inspection of the flood and rain records does not reveal an obvious correlation with populations of *Locusta* there, and the population does not seem to fluctuate very rapidly, but a proper investigation might give valuable results. In the same (Niger) area, there have now been three successive years of locally low rainfall and there has just been the largest upsurge of red locusts ever recorded there.

Forecasting of red locust populations is only one of the new techniques in use in the International Red Locust Control Service. It is linked with operational researches by J. H. Lloyd and W. N. Yule[1,15] which have revolutionized control, and with quantitative assessment of populations developed by C. C. Scheepers and others[2,16]. The result is a spontaneous non-Parkinsonian[17] reduction in costs, accompanied by a great increase in efficacy.

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July 18.

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Survival of Frozen Fat Body Cells in an Insect

Intracellular freezing is usually considered fatal to animal cells[1,2], whereas extracellular freezing can be tolerated if not too severe or prolonged[2,3]. The latter is well documented, but the former is based on negative evidence—the failure to obtain survival of cells known to have been frozen internally. Although mammalian red blood cells and spermatozoa are now commonly kept alive at very low temperatures by adding protective substances such as glycerol to the media, it is uncertain from the literature whether or not the cells themselves are frozen. Frozen mammalian tissue grafts have proved only partly viable, and it has been suggested that those cells that died may have done so because they were frozen internally[4].

In southern Alberta, larvæ of the goldenrod gall fly, *Eurosta solidaginis* (Fitch), hibernate above the snow during much of the winter, freezing and thawing many times without harm. The cells of the fat body are very large, 0·2–0·35 mm. in diameter, and contain many small colourless droplets of oil. Because of their large size, frozen fat cells were readily observed and manipulated in a cold oil bath (−15° to −25° C.) under a dissecting microscope. Observation was aided by injection of the larvæ with fast green dye in Ringer's solution, which coloured the hæmolymph but not the fat body. The following observations showed that the fat cells froze internally when the larvæ were supercooled and frozen as they would be in Nature. (1) Probing with a cold needle revealed the interior of the fat cells to be solid in the sense of being firmly granular or mealy. (2) Bits of cell contents raised to the warmer surface of the oil bath changed, upon melting, from a whitish, irregular mass to a light amber liquid sphere. (3) The fat cells retained their subspherical shape when frozen and, as nearly as could be judged, their original size, showing that no appreciable amounts of water were removed as would be expected if extracellular freezing alone had occurred.

Thawing after freezing causes many of the oil droplets to coalesce; if freezing has been severe or repeated, fusion of most of the droplets into one or two large globules occupying most of the cell produces a striking change in its appearance. (This 'globulation' has also been observed by the writer in the fat body of many other species and in the yolk of grasshopper eggs.) The size of the globules is roughly proportional to the severity of freezing, or to its repetition. *Eurosta* larvæ normally acquire globulated fat bodies during the winter, without detriment to their survival. To determine whether the condition persisted or was repaired during later development, larvæ were kept under observation after freezing. Preliminary assessments of globulation were made through the transparent cuticle on fat cells near the surface. No changes were seen up to the time that puparium formation and pigmentation obscured the view; thereafter puparia, pupæ, and adults were dissected, but at no stage were there changes in the size and numbers of oil globules. Hence globulation does not appear to affect the cells adversely in this species.

The possibility that the solidification and liquefaction within the fat cells was of lipid rather than aqueous nature was contra-indicated by the following observations. (1) When frozen fat cells and hæmolymph were slowly warmed together, they melted at the same temperature. (2) Large oil globules that had been formed by previous freezing and thawing could be detected in frozen tissue as colourless spheres. Cooling the oil to as low as −50° C., either *in situ* or after squeezing it out of the cells into hæmolymph, did not solidify the oil or make it less transparent.

It is apparent from these observations that the fat cells of cold-hardy *Eurosta* larvæ customarily freeze internally without harm to themselves or to the larvæ, despite the physical disruptions caused by freezing, melting, and the coalescence of their oil droplets.

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BACTERIOLOGY

Transduction in *Pseudomonas aeruginosa*

Transduction has been demonstrated for *Salmonella* with phage *P*22[1], for *Escherichia coli* with phage *P*1[2] and phage 363[3] and a transduction-like process has been described for *Pseudomonas aeruginosa*[4]. Bhaskaran[5] has described a process of genetic recombination in *Vibrio cholerae* which apparently involved transfer of genetic material by a bacteriophage.

In these experiments, a phage, *P*110, active on strain 1 of *Pseudomonas aeruginosa*[6], has been shown to transduce various auxotrophic markers to that strain of *Pseudomonas*. The phage was propagated on a donor prototrophic strain of 1 and allowed to infect various auxotrophic mutants of this strain. The transduction was detected by the production of prototrophs.