possess a bachelor's degree or its equivalent and a broad training in the fundamental branches of chemistry. Applications should be sent to John H. Yoe, University of Virginia, Charlottesville, Va., not later than March 1. Further details will be furnished upon request.

THE London correspondent of the *Journal* of the American Medical Association writes: "The war has cut off the Scandinavian sources of material for making paper, and the supply of paper for the printing of periodicals and books is controlled by the government. The result is enforced economy in the consumption of paper. The first June issue of *The British Medical Journal* in 1941 contained only thirty-eight reading pages; in the corresponding issue of 1942 the number was reduced to thirty-two because the paper controller continues to cut the supply. Hence *The British Medical Journal* has made a further reduction in the size of the type and reduced the considerable space given to correspondence, and has enjoined conciseness on correspondents."

ATTENTION is called in a note printed in *Nature* to the extensive facilities available at the Imperial Institute, London, for the rapid supply of technical information relating to the trade, occurrence and utilization throughout the world of all kinds of raw materials, and the scope of the intelligence service is not so well known as they should be. The institute's staff includes tropical agriculturists, chemists, chemical technologists, economic botanists, economic geologists, mining engineers, mineralogists and statisticians, and, when desirable, the institute seeks the advice of members of its fifteen consultative committees. Further help is also afforded by numerous trade contacts. The institute also has an extensive reference library and a technical index covering most of the relevant trade and scientific publications issued during the past thirty years. The institute can deal with inquiries relating to sources of supply of, and other information relating to, raw materials and semi-manufactured products whether of animal, plant or mineral origin in all countries, cultivation of crops and the soil and conditions under which they have to be grown, methods employed in mining, smelting and dressing minerals for the market, and so on. Analysis and testing of samples of raw materials is undertaken in the laboratories of the institute. Inquiries should be made in the first instance to the Intelligence Section of the Plant and Animal Products Department or of the Mineral Resources Department, according to the nature of the subject concerned. No charge is made for services to departments of the United Kingdom Government or other Governments of the Empire contributing to the general funds of the institute unless a particular inquiry involves a volume of work so great that it can not be undertaken by the existing staff.

DISCUSSION

EFFECTS OF THE EARTH'S ROTATION ON THE RANGE AND DRIFT OF A PROJECTILE

THERE has been much discussion recently concerning the question: Does a projectile (or missile) move farther when fired to the east than when fired to the west? Some authors contend that the two distances traversed are the same, others that the distance to the east is greater than that to the west, and still others that the distance to the west is greater than that to the east.

Under the proper restriction each of these statements is correct. For, as we shall show below, if the angle of elevation of the gun were *just* 60° the two distances would be the same; if it were between 0° and 60° the distance to the east would be greater than that to the west, and finally if this angle were between 60° and 90° the distance to the west would be greater than that to the east.

In order to prove this, use will be made of some of the formulae which have already been derived by the author in his monograph entitled, "The Weight Field of Force of the Earth," published in Washington University Studies, New Series, Science and Technology, No. 11, 1940.

1st Proof: By a simple trigonometric transformation the second of formulae (129) on page 68 the range x of a projectile may be expressed in the form

$$\bar{x} = \frac{v_0^2}{g_1}\sin 2\beta + \Delta\bar{x}, \tag{1}$$

where

$$\Delta\bar{x} = -\frac{4 v_0^3}{3 g_1^2}\omega \cos\phi_1 \sin 3\beta \sin\alpha,$$

in which ω is the angular velocity of the earth's rotation with respect to the fixed stars, g_1 is the acceleration, due to weight, at the position of the gun, ϕ_1 is the astronomical latitude at the position of the gun, α is the azimuth (measured from the south through the west) of the direction of fire (*i.e.*, of the positive sense of the axis of x), β is the angle of elevation of the gun (measured upward from the direction of fire), v_0 is the muzzle velocity of the projectile. The ranges in value of the various angles are:

$$-90° < \phi_1 < 90°, \qquad 0° \leqq \alpha < 360°, \qquad 0° < \beta < 90°.$$

If the projectile be fired to the east, for which $\alpha = 270°$ or $\sin\alpha = -1$, we have, in particular,

$$\Delta\bar{x} = \frac{4\,v_0^3}{3\,g_1^2}\omega\cos\phi_1\sin 3\beta \begin{cases} > 0 \text{ for } 0° < \beta < 60°, \\ = 0 \text{ “ } \beta = 60°, \\ < 0 \text{ “ } 60° < \beta < 90°, \end{cases}$$

with the positive sense of x to the east.

If the projectile be fired to the west, for which $\alpha = 90°$ or $\sin\alpha = 1$, we have, in particular,

$$\Delta\bar{x} = -\frac{4\,v_0^3}{3\,g_1^2}\omega\cos\phi_1\sin 3\beta \begin{cases} < 0 \text{ for } 0° < \beta < 60°, \\ = 0 \text{ “ } \beta = 60°, \\ > 0 \text{ “ } 60° < \beta < 90°, \end{cases}$$

with the positive sense of x to the west.

In both of these cases the *deviation in range* (*i.e.*, $\Delta\bar{x}$) extends to the east if $0° < \beta < 60°$, and to the west if $60° < \beta < 90°$, and this deviation is zero if $\beta = 60°$. The first term in formula (1), namely: $\sin 2\beta \cdot v^2{}_0/g_1$, represents distance from the gun to the east if $\alpha = 270°$, and to the west if $\alpha = 90°$. It is from the terminal points of both of these distance-vectors that $\Delta\bar{x}$ extends to the east if $0° < \beta < 60°$ and to the west if $60° < \beta < 90°$, and produces no augmentation if $\beta = 60°$. We have thus proved the statements made in the second paragraph.

2nd Proof: Let us refer the motion of the projectile to a set of cardinal axes $0 - \xi, \eta, \zeta$ of which the origin 0 is at the muzzle of the gun, and the positive senses of the axes of ξ, η, ζ are to the south, east and zenith, respectively. Denoting the time derivatives of the coordinates ξ, η, ζ by ξ', η', ζ', respectively, the components of the muzzle velocity-vector (v_0) are $\xi'_0, \eta'_0, \zeta'_0$. Again referring to the above mentioned monograph, we find that equations (115), on page 63, express the coordinates ξ, η, ζ of the moving projectile in terms of the time t. If we equate to zero the expression for the altitude ζ and solve the resulting equation for t, we obtain the expression (123), on page 66, for the time of flight of the projectile. Substituting this value of t in the first two equations (115), we obtain for the coordinates of the *point of fall,* the expressions

$$\bar{\eta} = \frac{2\,\eta'_0\zeta'_0}{g_1} + \frac{4\,\omega}{g_1^2}\left[\zeta'_0\{\eta'^2_0 - \tfrac{1}{3}\zeta'^2_0\}\cos\phi_1 - \xi'_0\zeta'^2_0\sin\phi_1\right],$$

$$\bar{\xi} = \frac{2\,\xi'_0\zeta'_0}{g_1} + \frac{4\,\omega}{g_1^2}\eta'_0\zeta'_0\left[\xi'_0\cos\phi_1 + \zeta'_0\sin\phi_1\right].$$

If, in particular, the line of fire is along the east-and-west line (*i.e.*, along the axis of η), we have $\xi'_0 = 0$, and then the preceding formulae become

$$\bar{\eta} = \frac{2\,\eta'_0\zeta'_0}{g_1} + \frac{4\,\omega}{g_1^2}\{\eta'^2_0 - \tfrac{1}{3}\zeta'^2_0\}\zeta'_0\cos\phi_1,$$

(2)

$$\bar{\xi} = \frac{4\,\omega}{g_1^2}\eta'_0\zeta'^2_0\sin\phi_1.$$

Since now (*i.e.*, for $\xi'_0 = 0$) we have $\eta'_0 = v_0\cos\beta$, $\zeta'_0 = v_0\sin\beta$, (where β may now be regarded as measured from the positive η-axis and capable of ranging in value from 0° to 180°, so as to include the case in which $\alpha = 90°$ as well as that in which $\alpha = 270°$), the first of formulae (2) becomes the same as formula (1) when $\alpha = 270°$, and the second takes the form

$$\bar{\xi} = \frac{4\,v_0^3}{g_1^2}\omega\sin\phi_1\cos\beta\sin^2\beta,$$

which is the same as the expression for the drift (distance of the point of fall from the line of fire) given by the third of formulae (129), page 68, of the monograph, for the special case in which $\alpha = 270°$ or 90°.

The first of formulae (2) gives us the information we desire. For since $\zeta'_0 > 0$, it follows that the first term changes sign with η'_0 (since it enters to the first degree), whereas the second term *does not* change sign with η'_0 (since it enters to the second degree). Furthermore, the second term is positive, negative or zero according as

$$\eta'^2_0 - \tfrac{1}{3}\zeta'^2_0 = v^2_0\,(\cos^2\beta - \tfrac{1}{3}\sin^2\beta) = v^2_0\,(1 - \tfrac{4}{3}\sin^2\beta)$$

is positive, negative or zero, *i.e.*, according as the angle of elevation β is less than, greater than or equal to 60°.

WM. H. ROEVER

WASHINGTON UNIVERSITY

SUGGESTED CASTE TAXONOMY FOR THE COMMON TERMITE

FOURTEEN years have passed since the beginning of the work of the Termite Investigation Committee under Drs. C. A. Kofoid and S. F. Light, of the University of California. Early in the work, good fortune permitted my selecting as a subject of study the genus *Reticulitermes* with a caste system, more complex than that of any other wide-spread Nearctic genus of termites. I used, of course, the regular caste taxonomy of the time. Primary, secondary and tertiary reproductives were each studied as a caste. But long-time collecting yielded a series of specimens bridging the gap between the primary reproductive and the worker; the supplementary reproductives, far more prolific than the primary, gradually assumed, in a new line of thinking, the status of an intercaste. Nanoids, both soldiers and workers, were found, and at first were recorded as castes; then rare intermediate soldier-workers and still rarer soldier-reproductives had to be classified. At last I came to feel that we who are interested in the complicated society of the termitarium might be "picking castes from the air." Independent work since has extended my laboratory observations to include the chief species of *Reticulitermes* in each of the termite-yielding sub-regions of the Nearctic. I find that given sufficient time, we can produce or at least predict the appearance of most of the outstanding forms found in the labyrinths. This brought not a "break with the old system" but a gradual drifting away from it. What I regarded as a caste, fourteen years ago, may now seem no more than subcaste or intercaste; instead of listing newly discovered sizes and forms, each in a separate caste, it seems better to seek to relate each to one of the three more common castes: Reproductives, workers