montovich-Yvon hierarchy, presumably because, in his words, "Only when one has calculated the fluctuation spectra both ways is he likely to realize the extent to which the Klimontovich-Dupree approach is simpler." The reader who has fought his way through two formalisms to achieve this realization may well wish the author had encouraged him to accept this on faith, with appropriate references to the literature to convince the skeptics. In general, a sparser exposition of this portion of the material not only would have enhanced its clarity, but also would have left more room for the numerous topics of interest in unmagnetized plasmas which are omitted or treated so briefly that reference to the original literature is indispensable. The book concludes with a chapter on "Some illustrative experiments," an unusual feature in a book of this character, but certainly a most valuable one. It partially compensates for the somewhat abstract character of the theoretical discussions in the main part of the book.

Ecker's book suffers most from a turgid, heavy-handed expository style, with formal and mathematical considerations completely dominating physical insights or motivations. It is unsuitable for an introductory course, even at the graduate level; in fact, it is not clear to what class of readers it will be really useful. There is heavy emphasis on statistical mechanical considerations, the first chapter being devoted to a detailed and lengthy (72 pages) exposition of equilibrium theory for a Coulomb system, using cluster expansions. Again, this is a relatively complicated subject and the author's exposition is neither clear nor felicitous. (It is also so far from the current areas of research interest in plasma physics that it is hard to understand why it was included.) At all the difficult points, the reader is referred to the original literature. This is followed by an equally confusing chapter on the nonequilibrium theory, and then by a presentation of the "classical" Vlasov equation theory which is much less satisfactory than that given by Montgomery. Chapter 4 contains a discussion, along quite standard lines, of "collisional" effects, that is, the consequences of including correlations of the fluctuations about the ensemble average.

In the treatment of all of this material, the author restricts himself to electrostatic fields, presumably for simplicity and clarity of exposition. Unfortunately, he achieves neither. The last two chapters consider the general electromagnetic field, a subject that has been somewhat less worked over, in texts and original literature, than the subject matter of the first part. Single particle radiation, the dispersion relation for electromagnetic waves, collisional effects, light scattering, and similar topics are discussed. While the exposition seems better than in earlier chapters, there is little here that has not been presented as well, or better, in other texts or even in the literature.

Since only about a third of the material covered by Ecker is treated also by Montgomery, one is tempted to characterize the two books as being somewhat complementary. Unfortunately, little of Ecker's treatment is characterized by the freshness of approach or clarity of exposition that Montgomery achieves in many portions of his book. Whereas the Montgomery book could very nicely serve as a basis for an advanced, one-quarter or one-semester seminar on plasma physics, the one by Ecker seems suitable neither for this use nor as a text in a plasma physics course.

BURTON D. FRIED
Department of Physics, University of California, Los Angeles

A Problem in Statistics

Robust Estimates of Location. Survey and Advances. D. F. ANDREWS, P. J. BICKEL, F. R. HAMPEL, P. J. HUBER, W. H. ROGERS, and J. W. TUKEY. Princeton University Press, Princeton, N.J., 1972. x, 374 pp., illus. Cloth, $12.50; paper, $6.

The problem of robust estimation is to find an estimator for an unknown quantity under various conditions underlying the observations. There are various aspects of conditions that may have to be considered, but attention has been focused mainly on the shapes of probability distributions—more specifically, on the possibility or even the near certainty of some departure from normality. In reality, the exact shapes of the probability distributions cannot be known; only some vague range of possible shapes is assumed, and the estimator must be "robust" in the sense that it has uniformly relatively high efficiency over a class of distributions even though it may be slightly less efficient than the "optimum" estimator for a specific distribution.

This problem itself is not necessarily new, and can be traced back to Gauss himself, who first established the optimality of the standard technique of estimation under the normality. But a revival of interest in it has recently been initiated by J. W. Tukey, who distinguished the concept of "efficiency robustness" from that of "validity robustness" and emphasized the former in the problem of estimation.

So far research has been concentrated on the simplest case, that is, on the estimation of a location parameter where only one unknown quantity θ is involved and the observations x_i are equal to the sum of θ and the independent error V_i, which is usually assumed to be continuously and symmetrically distributed around zero.

There have been proposed four kinds of estimators. One is the linear combination of order statistics, the estimator of the form

$$\hat{\theta} = c_1x_{(1)} + c_2x_{(2)} + \ldots + c_nx_{(n)}$$

where $x_{(1)} < x_{(2)} < \ldots < x_{(n)}$ are ordered values of x_i. Especially, the trimmed means which correspond to the case when $c_1 = \ldots = c_r = c_n = \ldots = c_{n-r+1} = 0$, and $c_{r+1} \ldots c_{n-r} = 1/(n-2r)$ have been investigated. The second is the class of so-called M-estimators proposed by Huber which is equal to the value of θ minimizing

$$\sum_i \psi\{(x_i - \theta)/s\}$$

where ψ is a convex function and s is some estimator of the scale. Huber especially recommended the type where ψ is defined to be

$$\psi(x) = \begin{matrix} x^2 \text{ for } |x| \leq k \\ kx \text{ for } |x| > k. \end{matrix}$$

The third is the estimators derived from the rank tests, among which the only practically tractable one is Hodges-Lehmann's, which is derived from the Wilcoxon signed rank sum test and is defined by

$$\hat{\theta} = \text{median of } (x_i + x_j)/2 \text{ for all } i < j.$$

The last group are the estimators which are "adaptive" in the sense that the estimation procedures include some steps of estimating the shape from the sample and choosing the estimator based on it. Such a possibility was first suggested by Stein, but practical procedures were proposed by Hogg, Takeuchi, and Johns.

Recent studies by various authors

have given at least some idea of what can be done with the use of such estimators, and now the time seems to be ripe for exploiting various possibilities by a large-scale systematic theoretical-numerical study. This volume contains the results of a large-scale Monte Carlo study of exactly that kind, which was undertaken at Princeton in 1970–71 under J. W. Tukey, with the participation also of P. Huber, J. Bickel, and others. Some 70 estimators are tested, including all four of the kinds described above, as well as some special ones such as the maximum likelihood estimator for the Cauchy distribution. The sampling distributions of those estimators are calculated for several shapes of distributions ranging from the normal to the Cauchy for the sample size $n = 5$ to 40.

It is difficult to assess exactly such a large quantity of numerical results, and still harder to explain them in few sentences. Moreover, the judgments of the authors themselves do not seem to be always unanimous. The general impression does not seem to be radically different from what has already been observed unsystematically, but it seems that Hampel's estimator, which is the M-estimator with the ψ' function defined as

$$\psi'(x) = \psi(x) = \operatorname{sgn} x \cdot \begin{cases} |x| & 0 \leq |x| < a \\ a & a \leq |x| < b \\ \dfrac{c - |x|}{c - b} a & b \leq |x| < c \\ 0 & |x| \geq c \end{cases}$$

behaves universally well and also that some simple adaptive procedures such as choosing among trimmed means are much better than the simple ones, and usually better than the really adaptive procedures like Takeuchi's. Although there might be found still better estimators, the reviewer thinks that much overall improvement is impossible, and some simply adaptive procedures can be recommended to the practicians. The interested reader will have to refer to the book about exactly what procedure he should choose.

The book contains many interesting details which should stimulate further investigations. And the reviewer would like only to add a few comments.

1) One should clearly distinguish the possible range of distributions, and the choice of "good" estimators depends on the size of the range. At least four cases should be distinguished: (i) from the normal to the t-distribution with four to five degrees of freedom; (ii) to the t with two degrees of freedom and grossly contaminated normals; (iii) to the Cauchy; and (iv) to beyond the Cauchy. And for the first case the Hodges-Lehmann estimator seems to be better than this book suggests it to be. For the last case, which is rather unrealistic, we cannot do much better than simply use the sample median. For the third case some adaptive procedures should be used. The most difficult and practically most important case is the second one, and here the results of this book are most suggestive.

2) The desirable adaptive procedure should have the property that by applying it one not only can choose good estimates but can also get some idea how far the distribution is from the normal. In this sense test-estimation type procedures are better. Takeuchi's procedure can be modified in this way. In any case, a little loss in the efficiency can be disregarded if the "meaning" of the adaptive procedure is intuitively clear.

3) The location parameter problem is only a miniature of really relevant problems of statistical data analysis, and procedures which are directly applicable to a wider class of problems, for example to linear regressions, are more important than others. In this respect, M-estimators seem to be very promising.

K. TAKEUCHI
Faculty of Economics, University of Tokyo, Tokyo, Japan

Insect Methodology

Aphid Technology. With Special Reference to the Study of Aphids in the Field. H. F. VAN EMDEN, Ed. Academic Press, New York, 1972. xiv, 344 pp., illus. $18.50.

Many direct and indirect contributions to science and to society will result from studies undertaken in the International Biological Program. This book, the first on aphid technology, is one of these contributions.

Aphid Technology was conceived at a meeting chaired by Michael Way of Imperial College. Way and the other participants were intent upon establishing an I.B.P. undertaking on the biological control of aphids. It was obvious that a uniform technology would be necessary to operate such a project.

Under the editorship of H. F. van Emden, this book has gone far beyond the original needs of the project. Twelve competent researchers have contributed to the book. Most of the chapters are so informative that even readers without access to the original publications can use the described techniques. Adequate bibliographies are included with each chapter. These are not as recent as might be desired. Of some 750 references, fewer than 30 are later than 1968 and half of these are in chapter 1. This, however, is not a serious defect because the authors selected well.

Information is presented that is not generally available because it has appeared in highly specialized publications. Fortunately some of the authors interpret, evaluate the methods, and add unpublished observations and experiences of their own and others. For example, I have used the technique for preserving aphids on slides that is suggested in chapter 1 and have experienced most of the difficulties listed. Here remedies are given for the difficulties.

It is estimated (table 1) that there are over 3700 species in this diverse group of insects. Despite the enormousness of the task, the biological properties of the aphids are well covered and both the laboratory and the field methods used to obtain this information are given (chapter 2).

Aphids have natural enemies and, since outbreaks occur when these are interfered with or when populations temporarily outstrip them, methods for estimating the effectiveness of natural controls are included (chapter 4).

Many scientists are only beginning to realize the importance and the research possibilities of this group of insects. These researchers need to know how sampling is carried out (chapters 3 and 5), how the environment is measured (chapter 6), how problems of population dynamics are handled (chapter 7), and finally how the data obtained can be understood (chapter 8).

In this book specialists talk to each other, but it should be pointed out that if this were the only contribution the book made it would not be of wide enough interest for review in *Science*. The technology presented here can be applied to many invertebrate groups.

The insects are important. The methods are applicable to other animals. The book is recommended to aphid specialists and to other biologists.

JAMES B. KRING
Connecticut Agricultural Experiment Station, New Haven