putrid smells with the low-salt bacon; biochemical changes were accelerated generally at 30°. Coagulase-positive *Staphylococci* were found occasionally in the low-salt bacon kept at 20° but did not multiply; at 30° limited multiplication occurred but other bacteria reached counts 100- to 1,000-fold greater; no coagulase-positive *Staphylococci* were found in the bacon of higher salt-content.

Among the lactic acid bacteria making up the dominant element in the spoilage flora, several genera were distinguished: *Lactobacilli*, Group *D Streptococci*, *Leuconostocs* and *Pediococci*, besides types not precisely identified. The development of large numbers of Group *D Streptococci* is noteworthy—it is clear that these organisms are not a valid index of faecal pollution in this product.

Data were presented to show the gradual disappearance of nitrate and nitrite from the bacon during storage with, occasionally, a peak in nitrite production; and these changes were related to the proportions of nitrate- and nitrite-reducing *Micro-*

cocci under the different conditions. It was remarked in discussion that this bacon contained unusually small quantities of nitrate and nitrite, so that the data could not be regarded as typical.

The striking general feature of the symposium was the contrast in treatment between the fruits and the meats. For the fruits, it was possible to discuss changes in the internal atmosphere of a package with confidence, but not for the meats. Two reasons for this difference may be suggested. First, research on the gas storage of fruits during thirty-five years has provided detailed information about their respiratory activities under a variety of atmospheric conditions and temperatures, but there are few corresponding data for meats. Secondly, while micro-organisms seldom make any significant contribution to the gaseous exchanges in a fruit pack, they sometimes do so with meats; and for the micro-organisms, also, there is a dearth of information about their activities under the relevant conditions. Here are two examples of the need for more basic research on meat. M. INGRAM

ECONOMIC ENTOMOLOGY IN AUSTRALIA

THE annual report of the Division of Entomology of the Commonwealth Scientific and Industrial Research Organization (Australia) for the year 1960-61* records work in progress over a wide front. The work of the Division embraces the whole field of economic entomology but with minimum attention to short-term applied studies and particular emphasis on basic research involving long-term field and laboratory investigations.

In recent years the disadvantages of controlling insect pests solely by chemical means have become increasingly manifest in Australian agriculture as they have elsewhere in the world. Induced resistance to insecticides, the suppression of beneficial species, the accumulation of toxic residues, are making chemical control measures more and more difficult and costly to implement. Many of the insect pest problems involved are of great importance to the economy of Australia, and, as part of a long-standing policy, the Division of Entomology is investigating means of control which will circumvent the difficulties consequent on relying entirely on the use of insecticides.

New approaches are being sought to control such pests as sheep blowfly, cattle tick, codling moth, fruit-fly, phasmatids and various pasture pests. By deliberately manipulating the environment of the pest, 'natural control' factors are being utilized to limit the abundance of some of these pests. For

example, investigations carried out on the control of codling moth by such methods point the way to a possible solution of this and other orchard pest problems through the alteration of favourable breeding conditions by 'pest management'. Rotational grazing, strategic dipping and the use of tick-resistant cattle are ecological measures which may be of increasing importance in the control of cattle tick. The mechanism of insecticide resistance in the housefly and the cattle tick continues to be studied so that insecticides and other control measures may be used to the greatest advantage.

In recent years stick insects (Phasmatidae) have been increasing in importance as pests of forests in New South Wales and elsewhere. A new field station has been established to study the ecology of the species concerned. Other established stations deal with biological control, cattle tick investigations, fruit-fly investigations, pasture pests (which means chiefly the lucerne flea and the red-legged earth mite) and locusts.

The headquarters of the Division in Canberra have a particularly impressive research programme in insect physiology and biochemistry including, among many other projects, the digestion of wool, chitin, and other resistant substances, the chemistry and hardening processes in insect cuticle, the chemistry of insect hormones. Other sections deal with population dynamics, insects and viruses (which include the development of insect tissue culture) and systematics.

V. B. WIGGLESWORTH

* Commonwealth Scientific and Industrial Research Organization, Annual Report of the Division of Entomology, 1960-61. Pp. v+46. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1961.)

PREHISTORY IN NIGERIA

IT should never be forgotten that prehistory as a study continues to a late date in large parts of Southern, Central and West Africa. Even when European traders had opened trading posts at various places along the sea coasts, little information as to what was happening in the interior of the continent filtered through them. Even in Nigeria, which seems to have been influenced by the Portuguese as early as the late fifteenth century, the story of what was taking place in the country was little known outside

it. Modern investigators have been startled by the recent discoveries of really beautiful naturalistic sculptured heads both in terracotta (probably the earlier) and in bronze.

Who were responsible for this splendid art, and who introduced the working in bronze which is certainly not indigenous since the metal is scarcely found in the country? There seem to have been, from time to time, some east-west movements of peoples, and doubtless it is to some folk from Nubia or farther

east that we must look for the origin of cultures, late in time though still prehistoric, in Nigeria. The town of Ife was thought to be the centre of the world. Here, according to Yoruba tradition, the High God came down a chain from heaven with a five-toed chicken and a bowl of sand, which the chicken scattered over the ocean to form land. Fifty years ago Frobenius made a number of investigations at Ife, and desultory discoveries have been made since in the sacred groves. Old Oyo was once the capital of Yorubaland, a site of vast size which until recently had scarcely been touched by the archaeologist. Both these places have now been studied by Frank Willett, who was released by the University of Manchester to work as an archaeologist in the Nigerian Department of Antiquities.

Willett would be the last person to suggest that he had more than scratched the vast site of Old Oyo. Not only is the site very difficult of access, but it has also been completely overgrown. However, a rock-shelter site was excavated and below the

Yoruba-levels occurred one with Pygmy tools and no pottery. Such industries are not unknown in Africa since Magosi times, but the exact age of the finds at Old Oyo are, of course, unknown. Several 'gong' sites were also discovered. Here, exfoliated chunks of rock occur which give out a musical tone when struck. Not infrequently, paintings can be found in the rock-shelters where the 'gongs' are present.

At Ife, Willett has been more concerned with bringing together the knowledge already obtained by various previous investigators. As a result, what is known to date of the early history of Ife, and, to an increased extent, of Old Oyo, is now set out in convenient form. Students of the later prehistory of Yorubaland in Nigeria will do well to get hold of Willett's two articles, namely, "Investigations at Old Oyo, 1956-57, and Interim Report" in the *Journal of the Historical Society of Nigeria* (2, No. 1; 1960), and, "Ife and its Archaeology" in the *Journal of African History* (1, No. 2, 231; 1960).

M. C. BURKITT

INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH

A NEW international journal, devoted entirely to problems of production in industry, has been launched by the Institution of Production Engineers. The first issue reaches a high standard and contains a number of articles which should prove of value to all industrial engineers*.

Of particular significance is a note submitted by C. Gregory of the Department of Statistics, University of Melbourne, indicating a method of estimating the precision of time-study observations. In conventional time-study practice the work content of a job, or element of a job, is expressed in terms of the time that the job should take at a prescribed rate of working. The time-study engineer bases this time value on observations of performance of the actual job, and is handicapped by the fact that he cannot normally require the job to be carried out at the prescribed rate of working, even if he could define it precisely. He has to take observations at the prescribed rate of working that he happens to see.

The method adopted is to time the job on several occasions, each time independently assessing the rate of working. Of the several ratings scales in use, probably the most common is that which assigns a rating of 60 to a rate of working which, in terms of the effort involved, is equivalent to walking at 3 m.p.h. The time taken to do a job at a rating of 60 is known as the 'normal time', and this is generally accepted as a measure of work content. Since, *inter alia*, production planning and incentive payments are based on this measure, the need for an accurate estimate of work content is apparent.

The method used is to convert each observed time to 'normal time' by multiplying by the ratio of the estimated rate of working to the normal rate. Thus, if the observed time is T and the estimated rating is R , the estimate of the normal time is $RT/60$. In theory, the reciprocal of the rating is directly proportional to the time taken. There are several sources of error in the observed rates of R and T , by far the most important of which is the error in rating.

The subjective nature of the procedure makes errors inevitable, but certain steps can be taken to ensure uniformity not only between several time-study engineers, but also for an individual over a period of time.

A series of observations may be taken of a job where the definition is clear, the raw material is uniform, and timing may be obtained accurately. The job of walking a measured distance is an example, which has the advantage of a generally accepted normal time. The job is repeated a number of times varying the rating over the practical range of about 40-100. An individual time-study engineer records his ratings, and if y , the reciprocal of the rating, is plotted against the time T , the relationship should be a straight line through the origin. The slope of the line should be $(60/W)$, where W is the accepted normal time of the job. Comparison of the regression line $y = a + bT$ with the theoretical line $y = (60/W) - 1T$ will indicate the degree of agreement between the theoretical rating scale and the engineer's conception of it.

The first hypothesis to be tested is that the value of y corresponding to $T = W$ is 60^{-1} , that is, the engineer has the correct concept of normal rating. Confidence limits for the regression value of y corresponding to $T = W$ are calculated, and, if these include the value $y = 60^{-1}$, it can be assumed that the correct concept of normal rating is being used. Having established this, it is then reasonable to ask whether or not the line which is apparently being used is of the correct slope. A common fault, and one which a time-study engineer would recognize, is 'flatness', that is, a tendency to underestimate high rates of working and overestimate low rates, resulting in a smaller gradient than the theoretical line. This hypothesis $B = (60/W)^{-1}$ can be tested. If the tests $\alpha = 0$ and $\beta = (60W)^{-1}$ had been used, it would have been possible to reject both hypotheses while still having the correct concept of normal rating. This would, in fact, occur frequently.

The above tests have measured 'concept of normal' and 'flatness'. A third measure of interest which can be derived from the regression analysis is that of 'consistency' and Gregory suggests a new equation to measure this.

T. H. HAWKINS

* *The International Journal of Production Research*, Vol. 1, No. 1 (November 1961). Pp. x+1-65. Published quarterly. Subscriptions: Members of the Institution of Production Engineers, 84s. per annum; Non-members, 105s. per annum. (London: Institution of Production Engineers, 1961.)