each abstract may be kept separately, either pasted on cards or filed in binders (appropriate holes are already punched).

There are about 160 abstracts in this first issue and the eleven journals which are abstracted on a complete or virtually complete basis account for about three-fifths of the total. This is to be expected, but it is even more important to stress the fact that the remaining 40 per cent of the abstracts are from journals that the majority of statisticians would be unlikely to see regularly. This is quite a high proportion.

All in all, the journal seems likely to prove a very useful information service, and it should be particularly appreciated by the professional statistician.

D. G. BEECH

Norman T. J. Bailey: *Statistical Methods in Biology*. London: English Universities Press, 1959. Pp. ix + 200. 25s.

In recent years it has become clear that statistical methods are a very great assistance to biologists. In many branches of biology they are essential. Hence there is a need for books explaining elementary statistics to biologists in a simple straightforward manner, without that air of mystery which so often surrounds the subject in standard textbooks. Some books attempt this, but none so successfully as Dr Bailey's.

The book deals with all the standard concepts and methods: normal, Poisson and binomial distributions, *t*-tests, contingency tables, total and partial correlation and regression, the analysis of variance, experimental design, factorial experiments, randomisation, and sampling procedures. A very useful appendix gives a summary of statistical formulae, with a guide indicating for any ordinary type of data the appropriate scheme of calculation and the tables (either in this book or elsewhere) needed for the final interpretation. The explanations throughout the book are lucid, and the comments shrewd and sensible.

There are a few minor lapses from this high standard, which are, however, almost inevitable in a first edition. For example, the definition of probability on p. 10 is so worded that it fails to give any clear definition at all. The addition and multiplication laws of probability are used on pp. 11 and 12 without much explanation, and the symbol $n!$ is introduced without definition on p. 12. In addition, the author several times recommends the use of Bartlett's test for homogeneity of variance, but only mentions in a rather inconspicuous paragraph that it is sensitive to deviations from normality. The section on contingency tables might be improved by an account of Woolf's G test, as well as χ^2. The example in Table 2, p. 12, would be more plausible in animal than in human genetics (for human families of this kind lacking albinos would be undetected). The recommendation in the second paragraph of p. 129 seems to suggest that it is wrong to make estimates too accurate. Surely it depends on how these estimates are obtained, and what use is to be made of them? An accurate estimate may be useless in a significance test, if its estimated standard error is too big, for a possible significance may then be missed. But in an estimation problem this objection may be less important. These criticisms are, however, only concerned with minor details.

In short, this is just the book for the beginner. It can also be recommended to those who have already learnt to apply statistical methods somewhat mechanically, but wish to understand them better.

However, it is interesting to look at this book from another angle. Here

we have set before us with great clarity a panorama of modern statistical methods, as used in biology, medicine, physical science, social and mental science, and industry. How far does this show that these methods fulfil their aims of analysing the data reliably, and how many gaps are there still in our knowledge? There are four main types of problems which arise, namely those dealing with proportions, means, variances, and degrees of association. In the case of means and proportions the book shows that the position is generally very satisfactory. There are some controversial points, but these make little difference in practice: there is also need for further study of the effect of large differences in variance on some types of analysis of variance procedure. Bailey is very conscientious in giving warnings of the need for caution in interpretation in certain circumstances, such as non-normality in t-tests or small numbers in contingency tables. But it is unfortunate that at present these warnings must be rather vague: the reader will want to know how much allowance to make for failure in the assumptions. (Perhaps non-parametric tests might be useful?) Comparisons of variances are more difficult, since the F and Bartlett tests depend rather critically on the assumption of normality. In the case of measures of association, there is already a formidable mathematical apparatus of regression and correlation coefficients. In practical problems it is often less clear which method to use, and some discussion might be helpful. For example, is a problem most appropriately solved by using the regression of y on x, or that of x on y, or by some intermediate curve? The aim of the experimenter may be concerned here, as well as the mathematical properties of the statistics.

One feature which can puzzle an outsider, and which requires much more justification than is usually given, is the setting up of unplausible null hypotheses. For example, a statistician may set out a test to see whether two drugs have exactly the same effect, or whether a regression line is exactly straight. These hypotheses can scarcely be taken literally, but a statistician may say, quite reasonably, that he wishes to test whether there is an appreciable difference between the effects of the two drugs, or an appreciable curvature in the regression line. But this raises at once the question: how large is 'appreciable'? Or in other words, are we not really concerned with some kind of estimation, rather than significance?

Another feature which requires more explanation is that of using the result of a supplementary significance test to decide the type of analysis. For example, if the variances in two samples do not differ significantly, we use a t-test to compare their means: otherwise some modification is necessary. But what magic is there in some arbitrary significance level, in that the method of analysis should depend discontinuously on whether it has been exceeded or not? Sometimes this difficulty can be resolved fairly simply, as in the case, considered on p. 95, of a test for independence in a number of 2×2 contingency tables which may not be homogeneous. For each table we calculate the expectation and variance of the entry in the top left-hand cell, using the exact distribution. The observed numbers in this cell in all tables are then added together, and so also are the expectations and variances: the square root of the total variance is the standard error of the total. Finally the difference between the total observed and expected is compared with the standard error, to see if there is significant disagreement. Provided the numbers in the individual tables are not too small, this gives a satisfactory test. (It remains valid even if some tables have small numbers, but loses efficiency).

Here are at least some of the gaps which must be filled before the perfect book on statistics can be written. Meanwhile we must be content with a good approximation, and Bailey's book provides that.

CEDRIC A. B. SMITH

James H. Batchelor: *Operations Research: An Annotated Bibliography*. Saint Louis University Press, 1959. Pp. x+866. $10.

It would seem that the two desiderata of any bibliography are an adequate degree of selection of material for inclusion and a comprehensive system of cross-referencing. In this case, the unnecessary inclusion of irrelevant articles has been compensated to some extent by a very useful index.

The criterion for inclusion in this book has been 'that the author or editor has indicated that the work concerns operations research, or that it has been cited in support of such work'. This has resulted in some curious references such as:

1405 R. S. GANDER—Appreciation
JORSA, Jun 1956, 4:3:361.
Appreciation for the generous response to requests for papers.

On the other hand, it has entailed quite a number of omissions. Thus, for example, there is no mention of the work done by Lloyd S. Shapley for the RAND Corporation on the Theory of Games.

So that the reader can judge for himself, I have taken the first ten four-digit random numbers from Fisher and Yates's Statistical Tables that are less than or equal to 4195, the number of references, and have given below the titles, without annotations, of the corresponding references:

0347 EDWARD G. BENNION—Capital budgeting and game theory.
3661 H. STEINHAUS—O prognozie (On prediction).
2616 CARSON B. McGUIRE—Steam locomotive availability and terminal facilities.
1410 H. NEWTON GARBER—Information handling at Westinghouse's Transformer Division.
1457 WELDON B. GIBSON—Techno-Economics—a revised check and balance for management of industrial research.
2042 H. G. JONES, A. M. LEE, D. T. STEER—Oxygen for steelworks use.
3732 LEONARD W. SWANSON—Operations research in business and industry.
2707 MODERN INDUSTRY—Putting your problems through college.
3606 VERNON L. SMITH—Economic equipment policies; an evaluation.
1676 B. HARRIS, A. HAUPTSCHEIN, L. S. SCHWARTZ—Minimum cost decision-feedback systems for detecting signals perturbed by additive gaussian noise.

The annotations are clear and concise; the printing (mimeographed) is, however, a little difficult to read. The references are arranged in alphabetical order of authors' names and an index is provided in a single alphabetical order with entries by author, title, and subject. The references cover the period up to the end of 1957.

It should be noted that there exists another bibliography on operations research which is published by the Operations Research Society of America, covering a rather more relevant area of work; it does not, however, contain summaries of the contents of the articles. Although the industrial statistician will probably be content to thumb through back-numbers of the relevant journals, there is little doubt that either one of these bibliographies could ease the burden of many librarians.

A. MUIR