pollinated continued to develop and formed seed pods; but later buds turned yellow in colour, shrivelled and dropped before opening. At the same time the bracts on the inflorescence stalks started rapid growth, eventually forming a dense mass, and finally, after a few weeks, leafy shoots were observed to develop.

It was found that these vegetative shoots could be rooted[1] in sand and produced plants which did not appear to differ in any respect from those raised from seed, and which formed curds at the normal season for the variety.

The following year a series of curd cuttings were rooted and grown on until the first flower buds were opening, when some of the plants were transferred to a glasshouse where the temperature ranged from 60° to 80° F. The remainder of the plants were kept in the unheated glasshouse where the temperature at the time of the year ranged from 40° to 70° F. After four days the flower buds on the plants at the higher temperature were observed to be aborting, with rapid development of bracts. The buds on the plants at the lower temperature opened normally, were pollinated and produced seed.

The results appear to follow closely those obtained with Danish Ball Head cabbage, in which flowering is suppressed at an average temperature of 60° F.[2].

When breeding cross-pollinated species it is often desirable to be able to return to the original parent material. It is also of considerable value to be able to establish clones. This has not previously been achieved with cauliflower and broccoli. By removal to a temperature of 70°–80° F. for a relatively short period, plants which have already formed curds can be returned to a vegetative state. Large numbers of plants can then be obtained from a single curd by rooting the leafy shoots which develop after flower suppression at the high temperature.

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[1] Graham, R. D., and Stewart, L. B., *Trans. and Proc. Bot. Soc. Edin.* 30, Pt. 3 (1930).

[2] Miller, J. C., *Bull. Cornell Univ. Exp. Stat.* (1929).

Could an Arms-Race end Without Fighting?

Dr. L. F. Richardson has attempted (*Nature*, Sept. 29, p. 567) to foretell the result of the arms-race by means of differential equations. While his conclusions are most interesting, has he investigated the effect of assuming slightly different initial equations which would appear at least as reasonable as those he adopts? The following argument suggests a somewhat altered form for his equations (1) and (2).

There would not appear to be anything particularly absolute in reactions to any given arms expenditure; what one generation considers heavy, a succeeding generation considers but slight. Hence all terms in the equations should imply influences relative to the general rate of expenditure, not to the absolute rate. This implies that the equations should be homogeneous in x and y—thus throwing doubt, in the case of equation (1), on the terms $ky\{1 - \sigma(y - x)\}$ and g. Since Dr. Richardson assumes $g = 0$, this term need not be discussed further; but consider the effect on the former term of a general increase of arms expenditure when, initially, $\{1 - \sigma(y - x)\} = 0{\cdot}5$. A doubling of expenditure by both sides would then reduce the 'defence' reaction of the first side to zero—a result which seems scarcely likely.

A more reasonable form of equation (1) would seem to be:

$$\frac{dx}{dt} = ky - \sigma(y - x) - \alpha x. \qquad (a)$$

Assuming that a similar equation, with identical coefficients, governs the rate of increase of expenditure of the second side, the two simultaneous equations lead simply to:

$$x + y = (x_0 + y_0) \exp[(k - \alpha)(t - t_0)] \qquad (b)$$

$$\frac{x - y}{x + y} = \frac{(x_0 - y_0)}{(x_0 + y_0)} \exp\ [2(\sigma - k)(t - t_0)], \qquad (c)$$

where x_0 and y_0 are the values of x and y at time t_0. If at any time (say, when $t = t_0$), $(x + y)$ is increasing, then $k > \alpha$, and $(x + y)$ continues to increase exponentially. If $\sigma > k$, that is, if the 'submissiveness' coefficient σ overrides the 'defence' coefficient k, the relative difference in arms would increase, again exponentially (equation c), and one might perhaps presume that there would be no war. If the reverse were true, the armed strengths of the two sides would become relatively almost equal, and one would probably regard war as increasingly inevitable.

On this analysis, therefore, an arms-race would lead to war unless there were an appreciable degree of 'submissiveness'—a result which is perhaps scarcely surprising.

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Mr. M. R. Horne's letter should be welcomed as raising questions that will not be understood until they have been argued. The question at issue may be stated thus.

Let us name $\frac{\partial}{\partial y}\left(\frac{dx}{dt}\right)$ the 'effective' defence-coefficient. Now, on Mr. Horne's hypothesis,

$$\frac{\partial}{\partial y}\left(\frac{dx}{dt}\right) = k - \sigma,$$

which can have either sign, but cannot change sign. But on Richardson's (1939) hypothesis,

$$\frac{\partial}{\partial y}\left(\frac{dx}{dt}\right) = k\{1 + \sigma(x - 2y)\},$$

which can change sign according as $2y - x \gtrless 1/\sigma$. The common saying that 'all bullies are cowards' suggests that a change of sign occurs somewhere. However, the present equations are intended to represent the behaviour, not of individuals, but of nations. The effective defence-coefficient of Germany has been estimated from statistics of warlike expenditure, and was found to be positive during 1908–14, negative during 1920–30, and positive again during 1930–39. The discussion of the submissive interval is at present published only in microfilm[1].

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October 15.

[1] Richardson, L. F., "Arms and Insecurity", published by the author (1949).