some of which are carcinogenic, and nuclear referenda and government regulations unknown to history, some of which may be precipitous. Lowrance's study, performed while he held a postdoctoral fellowship at the National Academy of Sciences, provides a summary of the ways in which industrial society may methodically appraise risk. Given the times, it is a useful thing to have. Yet the book is disappointingly unprovocative: safety analysis, it appears, is little more than common sense routinized.

The fundamental distinction in this subject is between risk and safety, Lowrance says. Risk is here taken to mean the (objectively ascertainable) probability of harm. "Safety" denotes the social and legal judgment that that probability is appropriately low; "a thing is safe if its risks are judged to be acceptable" (p. 8). The statement has a peculiar ring to it.

What is peculiar is its flatness. Lowrance omits a crucial signpost that would help to orient the reader in the conceptual marshes of hazard assessment. The long-running dispute over the interpretation of probability measures is of central, if unacknowledged, importance for the definition of risk. One school holds that probabilities are primarily reflections of the actual frequency of occurrence of events; probabilities are therefore objective, as Lowrance postulates. Another school holds that the assignment of probabilities primarily reflects the assigner's belief or confidence that the events in question will occur. This subjectivist view would, if adopted, blur the difference between risk and safety that Lowrance seeks to discern: probability and judgment are intertwined, not separate. Significantly, most disputes about safety concern situations, as in the case of carcinogenic pollutants or nuclear waste, where the frequency of mishap is low but the potential damage high. Here public policy is based upon probabilities *subjectively* estimated. Lowrance's easy distinction between risk and safety turns out to be unavailable in practice. Probabilities, in the hard cases, must be estimated under poor conditions, where neutral objectivity is out of reach.

This is not cause for despair, however. Lowrance provides two clearly written inventories of the elements of safety analysis: a list of the types of data that bear upon probability estimates, and a discussion of factors that affect judgments about the acceptability of risks. The data are often haphazard—"most test methods 'just grow' " (p. 54). The criteria of acceptability are similarly disjointed. The controversial Delaney amendment to the Food and Drug Act erects an absolute barrier against food additives found to cause cancer, but air and water pollution pose larger dangers, which are imperfectly recognized and unevenly regulated.

What the inevitable subjectivity of safety assessments does do is to place an uncomfortable burden upon scientists and public officials. For technical experts must, in their judgments, exceed the authority that properly belongs to them. A finding of adequately low probabilities is inextricably tied both to one's technical intuitions and to one's idea of what is adequate. Public officials, complementarily, must rule on safety with some arbitrariness when the experts disagree. There is no objective means by which to choose among experts when their judgments are partly subjective.

How to steer between the Scylla of scientific arrogance and the Charybdis of uninformed governmental ukase? Lowrance proposes a professional *contrat social*: society subsidizes the education of professionals and in turn becomes a partner in "a trust that the professions will watch over the well-being of society" (p. 122). The idea of a social contract linking scientists and those affected by their expert judgments is surely partly correct. The criticisms of nuclear power would have been poorer by far without the voluntary contributions of many academic scientists, and their statements of motive have often included references to the stewardship implicit in their training.

But the trust is, one should note, a blind one: the technological adjustments that can minimize risk are often obscure, Lowrance notes, and "only technical people can envision the possibilities" (p. 121). For some professions, notably medicine, a legal conception of malpractice has developed. (Interestingly, the training of physicians has also been less visibly subsidized by government—though one hardly imagines that aid to medical education could be rationalized as a way to strengthen doctors' social responsibility.) For other professions such as engineering, malpractice is a concept with so few worked out cases that it remains quite elusive. And none of the sciences have any standards of social performance at all—only the tender mercies of the refereed journal.

The trend is plain: the more the contribution of the technical expert is confined to providing information and counsel, the less is the trust relationship with society enforceable, the less it is realizable. In the hard cases, where judgment must substitute for empirical action, the accountability of the technical adviser is elusive indeed.

Of Acceptable Risk could have pointed toward the hard questions and the promising lines of inquiry. Psychological studies of individual perceptions of danger, for example, still do not add up to a coherent account of how social customs emerge to cope with new hazards. The puzzle of how to reconcile legal forms and procedures with the processes of technical analysis points to a conspicuously problematic boundary between two kinds of social custom. More broadly, the systematic interpretation of technological possibilities in terms of their social implications languishes, as does the establishment of criteria for evaluating these implications. Between hard technical possibility and formalized regulation lies the often murky middle ground of the social criterion. It is murky for new technologies because scientific conceptions are forced to substitute for a social experience that has yet to occur. That is, as the late Hannah Arendt noted, an unrevealing, unsatisfying alternative so far as social policy is concerned.

These problems lie beyond the complacent pale of Lowrance's account. His is nonetheless a useful survey for the scientist or engineer who is interested in, but has never thought about, the rational approach to peril.

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The Endocrine System

Trends in Comparative Endocrinology. Papers from a symposium, Kenya, June 1974. E. J. W. BARRINGTON, Ed. American Society of Zoologists, Thousand Oaks, Calif., 1975. vi, 270 pp., illus. $12. *American Zoologist* Supplement 1975.

Endocrinology is innately an integrative branch of science, and this collection of papers deals with a wide variety of functions in a wide variety of organisms. There are few zoologists who will not find information pertinent to their specialties in these papers, and comparative endocrinologists will find recent information on a generous number of the subjects that constitute their discipline. The few areas that have been neglected, such as the hormonal control of hydromineral functions and calcium metabo-

lism or the gastrointestinal hormones, are for the most part ones that have been reviewed recently or in which there has been little recent activity.

Several interesting evolutionary themes are elaborated in the papers. Berta Scharrer, in her discussion of the role of neurons in endocrine regulation, traces present-day integrative systems back to a stage in which neurons were the only source of hormones. In another chapter M. Fontaine and M. Olivereau discuss those endocrine glands that appear to have originated by the transformation of exocrine glands or by the concentration of scattered islets of cells.

The evolution of steroidal hormones is considered by Thomas Sandor, Sorin Sonea, and Afzal Z. Mehdi, who suggest that the common feature of steroids, the cyclopentanoperhydrophenanthrene nucleus, is of abiotic origin. Also, Peter Karlson, Jan Koolman, and Jules A. Hoffmann point out that the steroidal ecdysones of insects and crustaceans are related to phytoecdysones (ecdysone-like substances detected in plants). L. Gallien writes of steroidal effects in vertebrate oogenesis. D. Price and co-workers treat the steroidal control of gonoductal differentiation in amniotes, pointing out, however, that the inhibitor of the Müllerian duct of the mammal is probably not a steroid. Although steroids have many diverse functions, the types that have been synthesized and their biosynthetic pathways and mechanisms have shown little or no evolutionary change over an extensive range of organisms. Precise and detailed information regarding the mechanisms of action of two steroidal hormones is set forth by B. W. O'Malley and his associates, who summarize evidence that estrogen and progesterone activate specific genes to produce specific proteins in the oviduct of the chicken.

The discussion of sex and reproduction in fishes by J. M. Dodd shows on the one hand that much attention has been lavished on this enormous and diverse group, but on the other that the accumulated data are still too few to serve as a basis for generalization.

The pineal gland is still a puzzling structure, but in recent years, as Charles L. Ralph's chapter makes clear, much has come to light regarding its function in mammals. The regulation of release and the mechanism of action of melanophore stimulating hormone are comprehensively reviewed by Mac E. Hadley and Joseph T. Bagnara.

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Vascular Physiology

The Peripheral Arterial Chemoreceptors. Proceedings of a workshop, Bristol, England, July 1973. M. J. PURVES, Ed. Cambridge University Press, New York, 1975. xiv, 492 pp., illus. $39.50.

Although this proceedings volume is entitled *Peripheral Arterial Chemoreceptors*, the papers are primarily studies on the carotid body. For those of us indirectly concerned with the functions of chemoreceptors or with chemoreflexes, the book provides an excellent means of updating our knowledge.

The book is unusual in two respects: First, the discussion of the functional role of chemoreceptors deals not, as is usual, with respiratory function, but with various aspects of the regulation of cardiovascular function. In particular, there is discussion of the interactions between chemoreceptors and baroreceptors, the role of the chemoreceptors in the "diving" responses, and the effects of chemoreceptor stimulation on various vascular beds, for example, coronary, skeletal, and cerebral. Second, the book provides a historical perspective. In its first paper Eyzaguirre and Gallego examine the original slides of de Castro, which are also republished in the volume. The inclusion of these slides permits an assessment of the progress that has been made in the study of histological morphology.

The book summarizes what, I think, are the major remaining controversies concerning the carotid body. These concern the morphology and function of the afferent and efferent components of carotid body innervation; the identity of the chemoreceptor; and the function of the glomic cells. That the meeting did not resolve the controversies is obvious from the discussions following almost every paper. These discussions, by the way, are most enlightening as to the views or, if you will, prejudices of the participants.

In addition to the papers on the carotid body, the book includes a paper by Speckmann and Caspers on the responses of neurons that are not part of the primary respiratory controlling system, in the lumbar spinal cord and the cerebral cortex, to changes in P_{O_2} and P_{CO_2}. They report that an increase in local P_{CO_2} leads to a depression of activity in the majority of cells whereas a decrease in P_{O_2} has a biphasic effect—first excitation and later blockade of activity. Treatment of the effect of P_{CO_2} on respiratory neurons of the brainstem is limited to a brief summary by Mitchell in the discussion following Speckmann and Caspers's paper.

The papers and discussions concerned with the function and innervation of type I cells are most stimulating. The views presented range from the idea that these cells are similar in function to the small, intensely fluorescent cells of sympathetic ganglia, secreting dopamine as an inhibitory transmitter (papers by Fillenz and Sampson, for example), to the idea that type I cells release acetylcholine, causing type II cells to contract (a paper by Jones).

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Catalysis in Organic Syntheses 1976. Papers from a conference, Boston, Apr. 1975. Paul N. Rylander and Harold Greenfield, Eds. Academic Press, New York, 1976. x, 364 pp., illus. $16.50. *To order this book Circle No. 357 on Readers' Service Card*

(Continued on page 168)