by a group of individuals to solve collectively a problem which no one of the individuals could expect to solve singlehandedly, then group research falls in line with a long tradition in experimental science.

Group research is not only a scientific venture but also an experiment in human relationships. In the ideal group, such as existed in the laboratories of some great experimentalists, petty jealousies were minimized and the creative skills of all members were used to the fullest. The proper leader of a research group should be interested primarily in solving a problem. Anyone who can contribute to this end must be encouraged. A group dedicated to the solution of a problem, governed by the conviction that seniority, title, and rank are irrelevant issues in the evaluation of ideas and suggestions, and convinced that the fortune of the individual is tied up with the fortune of the group as a whole is, I believe, one of the most powerful instruments yet devised for conducting experimental research.

The standards of modern science impose an almost herculean burden on the lone investigator. For example, the successful prosecution of any of a large number of biochemical problems requires considerable competence in the techniques of protein fractionation, organic syntheses, manometry, spectrophotometry, and chromatography and in the fields of analytic, organic, physical, and biological chemistry. There have been and probably will be a few giants who will be equal to such all-but-impossible assignments. However, the great mass of investigators can be effective only by dint of specialization. Thus, group work provides one of the few devices by which the efforts of specialists can be integrated and unified and by which skills, useless when uncomplemented, can be fully utilized.

There is a vague uneasy feeling among some scientists that group research means the end of the individual. All research in the end is individual research, and group research conducted properly refers to individuals working together with other individuals. Any tactic that does violence to the rights, privileges, and sensibilities of the individual should be as abhorrent to the group as to the individual. Group research has often foundered on the rocks because the leader has failed in his duties to the individual members of the group by being arbitrary and inflexible or by suppressing differences of opinion. Where group research has prospered, the rights of the individual have rarely been neglected.

In tackling a major experimental problem, there is no telling from which direction a solution may come. The individual, perforce, is limited to a single choice; and, while he may show superior discrimination in the exercise of this choice, he is at a great disadvantage *vis-a-vis* a group where multiple choices may be made and followed up simultaneously. One can be more daring and enterprising in a group where multiple failures for several individuals can be compensated by at least one successful venture by another in the group. If the individual has to carry alone the weight of failure which can be more equitable distributed within a group, he is not likely to undertake a problem that holds forth prospects of more than a fair share of unrewarded exploratory work and experimental dead ends.

There is ample room in our scientific life for both individual and group research. The nature of the problems, of the individuals, and of the physical setup should be the determining factors in deciding which arrangement should be followed, and not a cut-and-dried formula that science can prosper only by leaving the individual to his own devices.

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Contribution to the Chemistry of Thorium and Morin

THE U.S. Geological Survey has been studying the reaction of thorium with organic compounds in a search for a highly sensitive and, if possible, selective reagent for the quantitative determination of trace amounts of thorium. One phase of this investigation consisted of a spectrophotometric and fluorimetric study of the complex formed in the reaction between thorium and morin. Morin is 2′,3,4′,5,7-pentahydroxyflavone ($C_{15}H_{10}O_7$).

In weakly acid solutions, the stable complex Th(morin)$_2$ with a dissociation constant of approximately 2×10^{-10} is formed. The sensitivity of the reaction is such that 0.1 to 0.2 µg of ThO_2 in 50 ml of solution can be determined either colorimetrically or fluorimetrically. The color system follows Beer's law; and, under proper conditions, the fluorescence shows a linear relationship with the concentration of thorium over a wide range. Morin is about 2½ times as sensitive to thorium as thoron, 1-(O-arsonophenyllazo),-2-naphthol-3,6,-disulfonic acid ($C_{16}H_{13}O_{10}N_2S_2As$), which is the most sensitive reagent generally available. So far, morin has been used only with pure solutions of thorium, but the reaction could be used as the starting point in the development of methods for the quantitative determination of trace amounts of thorium in rocks and other materials.

In the course of this work, the fundamental relationship between the fluorescence and light absorption was studied, and a mathematical equation was derived to express this relationship. Uncombined morin in the solution affects the fluorescence produced in two opposing ways. The amount of complex formed from a given amount of thorium is a direct function of the amount of free morin, whereas the amount of fluorescence obtainable from a given amount of complex is an inverse function of the amount of free morin. The inverse function results from quenching by the morin, and an equation has been derived that relates the amount of fluorescence obtained to the amount of free morin. The relationship is hyperbolic and similar to that shown by other fluorescent systems reported in the literature.

In addition to their theoretical significance, these mathematical functions were directly applicable for determining the proper concentration of morin in the fluorescent system. The combined effects of the opposing functions indicated the one region of free morin content that gives linearity and also maximum sensitivity for this system. Working curves prepared with this optimum amount of morin are linear over a wide range of thorium concentration.

A transmission fluorimeter was designed and built for use in this investigation. Its light source, sample cell, and phototube are arranged on a linear axis with a lamp and phototube on opposite sides of the sample. This arrangement is superior to that of conventional fluorimeters for theoretical studies, because it simplifies the development of the mathematical relationships of light absorption and fluorescence.

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Ground Water in the High Plains of West-Central United States

THE vast High Plains of the west-central United States constitute a region of transition—rather abrupt transition—between the humid East and the arid Southwest. Here, water problems are the more trying because, from year to year, the region "vacillates" between a semiarid or arid environment and a moist subhumid environment. Here, then, "average" water conditions can be misleading indeed.

The High Plains are unique in many respects. Once the grass-covered home of buffalo and nomadic Indians, they were conquered and settled first by cattlemen, who found the virgin grasses ideal for stock raising; then by dry-farmers, encouraged by the Homestead Acts, who discovered the high fertility of the soil; and finally by farmers who found that in parts of the area the uncertainties of meager precipitation could be offset by irrigation—first from streams and later from wells. To a growing agricultural development, discoveries of large oil and gas fields have added substantial industrial development.

The agricultural development has not been without failure and hardship, for nature has tried many times to undo man's accomplishments and often has succeeded over all but the most persevering. Severe drouths and dust storms have ruined dry-farming periodically, but, thanks to irrigation (largely from wells), a stable and prosperous agricultural economy has been established at many places.

Available information indicates that the ground-water reservoir beneath the High Plains probably contains more than 2 billion acre-ft. An estimated 2,700,000 acres now is irrigated by pumping from about 26,000 irrigation wells. The Llano Estacado in Texas and New Mexico, the most heavily pumped part of the High Plains, typifies a large part of the area where ground water is the sole source of supply. Some areas remain undeveloped but some are overdeveloped.

Basic information, collected and studied over a period of more than 20 years by the U.S. Geological Survey, in cooperation with the several States, has materially aided the understanding and orderly development of ground-water resources, but much more investigation and study are needed to realize full development.

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Preliminary Report on the Geology of the Aleutian Islands

SINCE 1946 the U.S. Geological Survey, in cooperation with the Department of Defense, has been making a reconnaissance study of the geology of the Aleutian Islands. The Aleutian Islands form a volcanic island arc extending 700 mi westward from the Alaska Peninsula. A deep submarine trough, the Aleutian Trench, lies along the southern convex side of the arc. The northern concave side is marked by a line of stratovolcanoes and is bounded, in part, by a steep scarp that extends to the floor of the Bering Sea.

The oldest rocks crop out on Attu, Agattu, Rat Island, and Amchitka in the western Aleutians and along the southern edge of many of the central and eastern Aleutian Islands. The association of rocks is typical of volcanic geosynclines in orogenic zones and consists of a thick sequence of pillow lava, submarine pyroclastics, siliceous mudstones, argillite, sandstone, and conglomerate. The pillow lavas are basaltic and spilitic. Many of the submarine tuffs are keratophyres. These oldest rocks have yielded no identifiable fossils, and they differ somewhat in lithology from island to island; neither their age nor their interisland correlation is known. On Attu and Amchitka an unconformity separates them from overlying rocks containing early Tertiary fossils.

On Attu and Amchitka, the spilitic suite is overlain by several thousand feet of conglomerate and banded, well-bedded siliceous mudstones, argillite, sandstone, and limestone, all deposited in shallow water. Foraminifera suggest an Eocene-Oligocene age. Rocks of early Tertiary age have not been recognized in the central and eastern Aleutians.

Both the spilitic rocks and the early Tertiary sedimentary rocks of the western Aleutians have been intruded by dikes, sills, and small plutons of gabbro and by a few stocks of albite granite. Batholiths and stocks of diorite and quartz diorite have been found in the central and eastern Aleutians. In general, the intrusive rocks of the Aleutian Islands belong to the calc-alkalic circum-Pacific suite.

Unconformities younger than the plutonic intrusive activity have been mapped on Attu, Kiska, Umnak,