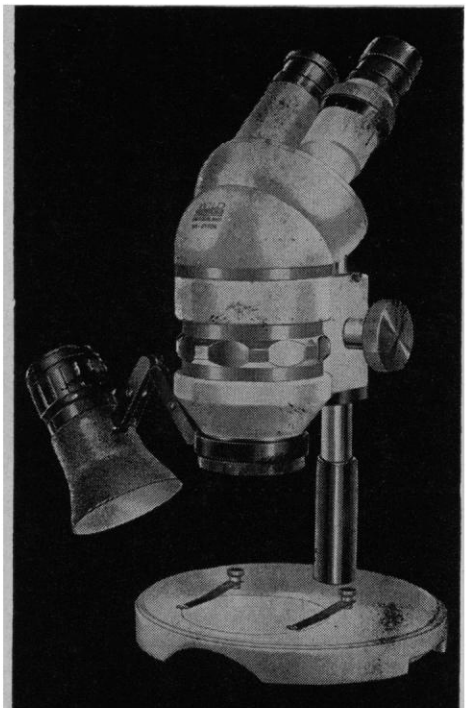



# Letters

## Quantum Phenomena in Biology

C. Reid (*1*) discusses (among other topics) some recent trends in research on the visual process. In so doing, he keeps the action of rod and cone cells separate, referring to the former as a "monochromatic mechanism" and to the latter as a "trichromatic color-vision process." Wald (*2*) presented a very interesting set of deductions and speculations on the action of rhodopsin and the effect of its bleaching on rod *and* cone activity. The hypothesized structure of both rods and cones is one of compartments containing rhodopsin molecules. The number of compartments per cell can vary, as can the number of rhodopsin molecules per compartment. Sensitivity of a cell is a direct function of the number of compartments and of the amount of rhodopsin per compartment: the more rhodopsin, the higher the probability that that cell will absorb a quantum of light. Several deductions follow from a statistical theory based upon Wald's suggestions—for example, light and dark adaptation phenomena and scotopic and photopic luminosity curves. One new prediction was derived and tested with critical flicker fusion (*3*). The data showed a closer approximation to Wald's conceptualizations than to Crozier's (*4*).

With monochromatic light sources, similar predictions would be difficult to make. Again, some well-grounded speculations may be cited (*5*). First, it is interesting to note that Reid talks of a "trichromatic color-vision process in the cone cells" and observes that "none of the three mammalian cone-cell pigments (these have not yet been isolated) is rhodopsin." Young and Helmholtz started the trichromatic theories; Hering and Ladd-Franklin opposed them; Granit and Hartridge presented ample evidence that perhaps 7- or 11-color theories may be more correct (see *6*).

Trichromatic theories are still in vogue today, due to the existence of three physical primaries, or to our language habits, or to inertia, or to some combination of these, despite the evidence. From the work of Granit and Hartridge it is only one more step to a statistical theory of color vision. This is the step Shaw has taken. One could return to Wald from Shaw's theory and conceptualize compartments containing varying amounts of chlorophyll, xanthophyll, carotene, and other optically active substances. These varying amounts would be distributed normally (like rhodopsin) among cones and cone compartments, so that any given cone might contain close to the mean value of chlorophyll; or it might contain an amount of chlorophyll three standard deviations above the mean and would therefore be a "green cone"; or it might contain a large amount of xanthophyll and be a "yellow cone." Such a theory would seem to be more promising and closer to the content of Reid's paper than a trichromatic theory. I leave the details of such a theory to someone better versed in photochemistry than I.

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### References and Notes

1. C. Reid, *Science* **131**, 1078 (1960).
2. G. Wald, *ibid.* **119**, 887 (1954).
3. H. F. Gallup, *NAMC-ACEL-341* (16 Aug. 1957).
4. W. J. Crozier, *Proc. Natl. Acad. Sci. U.S.* **28**, 65 (1940).
5. W. A. Shaw, *Psychol. Rev.* **63**, 228 (1956).
6. S. H. Bartley, "The psychophysiology of vision," in S. S. Stevens, *Handbook of Experimental Psychology* (Wiley, New York, 1951), chap. 24.

I believe that Gallup's interesting ideas about cone vision cannot be reconciled with the experimental facts. For instance, Rushton [*Proc. Natl. Acad. Sci. U.S.* **45**, 114 (1959)] has shown, by examination of the reflection spectrum of the fovea centralis of red-blind (protanopic) individuals, the absence of a pigment throughout the red region of the spectrum. Because of the widespread occurrence of this phenomenon, it seems very unlikely that more than one pigment is missing, and consequently this single pigment must be effective over a considerable region of the spectrum. A second pigment, effective in the blue-green region, was also identified by Rushton, and it seems quite reasonable to conclude that a third must exist, covering the blue part of the spectrum. There is nothing in Rushton's spectra to indicate the presence of rhodopsin in the cone cells.

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## Pseudo Science and Censorship

With reference to the editorial "Rebutting the preposterous" [*Science* **131**, 1163 (22 Apr. 1960)], two important questions are implied therein.

1) Who is to judge that grey area, between "accepted science" and pseudo or crackpot science? For it is here that new discoveries arise, and here originate the "breakthroughs" that all are so eagerly seeking. I remember well when the expanding universe and virus as a causative agent in cancer were two ideas believed to have very little merit —then pseudoscientific, if you will.

2) Who shall constitute the "Committee on Censorship by Selection," responsible to see that the general public shall be permitted to read only "acceptable" popularized scientific reporting?

The attitude of many scientists and the hubbub of the writer-scientists who forced the suspension of publication of a "pseudoscientific" book are reminders of another era. But the shoe is on the other foot. Remember the Condon case and the committees which judged "guilt by association?" Is an individual to be judged a pseudoscientist by reason of his association with ideas which are not acceptable to the "Committee on Censorship by Selection?" The cost of complacent conformity comes high, especially just now.

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### Closer Scientific Contact with Czechoslovakia

For a period of 10 years there has been little scientific contact between the Western democracies and Czechoslovakia. During a recent visit to that country, at the invitation of the Czechoslovakian Academy of Sciences, I had an opportunity to meet many scientists, especially botanists and agriculturists, and enjoyed a most cordial and delightful reception. As almost everywhere in the world, support of scientific work has greatly increased, and a large number of serious and dedicated young men are devoting their lives to science.

In the Austro-Hungarian empire there was only one university in the territory which is now Czechoslovakia, the Charles University in Prague, with two evenly supported divisions, one Czech and one German. This equality in support went so far that two identical buildings for botany were erected in the botanical garden, one for Professor Molisch and the other for Professor Nemeč. Now one of the buildings is the laboratory of plant physiology and genetics; the other is for plant taxonomy. Several other universities and colleges were created in the Czechoslovakian Republic before World War II, like the Masaryk University and the Agricultural College in Brno. These institutions are thriving, with a large enrollment and adequate financial support for research and teaching.

In addition to the educational institutions, a number of research institutions have been created during the last 10 years. They are now administered under three Academies: the Czechoslovakian and the Slovakian Academies of Science and the Czechoslovakian Academy of Agriculture.

These academies are administered by the members and are operated as departments of the government, with their own appropriations. When in 1950–51 the first research institutes for fundamental investigations were organized, there was no government agency under which they could properly be set up, and the existing academies were reorganized around their original membership to administer the research institutes.

The greater part of my visit was spent in Prague, especially at the Institute of Biology of the Czechoslovakian Academy of Sciences. This institute consists of a number of special sections; I was most interested in Plant Physiology and Physiological Genetics, of which Dr. Blatzky is director. There are approximately a dozen research workers in this group, studying problems ranging from photosynthesis, plant hormones, and sterile plant culture to the biochemistry of plant development. The laboratories are well-equipped, with apparatus largely constructed in Czechoslovakia and apparently of excellent construction. Only approximately 20 percent of the research apparatus had come from England or America. It was interesting to note that the prices of scientific apparatus were just about the same there as in America.

Personal contact with the research workers was very pleasant, and everyone endeavored to speak English, although German and Russian are the foreign languages most generally spoken by the Czechoslovakian research workers. I greatly appreciated their courtesy in speaking English.

It is a rewarding experience for any scientist to visit Czechoslovakia. Arrangements for trips are most easily handled through the Foreign Department of the Czechoslovakian Academy of Sciences in Prague. I also hope that it will be possible for Czechoslovakian scientists to come and work for some time in the United States.

It is remarkable how much has been accomplished during the last 10 years in the field of science in Czechoslovakia, particularly after the complete suspension of all teaching and most research during the war years, when the universities were closed. In this resurgence of science, Russian and Polish scientists have played an important role, inasmuch as Czechoslovakians received most of their foreign training in those countries.

There are some interesting new developments in Czechoslovakian science. Since no young, trained people were available for research at the end of the war, a new system of apprenticeship was inaugurated in the institutions. These positions could be filled by young persons who wished to become scientists but who had no formal training in research at the universities. These persons are employed for a 3-year period, working with qualified research scientists and thus becoming acquainted with various research techniques. After this 3-year apprenticeship they receive a diploma and can continue working at the universities. In this way students can acquire research experience without overburdening the universities.

Botanical research problems under investigation at the universities and research institutes cover the same range as in the United States, with probably somewhat less emphasis on genetics and more on ecology. One interesting development was that several botanists were engaged in producing film sequences on their research work to be shown as "shorts" in the State movie theaters. They were surprised to learn that such educational films are not shown in the United States. But they never had seen any of Disney's natural history films. It would be an excellent idea if such films could be shown, to acquaint Czechoslovakians with another side of our cultural accomplishments and to show that people here in the United States are also concerned with problems other than atomic bombs and rockets.

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### The Space Race

A journey through Lebanon, Syria, Jordan, and Israel during October and November 1959 brought to my attention a significant attitude concerning the United States–U.S.S.R. "space race" and its effect on other peoples as a measure of the prestige position of the two protagonists [see the editorial "Space exploration as propaganda," *Science* **131**, 799 (1960)].

A high percentage of the people with whom I talked could hardly care less. A typical comment was the bitter one that for the cost of one moon shot either great country could irrigate and make fruitful such-and-such a valley. To farmers grimly hoping for enough rain this spring to fill the cisterns on which their farms must depend through the summer ahead, the space race is immaterial.

In evaluating the propaganda effect of such efforts as space exploration, we must not assume that these operations are as important to persons of other cultural backgrounds as they are to us. To a man whose immediate problem is his next meal, the moon is very far away indeed.

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