Letters

An Unexpected Nuclear Spin-off

May I call attention to the *Atlas of the Domestic Turkey* (Meleagris gallopavo): *Myology and Osteology*, by E. B. Harvey, H. E. Kaiser, and L. E. Rosenberg (U.S. Atomic Energy Commission, WASH-1123, TID UC 48, 1968; xi + 247 pp., 85 figs.). This is another publication in the AEC's controversial WASH series, which also includes, for example, WASH-740, "Theoretical Possibilities and Consequences of Major Accidents in Large Nuclear Power Plants"; WASH-1083, "Current Status and Future Technical and Economic Potential of Light Water Reactors"; WASH-1099, "Reactor Fuel Cycle Costs for Nuclear Power Evaluation"; and WASH-1141, "Safeguards and Nuclear Materials Management."

Many have been concerned that the AEC, in this time of slack in the nuclear industry (a period which began in the mid-1960's)—this time when problems are few and funds are abundant—would not rise to the challenge of defining a new role for itself. These skeptics have not reckoned with the active, fertile minds that populate the AEC's Division of Biology and Medicine. As an anatomist, this reader can hardly contain his enthusiasm over the possibility that WASH-1123 portends a new, and possibly major, area of interest, a possibility given further credence by the recent report of other avian research. I refer, of course, to the pneumatic chicken-cannon described briefly in *Environment* (January/February 1971, p. S-4).

The work itself is a most complete atlas on the subject of the domestic turkey. To quote the preface, "This Atlas is designed to bring into one publication labeled drawings of the muscles and bones of the domestic turkey, *Meleagris gallopavo*, an important member of the gallinaceous birds." The drawings are of excellent quality, clearly labeled, and adequate in number. As an aid to the comparative avian anatomist, an extensive table of Bird Muscle Synonymies is provided relating the muscles of the turkey to other works on the muscles of the dove, the whooping crane, the chicken, and the raven. The obvious omission of the ostrich, the penguin, and the Rhode Island Red only suggests the potential fertility of this research field. The osteology portion of the report is similarly complete and lucid. The report is indexed, appropriately bound, and more than sturdy enough to withstand the rigors of expected use.

The authors close their introduction thus:

> An atlas of the myology and osteology of any species does not in itself help to resolve questions of phylogenic relationships or the history of domestication. However, if this Atlas increases interest in either of these problems or makes possible new research utilizing the turkey, it will have served its purpose.

Only time will tell.

There is little doubt that avian anatomists will find this report exciting and useful (if they find it at all—some anatomists don't search the nuclear literature exhaustively). The report has something for others, too. For ecologists the report suggests nuclear energy and the turkey as another relationship in the web of life; for the legal mind there is the challenge of finding precedence for the turkey study in the Atomic Energy Act of 1954 or subsequent legislative history; and since nearly 100 million domestic turkeys die annually in the United States and most of these are dissected at the dining table, the report could prove to be of especial benefit to the American consumer. If bureaucratic jealousies can be transcended, a popular version done in conjunction with the Department of Agriculture should be considered.

A review of this report would not be complete without noting the acknowledgments in the preface. Particularly it should be mentioned that this Atomic Energy Commission report on the turkey would apparently not have been possible without the continual encouragement and stimulation of a Mr. R. Pigeon from the Division of Technical Information. The reviewer can only hope that someday, somewhere in the AEC, a patron of similar conscience and conviction will be found for an equally definitive WASH report on the chronic effects of low-level radiation.

DEAN E. ABRAHAMSON
Center for Studies of the Physical Environment, University of Minnesota, Minneapolis 55455

Pet Cats and Pollutants

Although the unfortunate contact of Mr. Leo Pard and his zoo colleagues with city pollutants (see News and Comment, 9 July, p. 130) provides an exotic basis for the suggestion that "the zoo animals could potentially serve as barometers of the medical effects of the variety of pollutants in the city's air," one needn't consider only captive wild animals for this purpose. Since members of the cat family groom themselves with their tongues, it should come as no surprise that the first cases of lead poisoning observed at the Staten Island Zoo were in cats. The city contains, however, a far larger and more appropriate "barometer" in its domestic cat population; surely pet cats would concentrate pollutants as well as big zoo cats, and would have the added advantage of sharing an environment more nearly like that of their owners.

WILLIAM A. PRIESTER
National Cancer Institute, Bethesda, Maryland 20014

Complementarity

In his article "Sensuous-intellectual complementarity in science" (4 June, p. 1003), Blackburn draws valuable attention to a point that concerns many who aspire to a counterculture or superculture, but largely overlooks the major obstacle to blending sensuality and intellectuality in science. It is an error to suppose that quantification and objectivity are the aims and dictators of science. They have been useful tools for many purposes, but we do not reject as unworthy the essentially verbal description of much systematic biology, and we are aware of the dramatic role of intuition in many key research efforts.

Science, as distinguished from technology, is a common intellectual endeavor. The emphasis must be on "common." We stand on the shoulders of our predecessors, we support one another, and our successors stand in turn on our shoulders. Personal insight alone is not enough in this endeavor. We have to communicate our findings and our thoughts in language and symbolism that are as unambiguous as we can devise. The goal of scientific investigation is not simply to gain personal insight, but to gain it in such terms that we can, ideally, transmit it undiminished to another mind. Perhaps this mode of communication, which seeks to inform and to cement mutual insights in specific guise, can be contrasted with poetry. A poem that stimulates can be great even if its intended meaning is in doubt. Books can be written debating its meaning, and its value is only enhanced. In the case of a great scientific theory, matters are qualitatively different. Books can be written about its uncertain implications, or about its failings in fact or logic, but uncertainty as to its intended meaning must reflect an inherent flaw. If it is ambiguous, it cannot form the basis for common knowledge.

If raw sensuality is to be injected formally into the scientific endeavor, the challenge, then, is to devise means not only to gauge its import initially, but also to communicate its import in terms precise enough to provide a common ground for agreement. The obvious hazard is that an incomplete attempt will only provide grist for controversy among individuals whose senses differ for biological or cultural reasons. The extreme difficulty of avoiding this posture must be recognized. Public decisions to ignore, modify, amplify, or discount specific scientific insights or judgments for humanistic or political reasons, both moral and expedient, are commonplace. Sensuality of one kind or another plays a large role, and inevitably so, in these actions. Until the force of this sensuality can be expressed in a fashion more concrete than the sort of vague imagery that is customary, it would only cloud issues further to suppose that the sensuality is an integral part of the related scientific edifice under either construction or attack.

Make no mistake. I do not reject sensuality. All science is based on sensory observation or detection of some kind. I merely contend that to welcome sensuality in the abstract is to beg the question. This question is whether or how sensuality, as Blackburn uses the term, can be made systematic and communicable enough to become a part of common endeavor, rather than personal quest, for which it is assuredly the indispensable factor.

WILLIAM R. DICKINSON
Department of Geology,
Stanford University,
Stanford, California 94305

Blackburn has helped me express thoughts that I had been unable to formulate for years.

Science teaching in the universities and in the high schools has become increasingly abstract during the past 20 years. Far from becoming more modern, we are dangerously approaching the scholastic mentality of the Middle Ages.

The general biology courses that are taught at the beginning of a scientific or liberal arts curriculum give information on abstract concepts which the students cannot comprehend because of lack of practical experience with specimens. Freshmen who take these courses must memorize and learn to manipulate abstract concepts and even come to logical conclusions without ever comprehending the contents of the exercises. Indeed, very few teachers truly understand the contents of these courses. The end results of the lifelong labors of great scientists are presented in ready-made form.

Educators have forgotten that those scientists who have made the modern discoveries could not have accomplished their feats without a thorough familiarity with nature, which begins in childhood, in backyards, woods, and fields. Intelligent, meaningful science gradually develops with the observable world around us. This is the world of visible, audible, smellable, touchable, dissectible organisms, rocks, and minerals, the visible stars and clouds, and the feelable atmosphere.

Students ought to be guided from the "sensuously" perceivable to the theoretical explanation of the observable. This is the path along which all science has evolved and the only "relevant" road for teachers of science. It is impossible to awaken enthusiasm for science when the beginning is also the end result.

HANS ELIAS
Department of Anatomy,
Chicago Medical School,
University of Health Sciences,
Chicago, Illinois 60612

Analogy may be fruitful. Unsupported by logical argument it can be misleading, as Blackburn has indicated with his non sequiturs. To argue for a sensuous science from Bohr's principle of complementarity does justice neither to the idea nor to the man.

The particle and wave theories are two ways of looking at the same thing, but both were formulated and extended by rigorous mathematical analysis. Both are clearly in the mode described as "quantitative science," and their example provides no analogical support for Blackburn's leap into an alternative, sensuous domain. Furthermore, by equating intuition simply with sensuous experience, he ignores the whole history of scientific inquiry in the intellectual domain. Creative investigation has always been nurtured by intuitive insights, guesses, and hunches, but these have been tested later as rigorously as possible. After all, intuition can be wrong.

Finally, Blackburn is quite wrong when he excludes the holistic naturalist from the act of simplifying reality for the sake of intellectual comprehension. No one can define, let alone understand, the numbing complexity of reality. We are all of us quantifiers and feelers (and what emotion-laden words these are), homomorphic or many-to-one mappers and modelers. We select certain things and filter out the rest. The question is whether we should be more aware of the filters.

PETER R. GOULD
Department of Geography, Pennsylvania State University, University Park 16802

If the idea of complementarity is generalized from its precise, operational meaning in quantum physics, so that it becomes a broad philosophical tenet that takes into account the behavior of the human observer, it is wholly indistinguishable from the philosophical concept of pluralism as advocated by William James in *A Pluralistic Universe*, first published in 1909.

WALTER M. ELSASSER
Institute for Fluid Dynamics and Applied Mathematics, University of Maryland, College Park 20742

I had no intention of advocating unseemly leaps into alternative domains; that would be as big a mistake as to deny the human and scientific importance of sensuous experience. It is to the second error that I addressed my-

self, feeling that the first was relatively unlikely to occur within the house of science. Rather than reasoning by analogy from physical to sensuous-intellectual complementarity, I tried to generalize the idea of complementarity, and then to show that both types may be examples of a fundamental epistemological phenomenon—an enterprise, by the way, that Bohr himself pursued for the last 30 years of his life.

I agree entirely with Dickinson. Our codification, so to speak, of sensuous knowledge is centuries behind our analytical systems. In fact, as embodied in art and poetry, it has indeed become embedded in "personal quests," where it has shown, in capable hands, a very powerful precision. However, since at least the era of Goethe, Coleridge, and Faraday, the sensuous and the analytical have followed different concerns—to the detriment of both.

THOMAS R. BLACKBURN
Department of Chemistry, Hobart and William Smith Colleges, Geneva, New York 14456

Artichokes

I refer to the technical comment by Eisner and Halpern (25 June, p. 1362) on the article by Whittaker and Feeny (26 Feb., p. 757), on chemical interactions between organisms.

A less dramatic distortion of taste occurs after one eats artichokes, the flower heads of *Cynara scolymus*: things taste sweet.

W. M. WOODS
114 Tabor Road, Oak Ridge, Tennessee 37830

Reciprocity

Sev S. Fluss (Letters, 11 June, p. 1083) complains that Russian scientific authors in citing non-Russian sources fail to give the original (that is, Latin) spelling of names along with the transliteration. Before the AAAS adopts his suggestion that it urge this worthy practice on the Russians, it might urge the editors of *Science* (and other American journals) to adopt the practice of including the Cyrillic spelling of Russian authors' names in citing them.

ROBERT G. GLASER
Department of Physics and Astronomy, University of Maryland, College Park 20742