epistemological or sociological—perhaps almost an anthropological—approach, our history would be barren." It would also be clearer. After stripping away the terminology and generalizations dictated by this approach, a solid revisionist history of the British Association emerges. This history is based upon the lives and letters of the "gentlemen of science," 23 men who held major offices in the association for more than one term. To Morrell and Thackray, the early years of the association are comprehensible in terms of the attitudes, interests, and even the fears of this liberal Anglican and politically conservative inner core of a wider "scientific clerisy."

A plank of the revisionist platform, then, is that, far from being run as a democratic "parliament" (not to mention a "republic") of science as its rhetoric suggested, the British Association was controlled by a closed oligarchy. The group in power carefully steered a course between those who wanted government to take a strong hand in countering the alleged decline of science and those who thought otherwise. By sidestepping the "Declinist" crusade to create paid positions for scientists, the gentlemen of science avoided associating themselves with the cause of professionalization. They viewed science as a "calling" or as an opportunity to establish an intellectual reputation.

One problem with Morrell and Thackray's interpretation here involves the size and composition of the governing elite. Vernon Harcourt and Roderick Impey Murchison seem to run the show; more than half the cast rarely utter a line. According to the authors' own account, one of the oligarchy, the aged and infirm John Dalton, was trotted out on occasion merely as an "emblem" or "symbol." Given the backdrop of social and political ferment the authors present, in addition to the confusion over short-term strategies and ultimate purposes within the association, it seems remarkable that any single clique could direct the action for some 15 years. In this regard, A. D. Orange's essay in *The Parliament of Science* may provide a useful corrective. He divides the association's history into three stages before 1851, with a different "gentleman" imprinting his character on each phase: first the editor David Brewster, then general secretary Harcourt, and finally Harcourt's successor, the geologist Murchison.

A second part of Morrell and Thackray's revision concerns the role of the provinces. They argue that, contrary to conventional wisdom, the group that controlled the British Association insured that it represented the interests of centers of learning and culture, such as Cambridge, Dublin, and Edinburgh. Just as the elite distrusted the common scientist, they hesitated to enter the unpredictable hinterland, whether a "coal hole" like Newcastle or a textile town like Manchester. The function of provincial philosophers, according to this view, was to swell membership rosters and thus fill the organization's coffers with their subscriptions. Since these funds would then be channeled in the form of research grants to the directors' pet projects and protégés, the provincials handed over their hard-earned shillings to an indifferent and metropolitan-inclined leadership. Against this interpretation of the cunning savant exploiting the country bumpkin, Philip Lowe in *The Parliament of Science* emphasizes the benefits that flowed to towns from hosting the association. These included a stimulus to local commerce and the possibility of tapping the expertise of visiting scientific eminences.

Another heretofore unrecognized characteristic of the young organization is the low status it accorded technology. The prevailing mythology that traces the origins of the British Association to provincial interests has linked the organization with emerging manufacturing concerns. *Gentlemen of Science,* in contrast, maintains that the appeal to applied science and technology was either a rhetorical device or a deliberate cultivation of spectacle. According to Morrell and Thackray, the association's grant allocations and government lobbies in fact enshrined the physical sciences, especially astronomy, tidology, and terrestrial magnetism. The essay by W. H. Brock in *The Parliament of Science* points out that these pursuits—dubbed "Humboldtian sciences" by S. F. Cannon—were precisely those eulogized by a succession of association presidents. This congruity between the views of the association and its historians leads one to suspect that Morrell and Thackray adopt a portion of the rhetoric that they intend to debunk. The role of the association as "knowledge maker" may be portrayed more realistically by examining communications to the geology section, for example, which, according to Orange, dominated early meetings.

Gentlemen of Science, the authors tell us halfway through the book, covers only the "first cycle" of the British Association. Oddly, we are not provided with any sort of conclusion to the history of the period. This omission is particularly puzzling given the propensity to draw a moral and the sometimes excessive amount of detail included. The essays in *The Parliament of Science,* however, treat the 1830's and 1840's as part of the golden age of the association and place its decline in the 1880's. When on the defensive, the organization turned to new ventures, seeking in popularization, education, internationalism, and imperialism a means of strengthening its position. As MacLeod suggests, the situation of the association mirrored the changing place of science in society. No longer seen as a necessary part of the acculturation of a gentleman, science had become merely one among many competing forms of culture.

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Biological Timekeeping

Handbook of Behavioral Neurobiology. FREDERICK A. KING, Ed. Vol. 4, Biological Rhythms. Jürgen Aschoff, Ed. Plenum, New York, 1981. xx, 564 pp., illus. $45.

Natural scientists have long been intrigued by biological clocks. Indeed, many now believe that few physiological or behavioral processes can be fully explained without some reference to temporal organization. This realization has led to a significant increase in the number of laboratories addressing problems involving biological timing as well as the curious development of the occult study of "biorhythms."

Since the inception of biochronometry (or chronobiology) as a coherent field, efforts have been made at irregular intervals to provide summaries of research progress. The first such treatise, the proceedings of the 1960 Cold Spring Harbor Symposium on Quantitative Biology, confirmed the multidisciplinary nature of the enterprise and provided the first well-developed formal models of biological rhythms as overt expressions of underlying clocks. The present volume is the fourth effort to capsulize our knowledge about biological timekeeping.

Even a cursory glance at the volume reveals that research emphasis in biochronometry has not remained stationary during the past two decades. Absent are papers focusing exclusively on exogenous sources for biological rhythmicity, evidently replaced by an increasingly sophisticated approach in which environmental cyclicities are treated as synchronizers for endogenously generated rhythmicities. Gone too are the purely

theoretical treatments or electronic analogs for biological pacemakers, supplanted by biologically relevant formal models anchored firmly by experimental data. Also evident is a manifold increase in physiological investigations aimed at identifying the cellular organization of pacemaking systems. Whereas the 1960 symposium contained a single paper on pacemaker localization within the nervous system, nearly one-third of the current volume is devoted to the physiological analysis of pacemaking systems. Similarly, other additions reveal that the field has profited from its newly acquired sophistication with genetic, endocrinological, and electrophysiological techniques.

A more careful reading reveals a source book that is impressively comprehensive, covering both behavioral and physiological aspects of circadian rhythms as well as related aspects of circannual, tidal, and lunar periodicities. Also covered is the involvement of circadian clocks in photoperiodism and time-compensated orientation.

Though the volume is clearly too extensive to have a single motif, one important idea stressed throughout is that most, if not all, endogenous timing systems consist of multiple oscillators. Certainly the notion of multiple oscillators within one organism is not new. As early as 1960 Pittendrigh concluded, "We are forced, in fact, to abandon our common current view that our problem is to isolate and analyze 'the endogenous rhythm' or 'the internal clock' and are faced with the conclusion that the organism comprises a population of quasi-autonomous oscillatory systems." What is new, however, and not implicit in Pittendrigh's dictum, is that the conceptually distinct oscillators are turning out, in many cases, to be anatomically distinct entities. This finding, more than any other, shapes our contemporary view about the organization of biological timing systems, sets boundaries on purely reductionist strategies, and makes it clear that a complete understanding of endogenous timing will require an appreciation of the integrative relationships among pacemakers.

While the multioscillator nature of biological timekeeping is a major theme, the book is balanced in its overall coverage and lives up to its designation as a comprehensive reference text. For example, it provides a most detailed treatment of the entrainment process, including entrainment theory (chapters 5, 6, and 7), identification of critical environmental signals (chapters 6 and 11), and localization of sensory structures mediating entrainment (chapters 9 and 13). In addition, as mentioned, there is outstanding coverage of photoperiodic phenomena both in insects (chapter 22) and in vertebrates (chapter 23) as well as excellent reviews on noncircadian endogenous periodicities.

Aschoff insisted that the 25 contributors use a common technical vocabulary, and this strategy significantly avoids the dialects that have sometimes plagued this field. Though there is unevenness in quality and some redundancy, most of the chapters are well written and a few truly elegant (for example, chapter 5 by Pittendrigh).

In summary, the volume should serve the biological community as an important reference source as well as a textbook.

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Risk Factors in Breast Cancer

Hormones and Breast Cancer. Papers from a conference, Oct. 1980. MALCOLM C. PIKE, PENTTI K. SIITERI, and CLIFFORD W. WELSCH, Eds. Cold Spring Harbor Laboratory, Cold Spring Harbor, N.Y., 1981. xii, 492 pp., illus. $65. Banbury Report 8.

How can hormonal function influence a woman's risk of breast cancer? The question is a major clinical and public health issue and also presents complex methodological problems in epidemiology, endocrinology, and tumor biology. As this volume of symposium proceedings reveals, some elements in this relationship have been quite clearly defined, but we know much less about the interaction of endogenous hormones with one another and with exogenous agents that may initiate or promote tumor growth and about the impact of these interactions on a woman's risk of breast cancer.

One perspective from which to approach the relationship of hormones to human breast cancer is that of the endocrinology of clinically asymptomatic women whose family histories of breast cancer statistically increase their risk of developing the disease. Probably the factor most dramatically increasing a woman's risk of breast cancer is the presence of breast or ovarian cancer in close relatives, especially if these relatives developed tumors bilaterally while young (*1*). In at least some such families, susceptibility to breast cancer appears to be inherited (*2*). But how might susceptibility genes be expressed biochemically and physiologically? Some fascinating clues appear in this volume.

Bulbrook *et al.* report that in a series of prospective studies they have demonstrated that healthy women in their 40's and 50's with close family histories of breast cancer have depressed thyroid function compared with women of the same ages without such family histories. Even more dramatic, women with a family history of breast cancer who later develop the disease have depressed thyroid activity compared with other breast cancer patients, years before any of them are diagnosed. Bulbrook *et al.* suggest that nonfamilial breast cancer may be unrelated to thyroid function, whereas familial breast cancer may be due to inherited thyroid abnormalities or other defects influencing thyroid function in some women.

Furthermore, Siiteri *et al.* report that they have determined that in some breast cancer patients the proportion of estrogen circulating freely in serum is higher than in unaffected women. This is important because only "free" estrogen appears to be available to target cells in the breast. Siiteri *et al.* attribute the elevation in the percentage of free estrogen to depressed levels of sex-hormone–binding globulin (SHBG) in serum and suggest that inherited low SHBG activity or defective SHBG may be responsible for familial susceptibility to breast cancer. A related study reported by Ottman *et al.* of the characteristics of estrogen receptors in the tumors of familial and nonfamilial breast cancer patients supports this hypothesis. The two groups of patients do not differ in amount of estrogen receptor, but the dissociation constants (K_D) of the receptors in familial patients' tumors are significantly higher than those of nonfamilial patients. Ottman *et al.* suggest that this difference may result from higher levels of estrogen in breast tissue of some familial patients. Because thyroid hormones stimulate SHBG, the results reported by Siiteri's and Ottman's groups may represent a later step in the same process Bulbrook *et al.* describe.

A third series of studies, of totally different design, are analyses by Henderson and Pike of plasma levels of estrone plus estradiol ($E_1 + E_2$) and of prolactin in the healthy daughters of unselected breast cancer patients, daughters of bilateral, premenopausal breast cancer patients, and daughters of unaffected women. Their results support the notion that