A Small Grading Temperature Apparatus for Entomological Use

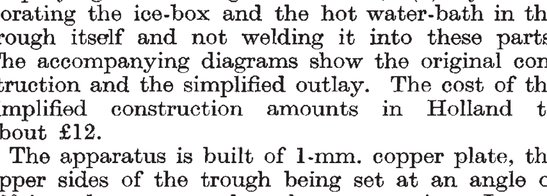
I HAVE devised an inexpensive grading temperature apparatus (or 'multiple incubator'), especially for a range of below-room-temperatures, for example, + 7°, + 13°, + 17·5° C., which otherwise would require three different refrigerators with thermo-regulation. This is based on the 'Brueckenthermostat' of Zwoelfer[1], and although much simpler, gives excellent results.

The original grading temperature apparatus consists of a copper trough, divided into six (or eight) compartments. One end is welded into an ice-box, the other into a water-bath, in which the temperature is controlled by a thermostat. The copper trough, which is insulated, lies on one side ⊏, and each compartment is closed by a small door, which contains three or four layers of glass. The temperature-range of an apparatus of this construction usually covers the temperatures 7, 13, 17·5, 22, 26·5 and 32° C. Its cost amounts, in Holland, to about £300.

In order to cut costs in materials and man-hours, it was decided to simplify the outlay in several ways : (1) temperatures above mean room temperatures are easily obtained by a simple incubator with thermostatic control ; (2) the copper trough is kept upright (⊔), thus preventing cold air flowing from the compartments when the doors are opened, and simplifying the closing mechanism ; (3) by incorporating the ice-box and the hot water-bath in the trough itself and not welding it into these parts. The accompanying diagrams show the original construction and the simplified outlay. The cost of the simplified construction amounts in Holland to about £12.

The apparatus is built of 1-mm. copper plate, the upper sides of the trough being set at an angle of 90° in order to strengthen the construction. It contains only four compartments for below-room temperatures, which shortens the apparatus considerably, thus cutting costs for raw material. The trough is placed in a wooden cradle and insulated with 'Excelsior', this being the cheapest insulating material available. The trough is closed with 'Celotex' board, each piece of board covering two compartments. Finally, a blanket is put on top of the whole apparatus. The thermometers, one in each compartment, protrude through the insulation at one side of the cradle.

The ice-box needs filling twice a day, thus keeping the first compartment at 7 ± 0·5° C. ; the central compartments show an even smaller deviation. The hot water-bath may be controlled by a thermostat at the temperature wanted. The simplified apparatus, constructed at the Zoological Department of the University of Utrecht, is mounted in a cellar, at a mean temperature of 18 ± 0·5° C., the fluctuations in the apparatus being about the same order, without any thermostatic control being used.



Upper diagram, usual construction of grading temperature apparatus ; lower diagram, simplified construction of apparatus

A 15-watt electric light bulb, which is built into the water-bath, keeps the hot side of the apparatus at 25·5° C., giving a range of 7, 13, 17·5 and 22° C.

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[1] Zwoelfer, *Z. Angew. Ent.*, **19**, 497 (1932).

Statistical Analysis of Results for Successive Tests on the Same Organism

A RECENT paper by Emik[1] demonstrates a method of dealing with counts of trichostrongylid eggs in the fæces of sheep. The method given is fundamentally wrong and in fact makes the paper so misleading that it seems worth outlining a more appropriate statistical treatment. The data were accumulated in a survey of the worm-egg numbers in the fæces of the lamb flock at the University of California. Trichostrongylid eggs were counted in fæces samples by a technique modified from that of Caldwell. Samples were taken once a week for twelve weeks and duplicate dilutions examined.

The counts per 0·02 gm. of fæces (x) were transformed to $\sqrt{x + \frac{1}{2}}$ and the transformed data used to calculate the variance of the differences between duplicate dilution counts. This variance agreed well enough with the theoretical variance, so the next step was to add together the duplicate counts on each sample and transform this total $(x_1 + x_2)$ to $\sqrt{x_1 + x_2 + \frac{1}{2}}$. No reason is given for making this new transformation ; it does not seem worth the extra trouble involved. The variance of these transformed data was then calculated and analysed.

The fundamental error in this analysis is not uncommon in biometric literature[2,3] and has been attacked by Anscombe[4] and by Cochran[5] ; it arises from regarding successive tests on the same animal as independent. The twelve weekly counts on the same sheep have been treated as the items of an independent variate called 'weeks' ; the variance has been analysed into a portion due to variation from week to week and into portions due to the interactions of 'weeks' with the main effects. Not only is the assumption of independence a logical error, but also it is quite clear that in this case the 'weeks' portion of the variance consists very considerably of co-variance between one week and the next.

The practical consequences of this error are twofold, namely, that the error variance becomes too small, giving undue significance to items that are compared with it in the F-test ; the second consequence is that the statistician is led into examining factors which have no practical meaning and into making statements such as "the sex × weeks interaction was not significant within the classes, but the class × weeks interaction was significant within the sexes".

On the data given by Emik (Table 1) the appropriate analysis of variance should be the following :

	Source of variation		Degrees of freedom
1	Sex		1
2	Breed and sires		6
	2*a* Sires within breed	2	
	2*b* Class of breed	1	
	2*c* Breed within class	3	
		6	
3	Sex × 2*a*, 2*b* and 2*c*		6
4	Error		87
	Total		100