The volatiles were subjected to gas-liquid chromatographic analysis in a modified Perkin-Elmer vapor fractometer, model A. The retention times of compounds in a typical sample of fungal volatiles as compared to retention times of known compounds, determined on a Carbowax 1500 column and a di-*n*-decylphthalate column, respectively, are reported in Table 1.

The approximate percentages of each of the components of the mixture were determined from estimations of the areas under the peaks recorded during the analysis made on the di-*n*-decylphthalate column. The two major components, with retention times essentially the same as those of authentic isobutyl and ethyl acetate on both columns, accounted for approximately 58 and 30 percent of the mixture, respectively. Components having the same retention times as isoamyl acetate, ethanol, and methanol were present in measurable amounts totaling approximately 11 percent. Traces of components presumed to be isoamyl and isobutyl alcohol were detected.

One milliliter of the volatile mixture was refluxed with 10 ml of 1*N* KOH for 3 hours. The mixture was extracted exhaustively with ether, and most of the ether was removed from the extract by careful distillation. Gas-liquid chromatographic analysis of the extract on the di-*n*-decylphthalate column revealed the absence of the three previously observed ester peaks and revealed marked increases in the isobutyl, isoamyl, and ethyl alcohol peaks.

The alkaline solution used in the saponification procedure was adjusted to *p*H 1.0 with H_2SO_4 and extracted exhaustively with ether. The ether solution was dried over anhydrous Na_2SO_4 and treated with an excess of diazomethane in ether to convert any acids present to their methyl esters. The excess diazomethane was dissipated by the dropwise addition of 2*N* HCl and by vigorous shaking. The ether solution was again dried and then distilled to remove most of the ether. Gas-liquid chromatography of the residue on the Carbowax column revealed a peak at a retention time identical with that of methyl acetate. Since no other methyl esters were detected, and since isobutyl, isoamyl, and ethyl alcohol were liberated during saponification, it must be assumed that the esters in the volatiles collected from cultures of *Chalaropsis thielavioides* are acetates of these alcohols (*8*).

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Statistical Codes for Geometrical Figures

Abstract. A point function may be defined on the "cells" of cellular approximations to plane figures which retains much of the information of the figures and whose distribution function is relatively invariant with respect to cell size; the function is useful in constructing a quantitative field theory in embryology and a nonaddressed system for pattern generalizing in neurophysiology.

It is the purpose of this note to present some of the properties of a coordinate free code for geometrical figures and suggest some applications of such to the theory of embryology and neurophysiological models. The discussion is limited to the two-dimensional case.

Consider the approximation of a plane figure F by a cellular structure of N cells each of area A/N. Call the cells x_i, where $i = 1, \ldots, N$. Let $d(x_i,x_j)$ be the distance between the midpoints of cells x_i and x_j. A single-valued point function, $r(x_i)$, is then defined by the set of equations,

$$r(x_i) = K - \frac{U}{\left[N\left(\frac{A}{N}\right)\right]^{1/2}} \sum_{j \neq i} \frac{r(x_j)\left(\frac{A}{N}\right)}{d(x_i,x_j)}, \quad i = 1, \ldots, N, \qquad (1)$$

where K and U are appropriate constants. Before the biological interpretations are given to these functions an important mathematical property will be developed. To do this let $N \to \infty$, in which case the sequence of functions defined over the cellular approximations to the figure F converge to the function $R(x)$ defined by the integral equation,

$$R(x) = K - \frac{U}{A^{1/2}} \int_F \frac{R(y)}{d(x,y)} dA. \qquad (2)$$

From this it follows that the normalized distribution functions of the $R(x)$ functions defined over two figures of the same shape but of different areas A and A' will be the same. This follows since if x,y and x',y' are homologous pairs of points of similar figures F and F' of areas A and A' then,

$$\frac{d(x,y)}{A^{1/2}} = \frac{d(x',y')}{(A')^{1/2}},$$

and,

$$\frac{dA}{dA'} = \frac{A}{A'}.$$

Hence,

$$R(x') = K - \frac{U}{(A')^{1/2}} \int_{F'} \frac{R(y')}{d(x',y')} dA'$$

$$= K - \frac{U}{A^{1/2}} \int_F \frac{R(y')}{d(x,y)} dA.$$

Since the point function $r(x_i)$ defined over a cellular approximation to a figure itself approximates the function $R(x)$ the above result implies that the distribution functions for $r(x_i)$ functions defined over a figure are relatively invariant with respect to changes in cell arrangement and size.

It can now be shown how a shaped figure (organ) could develop with the aid of an $r(x_i)$ code. Let $D(R(x))$ be the distribution code defined by the figure, and let us suppose a single original cell contains the information needed to define this function. Suppose the cell divides and segregates in the two daughter cells the information defining the upper and lower halves of the distribution, and that when these cells divide they segregate the information defining the quartile distributions, and so on. Suppose that the rate of division is uniform and that cells grow to a uniform mature size before they divide; then A/N is a constant, and since N depends on the number of cell divisions a simple memory mechanism can provide each cell with the variable A. Suppose also that each cell c_i produces at its center x_i a substance S at a rate $\overline{R}(c_i)$ equal to the average value of the distribution defined on it. Suppose that S diffuses freely except for a small region Y_i around its point of origin x_i in each cell. Suppose S may both leave and enter Y_i but that a proportion $1-[U''/(A^{1/2})]$ is destroyed leaving the region. Now, for diffusion in the plane the concentration at any point y is the sum of the components due to each source. The component at y due to $x_i \neq y$ is inversely proportional to the distance between y and x_i and directly proportional to the source strength of x_i. Hence, for a point y_i

in Y_i at a small fixed distance from x_i we may write for the concentration $C_S(y_i)$ of S,

$$kCs\,(y_i) = \bar{R}\,(c_i) + \frac{U'}{(A)^{1/2}} \sum_{j \neq i} \frac{\bar{R}\,(c_j)\frac{A}{N}}{d(y_i,x_j)}$$

Finally, suppose that each cell c_i moves in the direction bringing $kC_S(y_i)$ closer to K. Now, since the distribution of $\bar{R}(c_i)$ converges to the original distribution $D(R(x))$ the cell structure will evolve in the direction of the organ shape provided a metastable impasse is not reached.

The application of the concept of an $r(x_i)$ code to embryology not only leads to the quantitative "field" theory sketched above but predicts as well the clumping seen during early stages of reorganization of experimentally dispersed embryonic tissues.

The neurophysiological application of the above ideas involves identifying the figure F with a subset of cells in a nucleus G and the rates of firing of the cells x_i with the values $r(x_i)$. Suppose the rate of firing of a cell is the sum of the values of its excitation and its inhibition if this sum is positive and zero if the sum is negative. Suppose all cells in the pattern F have excitation K and all other cells have zero excitation. Suppose that the inhibition of any cell x_i is equal to the sum of inhibitions from other cells x_j and that the inhibition I_{ij} of cell x_i by cell x_j is proportional to the rate of firing of x_j and inversely proportional to the distance $d(x_i,x_j)$ between the two cells. That is,

$$I_{ij} = -\left(W\frac{A}{N}\right)\frac{r(x_j)}{d(x_i,x_j)}.$$

If we let W, the distance coefficient of spread of inhibition, depend on the area A of F according to,

$$W = \frac{U}{A^{1/2}},$$

then we have,

$$r(x_i) = K + I_j$$

$$= K - \frac{U}{(A)^{1/2}} \sum_{j \neq i} \frac{r(x_j)\frac{A}{N}}{d(x_i,x_j)}.$$

Hence the rates of firing of cells of G are structurally determined by F according to Eq. 1. Then, if axon branches of the cells x_i of G constitute its efferent projection the distribution function $D(r(x_i))$ of the rates of firing of the efferent fibers of G is a relative invariant of the shape of the figure F with respect to size and position of F within G. It should be pointed out that since the information of such a signal is carried purely by the distribution function it is ideal for transmission of information over nonaddressed channels. A distribution type code and suitable decoding system have previously been suggested for the auditory system, but for this system the initial coding problem is much more straightforward (*1*). Finally, a spatial function much like the one defined in this report has been reported in the visual system of the horseshoe crab (*2*).

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Perturbations in Perigee Height of Vanguard I

Abstract. The effect of solar radiation pressure on the perigee height of satellite 1958β_2 (Vanguard I) has been considered. Previous consideration of the effect of the third harmonic and the lunar and solar gravitational perturbations left an unexplained discrepancy between the observed and calculated values of perigee height. The inclusion of the effect of radiation pressure leads to close agreement between the orbit data and the theoretical results for Vanguard I.

We have extended the previously developed theory of gravitational perturbations to include the effects of solar radiation pressure (*1*, *2*). The theory leads to an analytical development of the long periodic perturbations in the orbital elements. The applications of the results of this theory to the Vanguard I satellite indicate that solar radiation pressure will produce a variation in the perigee height of this satellite with a period of ~850 days and an amplitude of 1 or 2 km. This effect accounts almost completely for the observed variations in perigee height when combined with the previously determined solar and lunar gravitational perturbations (*3*) and the effect of the third harmonic (*4*).

The results of the calculation for Vanguard I are shown in Fig. 1. The radiation pressure calculation was based on an estimated acceleration of 9.7×10^{-6} cm/sec^2, which is obtained by using the assumption of specular reflection, a solar constant of 2.0 cal/cm^2 per minute, an effective cross-sectional area of 308.4 cm^2, and a mass of 1456.7 gm. The effects of reradiated and reflected light and of shadowing by the earth were considered negligible in a first approximation.

The data for the perigee height of Vanguard I are indicated in Fig. 1 by circles. Curve A represents the results of the analytical development of solar and lunar perturbations acting on the satellite (*5*, *6*). It is seen that curve A departs from the observed values of perigee height by several kilometers over the course of two years.

Curve B contains the results of the present calculation in which solar radiation pressure is included. The agreement between curve B and the data is now within the scatter of the experimental points, with the exception of an oscillation of relatively short period which becomes noticeable in the second year of observation.

The data shown in Fig. 1 were obtained by removing the effect of the third harmonic from the published values of perigee height. Each published datum is a determination of the Vanguard orbit elements from Minitrack readings for a 7-day interval. It is important to note that these Vanguard elements are not osculating elements, but are constants of integration of the orbit theory used. That is, if all the

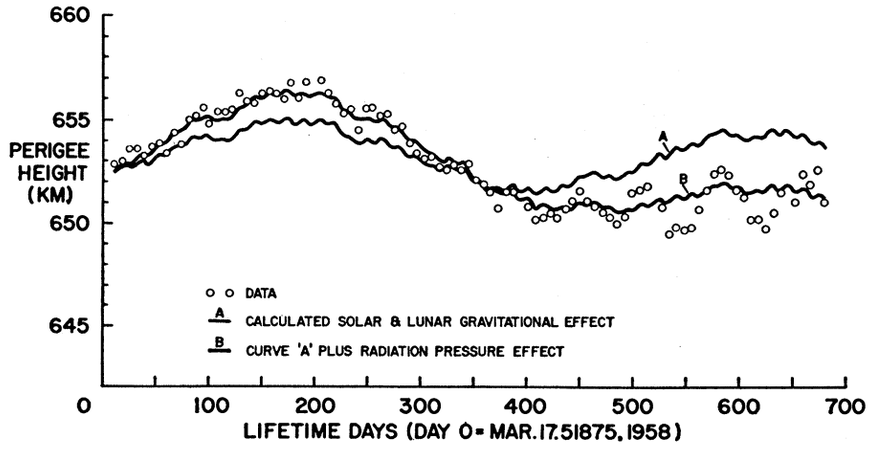

Fig. 1. Perturbations on perigee height of Vanguard I; the data are published orbital elements with the effect of the third harmonic removed.