in waves from one or more sources, as maintained by both Allard and Hudson.

It is evident that none of these various notions provides a satisfactory explanation of synchronous flashing. It is the purpose of this paper to present experimental evidence that has a direct bearing on this problem.

Osten-Sacken,[23] McDermott[24] and Mast[25] have studied the mating habits of a number of native species of firefly. In *Photinus pyralis* the male flies about emitting a single short flash about every 5.7 seconds. The female remains in the grass and responds to some nearby male by flashing shortly after each of his flashes. This exchange of signals continues until the male reaches the female and copulates with her. The above investigators did not ascertain how the male distinguishes between the flash of the female and that of another male, but the writer demonstrated conclusively (forthcoming publication) that no possible difference in the light of the two sexes is operative in this discrimination, and that the essential factor involved is the fact that the female (who flashes only in response to the flash of the male) invariably maintains the period of about 2.1 seconds at which she replies to each flash of the male. A striking feature of this "attraction," observed many times by the writer, is that whereas the exchange of signals is initiated by a single pair of insects, other males within range of the female (10 feet) often join in also, so that at times as many as 5 males may fly simultaneously toward the same female, and that under these conditions all these males flash in unison.

Here, obviously, there is some mechanism other than chance which induces males originally out of phase with each other and flashing with different periodicities to break their ordinary rhythms and readjust them to that of the particular male which first responds to the female. The writer has often observed this readjustment of flashing in the field, but the factors involved therein still remain, in spite of considerable investigation, obscure. At any rate the process results in several males responding simultaneously to the same female, whereupon (since their flashing periods are nearly equal) they necessarily flash in unison. Thus it appears that synchronous flashing on a small scale occurs regularly in nature as a normal preliminary to mating.

Precisely the same response on a larger scale can readily be induced by selecting a male, and in proper imitation of the female, flashing a flashlight 2.1 seconds after each of his flashes. In a well-populated region the writer, in this way, has many times attracted from 15 to 20 males simultaneously to the flashlight. It is indeed an impressive sight to see such a group converging through the air toward one point, each member poising, flashing and surging forward in short advances, all in the most perfect synchronism. This extension of the normal phenomenon to a larger number of males is clearly due to the greater intensity of the light produced by the flashlight as compared with that produced by the female.

The facts presented indicate that the observed flashing in unison of large numbers of specimens distributed over a large area is probably produced as follows: A little group of synchronously responding males built up around one female, as described above, acts as a unit in stimulating another female a considerable distance away because the combined intensity of the several simultaneous flashes is greater than that of a single flash; the second female, then, in responding to the first group of males, gathers in to herself a coterie of males which flash in unison and are, of course, synchronized with the original group; they in turn stimulate a third female which "attracts" a third cluster of males, also synchronized with the original, and so on, until a large number of fireflies scattered over an extensive area are flashing in unison. The whole process thus depends on the fact that all the females reply to each of the flashes of the male at the same definite interval.

Several reports (Allard, Hudson, the Snyders, etc.) indicate that the apparent rarity of the phenomenon in large numbers of fireflies is due to the fact that it only occurs under special environmental conditions, such as calm, unusual humidity and darkness, and a large open space crowded with the insects. This fact supports the interpretation presented above, as such conditions would be favorable to the spread of synchronism from group to group, in the manner suggested. The flashing in unison, once established, would probably continue, owing to the normal rhythmic flashing period of the male, until terminated either by some environmental disturbance, such as a breeze (which does actually interfere with the regularity of flashing of the male), or, since luminosity ceases with copulation, by exhaustion of the evening's supply of responding unfertilized females.

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[23] Baron Osten-Sacken, *Stettiner Ent. Zeitung*, 22: 54, 1861.

[24] F. Alex. McDermott, *Canadian Entomologist*, 42: 357–363, 1910; 43: 399–406, 1911; 44: 73, 309–311, 1912; 49: 53–61, 1917.

[25] S. O. Mast, *Jour. Animal Behavior*, 2: 256–272, 1912.

TREE RINGS IN NEW ENGLAND

IN the course of an attempt to determine how well the annual rings of wood in a tree reflect climatic influences in New England, some hemlock tree stumps

at Wolfeboro, N. H., have been found to reveal a logging operation between the growing seasons of 1794 and 1795. The evidence for it appears in the sudden "release" of the then small hemlocks, as shown by the change from suppressed growth and very narrow rings to normal growth and broad rings after 1794.

Although such evidence of release of young trees by removal or death of much larger trees is commonplace to students of forestry, it is thought that the observations here recorded form something of a record in that they date an event in the eighteenth century. A total of 129 annual rings had been formed under the new conditions by each of the six trees chosen at random from about ten times as many cut early in 1924. This precise agreement showed that the release was not due to natural causes but to an act of man, and the history of the site confirmed the idea because it was then adjacent to the cultivated land on the well-known estate of John Wentworth, provincial governor of New Hampshire. From our analyses of other hemlocks on other sites, the release of individual young trees is evident, but, even though growing within a few rods of each other, their sudden increases in rate of growth occur in different years.

It is also possible to make a preliminary announcement that this study of climatic effects on growth rates of the hemlock, *Tsuga canadensis*, has produced positive evidence in favor of a marked control of growth by rainfall *during the growing season*. Drouth years in particular are marked by narrow rings, while seasons with abundant rainfall usually give relatively wide rings. Since the trees used for analysis have as many as 335 rings of wood, the results should add to our knowledge of rainfall in New England well back into the seventeenth century.

This work is being supported in part by a grant from the American Association for the Advancement of Science, and a detailed report of it will appear later. In the meantime, information concerning old growth hemlock stumps and butt logs in New England (with known dates of cutting) will be welcomed as an aid to the collection of accurate data from widely separated sites in the area.

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NATIONAL WELFARE, BUSINESS PROFITS AND INDIVIDUAL BENEFIT

IN an admirable article in SCIENCE (Vol. 81, No. 2090, January 18, 1935, pages 55–62), Professor Wesley Mitchell has presented what may eventually be considered the definitive case for national planning. Although he has neglected the vital distinction between an *oligarchic* "planned" society and a co-operative or *democratic* "planning" society, Professor Mitchell has, I think, demonstrated the inevitability of some kind of large-scale social planning. By whom and for whose good the planning shall be done now becomes the crucial issue.

I am, however, concerned by Professor Mitchell's apparent retention of an outworn theory of motivation as the psychological basis for economic behavior. He states that the "*application* [of scientific discoveries] has been effected *mainly* by men who were seeking profits." By implication, these fundamental discoveries themselves were *not* made because of the driving power of the profit motive. Granted that capitalistic enterprise since the industrial revolution may be equated with the "profit system," it is a defective picture of human nature to assert that even the work of the competitive business world has ever been *mainly* performed under the incentive of profits. At least 95 per cent. of the people (in which I would include most of the readers of SCIENCE) make no "profits" in the technical meaning of the term as the positive difference between sales price and cost of production, including administrative salaries. They do, however, secure personal "benefits" and "advantages," *i.e.*, individual "gains," which are an altogether different matter. Human needs demand gratification, but the "need" for profits is a feeble acquired want in most men. The mere existence of technicians and professors who are gratified by an elevation in rank with an accompanying drop in compensation (not a rare combination in recent years!) is sufficient refutation of the strength of the "profit" urge among applied scientists. Certainly industrial psychology and personnel management would be non-existent fields if the lure of an excess monetary reward were the only, or even the principal, factor making for cultural advance.

Economists, executives and advertisers are keenly aware of the reality of "non-financial" incentives. It is, therefore, all the more strange that in philosophizing about the present social order, so many of them make such an inadequate and false distribution of emphasis in cataloging the motives underlying their own activities.

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CHINESE MAGIC MIRRORS

A RECENT news item in the *Herald-Tribune* of New York was to the effect that certain scientists had started an investigation as to how the Chinese magic mirrors were constructed. This interested me very much, for I recall how the late physicist, Dr. Thomas Corwin Mendenhall, with whom I was associated on the board of trustees of The Ohio State University, had become interested in the same question while teaching in Japan, how he had discovered