Birch

The leaf buds of the Birch are small and rather irregularly shaped and for this reason are not easy to work with. I have done rather less with them than with some other species and the results are not always quite so consistent. Nevertheless what experience I have goes to suggest that they are well worth working with, and a great deal more research is needed here. Traditionally this tree is associated with the planet Venus, and experience seems to confirm this. The buds vary greatly in form on different parts of the tree. Near the periphery of the organism we find many thin stems, each with a single terminal bud and many lateral ones which growing very close to their stem. This means that these lateral buds have two aspects, what I call a broad aspect, and a narrow. They are illustrated to the right of this column, the broad, b, and the narrow, n. The broad has the appearance of being quite a good path curve form, the narrow not nearly as much. Unexpectedly if one takes the mean of the two aspects one comes usually on a good path curve form, with quite low MPDs. These peripheral buds are soft and quite malleable. As one moves inward along the stem one finds the buds increasingly growing away from their stem, until when one comes near to the main trunk they are completely upstanding. These latter buds have only the one kind of aspect, and they thus give the appearance of being better path curve forms, but strangely they do not usually have noticeably lower MPDs, and their "s" are usually quite close to those of the more peripheral buds. These inner buds are usually less numerous, and they give the impression of being gnarled, woody and old; one cannot easily imagine them being susceptible of delicate variation, but as with the Oak this may well be a false impression. I think one needs to work either with the one kind of bud, or the other. To take buds from some intermediate position along the stem would make absolute comparability very difficult to maintain.

An examination of the graphs, g1 onwards, I think reveals that there is a good deal of evidence shown for the rhythms here put forward. As usual the arrows show the alignments of Moon with the relevant planet. In this case Venus, adjusted to be in line with the current phase-shift as shared with all other species under observation at that time. It will be seen that out of 20 alignments all but the last, October 17th 1950, are clearly acknowledged by dips in the curve. The record however is not completely pure, being marred by a tendency to the presence of unwanted dips, i.e. at times when there was no alignment. Whether this is due to 'noise' in the curve, caused by the small irregular shape of the buds, or to the working of some other influence yet to be discovered, must wait to be seen until we have much more evidence.
Primrose

The Primrose is a species which yields very fruitfully for this kind of work. The buds are comparatively large and firm, and are easy to handle and measure. Each bud spends its early days completely encased in its surrounding green sepals, and only about half way in its development does the yellow of its petals begin to thrust into view at the tip of the bud. This stage is rapidly passed and it is not easy to find enough buds each day at exactly this stage. If one looks into the heart of a single plant round about the middle of the budding season it is usual to find several blossoms fully open, one or two that are well past the moment when the petals first thrust through, and some half dozen, or more, which are still fully hidden in their surrounding sepals. These latter will be at various stages, from those which are very small indeed, to those which are obviously just about to break through. I chose from each plant the biggest and most mature one of these, and I find that this policy gives good consistent results through the season.

The plants tend to appear in patches, in the woods, on the open hill-sides and along the hedges and, ideally you would pick all one's buds from the same patch, but practically this means this does not yield enough buds each day. One therefore has to work with several patches, taking, as far as possible, the same number of buds from each patch each day. Preparing the bud for measurement is, with some practice, quite easy. One inserts one prong of a pair of sharp forceps under the lower end of a sepal, and carefully peels it off, from below upwards, taking care that the petals are wholly undisturbed. One should be careful to place the bud on the glass measuring plate with only the lower, stem end touching the sticky tape, and the petals themselves projecting above the top edge of the strip of tape. If one is not careful about this, when the bud is lifted in order to turn it through 90° for re-measurement, the petals will tend to stick to the tape, and the form of the bud will be altered. At this point the bud appears as illustrated on the right of this column and unfortunately a certain element of human judgment has to enter the work. Where should one place the lower pole of the bud? One needs to develop a feeling for the form of the bud which can be applied consistently day by day. I have dotted into the drawing, how I would sketch the lower end of the bud. Whether this is the 'right' way or not is less important than that I should do it exactly the same way from day to day, and with a little practice this can be confidently achieved. The consistencies of the results which follow is evidence for the confidence which one can place in such judgement.

The Primrose belongs to that small group of plants which I called, in The Vortex of Life, deviant. Its buds are not really good path curves, being rather too wide at the tip compared to their form at the base. Their M.H.s usually range somewhere between 5% and 7%. This
does not mean that they are not strongly of a path curve general appearance, and one still has a firm feeling that the path curve is definitely at work here, although somewhat modified in the way it is working. Neither does it seem to affect the way these buds react to the planetary correlations. When I started the daily work on the primroses, in 1983, I had no hint, from traditional lore or any other source, as to what sort of correlation to look for, or indeed that any such correlation existed. However it became apparent very soon that the $\lambda$ of these buds was suffering a small drop every fourteen or fifteen days, and this rhythm pointed one's attention immediately either to the Sun or to one of the inner planets, Mercury or Venus. And in the ensuing years it was the lunar alignments with the Sun, i.e. new moon and full moon, which established themselves as the prevailing influence, and it is these moments, consonant with the current phase-shift of the generality of species, which are marked by the arrows on the primrose charts.

Examining the graphs 11, 12, 13 and 14, one sees a remarkable consistency in the results for those years from 1983 to 1987. $\lambda$ varies between 2.6 and 2.8 for most of the time, falling below 2.5, and sometimes below 2.4, at fortnightly intervals. Never once during all that time did an alignment go unacknowledged. The critical level seemed to be 2.5 and never was a fall below this level seen except at the time of such an alignment. In the years 1989 and 1991 (graphs 15 and 17) the curve falls just as regularly at the time of each alignment, but the critical level is higher, at about 2.7. What factor, celestial or terrestrial, which should cause a whole species to undergo a subtle change such as this we do not know.

Only in the year 1990 is the record somewhat clouded. In that year the general higher level of $\lambda$ which had been recorded in the previous year was maintained, and the first alignment, of March 25th was well acknowledged. However, after that the dips in the curve began to come too early, and increasingly so as the weeks passed. MRDs were higher than usual during that year and the species as a whole seemed to be generally disturbed. I do not know any reason for this.

Graph 15 is an interesting one to study. This was made at a time when the general phase-shift was at near to zero as it can become and we see the dips in the curve coming as sharp and sharply as it is possible to record them, i.e. each dip lasts just about one day. The result of this is that these dips are diminished and partly obscured in the heavy trend curve (calculated by three-day-means) and one needs to look at the lighter, daily curve in order to see what was really happening. As soon as one does, one sees that the dips in the curve were really there, and coming exactly on time, except for that of March 22nd which for some reason came two days early. It is interesting to compare this graph with, say 13 or 14, where a relatively high numerical phase-shift was in force; also to compare it with graph 18 made for the Oak only a few months previously.
Stitchwort

The buds of this delicate little white wild flower, which blossom in our hedgerows and meadows during May and early June, develop in some ways similarly to those of the primrose. They start their life fully enclosed by the plant's green sepals, and only part of the way through their development do the tips of the white petals thrust their way into the open. But there are differences. The sepals of the primrose are crinkled and they lie loosely over their bud. There would be no use whatsoever in studying the outward form of the bud at this stage; it would give no hint whatever of the form of the true bud inside. But for the same reason it is easy to remove the sepals without any way injuring that true bud. But with the Stitchwort the sepals are smooth and thin, and they lie closely adhering to the petals beneath them; and I have not found it possible to remove them without destroying the form of the true bud within. But for this very reason the form of the bud, while still covered by its sepals, can be taken to represent well the true form of the bud. And this is the way I have studied it. Although it is not an ideal way of working we are still, by doing the same things day after day, maintaining comparability. Experience goes to show that results obtained in this way are consistent as well as significant. But we still need to be able of ensuring that the buds, day by day, are at the same stage of development. I do this by picking each bud at that stage when the true, white-petaled, part is protruding from the green sepaled part by one fifth to one quarter of its length. The whole thing is then measured for just as it is. Again it must be stressed that whether this gives a 'true' value is less important than that we proceed in exactly the same way day after day.

As with the Primrose, when I first started working with the Stitchwort on a daily basis, I had no hint as to whether such a correlation existed, nor what would be its nature if it did. Graph 1 shows the result of this first year's exercise. The budding season for this species is rather short, so the graphs tend to be small, especially in the early years, before I had discovered just those places where the earliest buds are to be found. The graph shows two clear dips in the curve at about a 13-day interval; after May 26th I had to be away from home, but returned in early June just in time to catch the curve, perhaps, recovering from a third dip. A 13/14 day interval suggested one of the outer planets, Jupiter or Saturn, and it was noticeable that each of the earlier dips came just one day ahead of Moon/Saturn alignments. If we consult the phase-shift chart we see that at this time the phase-shift must have been moving to a value of about minus half a day, so in fact these dips were very closely punctual. But I had no knowledge of this at that time, so I could only note the facts as I knew them and wait for future con-
firmation. This was not slow in coming; the lower graph of page k1
shows the result of similar observations taken just a year later.
We see two dips in the curve coming punctually at what we now kno
with hindsight, to have been the current phase-shift of minus one
day. At that time there was still more than six months to pass be
fore I should become aware of this phenomenon of the changing phase
shift, and I came to the conclusion that perhaps it was just a speci
characteristic of the Stitchwort that it reacted a day ahead of
the actual moment of the alignment. However, I could not help being
somewhat disappointed at the smaller amplitude of the variation, not
nearly as strong or marked as the previous year. Again with hind
sight we can to-day look back to these early observations and note
the fact that at that time Mars was approaching close to Saturn, and
stayed so during a large part of that summer. The fact that these
planets inhibit one another’s activity was already showing but
at that time I had no knowledge of this.

Graph k2 was taken two years later, and here we see the working of
the Stitchwort fully restored to normal proportions. The arrows here
mark the alignments of Moon/Saturn with the then-current phase-shift
and we see the dips in the curve coming very punctually in time with
them. And one year later, in the upper graph of page k3, we see a
similar situation except that the first dip seems to come a day be
fore it was due.

However these delicate little buds are not always at all easy with
which to work. Not only are they very frail to handle but they are
easily affected by the weather. In the lower graph of page k3 we see
the results for 1988. This was a very hot May and even when in the
field picking the buds they could be seen to be wilting. Looking at
the graph we see that the first dip, if indeed it really existed,
must have come very considerably earlier than the date due for it
with respect to the current phase-shift (well before the start of
observations) while the second one, again if it was really there,
not only came one to two days early, but did not have a restored to
its proper value after it. One cannot look at this graph and say it
shows any proper correlation with the alignments. In the middle of
the month we were struck by quite a severe heatwave; the buds dried
up and shrivelled, and the season came to an early and unsatisfac
factory end.

Page k4 shows graphs for the two following years, and here we see
the resumption of normal working. We remember that when considering
the Oak and the Primrose for the spring of 1989 we saw a special
quality coming into the curve just at this time when the phase-shift
was approaching zero. The dips became very sharp, each one lasting
scarcely more than a day. By comparing the light, daily, line for
the two graphs on this page I think one can see that a similar thing
seemed to be happening in 1999 for the Stitchwort, although to a
rather less marked degree. As with the Oak and the Primrose, in the
following year this effect was not to be seen, although the phase-
shift was still close to zero.
STITCHWORT

1989

1990
But the greatest difficulty of working with this species is with the large number of different varieties contained within it. These are not easily distinguished by means of their buds or blossoms but only with regard to subtle differences in their foliage. How far moving from one variety to another affects the $\lambda$ of the buds has not been established yet, but in order to be sure of maintaining full comparability it is obviously necessary, in the present state of our knowledge to stick strictly to just one variety during the course of any set of observations; and this is not always easy. In the immediate neighbourhood of Strontian it is the Ranunculus Repens which comes into bud first, and in order to have as long a budding season as is possible this is the variety which I decided to study alone. The first buds appear early in May and are large and full-looking, with a comparatively high $\lambda$-value. Quite quickly however, in the course of the next ten or twelve days, the buds begin to grow smaller and their $\lambda$-value undergoes a steady fall. By the first half of June one finds oneself presented by a mass of tiny buds covering all the meadows and hedgerows, in the meanwhile other varieties, principally Ranunculus Acris, and perhaps some Bulbosa, have sprung up, often with their foliage so intimately intermingled and matted with that of the Repens that they are exceedingly difficult to separate and distinguish. The remarkable fact is that these very tiny buds open into blossoms that are just as large and beautiful as the much bigger and fuller-looking buds of a month previously. To what extent these changes are due to a change of varieties, the Acris and probably other varieties being now much more predominant, is not easy to be really certain, but I think there is good evidence to show that the Repens, considered just within its own variety, does undergo a steady decrease in size and in $\lambda$, during those first weeks.

Looking at the graphs, $m_1$, $m_2$ and $m_3$, for the three seasons in which I have devoted myself to studying the Buttercup, I am reasonably convinced that they show, until very near the end of May, a true record of the variety Repens, but thereafter there may well be some adulteration due to an unwanted admixture of other varieties, especially Acris.

The results themselves are just as tantalising and difficult to assess. It is immediately apparent that there is a good degree of consistency from year to year, and a distinct pattern of fortnightly dips in the curve. The mean periodicity for these dips comes out at about 13.6 days, but with so few observations to work with, this figure may well be inaccurate by as much as plus or minus half, or
maybe slightly more of a day. This by itself would seem to indicate
probably one of the outer planets, Jupiter or Saturn. But when we
come to look for more definite indications we meet with considerable
difficulties. During the summers of 1988 and 1989 the aspect of
the heavens was somewhat peculiar. In 1988 there were no fewer than five
of the seven planetary bodies, and in 1989, four, all bunched close
together near to alignment, and as the moon came round she experi-
enced a set of four or five alignments almost simultaneously. It is
an interesting fact that each of these sets of alignments corres-
ponds fairly closely with the dips in the curves of graphs m1 and
m2, which makes it very hard to distinguish any one particular body
as being more suitable than the others. We are thus left with only
the observations of 1990 to guide us, and the relevant alignments
for these are shown on graph m3. We see that there are only three
contestants left in the field, Mercury, Sun, and Jupiter, and of
these the two latter are most likely. However it must be admitted
that a perfect fit does not seem to exist for either of them. In
view of the periodicity of something like thirteen and a half days
mentioned above Jupiter would seem to be our most likely candidate.
Since 1990 various causes have prevented me from doing the further
work on this that I would have like to have done. It is clear that
no firm conclusions can be drawn at this stage, and I publish this
in the hope that I, or others, may one day accomplish this extra
work.

Seeing that Jupiter seems to be quite the most likely planet to be
implicated here, arrows for the Jupiter alignments have been put in
graphs m1 and m2. It will be seen that the general agreement is
good, and this may prove to be of value when further work comes to
be done.
Knapweed (Hardheads)

This beautiful little purple flower grows in abundance on the hillsides and in the meadows of the west Highlands. As one of the composites its 'bud' is really more a flower-head, forming a little inflorescence of tiny purple flowers, contained in a small brown casing. This casing remains an accurate path curve form throughout its development, and this is the form which we measure.

Each casing is covered with a multitude of tiny hairs growing on it in path curve spirals. In dry weather these hairs stand erect and can make it very difficult to get a good clear image of the bud. To overcome this I always soak the buds for a few minutes before mounting them on the measuring plate. This causes the hairs to lie down close to the surface of the brown casing and thus enables one to get a good clear image. It also makes for good comparability as in bad weather the buds are wet from rain anyway.

When a bud first appears it is small, rounded in form and of low $\lambda$. As it matures it grows and gradually becomes more pointed, with a steadily increasing value for $\lambda$. A short time before the purple flowers within begin to burst through the top of the brown casing, a small whitish spot appears at the tip of the casing. The first appearance of this spot is the obvious time to choose for an easily recognisable moment of development at which all buds can be picked. However, during all the early weeks of the budding season no buds are yet to be found which have reached this stage, and if one simply adopts this policy one misses half of the budding season. The plan I follow therefore is, as soon as the first buds appear, to gather each day twenty of the most mature buds I can find, and to continue in this way until the time comes that the first white spots are beginning to show, and thereafter to gather all buds that are just starting to show the very first sign of such a spot. Following this policy one would expect to get a graph showing a steadily increasing value for $\lambda$, only levelling off towards the very end. In fact what one gets is a graph showing $\lambda$ increasing by fortnightly leaps. To see typical examples look at graphs 03 and 04.

My first observations of the knapweed were taken in 1985 and are shown in graph 01. One advantage of this species lies in its abundance; it grows everywhere, including under the high tension cables. The cables run here, in Strontian, are small, and quite largely pass through clearings in the forest where the knapweed is not to be found. For this reason it is not always easy, specially early in the season, to find enough buds growing exactly under the cables. Perhaps this is the reason why in following years I have not followed up this aspect of the matter as consistently as I ought. However in 1985 I followed through with it as well as I could. In graph 01 is shown, in the dotted curve, the results from the buds gathered from under the cables, while the continuous curve shows the results from those which were growing in the open. We see that the cyclic quality of this latter curve is completely lacking in the dotted curve.

Having achieved graph 01 the next task was to see whether one could
find an astronomical correlation to fit the critical points in this
curve. One found that there were no alignments which fitted the dips
in the curve, but that alignments of Moon with both Sun and Jupiter,
consonant with the current phase-shift of ~4 days, co-incided fairly
well with the little peaks. Observations in five subsequent years
have clearly shown that the Sun is not involved here, but alignments
of Moon and Jupiter have continued to correspond closely with all
the peaks, right up to the moment of writing (August 1992), and I
think it is clear that Jupiter is the executive planet here. All the
arrows in the Knapweed graphs have therefore been put in to cor-respond
with the Jupiter alignments.

Since that year I have not tried working with buds growing under the
high tension cables except for a short period in 1998, due to the
difficulty of finding enough buds in such a situation. In that year,
top graph of page 02, of two alignments the first, of June 29th,
completely failed to register with those buds which had come from
under the cables, but the second one, of July 11th, showed quite
well, as though something of the cosmic impulses had nevertheless
got through.
Geranium

I found this little pink flower growing in a patch by the roadside but it is probably a garden escape. I rescued it from the ravages of the road menders and it has since been growing happily in my garden. Although the petals are rather pale pink, the buds in their early stage are quite deep red, and the moment chosen for picking them is that in which the red of the bud first shows through the tip of the sepals.

Graph q1 shows the results of the first year's work. There was a strongly marked fourteen day rhythm but, as with the knapweed, I was not able to correlate the dips in the curve with any astronomical alignments. The peaks however coincided closely with alignments of Moon with both Sun and Mars. Later work showed the alignments with Sun to be irrelevant, but those with Mars continued to be effective, and it is these alignments which are marked by the arrows on the Geranium graphs.

The following year, 1984, started very disappointingly (Graph q2). The variation during the first part of June was so slight as to be only just discernable, and the peak of June 22nd was hardly better shown. Not until well into July was variation of anything like the strength of the previous year established. This was the very first case I experienced of the mutually inhibitory effects of an alignment of Mars and Saturn. Although these two planets did not come to an exact alignment during this period they were very close indeed to one another. The numbers across the top of the graph show their distance apart (measured in longitude) and it will be seen that anything like full variation was not observed until they were separated by at least 5°. In fact a similar phenomenon had been recorded only a few weeks previously but I had not realised it at the time. Graph k2.

Graphs q3 and q4 show the variation of this plant in following years and it will be seen that the rhythms were maintained with good regularity except for the first eleven days of June 1990. By observing the thin, daily line of measurements one can see that the life of this plant seems to have been disturbed at that time and coinciding with this a raise peak, i.e. one that did not seem to be warranted by any alignment, was recorded.

In 1991 I did not know what to expect. Mars was heavily encumbered with other alignments during the relevant period. Not only was he in opposition to Saturn on June 8th but in conjunction with Jupiter on June 14th. However Mars and Venus were running closely together during the whole of this time. Actual conjunctions took place on June 23rd and July 26th but during the whole of this period these two planets were not more than three degrees apart. One could only wait to see what would happen. In the event, rather to my surprise, the peak which was to be expected round about June 12/13th showed quite strongly although maybe a day late. But when the next one, to be expected about June
28th failed to materialise in any satisfactory way I felt that it would not be realistic to expect any further astronomical correlations during that season. As a matter of principle rather than for any other reason I decided that the observations ought to be continued as long as possible, and I worked on until the supply of buds ceased. As a result I was rewarded with a peak in the curve, round about July 11th, almost exactly 'on time', and as strongly marked as any that had been recorded in previous years. By this time the alignments with Saturn, and to rather less extent with Jupiter, had been well left behind, only that with Venus being still strongly in force. We already know, from the work of several different years, that the presence of Saturn inhibits that of Mars, and we see this confirmed here, and it would seem that perhaps it may also be the case with Jupiter; but from this year’s work alone, it might be considered that it is not the case with Venus; indeed there might possibly be something like an enhancement here.

The lower graph on page 45 shows the results for the geranium in the year 1992. In that year the first buds appeared fairly early and, with the very sunny weather, the progress of the plants seemed to gallop. The first two alignments with Mars show fairly well-defined peaks in the curve, but thereafter the supply of new buds sharply declined and the season came to an early end in the last week of June.
GERANIUM 1983

19 June 24 29 4 9 July 14

0

12 14 16
Cherry

The leaf bud of the Cherry has only been studied in one season, the year in which this aspect of the work was started. The work was done using a single bud, which was photographed actually on the tree, in the same way as the Oak bud of graph e1. The graph shows a small increase in $\lambda$, showing as a peak in the curve each fortnight. These peaks were found to coincide closely with alignments of Sun and Moon, i.e. new moon and full moon, and the arrows have been put into the graph to show these moments.

It has already been mentioned that this method of working was not found to be wholly satisfactory and it has not been repeated. Unfortunately it has not been possible to continue with work on this species with the later methods employed, i.e. taking twenty buds per day, owing to the sparsity of cherry trees in this neighbourhood. The result shown here must therefore be taken with caution. It is published here in the hope of encouraging others to continue with this work where cherry trees are more frequently to be found.
The Heart

The task of plotting the changes undergone by the heart during the course of its beating is one attended with considerable difficulty. In the first place, of course, one wants to learn how the normal, i.e. healthy, heart behaves, although later it may come about that pathological conditions will also interest us. The angiogram procedure, during which the end of a long catheter is inserted right into the left ventricle, is hardly a pleasant one, and moreover is attended by a certain, small, risk. Doctors are not normally willing to subject someone to this unless it is felt to be medically needed. Thus I believe that most of the angiograms which are described as 'normal' or 'healthy' were taken from patients who had come to hospital suffering from gastro-cardiac symptoms, and who, after the angiograms had been examined, had been cleared of actual heart disease. Their hearts were beating 'normally', but they could not be said to be in perfect health. Furthermore this process, during which some substance opaque to x-rays is squeezed into the ventricle, thus causing it to show up on the x-ray screen for the space of two or three heartbeats, is the cause of some real stress to the organ, and also almost certainly to the psychology of the patient. In view of all this it is remarkable that this highly mobile and very sensitive organ should react as robustly and consistently as it does, but we must always be aware of the possibility of anomalous behaviour from time to time.

The difficulties are enhanced by the very shadowy nature of these x-ray images. Even a doctor is often hard put to it to interpret such pictures with certainty, and much more so a layman. One really needs the experience of a highly trained radiologist or cardiologist for reliable results. This becomes most strongly the case just at the moment when one's interest is most highly aroused,—that almost magic moment of full systole, when the ventricle is at its greatest tension. At this moment the ventricle is almost completely squeezed empty of blood and its image nearly disappears from the screen. My early work with the angiograms was perforce made with my rather blundering outlining of the form of the ventricle and I was well aware of the uncertainties which were involved. It was nevertheless sufficient to indicate to me three things which I found of the most intense interest,—the strange resemblance of the parameters at the moment of full systole to those of the wild rosebud, the fact that this moment seems to be in some sense a dual event in which a Hopkins to a very high value followed immediately by a dramatic plunge and then an almost equally dramatic rebound, and the fact that every single heartbeat seems to be overlaid by another rhythm containing just, or at any rate approximately, seven little ripples to the single beat. My subsequent efforts were made with a view to confirming, or otherwise, these three facts: so when Dr. Altken who was at that time taking special training as a radiologist offered to make a series of tracings for me covering a whole heartbeat his offer was gratefully accepted. The result of this is published in The Vortex of Life, Chapter 6, and it gave what at that time I felt to be almost better confirmation than I had a right to expect. But I was acutely conscious that 'one swallow does not make a summer'
and I have been seeking for confirmatory evidence ever since. But before describing the results of this search it will be well to say a few words about the methods to be employed when measuring the pictures of an angiogram.

Before starting actual measurement, one should look carefully at all the frames of the angiogram (these will probably be between 35 and 50 of them, according to the rate of the heartbeat at that time) and decide on a number of fixed points which can be clearly identified from one picture to the next. All construction lines and measurements should thereafter be made in exactly the same way with respect to these points, in one picture after another. The maintenance of complete comparability is just as important here as with the buds.

Different hearts vary to a surprising extent and some may have to be treated differently. But our diagram here shows a fairly typical case. Usually the best marked point is at D, the upper end of the mitral protuberance (D E F) and this can be safely identified in almost all the pictures. The other side of the aortic vestibule, at A, is not always so clearly seen, especially in some of the frames. In those where it is hard to see, its position can be estimated by reference to previous or subsequent frames where it is better shown. The line joining D to A can be taken to represent the top plane of the invariant tetrahedron. The point X, at the apex of the organ, can usually be identified unambiguously, and the line joining this to Y, the midpoint between D and A, can be taken to represent the central axis of the ventricle. However the exact position of the tangent at X, representing the lower plane of the tetrahedron, is not easy to be sure of. One finds that if one puts it exactly at right angles to line XY one gets a quite convincing picture, and this is an easy way of ensuring identical treatment throughout.
Obviously it would be possible to conceive somewhat different ways of solving this problem but the final answers which they give, if they are to be at all convincing, could hardly look very different from the present one. Probably the question as to which one is the most 'correct' is less important than that each frame of the angio-
gram should be treated identically.

On all the graphs which follow after this, the arrows marked D and S mark the moments of full diastole and systole respectively, as determined by measuring just the straight-forward size of the image of the ventricle.

Some time after the first publication of the graph taken from the tracings by Dr Aitken an angioagram from one of the large Paris hospitals came into my hands. I had to make enlargements from each of the pictures in it and then draw the outlines using just my layman's skill. The result of this is shown on Graph 41. Between frames 43 and 56 the image became so hazy that I was not able to draw any out-
line with confidence; I just knew that was 'very high', but I got the distinct impression that there were two peaks in the curve here, the second of which being the higher, and representing the true mo-
ment of full systole. This being accepted we see that this angio-
gram gives a graph which is very similar indeed to that taken from Dr Aitken's tracings, - three of the little ripples leading up to full systole, and four following it, the dramatic plunge after systole being at frame 57, and the rebound at frames 58 and 59. This early confirmation of my first results was satisfying, but this angio-
gram had other things of interest to show.

When one examines an angioagram one finds that the first frames are blank except for the image of the curled end of the catheter which has already penetrated the ventricle. Then, at the moment when the opaque fluid is pumped in, the image of the ventricle itself springs to view, and it stays in view for the space of two or three complete beats, gradually fading thereafter as the opaque fluid is absorbed into the system. In this particular angioagram the ventricle first came to view just after full systole, at the frame which I have num-
bered 3, and the first full beat started about frame 29 (Graph 41).

On the top part of Graph 42 we see the early frames of this angio-
gram showing the second part of the beat previous to that of Graph 41. Below it we show the second part of the beat shown on 41; and at the bottom is the corresponding part of the following beat. It is remarkable how similar these are, but with, from top to bottom, a steadily decreasing emphasis. Features which show strongly in the top graph are barely to be descried in the bottom one. It strikes me that the bottom graph is one of a ventricle which is thoroughly fed up with life. It feels that it has taken as much ill treatment for one day as can fairly be expected of it; and it is not inclined to co-operate further. This indicates that if we wish to trace such fine changes we should always try to work with the first beat that appears on the film.

About the same time Dr. Feder made for me an excellent set of trac-
ings from another, this time London, angioagram covering fully a beat and a half. The result of measuring this is shown on graph 43.
Here we see a graph which is remarkably similar to the foregoing. The high point of full systole comes at frames 12 and 13, the post systolic plunge comes at frame 14, and the rebound at frame 18. When one is dealing with such subtle matters there are bound to be some uncertainties. The apparent little peak in the curve at frame 16 only shows because of the slightly lower value at frame 17, and this is supported only by that one frame. For this reason I think the peak at frame 16 is very uncertain and I have not put it in the numbering. On the other hand the exact moment of diastole is somewhat in doubt in this angiogram; it could possibly have come as early as frame 30, in which case the ripple which I have numbered 7 might be deemed to belong more rightly to the next beat. I think we can say that it is highly probable that this beat contained exactly 7 little ripples, but just possibly 8.

One can calculate that the systole for the next beat should have come at about frames 44 or 45, but judging just from the size of the image one cannot detect anything of the sort; and the whole graph for the beginning part of the next beat looks wholly disordered. It seems that succeeding beats may sometimes not be just inhibited but completely chaotic.

Considerably later I received a particularly valuable angiogram from the Royal Brompton Heart and Lung Hospitals. This was not on cine film but was encoded digitally on a computer disc, but what made it especially useful to me was that on every frame the image of the ventricle had been outlined by an expert cardiologist, thus removing many doubts and giving me some of the most certain evidence I had had to date. Graph u4 shows the results of measuring these outlines. There is little to say about this. Apart from the rather unduly high value for ripple No 5, at frame 29, I could hardly have wished for better confirmation of all that has gone before.

Very recently (August 1992) I have received a further set of angiograms made by the same expert, and Graphs u5, u6, u7 and u8 show the results of analysing the first four of these.

Graph u5: here we have in many ways a quite typical case of what we have been describing. This study has taught me that the heart is a very individual organ. As with the human countenance we meet here with infinite variety in a framework of archetypal uniformity. Each beats according to a definite pattern, but beats differently in each of us. At first sight this graph looks absolutely typical, but on closer inspection we see that although in most angiograms three little ripples lead to systole and four follow it, here four ripples lead to systole and three follow it. And the post systolic plunge is, I think, smaller than usual.

Graph u6: another almost archetypal case. Ripple No 2 is not well shown, and the rebound at No 4 is smaller than usual, but otherwise this is quite typical.

Graph u7: ripples No 5 and 6 are higher than usual, or alternative-
ly the systolic peak at frame 15 is lower. Apart from this, this angiogram is another good example of the things that are described here, with, as usual, just the seven little ripples to the beat.

Graph u8:- this is the first example we have of an angiogram which does not conform quite so well to the established pattern. We might describe it as a fluttering heart! We could count something like ten, or even eleven, little ripples to the single beat. However, several of these, notably those at frames 9, 22 and 27, are supported by only one frame each and must therefore be considered to be doubtful. I have given a tentative numbering to the others but it is clear that this does not make nearly so convincing a case as the others described here. However the post systolic plunge and the subsequent rebound are well shown, as is also the general principle that the main beat is overlaid by a system of little ripples.
Program LAM

10 INPUT N
20 DIM D(N), W(N), L(N), EE(N), DD(N), S3(N), MOD(N)
30 FOR I = 1 TO N
40 INPUT D(I)
50 NEXT I
60 Z = INT(1 + N/2)
70 FOR I = 1 TO (Z - 1)
80 W(I) = ABS(LOG((I + 1)/(N + 1 - I)))
90 VT = VT + W(I)
100 L(I) = V(I) * LOG(D(I) * (N + 1)/I) / (D(Z) * (N + 1)/Z) / LOG(D(Z) * (N + 1)/Z) / D(I) * (N + 1)/N - 1)
110 LL = LL + L(I)
120 NEXT I
130 LL = LL / VT
140 PRINT "LL = "; LL
150 FOR I = (Z + 1) TO N
160 W(I) = ABS(LOG(I/(N + 1 - I)))
170 WS = WS + W(I)
180 L(I) = W(I) * LOG(D(I) * (N + 1)/I) / (D(Z) * (N + 1)/Z) / LOG(D(Z) * (N + 1)/Z) / D(I) * (N + 1)/N - 1)
190 LU = LU + L(I)
200 NEXT I
210 LU = LU / WS
220 PRINT "LU = "; LU
230 PRINT "LAM = "; (LU + LL) / Z
235 LP = LU + LL / Z
240 GOSUB 700
250 PRINT "MOD "; SMALL
260 FOR I = 1 TO N
270 Y(I) = LOG(D(I) * (N + 1)/I)
280 X(I) = LOG(D(I) * (N + 1)/(N + 1 - I))
290 E = E + X(I) * Y(I)
300 F = F + X(I)
310 G = G + Y(I)
320 K = K + X(I) / Z
330 NEXT I
340 J = -(E * F + G * N) / (K - F * Z / N)
350 L = -I
360 PRINT "REGR. LAMBDA = "; L
370 GOSUB 700
380 PRINT "MOD = "; SMALL
385 L = 0
390 FOR T = 1 TO (N - 1)
400 X(T) = LOG(D(T) + 1)/(N + 1) / (D(T) + 1)/(N + 1) / LOG(D(T) + 1)/(N + 1) / D(T + 1)/(1 - T)/(N + 1)
410 L = L + (K(T))/(N - 1)
415 NEXT T
420 GOSUB 700
430 PRINT "MORPH. LAMBDA = "; L
440 PRINT "MOD = "; SMALL
445 IF N > 7 THEN 490
450 L = 10.51L / (LOG(T) * LOG(T + D(T)/D(1)) * LOG(3) * LOG(3 + D(S)/D(2)) * LOG(S)/D(S) / (3 * D(3))) - 1
460 GOSUB 700
470 PRINT "C.F. LAMBDA = "; L
480 PRINT "MOD = "; SMALL
490 END
500 FOR T = 1 TO N
510 DEV = 0
520 FOR I = 1 TO N

Program L

10 PRINT: INPUT "file name":NAME
20 OPEN NAME+"data.db": FOR INPUT AS 1
30 INPUT #1, N
40 DIM XL(N),YL(N),XR(N),YR(N),D(N),H(N),W(N),P(N),X(N),Y(N),EE(N),LD(N),SS(N),M
50 RD*N
60 INPUT #1,YT,XT,YB,XB
70 FOR I=1 TO N:INPUT #1,XL(I),YL(I),XR(I),YR(I):NEXT I:CLOSE 1
80 N=SQR((XT-XB)^2+(YT-YB)^2)
90 Z=INT(N+1/2)
100 FOR I=1 TO N
110 D(I)=SQR((XL(I)-XR(I))^2+(YL(I)-YR(I))^2)
120 H(I)=SQR((XL(I)-XR(I))^2+(YL(I)-YR(I))^2)
130 W(I)=ABS(LD(H(I))-LD(1-H(I)))
140 R=R+W(I)
150 NEXT I
160 FOR I=1 TO N:IF I=Z THEN 170
170 P(I)=W(I)*LOG(D(I)*H(Z)/(H(I)*D(Z)))/LOG(D(Z)+(1-H(I))/(1-H(Z))*D(I)))
180 Q=Q+P(I)
190 NEXT I
200 L=Q/R
210 PRINT "Lambda= ": L
220 INPUT "MRO= ":SMALL
230 FOR I=1 TO N
240 Y(I)=LOG(D(I)/H(I)))
250 X(I)=LOG(D(I)/(1-H(I)))
260 B=B+X(I)*Y(I)
270 F=F+X(I)
280 G=G+Y(I)
290 X=1+(X(I))^2
300 NEXT I
310 J=(E-P+G*N)/(1-P^2/N)
320 L=J
330 PRINT "Regr Lambda= ": L
340 INPUT "MRO= ":SMALL
350 END
360 FOR T=1 TO N
370 DEV = 0
380 FOR I=1 TO N
390 D(I)=LOG(H(T)+1-H(I))/(1-H(T)+H(I)))
400 DD(I)=D(T)/H(T)*EXP(W(I)*LOG(D(I))/1-L+H(I))
410 SS(I)=ABS(DD(I)-D(I))*100/D(I)
420 DEV=DEV+SS(I)
430 NEXT I
440 MRO(D(T))=DEV/N
450 NEXT T
460 T=1
470 SMALL=MRO(T)
480 FOR T=2 TO N
490 IF MRO(D(T))<SMALL THEN 480
500 NEXT T
510 RETURN
Program LM

10 CLEAR:CLS
20 DISPLAY PROGRAM NAME - THIS SECTION IS ONLY FOR "LOOKS", & MAY BE LEFT OUT
30 T"="" PROGRAM LM ""I=LEN(T):D#=STRING(20,"")"
40 PRINT D#:CHR$(201)+STRING$(1,205)+CHR$(187)
50 PRINT D#:CHR$(188)+T#:CHR$(186)
60 PRINT D#:CHR$(200)+STRING$(1,205)+CHR$(183)
70 PRINT D#
80
90
100 DIM XL(20),YL(20),XR(20),YR(20),P(20),X(20),Y(20),SH(20),SN(20)
110 ' THIS SECTION CHECKS IF A DISKETTE IS IN DRIVE A: (THE DISKETTE DRIVE)
120 ' IF THERE IS, IT WILL COPY ALL THE INPUT DATA INTO ONE DISKETTE FILE
130 ' IF THERE ISN'T, NO ATTEMPT WILL BE MADE TO WRITE TO DISKETTE
140 ' NOTE: DISK = 0 IF NO DISKETTE, = 1 IF THERE IS A DISKETTE
150 DISK=0:ON ERROR GOTO 170:T"="A:TEMP,QM:OPEN T#:FOR OUTPUT AS 2:CLOSE 2:
160 LL "A:TEMP,QM:DISK#:GOTO 180:
170 RESUME 180
180 ON ERROR GOTO 0:
190 IF DISK=1 THEN INPUT "Diskette is in - what is the date ":D#:I=LEN(C):IF
200 IF DISK=1 THEN D#="A:"+D#:".DAT":OPEN D#:FOR OUTPUT AS #2:PRINT "Will save
210 WRITE "Reading file:
220 FOR T=1 TO 20
230 T#="STRING(T):I#="RIGHT$(T#,LEN(T#)-1)
240 N=0:N=RIGHT$(SPACE$(16)+N#);I#;PRINT T#:1;
250 INPUT #1,N
260 IF DISK=1 THEN PRINT #2,N
270 PRINT "="#,#"
280 INPUT #1,XT,YT,XT,YB
290 IF DISK=1 THEN PRINT #2,XT,YT,XT,YB
300 FOR I=1 TO N
310 INPUT #1,XL(I),YL(I),XR(I),YR(I)
320 IF DISK=1 THEN PRINT #2,XL(I),YL(I),XR(I),YR(I)
330 NEXT I:CLOSE 1
340 N=SQR((XT-XB)^2+(YT-YB)^2)
350 Z=INT(1+N/2)
360 FOR I=1 TO N
370 D(I)=SQR((XL(I)-XR(I))^2+(YL(I)-YR(I))^2)
380 SD(I)=SD(I)+D(I)/20
390 H(I)=SQR((XL(I)+XR(I))/2-XB)^2+(YL(I)-YR(I))/2-YB)^2/N
400 SH(I)=SH(I)+H(I)/20
410 W(I)=ABS(LOG(1+H(I))-
420 SW(I)=SW(I)+W(I)/20
430 SH#=SH(I)/20
440 NEXT I
450 NEXT T
460 CLOSE 2:PRINT:PRINT
470 FOR I=1 TO N:IF I=2 THEN 520
480 P(I)=SW(I)+LOG((SD(I)+SH(I))/(SH(I)+SD(I))*LOG(SD(I)+(1-SH(I)))/(1-SH(I))+SH(I))
490 NEXT I
Program LM (cont.)

510 Q=Q+F(I)
520 NEXT I
530 L=Q/R
540 PRINT "Landau = "; L
550 GOSUB 710
560 PRINT "MRD= ";SMALL
570 FOR I=1 TO N
580 Y(I)=LOG(SD(I)/SH(I))
590 X(I)=LOG(SD(I)/(1-SH(I)))
600 E=E+X(I)*Y(I)
610 F=F+X(I)
620 G=G+Y(I)
630 k=K+(X(I))^2
640 NEXT I
650 J=(E-F+G/N)/(k-F^2/N)
660 L=-J
670 PRINT "Regr. Landau = "; L
680 GOSUB 710
690 PRINT "MRD= ";SMALL
700 END
710 FOR T=1 TO N
720 DEV =0
730 FOR I=1 TO N
740 EE(I)=LOG(SH(T)*((1-SH(I))/((1-SH(T))*SH(I))))
750 DD(I)=SD(T)/SH(T)+EXP(L*EE(I)/(1+L))*SH(I)
760 SS(I)=ABS(DD(I)-SD(I))*100/SD(I)
770 DEV=DEV+SS(I)
780 NEXT I
790 MRD(T)=DEV/N
800 NEXT T
810 T=1
820 SMALL=MRD(T)
830 FOR T=2 TO N
840 IF MRD(T)<SMALL THEN 820
850 NEXT T
860 RETURN