had the lowest. The incidence of CHD was not consistent with the death rates in Rome and the Netherlands. I suppose the most reasonable conclusion from all of this is that physical activity may be mildly protective, but the evidence is uncertain and inconclusive. In the comparison of communities the intensity of physical activity contributed nothing to explaining the differences in CHD mortality or morbidity.

Resting pulse rate. Generally the resting pulse rate at initial examination showed a graded, positive association with subsequent CHD mortality. This relation was much less apparent for CHD morbidity.

Respiratory function. The association between measures of pulmonary function and the occurrence of CHD was significantly inconsistent.

Diet. Average serum cholesterol values for the different communities were strongly correlated with the fat composition of the diet. CHD mortality and morbidity rates for the populations were associated with fat, and especially saturated fat, in the diet. As in other population studies, no association was found between dietary fat and serum cholesterol of individual study subjects. Keys presents a fairly detailed discussion of this recurrent problem of intraindividual variability.

Multivariate analyses. Analyses of the predictive value of the individual variables taken jointly provided general agreement with the univariate analyses. When the study populations are grouped into larger geographic regions, evaluation of the associations between the variables and the risk of CHD is summarized as in the table on p. 1138.

Although grouping the study subjects in this way is not strongly defensible, given the lack of homogeneity within the groups, the data indicate a marked similarity in the patterns of risk between the United States and Northern Europe and a dissociation of Southern Europe from those patterns.

When the equation derived from one of these regions is used to predict the occurrence of CHD in another, the observed incidence of CHD agrees with the predicted incidence quite well in a relative sense. That is, any population may be arrayed in groups from high to low risk by use of indices of risk derived from any other population. However, the total number of cases of CHD predicted in Southern Europe from the experience of the United States is more than one and one-half the number observed; conversely, applying the Southern European coefficients to the Northern European population yields a predicted number of CHD cases that is a little more than a third of the number observed. Thus, although the same variables determine risk in the same way in the three regions, equivalence of the risk indices does not establish equivalence of risk.

The extraction of information from this book is severely restricted by the variation in format from one graph or table to another. The 16 study groups are combined in a bewildering number of ways. Occasionally the logic of a particular aggregation is presented, perhaps in a statement that the groups did not differ, but more often no justification is given and very often antecedent data indicate that the communities grouped are very different from each other. The result of this is confusion and, even more serious, concern that the patterns illustrated often conceal important elements of diversity. One cannot select a single community and follow it through the chapters to discover how it looks with respect to CHD and each of the variables of concern. The information would be much more accessible and valuable if somewhere, perhaps in an appendix, a prescribed set of analyses of the communities had been presented in a consistent format.

The most consistent presentation is a series of graphs relating some community averages of each of the important individual characteristics to the death rates for all causes and rates for coronary disease in each community. These graphs usually include a linear regression equation and a correlation coefficient, and the correlation coefficients are often strikingly high. In a few of these graphs the magnitude of the correlation is clearly a function of one or a few outlying values combined with a cluster that appears randomly distributed.

This research presents some conceptual problems whose implications are profound but that are not discussed profoundly. The primary data, physiological measurements, are characteristics of individuals and are commonly viewed as related to the likelihood that an individual will exhibit coronary heart disease. When the average values of these variables are computed for each geographically distinct population group and the averages are related to the measured risk of illness in the communities, a different order of assessment is introduced. Comparisons of the characteristics of communities cannot be equated with comparison of the characteristics of individuals, even though the community descriptors are derived from observations of individuals. This distinction is important in all epidemiological studies where the characteristics of groups are used to draw inferences about the occurrence of disease in individuals.

This book is packed with information; the inconsistencies noted between different populations suggest many interesting avenues for additional research, and the observations need to be studied in more detail than can be approached in this brief review. Keys's contributions to the epidemiology of coronary heart disease are enormous, but this report suggests that what he has begun may be far greater even than what he has done.

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History of Mathematics

The Historical Development of the Calculus. C. H. EDWARDS, JR. Springer-Verlag, New York, 1979. xii, 352 pp., illus. $28.

Edwards explores here the antecedents and origins of the fundamental techniques of differentiation, integration, and analysis by infinite series as they were understood and set forth by Euler in the mid-18th century. Although two brief concluding chapters offer sketches of the work of Bolzano, Cauchy, Riemann, and Weierstrass in the 19th century and of Lebesque and Robinson in the 20th, Edwards concentrates on the earlier development of the calculus, in large part because he wishes to emphasize computation over concepts. That is, he presents the calculus as the outcome of some two thousand years of problem-solving. From earliest antiquity the problems involve determining the areas, volumes, and surfaces of curvilinear figures, and hence bringing the discrete process of counting to bear on the continuous realms of magnitude and motion. Later are added the problems of tangents and extreme values, of rectification of curves, and of the calculation of logarithms and of trigonometric functions.

It is specific instances of those problems, and specific techniques of solution devised to handle them, that form the substance of Edwards's book. Guided by his exegesis, the reader steps through—to cite just a few examples—the details of Archimedes's quadrature of the parabola and measure of the surface of a sphere; of Fermat's, Pascal's, and Roberval's quadrature of the general curve $y = x^k$ by means of summation formulas for series of the integers raised to powers (that is, $\sum_{i=1}^{n} i^k$); of Napier's calculation of logarithms; of Newton's formulation of the binomial series; of Leibniz's "arithmetical quadrature of the circle" (that is, $\pi/4 = 1 - 1/3 + 1/5 - 1/7 + \ldots$) by means of transmutation of areas.

On the one hand, then, Edwards's books adds nothing new to current understanding of the history of the calculus. Drawn substantially from secondary literature in English, it portrays the same figures and, for the most part, the same aspects of their work as any one of several standard histories (such as that of Carl B. Boyer); here as elsewhere the rich problem structure of early analytic mechanics remains untouched. Yet, on the other hand, the book stands on its own as a contribution to the literature, especially to that part of the literature addressed to the use of history in the mathematics classroom. For in his emphasis on problem-solving rather than on theory-building, Edwards treats past methods as serious mathematics in their own right, worthy of detailed and sympathetic exposition aimed at showing what they accomplished rather than at judging their limitations in comparison with more recent techniques. Edwards encourages his readers to explore the material for themselves by tackling exercises either drawn from the historical sources or designed to point up special features of the technique in question. As perhaps no other book outside the monographic literature does, Edwards's survey shows vividly that doing the history of mathematics means doing mathematics, often with challenging variations in the rules of the game.

But doing history of mathematics also means doing history, and at a certain point Edwards ceases to meet that challenge. It is the point at which, to convey the content of past mathematics, he strips it of its context, most notably by translating it entirely into modern notation, and hence inevitably into modern concepts. One example will have to suffice here. On p. 15 Edwards begins his presentation of examples from Book XII of Euclid's *Elements* with a proviso:

> In order to spare the reader a heavy burden of geometric algebra and Eudoxian proportions, our exposition will make free use of real numbers and modern algebraic notation. However, in order to preserve the original flavor and spirit as carefully as possible, we will follow closely both the geometrical constructions and the logical sequence of the proofs presented by Euclid.

The original flavor and spirit of Book XII of the *Elements* rest on Eudoxus's and Euclid's elaborate circumvention of the conceptual hurdles that in Greek mathematical thought separated discrete number from continuous magnitude. To sweep those hurdles aside by the free use of real numbers is to abandon both flavor and spirit and to make the logical sequence of the proofs seem strained at best.

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Chain Polymers

Scaling Concepts in Polymer Physics. PIERRE-GILLES DE GENNES. Cornell University Press, Ithaca, N.Y., 1979. 326 pp., illus. $38.50.

Pierre-Gilles de Gennes is a master of the simple, apparently easy, explanation of complex phenomena, and this book shows off his skills in a brilliant fashion. The systems treated, chain polymers, include molecules with very complex chemical structures. Yet, as was shown by the early workers in the field, notably Flory, when the molecular size is large enough new simple features emerge. In particular there appear univeral laws describing the static and dynamic properties of the system. This is somewhat reminiscent of the universality embodied in the thermodynamics of macroscopic systems. Our understanding of these universal laws has been greatly extended, experimentally and theoretically, in recent years. De Gennes has played a key role in these developments, and in this book he tries to describe them in an intuitive, albeit mathematical, form. In this he greatly succeeds, and the book is a most welcome addition to the literature on the subject.

The book is divided into three parts: Static Conformations, Dynamics, and Calculation Methods. The first part, which makes up about half of the book, consists of chapters on single chains, polymer melts, polymer solutions in good solvents, incompatibility and segregation, and polymer gels. As may be seen from the chapter headings, the book deals primarily with the theoretical aspects of the physical properties of long flexible chains in solution, melts, and gels; crystallization kinetics and glass transitions are examples of subjects not treated at all because "in these areas we do not know whether or not scaling concepts will be really useful."

The key to the understanding and derivation of universal laws for polymer chains as developed in the book is indicated in the title. It is the concept of scaling, which is used over and over again in a variety of forms. An example of a scaling law, first discovered by Flory, that plays a central role in all parts of the book is the power law dependence of the size R (root mean square of the end-to-end distance) on the number N of monomer units in the chain. For N large enough $R = KaN^{\nu}$ with ν a universal exponent very close to its Flory value of .6. It is the same for all kinds of polymer chains in a good solvent at very low concentrations, ideally an isolated chain. A good solvent is one in which there is a net repulsive force between two monomers that depends on their spatial distance from each other—no matter how far their chemical distance along the chain. This repulsion is further assumed to be characterized fully by a single "excluded volume" parameter ua^3; u enters into the coefficient $K(u)$ and a is the coherence length in a chain without excluded volume interactions (a = unit size in a completely flexible ideal chain) when $R = aN^{\frac{1}{2}}$. Note here the supposed abrupt change in the exponent ν at $u = 0$; it is $^1/_2$ for an ideal chain and $^3/_5$ for a chain with excluded volume. This is of course possible only because the scaling law refers to the asymptotic, very-large-N, behavior of the size R.

De Gennes gives, in the first chapter, a clear exposition of Flory's derivation of this scaling law. He then outlines in the last chapter a more systematic method for finding R when N is large. The method is based on renormalization group ideas used for critical point phenomena and makes strong use of the idea of scaling; the chain is repeatedly divided into groups of g units, after m steps there are (N/g^m) blocks, and R is assumed to satisfy the self-similar relation for all m

$$R_m = a_m f(N/g^m, u_m)$$

with a_m and u_m determined recursively starting from $a_0 = a$, $u_0 = u$. This leads to a "fixed point" for the block-block interaction $u_m \rightarrow u^*$ and $f(N,u^*)$ = constant $\times N^{\nu}$.

The book's smooth style may sometimes lull the reader into a false sense of confidence in his or her grasp of the material. A true understanding requires diligent reading and much thought—the concepts only appear easy. The author, like many other brilliant expositors, is not above slipping one by the unwary reader. For example, Eq. I.24 defines the probability distribution for the end-to-end distance r for $r >> a$ but the form is then used in Eq. I.29 for $r = a$ to derive relations between certain ex-