tances apart, and applies it to the attraction of bodies near the earth, then it makes a difference where within the earth the seat of attraction lies.

So it was not until about 1685 when Newton demonstrated the beautiful propositions related to attractions within and without the earth, including that of the zero force of attraction of a homogeneous shell upon any point within the shell, that he could locate the earth's seat of attraction definitely at its center. Then he was able to announce his law of gravitation.

When all our attempts to free the radiometer of the pernicious effects of electrostatic fields had failed, I bethought me of this beautiful theorem and its electrical analogue that the force within a closed conductor is zero. I suggested to my colleagues that we insert a brass tube, of rather small radius, centrally within the quartz tube which contains the radiometer. Small holes are bored through the brass tube to admit radiation and the viewing of the vanes, and another opposite the reflecting mirror. We feared, indeed, that the holes might introduce disturbance, because the shielding would be not quite complete.

To our great delight this device works favorably. No electrostatic fields we can create on the outer quartz tube seem to greatly modify the time of swing of the radiometer suspended within the brass shield. Thus Sir Isaac Newton's beautiful theorem has saved the day for the radiometer of highest sensitiveness.

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A 2,3-BUTANEDIOL-GLYCEROL FERMENTATION[1]

FORD'S strain of *Bacillus subtilis* (A.T.C.C. 2586) produces 2,3-butanediol and glycerol as the main products when grown at 30° C. on a glucose solution (3 per cent. glucose, 1 per cent. yeast extract, 1 per cent. $CaCO_3$) at pH 6.0–6.8 under anaerobic conditions. For each 100 mols of glucose fermented 57 mols of 2,3 butanediol, 40 mols of glycerol, 20 mols of lactic acid, 13 mols of ethanol and 5 mols of formic acid were found. The glycerol was isolated and identified as the tribenzoate and tri-*p*-nitrobenzoate; in each case a mixed melting point determination was made with an authentic sample. Ethanol was similarly identified as the *p*-nitro benzoate. Lactic acid was isolated as lithium lactate and identified by quantitative oxidation to acetaldehyde in boiling, dilute permanganate solution. The 2,3-butanediol was purified by distillation. Judging from its physical properties it is a mixture of the *levo* and *meso* isomers in approximately equal amounts. It was identified by bromine oxidation to diacetyl, the latter being identified by the melting point of its *bis*-phenyl-hydrazone. To the best of our knowledge this is the first time any species of bacteria has been shown to yield glycerol as a product of carbohydrate dissimilation.

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[1] This work will be described more fully in the *Canadian Journal of Research*.

IS CASTE DIFFERENTIATION IN ANTS A FUNCTION OF THE RATE OF EGG DEPOSITION?

THE problem of caste differentiation in ants has been a moot question for many years. William Morton Wheeler, in a posthumously published book,[1] describes the situation as follows:

> It must be admitted—that the brood relationship in ants is so elaborate, the difficulties of submitting it to controlled experimental investigation so great, and observations of it so conducive to conflicting "explanations" that the controversy concerning the determination of castes in these insects has persisted with little change for years. This is shown by the attitudes of the two very eminent myrmecologists, Emery and Forel. Although both were thoroughly conversant with all the relevant facts established during their lifetimes, Emery, nevertheless, remained an intransigent trophogenist throughout his career, and Forel—was as thoroughly convinced that the castes are determined in the egg.

In view of this situation it is not surprising that it is through studies of non-social groups of Hymenoptera closely related to the ants that a possible answer to the problem of caste determination has been revealed, an answer that appears to reconcile the views of Emery and Forel.

Recently several students of the Hymenoptera have made observations which suggest that the castes are determined in the egg by trophogenic means.[2,3,4]

The amount of nutriment in a normal hymenopterous egg may be either sufficient or insufficient for the complete development of the embryo. The eggs of certain endoparasitic species appear to be devoid of nutriment. In the case of the chalcidoid *Coccophagus capensis* the egg contains enough nutriment for the development of the male embryo but not enough for the development of the female embryo. The female embryo obtains the necessary additional nutriment from the host by means of a trophic membrane.[5]

[1] William Morton Wheeler, "Mosaics and Other Anomalies Among Ants." 95 pp. Cambridge: Harvard University Press. 1937.
[2] W. Goetsch, *Naturwissenschaften*, 25: 803–808, 1937.
[3] Rudolf G. Schmieder, *Ent. News*, 50: 125–131, 1939.
[4] P. W. Whiting, *Jour. Hered.*, 29: 189–193, 1938.
[5] Stanley E. Flanders, *Jour. Econ. Ent.*, 35: 108, 1942.

Even within the individual female the ripe ovarian eggs may vary in amount of nutriment. This variation appears in the deposited eggs.[6,7] In such eggs the loss in nutriment is an effect of the oosorptive or egg degenerative process. In many species of Hymenoptera, the processes of oogenesis and oosorption form a cycle. Only by ovulation, that is, passage into the oviduct, does the ripe ovarian egg escape the final effect of oosorption. In the chalcidoid *Metaphycus helvolus* the generation of an egg requires three days, its degeneration less than one day at temperatures about 80° F.[6]

Since oogenesis and oosorption, when the female is in a gravid condition, form a continuous process and since this proceeds at a relatively constant rate, the amount of nutrient removed from each egg and the proportion of nutrient deficient eggs deposited would vary with the rate of egg deposition. Schmieder[3] in a study of the dimorphism of the ichneumonid wasp, *Sphecophaga burra,* suggested that it might be the rate of egg deposition which determined which of two inherently possible lines of development was followed.

Oosorption probably is the basis of polymorphism in the ant. Differential rates of egg deposition account for the variation in size of the eggs deposited by a queen. Since it seems certain that trophic conditions in the ripe ovarian egg determine the line of development, the rate of egg deposition may determine the proportion of castes developing from any sequence of deposited eggs.

In ants, as in many of the parasitic Hymenoptera, it is probable that the sex ratio of a sequence of eggs is also determined by the rate of their deposition, provided of course, the parent female is mated.[8] In such species the higher the rate of egg deposition the higher the proportion of eggs escaping fertilization and therefore the higher the proportion of males.

It follows that if differences in the rate of egg deposition by the queen ant determine the occurrences of the various castes, the males and queens will be produced when the rate is high, that is, when the ripe eggs are retained in the ovary for a relatively short time, while the sterile female castes and associated anomalies will be produced when the rate is low, that is, when the ripe eggs are retained in the ovary for a relatively long time.

The number of eggs deposited by the queen during any given period is regulated, in part, by the number of ovarioles which make up her ovaries and, in part, by the environment, an environment which may include the several castes in varying proportions.

The hypothesis, as here advanced, is that rate of egg deposition (in so far as it affects the nutrient content of the egg) determines caste differentiation. Although based on studies of parasitic Hymenoptera this hypothesis may prove to be a suitable "explanation" for the sequence of castes of any Aculeate colony established by a single queen. The first brood always consists of small workers, those of succeeding broods gradually increase in size, and only after the largest workers have appeared are the queens and males produced.[9]

It is significant that the bee (*Melipona* sp.) has two sharply defined female castes in spite of the fact that all members of the colony undergo uniform treatment during their post-embryonic development.[9]

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[6] Stanley E. Flanders, *Ent. Soc. Amer. Ann.*, 35: 251–266, 1942.

[7] Anna R. Whiting, *Am. Naturalist,* 74: 468–471, 1940.

[8] Stanley E. Flanders, *Ent. Soc. Amer. Ann.*, 32: 11–26, 1939.

[9] William Morton Wheeler, "The Social Insects." 378 pp. New York: Harcourt, Brace and Co. 1928.

STAFFING SCIENCE DEPARTMENTS AFTER THE WAR

IN SCIENCE, for February 16, 1945, M. H. Trytten expresses forcefully the frequently heard fear that it will be difficult for universities to staff their science departments after the war because of competition with industry.

It is undoubtedly true that industry can afford to pay much higher salaries and sometimes also to provide better research facilities. I think, however, that universities need not be afraid of the future if they remain true to their traditions. They will still be able to attract first-rate scientists, not with money but by offering them time and leisure, the stimulating contact with students that forces them to revise their views constantly and to express them with clarity, the inspiring intercourse with colleagues from other faculties, physicians, philosophers, historians, sociologists, the long summer vacations that permit them to travel and continue their work in other institutions and countries, all the many imponderables that constitute what used to be called the academic atmosphere.

This presupposes, however, that universities have the courage and vision to reorganize their administrative and departmental structure and to resist trends that tend to turn them into speed-up, high-pressure schools with purely utilitarian purposes. No serious researcher will accept the position as head of a university department, if he knows that he will be crushed with petty administrative duties or with a load of routine teaching. Men should not be selected to fit a job, but the position should be made to fit a man, because it is not regulations and curricula that con-