the New South Wales State abattoirs for his co-operation in obtaining experimental material. The work has been supported by grants from the Planned Parenthood Federation of America and the Wool Research Fund.

I. G. WHITE
J. C. WALLACE

Department of Veterinary Physiology,
University of Sydney.

¹ Mann, T., and White, I. G., *Biochem. J.*, **65**, 634 (1956).

² Dawson, R. M. C., Mann, T., and White, I. G., *Biochem. J.*, **65**, 627 (1956).

³ White, I. G., Blackshaw, A. W., and Emmens, C. W., *Aust. Vet. J.*, **30**, 85 (1954).

⁴ Bishop, D. W., Proc. Third Inter. Cong. Anim. Reproduct., Cambridge, Sect. I, 53 (1956).

⁵ Olds, D., and Van Demark, N. L., *Fertility and Sterility*, **8**, 345 (1957).

⁶ Dawson, R. M. C., *Biochem. J.*, **62**, 689 (1956).

⁷ Mann, T., *The Biochemistry of Semen* (Methuen, London, 1954).

Lipoprotein Composition of the Film lining the Lung

SMALL bubbles ($\sim 50\mu$ diam.) in air-saturated water usually contract and disappear within a few minutes. In similar circumstances, however, small bubbles derived from animal lungs are stable. This is due¹ to their surface tension being reduced to 0.05 dyne/cm. or less by an insoluble surface film. This film is derived from the original film lining the lung alveoli; its (oven-dry) mass is about 6.4×10^{-7} gm./cm.². *In situ* it annuls the tension of the sharply curved alveolar surface, which would otherwise give rise to transudation from the blood or to atelectasis². For various reasons the film was at first thought to consist of mucoprotein.

Specimens of the substance lining the bubbles have now been isolated. Water was forced down the main bronchus into the excised lung of a cow, and was then allowed to well out, laden with bubbles. These bubbles were then washed with ten changes of water, so as to remove all dissolved matter and suspended solids. A sample of the washed froth, dried at 40° C., left a pale brown solid of waxy consistency.

This residue was examined in the form of a cast film on a potassium bromide plate by infra-red absorption spectroscopy, a model 137 Perkin-Elmer spectrophotometer being used. The spectrum, and that of a mixture of purified egg lecithin (95 per cent) and gelatin (5 per cent) for comparison, are shown in Fig. 1. Qualitatively, the curves are identical. The relative intensities of the ester carbonyl bands at

Fig. 1. Percentage transmission (on arbitrary scale) of infra-red radiation through (curve 1) lung bubble lining substance and (curve 2) mixture of 95 per cent lecithin and 5 per cent gelatin

5.75μ and the amide bands at 6.1μ and 6.5μ in the two spectra suggest that the proportion of protein in the bubble lining is about 1 per cent. The presence of small amounts (< 1 per cent) of other lipids or of carbohydrates cannot be excluded, but it is clear that the lining film consists in the main of a lecithin-protein complex; the very low value of the protein content suggests that some of the lecithin present may be adventitious.

Small stable bubbles have also been obtained from other sources. They are formed, for example, when dry powders of a bacterial lipopolysaccharide³, of thromboplastic lipoprotein⁴, or of acetone-washed egg yolk, are wetted. They may also be obtained by wetting acetone-dried or freeze-dried tissues (muscle, brain, etc.).

Lipoprotein complexes are known to form readily^{5,6}. When, for example, lecithin (4 gm.) and gelatin (1 gm.) are ground to a paste with water, and the paste is dried with acetone, a leathery porous substance results; this, when wetted and squeezed under water, yields stable bubbles. It may therefore be that some of the bubble-stabilizing substances found in dried tissues are artefacts which are not present *in vivo*.

R. E. PATTLE
L. C. THOMAS

Chemical Defence Experimental Establishment,
Porton Down,
near Salisbury, Wilts.

¹ Pattle, R. E., *Physics in Medicine and Biology*, **5**, 11 (1960).

² Pattle, R. E., *Nature*, **175**, 1125 (1955); *Proc. Roy. Soc., B*, **148**, 217 (1958); Symposium on Inhaled Particles and Vapours, Paper 12 (1960) (Pergamon Press, London, 1960).

³ Davies, D. A. L., *Biochem. J.*, **63**, 105 (1956).

⁴ Cohen, S. S., and Chargaff, E., *J. Biol. Chem.*, **140**, 689 (1941).

⁵ Chargaff, E., *Advances in Protein Chemistry*, **1**, 1, edit. by Anson, M. L., and Edsall, J. T. (Academic Press, New York, 1944).

⁶ Schjeide, O. A., and Urist, M. R., *Nature*, **188**, 291 (1960).

Effect of Exposure to Sun and Exercise on Heat Tolerance Coefficient in Murrah Buffalo Calves

IN continuation of our previous work¹, this experiment was designed to find out the effect of exposure to sun and exercise on heat tolerance coefficient. Eight Murrah buffalo calves, varying between 8 and 12 months of age, constituted the experimental material. These calves were randomly divided into two groups of four each. One group was exposed to sun, while the other ran at a speed of four miles per hour as recorded by the distance covered in a given time. The calves in each group acted as their own control. These experiments were conducted at 12 noon for half an hour on six consecutive hottest days in the month of May. The atmospheric temperature during test hours ranged between 92 and 105° F. and relative humidity between 28 and 47 per cent. The conditions of management of these calves has been given in detail².

The heat-tolerance coefficient was calculated daily for each animal, as control and after exposing them to sun or exercise, by Rhoad's formula³. The variations were analysed statistically⁴.

Table 1 indicates mean value, variance, standard deviation, and coefficient of variation of the atmospheric temperature, relative humidity and heat-tolerance coefficient. There seems to be a degree of consistency in the mean values of the controls of the