. The other is contained in *A New Science of Life* by Rupert Sheldrake, Blond & Briggs 1981 (Granada 1983), which was reviewed by Brian Stockwell in *Science Forum No.4*, p.23. Both view heredity within the context of the living world as a whole.

Bockemühl's method is wider than anything known in contemporary science. He is concerned, in the first place, with modes of observation and the nature of concepts. The concept 'plant', for example, is derived from numerous observations, linked in time and space; it owes as much to thinking as to perception. The seed is one stage in the life of the plant, and can be understood properly only in relation to the whole.

He envisages a non-physical organizing agency which, at all times, controls the growth and form of each plant. The existence of such an agency can be sensed, if not actually perceived, it is claimed, by a further development of Goethe's organic mode of observation on the lines suggested by Rudolf Steiner (1861-1925). The seed provides the physical link between one generation and the next, but its genetic substance does not contain all the information needed for the future development of the plant. The latter proposition is unnecessary if the activity of the organizing agency is recognized.

Starting from the general concept 'plant', or the totality which lives within it, we can direct our attention to its different forms of manifestation. We obtain a differentiated picture, comprising many families of plants. Carrying the process further, we attain an even clearer concept of particular species, which can be further differentiated into types. In any individual plant, the very wide range of formative possibilities embraced by the general concept 'plant' have been narrowed down to certain specific features.

Experience teaches that any ideally-conceived plan or process encounters limitations as soon as it is put into practical effect: each substance, mechanism or human agency involved introduces its own characteristic restrictions. Something similar happens, according to this view, in the process of heredity: all the formative possibilities of, for instance, a plant species are available to the next generation but they have to be transmitted by physical means (the seed) and the genetic substances concerned have limited properties — they are able to transmit some but not all of the whole range of formative tendencies that are potentially available. Each of the various types that arise in this way represents a limited range of the formative possibilities of the species. The seed does not contain these formative possibilities but it provides a physical basis for the activity of the (non-physical) formative agency.

Sheldrake's view of heredity forms an integral part of his 'new science of life' based on the hypothesis of 'formative causation.' This type of causation, as yet unknown to science, is considered to be responsible for all formative activity in both the living and inorganic realms. Form, in this sense, includes not only outer shape but also internal structure and order — in for example, crystals, cells, molecules, organisms. Formative causation depends on morphogenetic fields. The form of an organism, for instance, is determined by its morphogenetic field, and this is influenced by previous similar organisms and fields by a process of morphic resonance which acts across space and time.

The current mechanistic view of heredity, based on a study of the role of DNA and associated substances, leaves many questions unanswered. The hypothesis of formative causation provides, it is claimed, the possibility of a more comprehensive understanding. According to this hypothesis, organisms inherit the morphogenetic fields of past organisms of the same species. So heredity includes *both* genetic inheritance and morphic resonance from similar past forms. Morphic resonance plays a part in the inheritance of acquired characteristics, of behaviour and of tendencies to learn. If several rats, for example, learn a new pattern of behaviour, subsequent rats, all over the world, will tend to learn the same pattern more easily. The larger the number of rats involved initially, the stronger will be their influence on subsequent rats.

Sheldrake's Standpoint

Sheldrake's standpoint is basically that of a conventional scientist, although he exhibits a degree of emancipation from some traditional constraints. He looks critically at the prevailing mechanistic and other theories of life and points out their inadequacies whilst at the same time acknowledging their successes and the fact that there is, at present, nothing to replace them for most purposes. He refers to various scientific hypotheses, past and present, and shows how their significance lies not in their intrinsic appeal but in their ability to be tested, to produce results and to be absorbed into the general body of science. He recognizes that his hypothesis of formative causation will stand or fall by these criteria. He

notes how the philosophy of science can be progressively modified as new concepts and methods are developed.

To emphasise the distinction between science and metaphysics, he describes four metaphysical theories, each of which is compatible with the hypothesis of formative causation. The fourth of these "affirms the causal efficacy of the conscious self, and the existence of a hierarchy of creative agencies immanent within nature, and the reality of a transcendent source of the universe."

Of the scientific method, he remarks, ". . since physics presupposes the minds of observers, these minds and their properties cannot be explained in terms of physics." And of his hypothesis, "This new way of thinking is unfamiliar, and it leads into uncharted territory. But only by exploring it does there seem to be any hope of arriving at a new scientific understanding of form and organization in general, and of living organisms in particular."

Future Development of the Holistic Approach

The wide interest aroused by *A New Science of Life* suggests that Bockemühl's holistic approach to heredity might also awaken a response in contemporary thought, if presented in a comparable way. The method is, as yet, in its early stages, but it is perhaps not too soon to consider how it can be developed and related to contemporary thought and to existing science. The following comments are made with these ends in view.

a) The method combines scientific, artistic and moral values and therefore takes time to develop. Consequently, its merits cannot be assessed as readily and as quickly as with existing methods. It is possible, however, to give a good general description of the basic method, with illustrations — and a wide range of literature and related information is now available.

   Sheldrake's outline of some of the fundamental features of the scientific method, as applied today with special reference to biology, provides a basis for explaining how the method could possibly be widened to allow systematic study of qualitative, aesthetic and other aspects of Nature. He recognizes that the existing divisions of knowledge — chemistry, physics, biology, and the distinction between science and metaphysics — are man-made, but the over-riding justification for this structure of knowledge is that it provides a system *that works*. He would, one feels, be prepared to accept a wider, unified approach if it were shown to yield as good results as the existing system.

b) Sheldrake breaks out of the customary bounds of science in so far as he postulates forces at present unknown to science. Bockemühl, too, is concerned with forces unknown to conventional science, but it can be shown, with supporting evidence, that he has a sound historical and epistemological basis for his proposals. Links can be established, also, with other fields of study such as colour, astronomy, curative education, etc. Sheldrake's proposals, by contrast, contain a strong element of conjecture; and the description of one of his basic concepts 'form', for example, is limited — he makes no mention of Goethe or Ernst Lehrs.

c) Contempory science will be particularly interested in the following questions:

Question 1: How can the Bockemühl approach to heredity be tested?

Question 2: Can the approach be shown to be of significant practical value?

Question 3: Can it be presented as an inherently ordered system?

Question 4: Will it be dependent in part upon existing science? If so, will it be possible for its relationship to conventional science to be developed in a systematic and generally understandable way?

A first requirement will be to develop the idea of the controlling agency which is contained within the concept 'plant' or 'type'. An indication of how this can be done is given in *In Partnership with Nature*.

What is meant by 'all the formative possibilities of the species'? This cannot be determined by observation alone. Even if all the specimens that have ever existed were included, it would not necessarily exhaust all the *possibilities*. This suggests a way in which the validity of the concept could be demonstrated: first, elaborate what is meant by 'all the formative posibilities' for a particular species, through a comprehensive application of both theory and observation. Then (a) through renewed observation of naturally occuring plants of this species and (b) through controlled experiment, seek to show that a continuous range of forms (or other features of the plant) could be brought to manifestation. For some species there may be a close correlation between 'all formative possibilities' and the total of observed forms: for others it may be possible to show, in a striking way, how 'possible' forms, never before seen, can be produced, without manipulation of genetic substances.

The current trend towards recognition of the 'wholeness' of an organism, as in holistic medicine, must be of assistance in promulgating the concept of an 'organizing agency'.

Both Sheldrake and Bockemühl consider that the 'mechanistic' view of the role of DNA and associated substances in heredity is inadequate for a satisfactory understanding of the phenomena. The function of these substances, as proposed by Bockemühl, is to provide the means by which the non-physical, organizing agency (for example, the plant type) may link-up with and begin to work on physical matter. The organizing agency is the source of the controlling information and impulses necessary for subsequent growth.

In considering different plants of the same species, for example, what is the significance of any differences in the genetic material? These represent, according to this approach, different degrees of restriction of a comprehensive organizing agency. (This function is obviously a much simpler one than that assumed in the mechanistic hypothesis, and is more in accordance with the facts, in that the amount of information that can be contained in the genetic code is strictly limited.) A re-orientation of ideas concerning the role of genetic

substances and their correlation with macroscopic phenomena is here involved. If this can be developed in a systematic way, theoretically and experimentally, it may be possible to achieve a new working understanding of the role of genetic structure in the whole process of heredity, with beneficial consequences.

Questions of heredity often arise in a social or moral context, and here a wider approach and understanding of the subject is likely to be of practical value. One of to-day's problems is, 'Should a Downs Syndrome baby be allowed to live?' An holistic (or spiritual) approach to this and similar questions may lead to different answers from those based on a mechanistic view of heredity.

The above comments may, perhaps, stimulate further discussion and elaboration of these important ideas.

Comment by Jochen Bockemühl

Dr. Bockemühl of the Natural Science Section at the Goetheanum has kindly commented on the above article.

I do not know Sheldrake's work well but intend to go further into it. An important point in the article seems to me to be that Sheldrake appears to postulate *unknown* forces. The etheric formative forces, on the other hand, are *known* to us, in so far as we are continually concerned with them in our thinking, and in looking at the object which we call a plant we start from the plant Type which we experience in ourselves as concept or idea. In order to achieve certainty in this respect, a new relationship to thinking is required such as is provided in Rudolf Steiner's theory of knowledge. The forces become known to us in our thinking activity in connection with the external appearances — and in the same way the Type, as formative principle, acquires more and more content as we concern ourselves with the phenomena and with what follows from the phenomena. If we see this as the starting point of knowledge, the problems present themselves rather differently from usual, because conventional science does not enquire about knowledge of a Being but about the possibilities of manipulation. With respect to your *Question 1*, it would not be a matter of the testability of a theory but rather of an insight into relationships which are revealed to the investigator in the phenomena. For this purpose, the phenomena do not need to be new. It can easily be demonstrated that, for a real understanding of the phenomena, the concepts and mode of thought of genetics are not sufficient.

With regard to your *Question 2*, the practical value lies, in part, on a different level from that expected in conventional science. This will be shown in the next issue of *Elemente der Naturwissenschaft* (No. 39)*, taking the relationship between wild and cultivated plants as an example. An attempt is there made to follow the process by which plant-breeders concern themselves with pictures of the plant involving possible forms that have never yet been realized and towards which their work is directed. Knowledge of the abstract principles of genetics can only help to provide certain basic conditions. Strictly, it is not possible to bring to expression all the possible forms of a plant, and every form that arises is new, i.e. it is not identical with any other. The totality of the potential forms can only be grasped in pure thought. Nevertheless, for any actual plant, there are substantial limits to the possible forms and these limits can be altered by changing the conditions, and these include the genetic material.

Questions 3 and 4. Work is also being done on the further systematic elaboration of this approach. Essentially, it is primarily a question of a new theory of knowledge being developed by means of which a systematic presentation will become possible. When something truly new is discovered, he who wants to understand this new knowledge has to make a real effort. All one can do is to try to show the way.

* *For further details see page 21*

Books and Journals

Radiant Matter by G. Blattman and **Nuclear Energy** by M.Jones

(Floris Books, paperback)

In 1983 Floris Books published two books, by priests of the Christian Community, that are strongly anti-nuclear, anti-radiation and anti-National-Grid. While this development is partly to be expected these days, it still to me contrasts starkly with the personal approval, interest and encouragement I received from several leading figures in the Christian Community at the start of my career in nuclear power.

There is much to be criticised in *Radiant Matter*. To me, as a professional, it typifies the largely inconsistent and irrational bias of the strident anti-nuclear view steeped in disdain for the technical and large-scale industrial. The quotations are selected not to be representative but to support only the view of the author, who seeks to fight nuclear energy with fairy-tale images, a singularly puny form of weapon. Already, in the Introduction we find reference to only the doubters (of the right to use the atomic bomb) at Los Alamos, in the 1940's.

At the start of Chapter 1 it is stated that the Hiroshima nuclear explosions caused, or at least represented, a sudden breakthrough in human understanding of the ultimate nature of matter. Nuclear explosions were indeed an awesome novelty at that time, but from a Goethean scientific viewpoint are atoms and neutrons, etc., really the ultimate realities of nature? Why should even such a horrendous explosion enable man to perceive ultimate reality, in the sense that Steiner perceived and described? The atomic model had been shown to produce a most violent form of energy, but this does not actually prove its absolute correctness. The microscope has shown itself to be an invaluable aid in combating disease, for example, in this century, but Steiner is still justified in describing this instrument as a 'nulloscope', as he does in Lecture 10 of *Man as Symphony*. So let us not be dazzled by Ahriman into seeing nuclear energy as the final proof of the atomic theory, *as applied to matter in general*. Otherwise away with *Occult Science, Goethe the Scientist* and the rest of Steiner's scientific works!

Blattmann refers scornfully to the "race to find 'peaceful uses of atomic energy'". It is extremely hard to imagine how the forty years of painstaking development of nuclear reactor technology since the War can be described as a 'race'! And it is surely bias if not snobbery to continually equate 'maturity' with anti-nuclear prejudice as this author does.

The bulk of Chapter 1 is an elaboration of a somewhat arbitrary division of the Periodic Table of Elements into four double-Pages, the first side of the first double-Page being just a blank. (Alan Hall of Wynstones has suggested that this blank side could more realistically contain the word 'Energy', from which matter originally derived. Otherwise, what is the relevance of only one blank side, rather than two, or more?)

Then on Page 1, side 2, Blattmann places hydrogen and helium, characteristic of 'Primal Unity', according to him. But this is not true, even from a qualitative point of view, as hydrogen has two isotopes, deuterium and tritium, and helium has also more that one form, He_3 and He_4. Moreover, tritium is radioactive, a property Blattmann ascribes only to the nasty, decadent elements at the other end of the Table. And the same shortcoming applies, of course, to the several naturally-occurring radioactive elements to be found in the middle of the Table.

Blattmann's subdivision of the 'Pages' of elements into regular groups of increasing and then decreasing odd numbers, for instance 1,3,5,5,3,1 in the third Page (Periods 4 and 5), is perhaps a satisfying pattern, but chemically is quite arbitrary. Thus what is the common link, apart from the pattern, between those elements in the second group of five in, say, Period 4: arsenic, chromium, selenium, manganese, and bromine? Nonetheless, many of us agree that there are unsolved mysteries underlying the Periodic Table, in the realm of number, and number-ether principles, and Blattmann's scheme may prove to hold significance in our search to understand these principles.

Table 1, the Periodic Table of Elements, lists them all in order of their atomic weight, as is usual, but this is confusing, for Blattmann's description applies to a different order in the second half of the Table, Periods 4 to 7. These Periods each have two 'octaves' of elements, usually labelled A and B. Thus Period 4, for instance, contains elements nos. 19 (potassium) to 28 (nickel) in Group A, followed by nos. 29 (copper) to 36 (krypton) in Group B, as indeed Table 1 lists them. Blattmann's subgroupings (in this case 1,3,5,5,3,1) only make sense if the order of elements proceeds by taking the A and B elements *alternately*, in ascending from Chemical Group 1 to 8. Otherwise the Period 4 Group 8 triad, for example, iron, cobalt and nickel, would be split up between the two subgroups of 5. But why does he depart from the usual order in the first place?

Blattmann makes several very basic errors regarding the so-called rare earths, though I must admit that the subject is a pretty obscure one, except to a professional chemist. (I acknowledge help here from Howard Smith.) The rare earths are silvery and ductile, not 'earthy', and they are not in all respects merely copies of each

other: they have radically differing light emitting and neutron absorption properties for instance.

1945, the year of the Hiroshima bombings, is quoted as 'Year Zero of the New Age', a reference to a Rosselini film apparently. In some respects this is a true picture, as this year was a turning point in many ways. But from an anthroposophical viewpoint it is more significant to recognise it as Year sixty-six already, of the Michael Age. Put very briefly, the first thirty-three years of this Age, 1879-1912, produced the basic discoveries and inventions of atomic physics, mainly through the work of individuals. In the 1912-1945 period scientists, working much more as teams, showed the possibility of nuclear fission, with all its attendent problems. The harmful biological effects of radiation were already recognised by the year 1912.

The 1945-78 period has seen the nuclear arms race, the development of civil nuclear power, and the growing debate of all the nuclear issues. The following thirty-three year period will have to concentrate on the nuclear waste question, rather than shelving it. I am convinced that the harnessing of nuclear energy in this century will help us greatly in dealing with even more destructive physical forces to emerge in the twenty-first.

Blattmann's second chapter contrasts the dying earth and radioactivity, with the renewal of the earth and the ascent of human evolution, as if these were mutually exclusive. Does he not appreciate that the end product of radioactivity is stability, not cosmic death? Radioactivity itself dies, in time, but does not kill everything else off in the process.

Nor is it true that reactors are so badly built that radio-activity is released in significant quantities in normal operation. Nuclear power stations release less activity than coal stations, which emit traces of radium from the coal (not to mention sulphur dioxide). Is he suggesting maybe that all modern energy production is 'evil', and should be stopped as soon as possible? If so, are there enough candles to go round?

His final chapter on the Eucharist compares the four parts of the Sacrament with the four parts (Pages) of the Periodic Table, described earlier. This would offer much in bringing science and religion closer together (which as a member of the Christian Community I am concerned with), if there were not so many flaws and over-simplifications in his presentation on the Periodic Table. An unbiased reader will still need to be convinced that nuclear energy is utterly depraved and anti-evolutionary, and must be shunned at all costs, since not one of the benefits thereof is even mentioned.

Nuclear Energy, a Spiritual Perspective, on the other hand, is a lucid and widely-referenced book, containing twelve chapters, which speaks out with religious fervour against not only nuclear power, but also against atomic fission and modern energy-intensive technology as a whole. It describes some of the early discoveries and some current ideas in atomic physics, and relates them to wider issues. This is commendable, for any fruitful exchange between scientists and critics of nuclear power must begin along such lines. But in his final chapter he proceeds to damn nuclear fission as being wholly against evolution, and hence anti-Christian. I must ask, in turn, how can a natural phenomenon in itself be anti-Christian?

In general I found *Nuclear Energy* very readable, lively, well-informed, and accurate on the technical issues without being laborious. Most of the illustrations are clear and helpful, though the 3 diagrams of the main types of nuclear reactor, in the fourth chapter, are almost unlabelled, and hence assume much familiarity with reactor components. In the fifth chapter on Capra and the dance of life, Michael Jones quotes a most remarkable passage by the Polish poet Slowacki (1809-49), describing his memories of his own personal participation in the creation of the world. Slowacki portrays how plant life began to appear as a result of the Lord striking and breaking up the rock with lightning, life thus arising from "the first death".

The sixth chapter, on elements and ethers, is especially clear and concise, outlining the ethers' origins in the three former planetary evolutions, as described in much detail in *Occult Science*. Jones justifies his several quotations from Steiner, I am glad to say, by referring to various contemporary ideas in science that are compatible to some extent with Steiner's descriptions. I concur with the conclusions in Chapter 6, distinguishing nuclear energy from the Third Subnatural Force, although they do have some common aspects. My own view is that the Third Force is concerned not so much with death as with a perverted form of resurrection.

We should be grateful to Michael Jones for tracing the specific origin of the heaviest radioactive elements, at least, to one particular stage in the earth's development (see Chapter 8). To my knowledge this is the first time that this has been done. He presents in Chapter 11 a striking image of the atomic model as an inversion of the solar system: the electrons (Sun) dancing round the dense nucleus (Moon). Of course the standard interpretation of the Solar System, by contrast, ascribes the opposite qualities to the massive Sun and the tiny Moon.

But Jones concludes that nuclear fission and nuclear power are totally bad, with no benefits to society: evil in the full moral, religious sense. As a professional in this field I find that such an extreme interpretation goes quite against life experience. Assisting in the fuelling of a nuclear power station, for example, standing on top of it in fact, did I once feel surrounded by great forces of ghastly evil, and working with people having a cold, ruthless lust for power? Categorically, No.

As St. Mark's Gospel, VII, 15 says; nothing outside of man (Nature) defiles him: what lies within him, his evil motivations, defile him. Life teaches me that man is not so puny, or so depraved by materialism, as to be incapable of handling radioactivity and nuclear energy responsibly.

Robert Kersey Green

Elemente der Naturwissenschaft No.39 (1983)

This issue is devoted to practical and theoretical aspects of the new approach to heredity that Jochen Bockemühl has been developing for several years. The field of study considered is that of the comparison between wild and cultivated plants of the same, or similar, species.

In the first article, Dr. Bockemühl develops a re-orientation of our understanding of nutritional plants: plant and man together form part of a living whole. In the breeding of cultivated plants there are always two aspects: the goals towards which one strives and the methods that are used. The goal may be, for example, to enhance the growth of certain organs of the plant or to emphasise qualities which appeal to the aesthetic sense of the buyer.

Types of plants with the desired qualities are brought together through pollination or other forms of crossing. One-sidedly cultivated variants may be crossed, with the object of increasing still further their special characteristics. The cultivator takes the mechanism of the gene and directs his experiments according to its laws. The individual qualities are observed objectively, and combined as if the resulting variety sprang from such a combination of qualities. These methods are very successful — but are they in accord with the true nature of the plant? Some of the results suggest that too little notice is being taken of the plant, and its life-relationships, as a totality: breeding may result in a lowering of resistance or accelerated deterioration of the seed. The question arises, is the attitude of the breeder right not only for the plant but also for man, who needs plants for the building up of his organs as well as for the development of his faculties? Active powers work from the consciousness of the breeder into the development of cultivated plants. An important aspect of breeding research should be the striving for a lively understanding of the cultivated plant, its relationship to the plant-world in general and its relationship to man.

There are wild forms of plants, living today, which are similar to those of ancient times. By comparing these with cultivated plants, it is possible to discern how the goals of human beings have become embodied in the cultivated plants.

Three steps in the study of the relationship between wild and cultivated plants are described below.

1. Make exact observations of individual cultivated forms and of wild varieties that are nearest to them. Observe as many qualities and characteristics as possible: consider plants in their natural state and surroundings; note spatial relationships and the time-sequences of developmental stages. From these observations, develop a lively picture of each individual plant and its relationship to the species. By observing growth under different conditions of light, soil, time-of-year, form a picture of those qualities that are capable of change, under specific conditions, and of other qualities that are relatively fixed.
2. Practice and develop imaginative observation so as to bring out the element of *movement*. This embraces a living appreciation of the creative possibilities for change inherent in the plant Type (or the organizing agency of an individual plant). We are here concerned not so much with single observations as with a mobile form of perception which combines the results of many observations, and out of which *possibilities* may arise of themselves.
3. The third step consists in developing a sensitive awareness of the 'being' of each particular nutritional plant and of the way it is able to affect man. This involves, at first, a subjective element, but if the first two steps have been thoroughly grasped it can become a reliable guide in the investigation of nutritional plants.

As a practical example, Dr. Bockemühl then examines different aspects of the wild and cultivated forms of the chickory plant.

The next three articles are reports of experimental studies carried out by students, at the Goetheanum, following the lines indicated by Dr. Bockemühl. The first compares wild and cultivated forms of lettuce. The second examines the growth and development of different varieties of wheat and barley in order to discern the principles involved in the process of breeding. The third investigates wild and cultivated forms of oats. All the articles are illustrated with drawings and diagrams.

In the final article, Dr. Bockemühl describes the fundamental developmental stages of the higher plants. Four stages from seed to flower are designated, 1) Initial impulse, 2) Sketch, 3) Extension into the environment and 4) Fully-developed form. The fifth phase, fruit/seed, is described as 'individualising, dissolving of form'. The sixth phase embodies the concepts of rhythm and evolution. A life-cycle from seed to seed has been completed and connections with wider rhythms can be studied: there are also connections with the process of evolution in other organisms and in the planet as a whole.

Hedley Gange

On Leaf and Bud

Graham Calderwood

All that is antecedent to this report will be found in Lawrence Edwards' excellent book, *The Field of Form*[1], to which references are made in the text.

For some time now my concern has been chiefly with the 'simple leaf', and with its relationship to the bud. The outcome of the work with the leaf has suggested certain possibilities in respect of buds, particularly those buds which depart slightly from the 'ideal' path form, and which are therefore so interesting!

At our 'level' we may see the bud form as a path surface in the semi-imaginary invariant tetrahedron [1, chap. 4], which, with its measures, may be treated as a co-ordinate system in its own right *(fig.1)*. A point *P* in this system will be represented by three numbers, x_1, y_1 and ϕ, of which x_1 and y_1 are on a vertical plane, π, rotated about the axis of the bud by an angle ϕ radians from some reference plane, π_0. Considering the plane π on its own, we have an invariant triangle, *XYZ*, with vertex *Z* at infinity. There is a geometric scale in *XZ*, another in *YZ*, and a growth measure [1, chap.3] in *XY*. Any two scales will serve for our purpose, and I have concentrated on the geometric ones. For either we may write an equation like

$$a = Ae^{kt}$$

in which *A* and *k* are constants, and for the simplest instance we put both equal to unity. Then the two scales may be written as

$$a = e^{x_1}, \text{ and}$$
$$b = e^{y_1}$$

At the same time, we may set the triangle into a plane cartesian co-ordinate system *(fig.2)*, so that *P* may be described by two further co-ordinates, x_0 and y_0, and then we may convert x_0 and y_0 to x_1 and y_1, using similar triangles, by the equations,

$$x_1 = \log_e^{x_0/y_0}, \text{ and}$$
$$y_1 = \log_e^{x_0/1-y_0}$$

Now, measuring the form in terms of x_0 and y_0 is rather judging it from our point of view, is it not? It is the way to which we are accustomed. But were we to plot the quantities x_1 and y_1 on a cartesian graph, would not this be seeing the form from the bud's point of view? That is what I call it — the 'bud's eye view'! I also speak of 'levels'; in this connection: x_0 and y_0 are at zero or 'null' level, and x_1 and y_1 at the first level. Clearly, we can have any number of levels, and what is more, we can have path curves at any of them! Much of my work has been based on this notion: could a form, such as a leaf, which does not leap to the eye as a path curve, nevertheless be one at another level?

We can find a formalism to let us pass from level to level, and when

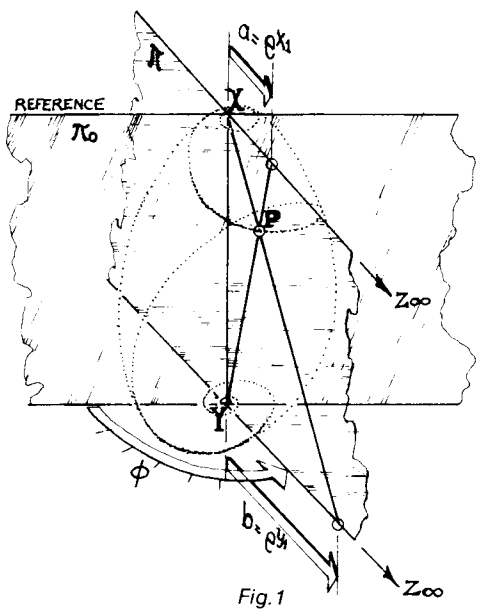


Fig.1

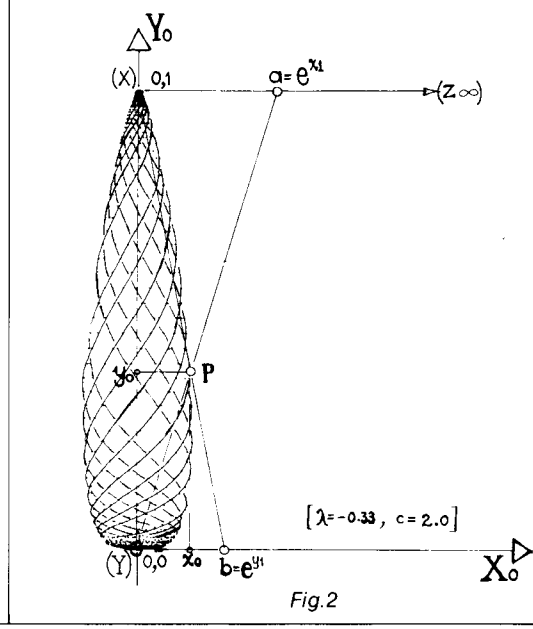


Fig.2

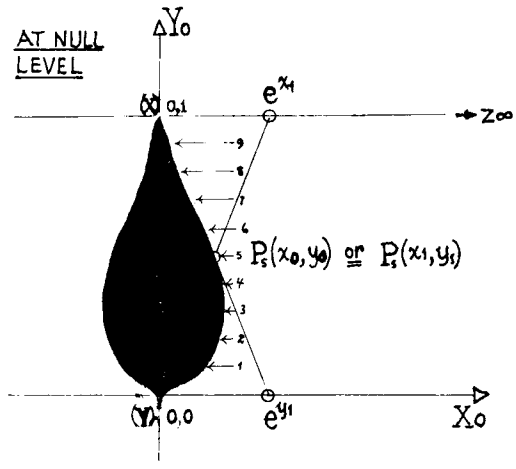


Fig.3a

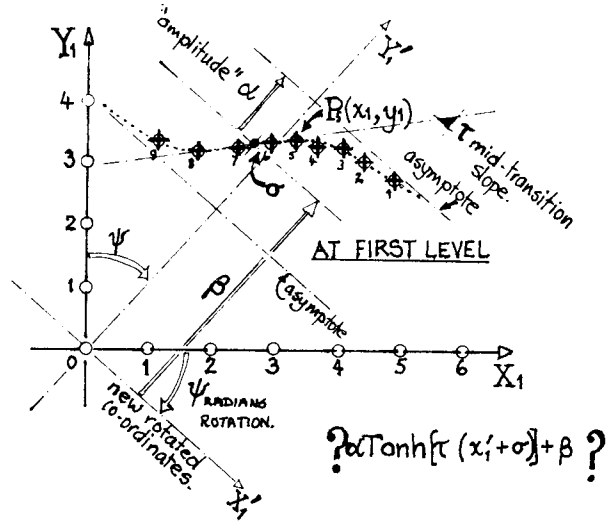


Fig.3b

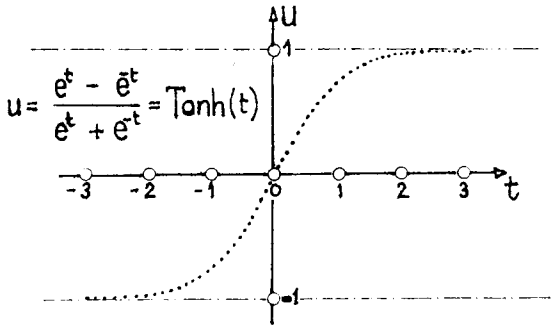


Fig.4

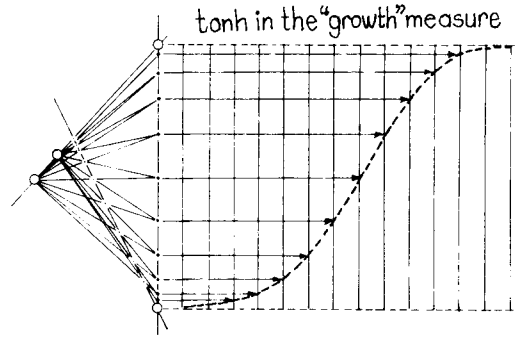


Fig.5

this is done for the bud itself, from null to the first, it becomes a straight line, or, more generally, a flat plane of infinite extent. Similar simplification is to be found when other forms are treated. Note that the bud meets this remarkable specification physically!

The 'ideal' bud-profile equation at first level is linear:

$$y_1 = \lambda x_1 + c$$

λ has exactly the same meaning and value as it has in Mr. Edwards' book, although he arrives at it by a different route. It is the 'form factor'. Its value specifies the form the path curve has at null level. On the other hand, c determines which one, of the infinity of curves of that shape, one has.

What is the bud's eye view of the leaf? I did the obvious thing: I put the leaf where the bud had been, with tip at X in the triangle, and the base at Y. I obtained a set of points $P(x_0,y_0)$ from the leaf, converted them to $P(x_1,y_1)$, and plotted them on a plane graph *(figs. 3a, 3b)*. And at once I thought the 'curve' I got might be a version of the function 'Tanh', the hyperbolic tangent *(fig. 4)*. I also thought, mistakenly, that it was the path curve I hoped to see!

It had to be checked. This is not the place to describe my crashing about in the unfamiliar thickets of statistical analysis in the effort to discover how to do this! At last I came up with a linear regression technique which I still use. There are irreducibly five parameters to be adjusted for a match of model to reality. The curve seems rotated on the first level plot, and displaced from the origin: this takes three parameters. There is the placing and separation of the two asymptotes, essentially, the 'amplitude' of the function: a fourth parameter. There is the rate of transition between the asymptotes, maximum at mid-transition: that makes five parameters. This is an enormous freedom! Linear regression reduces the number to be directly trimmed to three, since it supplies the other two, but even three is a great plenty! In the end I gave the job to a computer.

It pursued those small adjustments to the parameters which improved the match as judged by the correlation co-efficient, R, obtained from the regression process, until R was as close to the perfect-fit value of 1 as could be got.

The match was extraordinary! Co-efficients of 0.9999 were common, and they very rarely fell below 0.998. The model matched all kinds of real leaf to small fractions of a millimetre. It seemed too good to be true.

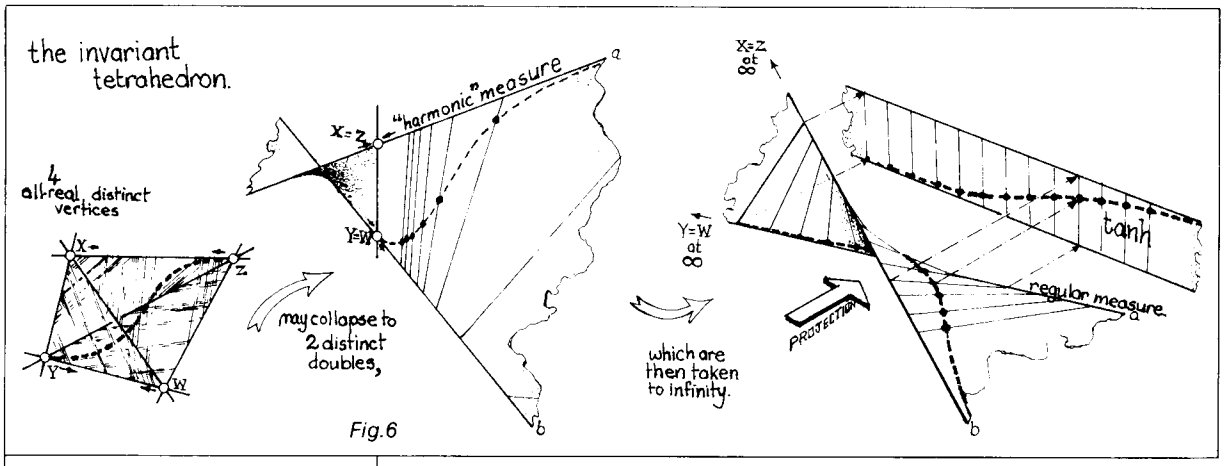


Fig.6

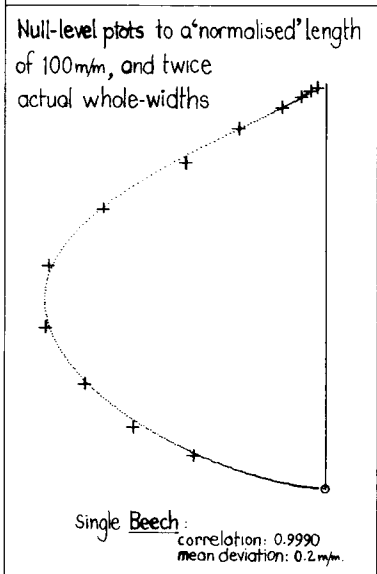


Fig.7

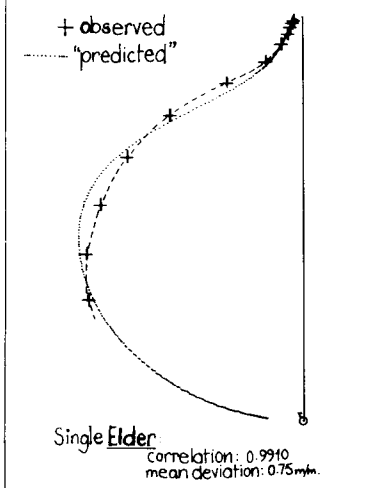


Fig.8

How flexible was the model? Would it fit anything remotely leaf-like? After all, the freedoms were large. I asked the computer to estimate, by direct trial on some ten thousand random forms generated by it, the probability that a match as good as those obtained for the real leaves would occur by chance. Reassuringly, it turned out to be less than 0.01%. The model was not so flexible after all, and this seemed to say that the probability that the model *will* match the real leaf is better than 99.99%. Not bad odds.

Now Tanh is interesting. It is the function which, from a metric point of view, 'controls' the growth measure *(fig. 5)*. It is also available as a *projection* of a path curve in a special, degenerate version of the invariant tetrahedron *(fig. 6)*. It is not a path curve itself, but it has very much to do with path curves. It seemed a very 'right' thing for the leaf to be. Yet, as more and more leaves came under scrutiny, it became clear that several leaves diverged slightly from it *(fig. 7)*, and a few diverged quite a lot *(fig. 8)*. The model is not as universal as I had been led to believe by the early results. Is it then completely wrong in principle, and a good approximation only by luck?

I have no satisfactory answer to this question. I can only say that none of the several other models I have tried has come as close to the reality as Tanh, though one, suggested by Ron Jarman, came almost as close. It lost the race only after an exhaustive statistical comparison, and, who knows? It, or another like it, may win the next round! So Tanh leads by a nose, and it is the best I have for the moment.

Help is most likely to come from theoretical considerations, I believe, since empiricism has well defined limits (*vid.* Karl Popper!), but one further piece of observation has shed some light on the position. In the study of the deviant bud, it is of interest to know how *lambda*, the shape factor, varies from point to point on the profile. Mr. Edwards has given it the apt name 'Morphographic Lambda' (M.L.), and indeed one does obtain from it detailed information about form from a path point of view. In my version, it is essentially the differential of the first level curve that is found, and I had a programme on hand to work this out, which I applied to the leaf. It at once revealed how simple Tanh fails in some cases: The asymptotes to which the curve runs are in these cases significantly non-parallel, though they still exist.

The M.L. chart of the ideal leaf is compared in *Fig. 9* with those of a Beech, which fits well to Tanh, and an Elder, which does not. The differentials of the Elder's asymptotes are distinctly different.

I have said that Tanh is available as a projection of a path curve in a special tetrahedron. It is not the only possible projection. Curves very similar to the kind obtained from what I will call 'deviant' leaves, those with non-parallel asymptotes, can be had if the point of projection is shifted. And in my studies of 're-entrant' leaves, those which have lobes at the base and give the

appearance of entering themselves there, I find this type of curve consistently, so far as I can tell. For re-entrant sorts I use asymmetrical or degenerate invariant triangles, and have never obtained a simple Tanh form. I now suspect that there is no difference in principle between the simple leaf and the re-entrant kind, and that that principle remains essentially Tanh, but I am as yet unable satisfactorily to measure the confidence these ideas deserve. The difficulties are greater, but I am working on it. Such checks as I have managed are encouraging but not conclusive. If there is anything in it, then perhaps I can resurrect my theory of path curves at more than one level.

This brings me to the final topic on which I wish to report just now. The path curve of which Tanh is a projection runs on a special sort of surface in its tetrahedron. I call it, perhaps loosely, a twisted surface. It is to be had from a line moving skew to itself in such a way that it is guided by measures in two lines, themselves skew. Provided that the measures have the same cross-ratio [1, chap. 3] (they do!), a third line can be found which will touch all those which make up the surface, and the surface will cut a general plane of space in a hyperbola. I have the distinct impression from all my observations of emerging leaves that there are twisted surfaces in them, and I am much engaged in studies with this in mind. But the possibility has suggested something very interesting about the deviant bud.

If the flower bud in particular is made up of petals which are in some ways leaf-like (many that I have measured are, in the sense that they conform quite well to Tanh—whatever this is now worth!), and if they have something of the character of a twisted surface at first level, then they may be expected to cut the plane which goes vertically down the bud axis in a hyperbola, at least approximately. In the closed bud, they are often wrapped closely on each other, and so we might expect the *petal-group* to do this. In a sense, the profile of the bud is like the horizon, and the plane I speak of similar to the 'sheet of sky' that descends to touch it, and the question is whether this horizon is a hyperbola at first level.

Part of the answer may be had from the M.L. chart. The M.L. for a shallow, canted hyperbola is depicted in *fig. 10* along with first level curves and the M.L.s for a Wild Rose and a Snowdrop, those buds which Mr. Edwards has identified as the leaders of two groups of deviants with polar features [1, chap. 7]. I think the M.L.s show this polarity very well indeed, and they compare very closely with the M.L. from the hyperbola. Could it be that the Snowdrop group tends to 'use' one 'limb' of the hyperbola, while the Rose-group tends to use the other? Could it further be that the little λ-climax that Mr. Edwards has detected in many buds [1, chap. 7] is a process of twisting towards opening in the petals? Could this be the geometric concommitant of the quality of 'Tension' described by Mr. Edwards? After all, is not twisting a common response to pain? Can all this show a unity between the form of the leaf and of the bud? Will it bring the 'normal' and 'deviant' bud under a single theoretical heading? Only a great deal of further study is likely to answer questions like these.

I have other irons in the fire! Some of these are of a 'technical' nature, having to do with the development of suitable apparatus, such as a fast scanner, with which to acquire the vast amounts of observational data these studies require in a reasonably brief and efficient fashion. Others are more fundamental, and some are the same as those done by Mr. Edwards. A report on these must be left to another time.

I would like to express my real gratitude for the help I have received from the trustees of the Margaret Wilkinson Trust, whose most generous support has made it possible to take the research on topics reported here, and on some others, forward faster and more effectively than I could have hoped otherwise, and made much of it possible which would have been impossible. I am grateful too for the help that others have given, through their interest and most valuable suggestions. My thanks to *Science Forum* for thinking publication of this report worth-while! I hope to supply further bulletins in the future.

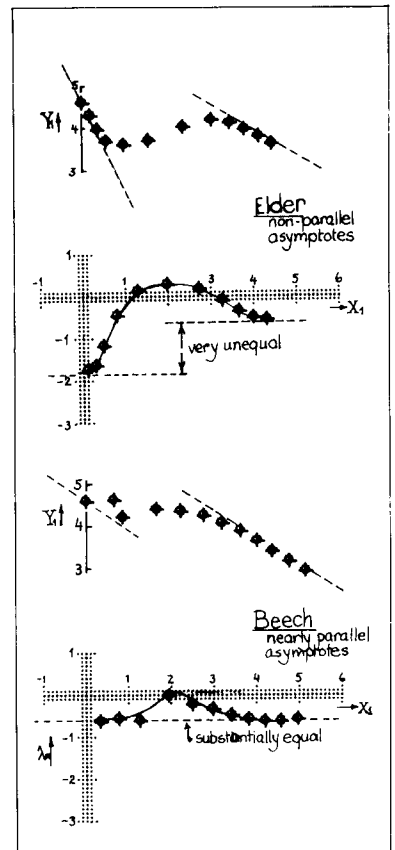


Fig.9

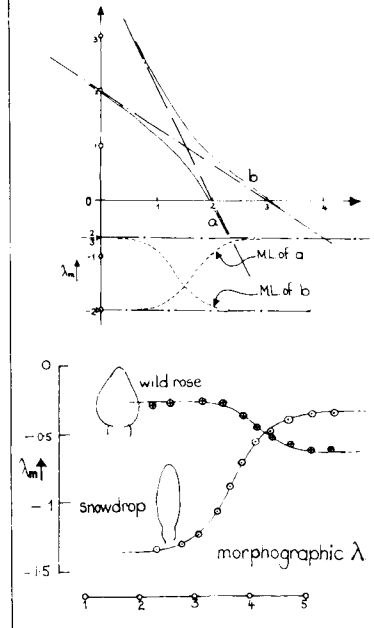


Fig.10

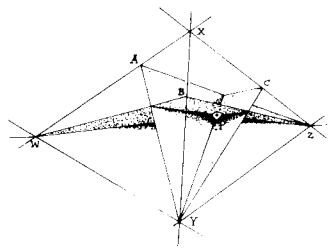


Fig. 1

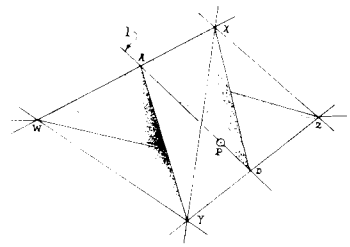


Fig. 2

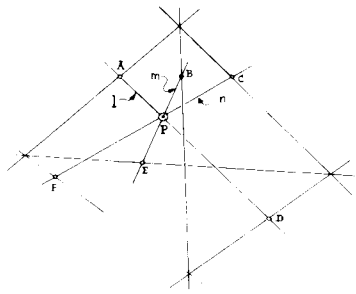


Fig. 3

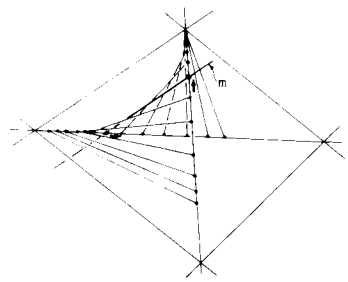


Fig. 4

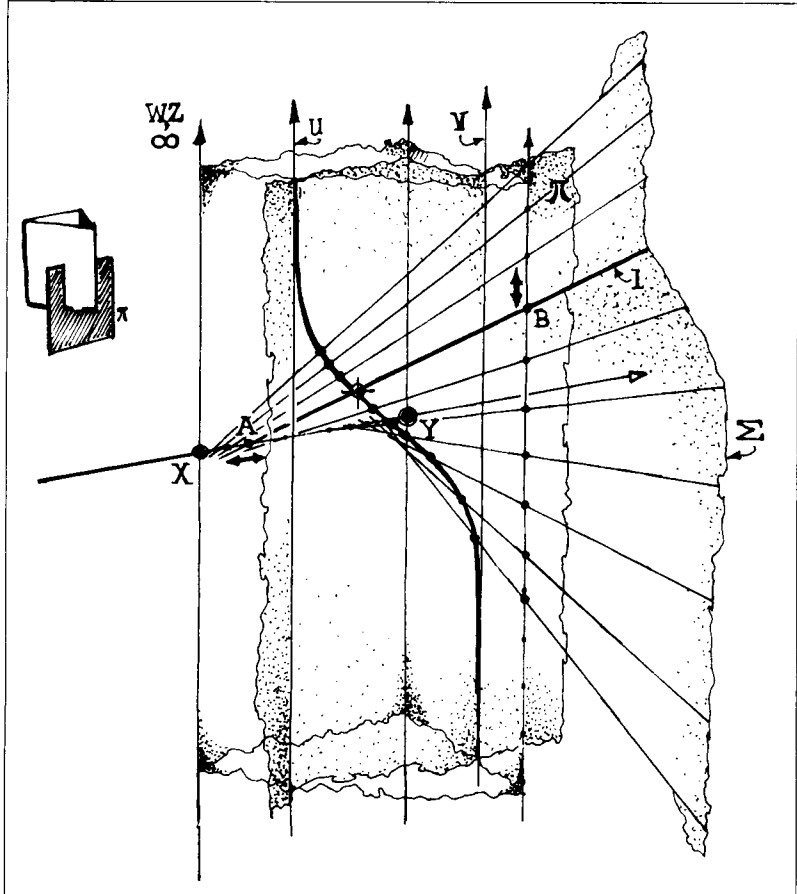


Fig.5

ADDENDUM

Since writing this report, I have worked a little further on the question of 'twisted' surfaces.

I was to rediscover something which I had noted a very long time ago, and had forgotten! It is the fact that the points moving in the sides of the invariant tetrahedron as the transformation runs its course are related by lines which all pass through the 'path point', that point whose history we trace as it moves in its path curve.

Doing things in the usual way *(fig. 1)*, we find that we can locate the path point *P* as the intersection of three moving planes, each guided by a point (*A*, *B* or *C*) moving in its measure, and each rotating in one of the sides of the tetrahedron. This is sufficient, but there are in fact six such planes ('internally'), one for each of the moving points in the six sides, and any two of the planes must have a line in common.

If we focus attention on a pair of planes rotating in sides which are *skew to each other*, we see *(fig.2)* that we have a line *l* joining the moving points (*A* and *D* in the figure) also belonging to these skew sides, and that *l* must pass through *P*, the path point.

There are three pairs of skew sides, so there are ('internally') three such lines (*l*, *m* and *n*) all passing through P, and each joining a pair of points moving in a pair of skew sides *(fig. 3)*.

The interesting feature is that any one of these lines sweeps out a twisted surface *(fig. 4)*, identical in every respect to the twisted surface mentioned in the report, save one: the measures in the 'guiding' lines will not usually have equal cross-ratios or characteristic numbers ('multipliers' in Mr. Edwards' term), so the surface will not in general be one on which all the generating skew lines may be touched by transverse straight lines other than the guiding lines themselves. However, this new surface is more general. The 'old' surface is a special case of this surface.

The old surface cuts a general plane of space in a hyperbola, and the speculations to which this led me are in the report, but the new cuts a general plane in a curve *which is some variation on the theme of 'Tanh.'* And so we find that both Tanh and the hyperbola belong to a family of curves relating to twisted

surfaces, and that all of these surfaces may bear whole families of path curves. Others may have known this before me, but it was intriguingly fresh to me!

At this point I began to wonder what 'properly' constitutes a path *Surface*, as opposed to a path curve. Does *any* surface which bears an infinite family of path curves qualify? I don't really know, but the emphasis on 'infinite' I think is proper. It means that no point on the surface may evade being a member-point of at least one of the curves. If this is sufficient, then the twisted surfaces are all path surfaces. and if they are, then here was just the surface I wanted for my leaves!

In the hope of making things a little clearer, *fig. 5* shows a tetrahedron in which a pair of vertices on the same side are placed together at infinity, while the vertices of the other pair are local and distinct. It is a structure like a very long greenhouse roof, here set on end! *A* and *B* are points moving in their measures in side *XY*, here called *a*, and in side *WZ*, here called *b*. A line *l* joins *A* and *B*, and somewhere on it lies the path point *P* (not drawn in). A plane π is set (like a mezzanine attic floor!) to lie parallel to side *b* and 'between' *a* and *b* in the accustomed sense of the word. For convenience, π is also parallel to *a*.

Now, point *A* moves in growth measure in *a*, perhaps from *X* to *Y*, while *B* moves in equal step measure in *b*, and in consequence *l* sweeps out a twisted surface, Σ. This surface cuts the plane π in a curve which is *precisely* Tanh. The curve is asymptotic to the lines *u* and *v*, which are lines in π where it cuts planes of the tetrahedron.

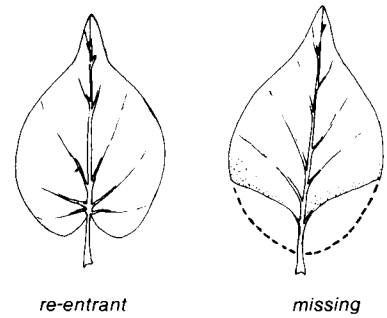
This is very nice, but nicer things can happen: π need not be parallel to either *a* or *b*, and the vertices of the tetrahedron can be anywhere we wish them to be. Whatever is done, either *a* or *b*, and the vertices of the tetrahedron can be anywhere we wish them to be. Whatever is done, the surface Σ will (almost) always cut π in a curve of the Tanh type, though it will of course not usually *be* Tanh in the strict letter of law, so to say. It could be Tanh in perspective, for instance, or, as has been said, when the cross ratios of the guiding measures are equal, a hyperbola. At any rate, it is a very general thing.

When we come to look upon a leaf enclosed in its bud just prior to opening, we often find 'ribs' diverging from a 'spine' at intervals strongly reminiscent of a growth measure, but perhaps not quite exactly such. Very often, the ribs cross the leaf blade to its extremity, and would go on, one supposes, were they not intercepted by another form, perhaps the 'back' of another leaf in the cluster. In nearly every instance, this other form is egg or bud-like, and is probably a good path surface. Already to be seen at the edge is the flex which will give the open leaf its characteristic profile.

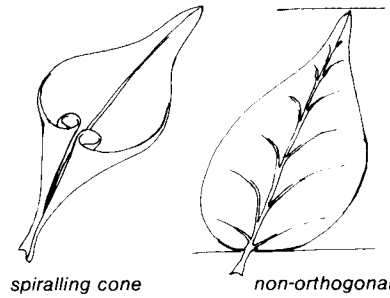
Let the ribs be modelled by a regular selection of lines *l* in Σ, all raised to first level; let the line *b* model the spine, also at level 1, and let π model the egg-like surface which will finally arrest the 'flight' of the ribs into bud space. Now note the freedoms we have in specifying tetrahedron and plane, and their orientations in bud space.

Could it be that in the enormous array of possible intersections and ribbings we will find just those that a particular real leaf uses? It seems to me to be a distinct possibility that we can. This model can in principle also cope with leaves which have presented problems — those with non-parallel asymptotes, or re-entrant sorts, for example. Some leaves, such as Nettle, have a 'spiralling cone' gesture in their opening. Others are 'incomplete' in the sense that part of the profile appears to be 'missing', such as Elder, Mountain Ash, or Nettle again, and some are 'knocked skew-wiff', like Hazel. The latter retain a sort of symmetry, but it is not orthogonal. All such features are potentially modelable where none was under the older, simpler method. Finally, it may be that the new method can track the opening of a real leaf; certainly the model can be made to 'open'.

I have worked out the equations needed to describe these things, put them in my computer, and had it draw what one may expect under various choices of bud space, tetrahedron and plane π, and have seen some very likely-looking things emerge — one or two of them are reproduced here in 'simple perspective' — and I am much encouraged.



re-entrant *missing*



spiralling cone *non-orthogonal*

All the same, I have here only a pretty hypothesis. I would be delighted to say that I knew how to test it! But I cannot. Not yet.

There are formidable problems with data collection, and with devising suitable model-matching algorithms for the computer. We encounter an embarrassment of riches! The very generality of the model leads to the need to choose, if not arbitrarily, then from very wide ranges, values of many parameters. At the moment, I am working on 'semi-interactive' programmes for the machine, which throw pictures on a screen of model and real leaf. I twiddle parameters by hand until a reasonable match is found of one to the other, and then leave the computer to close-trim from there. This is still the fastest way of managing it, I think, since the machine, in spite of its enormous speed and 'custom machine code' avoiding the circumocutions of high languages (this for the computer enthusiasts), is too stupid, or — let's be fair — too stupidly programmed, to omit redundant operations; it must nearly always *do* them to *know* they are redundant, and this takes time. Human beings do have some advantages!

I hope to report results, if any, in these pages when they come to hand.

Reference:

[1] *The Field of Form*, Lawrence Edwards, Floris Books, 1982.

Form out of Flowing Movement — 1 Practical Experiments.

Philip Kilner

Practical experiments revealing formative movements in water (or in other fluids) need not be difficult to set up; the formations and transformations that arise can be both fascinating and beautiful. Forms that may remind us of living organisms develop before our eyes, and as we watch them we may inwardly follow their unfolding movements.

Most of us, as children, have delighted in playing with water; as adults, with our inquisitiveness consciously sharpened, it can be just as fascinating to study and observe water. And I feel that to do this can be of great value, especially for those of us who have been through a scientific education. Observation of movements in water can help develop in us a controlled fluidity of thought, a sense for the delicately unfolding interplay of influences and responses as they are revealed in the sliding, changing forms of a fluid. A quality and discipline of thought corresponding to the element water (just as the disciplines that involve exact measurement, statistical analysis and distinct conceptualisation correspond to the element earth) must be a prerequisite of a science of life.

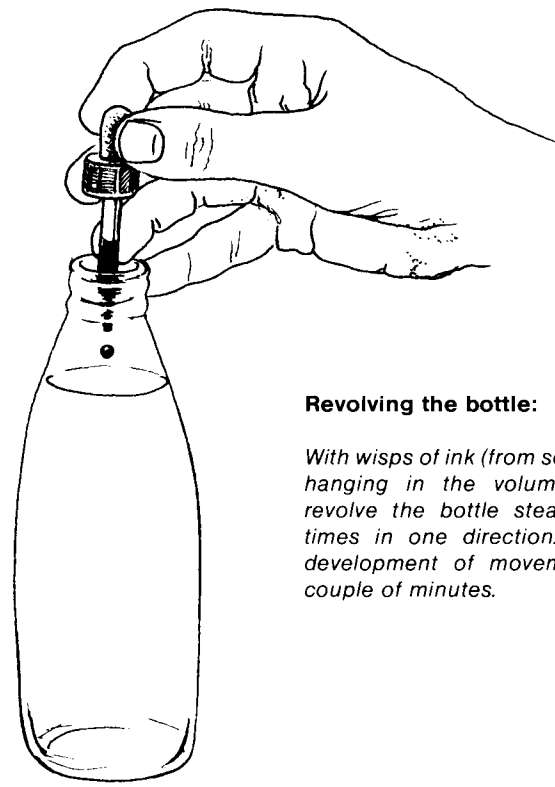
Living forms do in fact arise out of flowing movement, so perhaps it is not surprising that the purely 'fluid' forms often resemble organic forms. Such resemblances, however, raise some important and challenging questions. For consideration of these it will not be sufficient to compare photographs of forms, which can only be two-dimensional representations of particular stages in the respective formative processes. Through watching the actual development and movement of, for example, a vortex in water, we can develop a sense for the dynamic involved, and so begin to consider the question: how does this compare temporally as well as spatially with, say, the unfolding frond of a fern or with the spiral growth of a snail shell? There remains, of course, the more difficult question of how the ethers and the astral influences may relate to these and to other flowing and growing forms.

I would like to illustrate some examples of fluid and organic forms in a future article, and attempt to discuss some of the questions arising. This will certainly be more worthwhile if readers have already made their own experimental observations, and have considered for themselves some of the riddles they present.

So let us begin with something simple and delightful:

Ink drop in a bottle of water:

A single drop of ink (or of a 1:2 dilution of ink in water) is allowed to fall from the tip of a dropper (or a fountain pen) held steadily 2cm above the surface of still, cold water.
Watch...
What happens?
Variations may be tried: — alter height of dropper — try dropping different fluids (milk, water colour, etc.) — try drops into freezing cold and boiling hot water — try into water that hasn't yet settled. How long does it actually take for the water in a bottle to become still? And how long in a large storage jar or fish tank?



Revolving the bottle:

With wisps of ink (from several drops) hanging in the volume of water, revolve the bottle steadily, several times in one direction. Watch the development of movement over a couple of minutes.

Vortex in a stirred glass:

Firstly: simply observe water as it is stirred in a glass (preferably one with cylindrical sides and a flat bottom, but by all means try different shapes and sizes).

The form of the surface, the movement of any air bubbles and the changes with time, during and after stirring, should be carefully observed.

And then try the same with various additives:

1) with a small amount of sand or fine gravel. (A riddle presents itself here.)

2) with millet seeds or rice grains... or with grains of sugar.

3) with grains of potassium permanganate (easily obtained from a chemist — but keep them off your hands as they stain).

4) with a suspension of metal dust — e.g. from 'silver' ink or paint. This substance is particularly revealing in studies of water movements; it will be further discussed later.

5) in a large storage jar, try stirring with an egg immersed in the water.

How do these different additives move and position themselves?

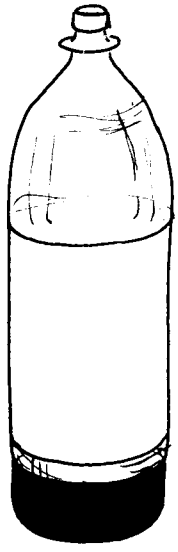
Do they reveal the water's movements?

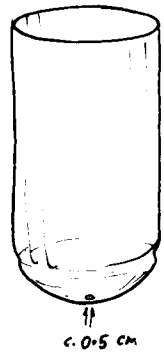
Is it possible to imagine the various movements through the whole volume of water?

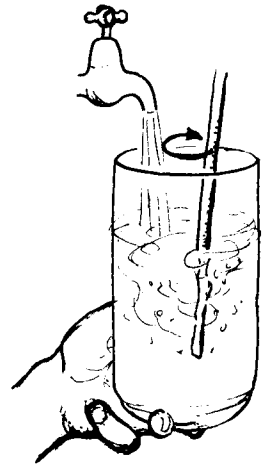
Which parts of the water revolve fastest?

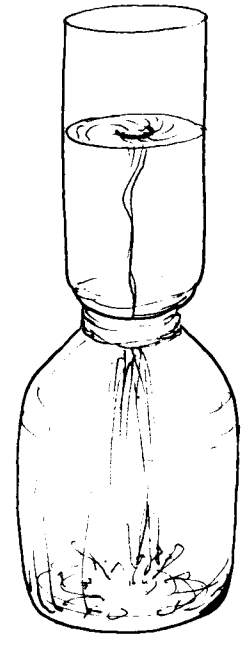
How do the movements change and come to rest after stirring has ceased?

(It is helpful to try to make sketches and to devise further experiments as questions present themselves).









Vortex funnel:

Preparing a clear cylinder with drainage hole:

Use one of those new clear-plastic two-litre fizzy-drink bottles. Remove the label, remove the black plastic base, cut off the top of the bottle and then drill or melt a 0.5cm hole in the centre of the bottom.

With a finger over the hole, fill the cylinder, give the water a good stir, and then place on top of a large storage jar (or on another two-litre bottle with its top cut off) to watch the vortex funnel that forms down the centre of the cylinder.

After repeating this a few times (the water just has to be tipped back into the funnel and re-stirred), variations may be tried:

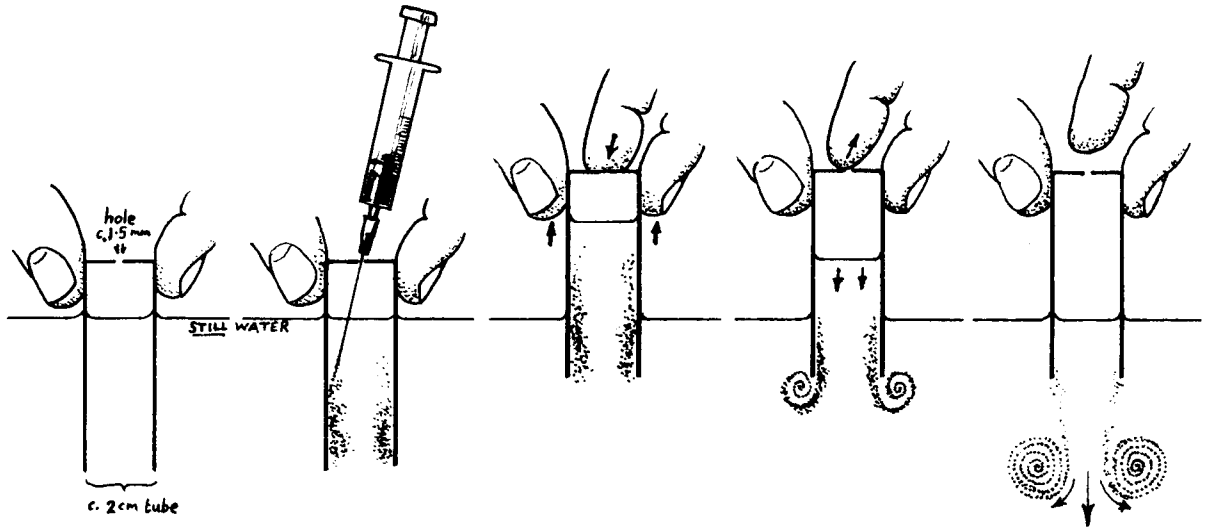
— try stirring other way

— try not stirring at all. Can you tell whether you are in the northern or southern hemisphere with this apparatus?

— try dropping some ink into the vortex, then beside the vortex.

— try dropping in millet seeds. How do they move around the vortex? Where does the water appear to move fastest? Why?

— you may wish to experiment with different sized drainage holes: plasticine may be used to narrow down a larger hole.



Ring vortex

Here the aim is to make the watery equivalent of a smoke ring. (In passing, it is worth noting that formative movements in air, water, and also in more viscous fluids, show many shared characteristics). The essence of the method is to allow a cylinder of coloured fluid to move steadily into a larger volume of still fluid. There are various methods that can be devised to achieve this. Described here is one that I have found to be very convenient and adaptable, but it does require a steady hand, and does not allow exact experimental repeatability.

Procedure: *Fill a large, clear-sided container with water, and allow to stand. A three litre sweet jar is suitable, a fish tank is even better, but will need to stand for longer before its water comes to rest.*

Take a plastic tube, about 2cm in diameter, and make a 1.5mm hole through its closed end. I have found either a 20ml medical specimen tube or the barrel of a 20ml syringe to be suitable for this. The latter needs to have its flanges trimmed, but already has a satisfactory hole through its nozzle. Now. . .

- *— carefully lower the open end of the tube through the surface of the still water.*
- *— holding the tube quite still, introduce ink through the hole, aiming to colour water around the opening of the tube. For this a 2ml syringe with a green needle is ideal, but a dropper may suffice.*
- *— with a finger closing the hole, raise a column of water in the tube.*
- *— finally, keeping the tube absolutely steady, allow the column to descend by carefully raising the finger*

With practice the finger tip can control the rate of descent, as will the size of hole drilled. A ring vortex should be seen forming below the tube, rolling layers of water into itself as it descends. The moment of its meeting with the horizontal plane of the bottom is worth watching, and watch how this varies according to the speed of descent.

Variations:

- *— a slowly descending ring vortex may be followed by a more rapidly descending one (it is not necessary to add fresh colour), so that the second passes down through the centre of the first — a remarkable sight!*
- *— with wisps of ink hanging in the volume of water, allow a ghostly, colourless ring vortex to descend, easing aside or incorporating colour as it passes.*
- *— aim the tube towards the side of the container so that a ring vortex meets the glass surface obliquely. This can lead to transformations which have a remarkably organic look about them.*

Most of the experiments so far have used ink to make certain parts of a volume of water visible, and in general we have had to protect the water in a motionless vessel in order to avoid disturbance of the particular movements under observation. The experiments may have allowed glimpses of the kind of formative movement that arises in fluids. Whenever a fluid is induced to move, its internal movement, although generally invisible, will tend to be both formed and forming; one can imagine flexible surfaces or contours, each distinguished by its particular velocity of flow, and each continuing with a certain momentum as it slides over and around, interacting with adjoining layers throughout the volume of fluid. Streams and vortices tend to slip and curl through the whole volume, but usually nothing is to be seen of these, except, perhaps, a certain troubling or dimpling of the surface. There is, however, a simple technique which reveals something of these movements, even when the complex dance of tight vortical movements which we call 'turbulence' would quickly disperse any marker fluid such as ink:

Observations using a suspension of metal dust in water:

Fine, dust-like filings of aluminium or brass, such as are used in 'silver' or 'gold' inks or paints, generally consist of tiny flakes of metal. The shearing movement of surfaces within a fluid will tend to align such flakes, and they will reflect or absorb light according to their orientation. Metallic water colour or ink dispersed in water will therefore reveal the forms of moving layers of fluid (at least, where they are close to the surface, or to the glass of the vessel).

The metal dust suspension may be:

- *— stirred in a glass, quickly or slowly, then allowed to come to rest.*
- *— shaken (vigorously) in a bottle. In the light of what may here be observed, it is interesting to reflect on the method of succussion as used in homoeopathic potentisation.*
- *— poured into a shallow dish or tray, allowed to come to rest (but not given time to sediment) and then observed as a finger or brush is drawn in a straight line through the fluid. This is a simple method of making a visible 'train of vortices'.*

Train of vortices:

A more elegant way of demonstrating the rhythmical formation of vortices in the wake of an object moved through a fluid uses lycopodium powder, to make visible the formed movements of the surface, and glycerine to make the fluid more viscous. The glycerine, which may be diluted with about an equal quantity of water, is poured into a dark coloured tray or trough. Various depths should be tried, particularly between 1 and 5cm. The powder is sprinkled in a straight line, the length of the trough, and then a paint brush or rod is drawn steadily through the fluid, along the line. It is interesting to note the effect of the glycerine; the increased viscosity slows and controls the fluid movement; the forms which arise, here made visible by the distribution of white powder against the dark background, slide smoothly to rest, with little mingling or dispersion. Variations of fluid depth and speed of movement, as well as viscosity, should be tried. The drawing of the brush may be repeated more than once. A variety of vortical forms and transformations may be achieved which, once again, can lead to interesting comparisons and questions in relation to certain organic forms.

In conclusion, I would like to emphasize that contemplation of these forms should include an attempt to recreate in thought the relevant formative process; this involves consideration of the third dimension (fluid movement through the full depth of the trough, in this last instance), and, most importantly, the *fourth* dimension — the unfolding of the process in *time*.

Note: My own explorations in this field owe much to stimulus and guidance given by John Wilkes, and, in turn, to the work of Theodor Schwenk. Excellent photographs of vortices, ring vortices and trains of vortices are given in Schwenk's book *Sensitive Chaos* (Rudolf Steiner Press, 1965).

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