

thrust against the vertebral column, be correlated with the absence of a functional sacrum? Secondly, as Piveteau appreciated, and as the nature of the caudal vertebrae suggests, the tail was much longer than the remains described by him. How can such an organ, so clearly incompatible with the salientian features listed above, be considered to have combined with them to form an efficient locomotory system?

These morphological enigmata can logically be resolved by regarding *Protobatrachus* as a tadpole in the later stages of metamorphosis. The tail with its ossified vertebrae is now explicable as a larval, locomotory organ destined for resorption at metamorphosis as in the case of *Megophrys major*. This view can also account for the moderate lengths of the ilia and hind limb bones and for the absence of a sacrum, for these elements complete their development and are knit into a functional unit only towards the end of metamorphosis when, after the resorption of the tail, they form the locomotory organ of the adult. It may explain, too, the paucity of the anterior cranial elements for, at this stage, they would not be ossified to any degree.

A detailed account of the structure and development of the vertebral elements in *Megophrys major*, with a discussion on anuran phylogeny, will be published elsewhere.

I. GRIFFITHS

Department of Zoology,
Birkbeck College,
London, W.C.1. Oct. 18.

¹ Piveteau, J., *Ann. Paleontol.*, **34**, 135 (1937).

Effect of Supplementary Choline and Methionine on the Response of Chickens to Folic Acid

THE wide range of folic acid requirements of chickens reported by various authors¹ is partly explained by considerations of dietary and genetic factors known to affect requirements. Excess intake of choline² and glycine³ has been shown to depress growth or produce anemias which can be prevented by feeding supplementary folic acid. In experiments at this Station, the effect of choline on folic acid requirements has been confirmed, and supplementary methionine has been shown to have a similar effect.

Two experiments, observing the effect of supplements of 0.2 per cent *dl*-methionine and 0.066 per cent choline (providing an equivalent quantity of labile methyl groups as 0.2 per cent methionine) on the response to supplementary folic acid, have been completed using White Leghorn chickens up to six weeks old. The basal diet contained crushed wheat, meatmeal and whey powder. Dietary supplements and results are summarized in Table 1.

The response to methionine added as the sole supplement or together with folic acid in experiment 1, and in the presence of both choline and folic acid in experiment 2, shows that the diet was deficient in methionine and that the response was independent of the role of methionine as a methyl donor.

In experiment 1, the absence of response to folic acid alone, and the response following addition of folic acid to the diet supplemented with methionine, indicate that the chicken's requirements of folic acid were higher following methionine supplementation. In experiment 2, the growth depression following supplementation of the diet with choline and the effect of addition of folic acid in reversing this

Table 1. EFFECT OF METHIONINE AND CHOLINE SUPPLEMENTS ON THE GROWTH RESPONSE OF CHICKENS TO A FOLIC ACID SUPPLEMENT

Exp. 1	Supplements to basal diets			
	Nil	4.4 p.p.m. folic acid	0.2% <i>dl</i> -methionine	4.4 p.p.m. folic acid + 0.2% <i>dl</i> -methionine
Relative weights at 6 weeks (difference for significance $P < 0.05$, 5 per cent)	100	98	112	129
Exp. 2	Supplements to basal diets			
	Nil	0.066% choline	0.066% choline + 4.4 p.p.m. folic acid	0.066% choline + 4.4 p.p.m. folic acid + 0.2% methionine
Relative weights at 6 weeks (difference for significance $P < 0.05$, 5 per cent)	100	83	101	106

response suggest that the methionine-folic acid interaction observed in the first experiment was due to the labile methyl group in the molecule. These results indicate that folic acid is required for the catabolism of excess methyl groups as well as in transmethylation processes. As glycine also provides labile methyl groups³, the effect of folic acid in reversing the toxicity of glycine further confirms this role of the vitamin.

Further details of these experiments will be published elsewhere.

M. W. McDONALD

Poultry Experiment Station,
Seven Hills,
New South Wales.

¹ Duckworth, J., and Ellinger, G. M., *Brit. J. Nutr.*, **3**, 253 (1949).

² Melas, V. H., Pearson, P. B., and Sherwood, R. M., *Proc. Soc. Exp. Biol. Med.*, **62**, 174 (1946). Davis, J. E., *Amer. J. Physiol.*, **142**, 402 (1944); **147**, 404 (1947).

³ Nabel, E. C., Sundt, M. L., Cravens, W. W., and Snell, E. E., *Poultry Sci.*, **30**, 925 (1951). Macklin, J. J., Denton, C. A., and Bird, H. R., *J. Nutr.*, **46**, 389 (1952).

⁴ Arnstein, H. R. V., and Neuberger, A., *Biochem. J.*, **55**, 259 (1953).

Science Babel

WHILE agreeing with the points made in the editorials of November 5 and 19, I may perhaps say that you reveal more than I think you were aware of when writing "a nation using . . . a minority language cannot escape bilingualism if it desires to attain high standards of culture and scholarship". If the sentence is understood as referring to the use of minor languages for publishing, it is indisputable; but all too frequently it turns the other way—scholars within the major language groups neglecting the literature outside their own language. In fact, if we take into consideration languages read as well as written, no language group can to-day avoid even trilingualism if it wishes to attain the highest standards of culture and scholarship.

To illustrate this point I have made a small survey of world scientific literature within a comparatively narrow field, so that the authors have had the theoretical possibility of drawing from the same, rather well-circumscribed scientific heritage. Two botanical journals were used from each country or group of countries¹, one with a background of ecology, the other more general. The most recent issue(s) was (were) used, and at least ten papers were analysed. No issue was older than 1952.

The idea was that, whereas it is difficult to calculate how much scientific material is presented in different languages, it is comparatively easy, by studying the reference lists at the ends of the papers, to find out what is really utilized by fellow scientists.