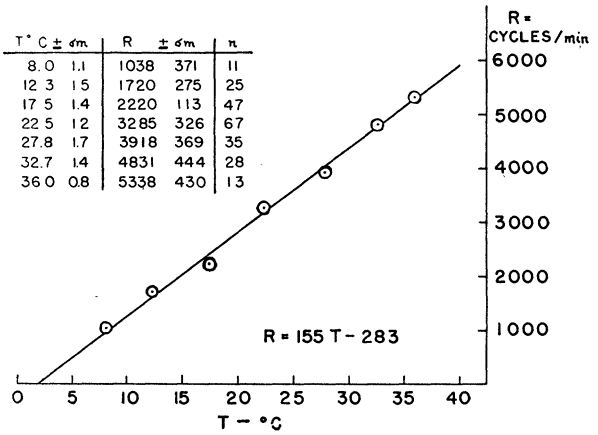

FIG. 1. Relationship between body temperature and rattling frequency in *Crotalus*.

The to and fro movement of the rattle is accomplished by 3 large muscle groups on each side Their fibers run diagonally, the origin and insertion connecting successive tail vertebrae. All 3 muscle groups on each side contract simultaneously during rattling. This has been determined by recording the action potentials of the several muscle groups simultaneously. The potentials were led off insulated needle electrodes that were inserted into the muscle tissue and isolated by an indifferent ring electrode. Frequencies of these electrical recordings were the same as those of the actual rattle movements observed simultaneously under the stroboscope. These observations, which were made in collaboration with Dr. E. B. Wright, suggest that there is no sequential alternation of contractions in the 3 muscle groups which might account for the high frequencies of rattling observed.

It is also of interest to point out that these tail muscles are dark red to brown in color, in distinct contrast to the other skeletal muscles of the body, which are white to light pink. This suggests the possibility of a high content of muscle hemoglobin or other respiratory pigment (*3*) which might be essential not only for the high frequencies but also for the long duration of uninterrupted rattling that is sometimes observed. Continuous rattling for periods as long as 20 min has been reported (*1*).

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A Technic for Shipping Live Mosquitoes with Particular Reference to *Culex tarsalis*

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Experience in isolation of viruses from mosquitoes has demonstrated the desirability of fresh material for test purposes. Even with the resistant western equine encephalitis virus a drop in titer may occur during prolonged storage of infected *Culex tarsalis* in dry-ice chests. In connection with virus encephalitis investigations at the Rocky Mountain Laboratory, our attention was centered on an adequate and practical method of transporting living female mosquitoes from considerable distances afield to the virus laboratory.

The first attempt to transfer mosquitoes over a long distance to our laboratory was made in the summer of 1952 when specimens freshly collected in Glasgow, Montana, were conveyed by automobile to Hamilton, Montana, a distance of some 500 mi. The mosquitoes, in the bags in which they were collected, were carried in a portable icebox, but out of direct contact with the ice. The elapsed time from packing to unpacking was about 28 hr. Mortality was negligible, and the mosquitoes were as active as when collected. The next attempt was made by shipping *C. tarsalis* females by Railway Express from Bismarck, North Dakota, to Hamilton, Montana, some 800 mi. The bags of mosquitoes were packed in a small carton within a large carton. Refrigeration was provided by Mason jars of water frozen solid by CO_2. Sawdust and newspapers furnished the necessary insulation. The elapsed time from packing to unpacking was about 39 hr. Again, mortality was negligible and the mosquitoes were active and vigorous on arrival.

Encouraged by the results of these trials, we have developed the shipping technic described below.

The dual-purpose collecting and shipping bag is a type widely used and is simply a cylindrical muslin bag with a window of bobbinet forming the closed end. The dimensions of the bag are accommodated to a supporting inner wire frame that forms the outlines of a right cylinder. This frame, of 3/32-in. Monel wire, consists of two 4½-in. rings, with parallel planes and on the same axis, held in position by a single vertical wire 8½ in. long. The bag is closed by rubber bands. For shipping purposes a bag of this size will hold up to 300 mosquitoes without crowding. It is desirable that a schedule be arranged whereby mosquitoes may be collected shortly before packing and shipping.

One or two bags of mosquitoes are placed in a substantial paper carton of a size that will permit the inclusion of a refrigerating medium. We have found Sno-Gel Refreezants,[3] model R10-B, to be an adequate

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[3] Manufactured by Sno-Gel, Inc., 334 Magnolia St., Oakland 20, Calif. "Refreezants are a harmlesss, odorless substance holding liquid in colloidal suspension." Model R10-B is such a substance in a cylindrical plastic skin about 10 by 2 in., sausage-like in appearance, freezing at 30° F. These can be frozen either in deep-freeze units or more quickly with dry ice, and can be reused indefinitely.

substitute for ice, and superior to ice in many respects because of less weight and volume, durability, and no free moisture. Two units are placed in the carton separated from the mosquitoes by a pasteboard partition. Any remaining space is packed with insulating material. This carton is sealed and centered in additional insulating material within a much larger carton (a standard 24-bottle beer case is a satisfactory size and is well made). We use mineral wool insulating blankets, of the type commonly used in building construction, sometimes supplemented by wadded newspaper. The outer carton, when sealed and wrapped in heavy brown paper, is ready for shipment.

In laboratory tests and in actual practice we have observed that in summer or at room temperature the effectiveness of the refrigerant, under the conditions described above, decreases gradually up to 50 hr and by 72 hr is lost. At this point a sudden rise in mosquito mortality may be expected, and usually occurs, so that the survival rate at 3 days is 80 percent or less. At 4 and 5 days mortality was excessive, in some cases 100 percent; invariably it was over 50 percent. Increasing the number of Refreezant units to 3 and to 4, and providing supplementary humidity, either by dampening mosquito bags or by adding moistened absorbent cotton, did not significantly alter the effective holding time or the survival rate.

Twenty-two shipments of live mosquitoes have been made, principally by air express. Twenty of these were to the Rocky Mountain Laboratory from Washington, eastern Montana, western Nebraska, and Arizona, and 2 were colony mosquitoes from Hamilton, Montana to Maryland. The number of mosquitoes per shipment varied from 30 to nearly 700 and averaged about 300. Nineteen shipments were considered successful. Mortality for the most part was negligible and in none did it exceed 15 percent. In the remaining 3 shipments, for reasons that we cannot satisfactorily explain, the mortality rate exceeded 50 percent. In all shipments the elapsed time from packing to unpacking was less than 60 hr and in most cases less than 36 hr.

In spite of the limitation imposed by the time factor of 3 days or less, we have found this shipping technic to be very useful, and feel that we are not premature in recommending it to others.

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Communications

Group Research

In an article on "Free Research versus Design Research" [*Science* **118**, 91 (1953)], Curt P. Richter examined the present policy governing allocation of grants-in-aid to research workers and, *inter alia,* used the occasion to deplore the present trend toward team or group research, which was represented by him as out of harmony with scientific tradition and as a somewhat naive tactic introduced by those who themselves understand little of the ways of scientists. Since group research involves an arrangement by which at least two persons undertake to solve a problem in concert, it is obvious that there will be almost as many arrangements as there are persons and that, before a fair evaluation of group research is possible, some effort has to be made to recognize the different ways in which such research has been and is carried out.

By and large, the theoretical scientist in all fields is a "rugged individualist" and has always been so. Collaboration between two theorists in the same field would be like collaboration between two champion chess players. They would hardly complement each other and, very likely, would just get in each other's hair. The very opposite tradition has always prevailed in the experimental sciences. Some of the greatest experimentalists of all times—Pasteur, Lavoisier, Rutherford, J. J. Thomson, T. H. Morgan, Emil Fischer, O. Meyerhof—thoroughly enjoyed working intimately with a band of colleagues and, in many cases, owed much of their success as experimentalists to the qualities that some of their colleagues possessed.

Why has group research found favor among the experimentalists? It is, I believe, the consequence of the fact that the major problems of the experimental sciences are usually far beyond the capacity of any one individual, however gifted, to solve unaided even after a lifetime of work. Consider a relatively straightforward problem, such as the mode of action of insulin. Despite heroic efforts by many workers in laboratories all over the world, this problem had still eluded solution. A vast number of hypotheses have been advanced, but a prodigious effort is involved in testing each one. Some hypotheses cannot even be tested with present methods and must await further technical advances. Major problems of experimental science are like giant jigsaw puzzles, which cannot be solved until hundreds of individual pieces are placed together in the proper patterns, and the placing together of any two pieces is a problem of no mean proportions. Clearly, when the over-all problem has so many facets, the chances of solution are roughly proportional to the number of facets investigated. The single investigator just cannot cope with the volume of experimentation, of trial-and-error search needed to find the necessary clues. Thus, it is not a question of whether group research is necessary in experimental science, but rather of what kind of group research works best.

Group research has come to mean to some a grotesque arrangement whereby some dictator in his office directs the energies of an army of research stooges in the laboratory by push-button control. If this is what group research is taken to be, then nobody in his right mind can make out a case for such a monstrosity. If, however, group research is looked upon as an effort