trons and officers. His painstaking prosopography shows that the original supporters were predominantly improving agriculturalists. As their influence waned, physicians and especially lawyers came forward, men who expected that the social problems of industrializing England could be solved by the applied science, or rational method, that the RI represented. A high proportion of its officers—some 40 percent in 1840—supported Utilitarian projects such as the University of London, the Statistical Society, and the Society for the Diffusion of Useful Knowledge. Berman infers that during the 1830's the RI was governed by Benthamite social engineers.

The interests of the RI's officers affected, and sometimes directed, the work of its staff. According to Berman, Humphry Davy succeeded by placing himself at the service of the agriculturalists. His *Agricultural Chemistry*, his studies of tanning, his analysis of feed grains established his position: first a reputation for analyzing manures, then glory via electrolysis. In 1809 he lobbied for the building of a large new battery on the ground that electricity was a factor in soil fertility.

The work of Thomas Brande, professor of chemistry from 1813 to 1831, and of his successor, Michael Faraday, reflects the interests of the professional men. Rather than agricultural materials, Brande and Faraday tested metals, glass, materia medica, and illuminating gas. They acted as expert witnesses in legal proceedings involving technological questions. They taught medical students and lectured to young lawyers. They helped to reproduce the class they served.

Berman sets forth these patterns clearly and persuasively. His is a solid accomplishment. And it is the more to be praised, or wondered at, because the interpretation he places on his findings suffers from blurred distinctions, bad history, and old new-left melodrama.

Much of Berman's interpretation turns on a conflation of science, technology, data collection, and rational problem-solving. His definition of science runs from poor relief to natural philosophy; it includes cut-and-try methods, collection of statistics, and economic policy. The conflation serves the thesis that the RI's chief work, and its world-historical significance, were to act as carrier of a new "ideology of science." First the improving landlords, then the social engineers, subverted the "amateur tradition" of Enlightenment science. The RI became a "crucial precedent": in it science changed from "avocation" to "enterprise." Such reasoning fetches the grandiose conclusion that the RI and institutions like it determined "the direction of scientific activity."

This is bad history. The organization of the study of natural philosophy owed little if anything to the RI and its descendants, and no major technological innovation came from them. The RI was not the seed of modern science or its ideology but a sprout from institutions characteristic of the 18th century. Berman does not mention the Society of Arts, founded before 1750 to encourage the application of experimental philosophy to trades and manufactures, or the emphasis on applied science in Enlightenment encyclopedias, or the technical curricula in continental mining and military schools. He appears not to know of the accomplishments of the Réaumurs, Wedgewoods, Watts, and Achards. He writes that Bacon's "idea of a marriage between science and industry [was] almost totally submerged in the course of the 18th century."

Ignorance of the 18th century also infects Berman's definition of science. He allows only two alternatives: either amateur, the admiring of "some shells or curiosities," or entrepreneurial, the ideology of the RI's officers. Into which camp shall we put Aepinus, Cavendish, Coulomb, Volta, Lichtenberg, and their like? And what can we make of Berman's assertion that, before the foundation of the RI, lectures on science were given only at philosophical societies? His own data expose this blunder. One of the RI's first professors proposed to pattern his "scientific course of experimental philosophy on the plan generally adopted in the universities."

Berman's bad history and over-broad conception of science serve a neo-Marxist analysis of modernization. "Science" is a tool of the oppressors of the working class. They placate the hungry oppressed with bones from their scientific soup kitchens; they control the belligerent oppressed by gas lighting and bureaucrats. One of their favorite ploys is the cover-up. They collect statistics, employ social engineers and hygienists, hire experts, all to mystify the common person, to imply that the ills of society are curable "technical difficulties" rather than diseases "endemic to the structure of industrial society."

Science is not responsible for belief in the expert or for the rise of modern capitalism or for the industrial revolution. It did not bring record-keeping, rational problem-solving, or bureaucrats. And it did not become an effective social force until after the time of which Berman writes. The RI was one of many premature attempts to promote the application of science to technology. It claims attention for the scope of its efforts and the quality of its staff, not as the governor of science or the yoke of the working class.

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Life in Thermal Habitats

Thermophilic Microorganisms and Life at High Temperature. THOMAS D. BROCK. Springer-Verlag, New York, 1978. xii, 468 pp., illus. $25.80. Springer Series in Microbiology.

This book is a remarkable document. It is primarily a synthesis of the 90 or so papers that came of the ten years that Brock spent studying life at high temperatures, particularly in Yellowstone National Park. The book also incorporates the work of others. Its scope is great, ranging from molecular biology to ecology to geochemistry. It is a book that flatters the ecological approach to microbiology and shows where it can lead.

The chapters "The habitats" and "The organisms" are general overviews. Chapters on the key genera (*Thermus*, *Thermoplasma*, *Sulfolobus*, *Chloroflexus*, *Cyanidium*) and on the thermophilic blue-green prokaryotes are well illustrated and contain detailed descriptions of the ecology, physiology, and biochemistry of the organisms. The chapter "Life in boiling waters" is an informative and provocative account of the bacteria that Brock proved were thriving in waters over 90°C but that so far have not been cultured or characterized. Brock includes a chapter on the formation of hot spring prokaryote mats, which appear to be analogous to Precambrian stromatolites. There are also chapters on the microbial world at low *p*H and on the calefaction of the Firehole River of Yellowstone, a case of natural thermal pollution.

It is the highly personal style of this account that makes the book remarkable. It is a readable and satisfying narrative of how ideas were generated, how experiments were done, and how mistakes were made. Brock takes time to give historical perspective and to cover many unusual but interesting aspects of his work. An example is a detailed, 2½-page history of the reviews and revisions of his paper first describing *Sulfolobus*

(the acidophilic autotroph that grows at >85°C), which was twice rejected by the *Journal of Bacteriology* and finally published by *Archiv für Mikrobiologie*. In these days when one is accustomed to reading the results of scientific research only in the format of severely edited journal papers, the book is refreshing and instructive. There are parts of some chapters that drag, perhaps because the results of published research are described in too much detail. The detail does, however, make the book a useful reference.

Biologists who read the book may be amazed to find that only 12 years ago there existed so extensive a habitat still essentially unexplored. Brock has been both a pioneer and a scientific exploiter of that habitat, and his discoveries of entirely new organisms and their attributes have created a rich lode for scores of other investigators.

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Flowering Plants

The Biology and Chemistry of the Compositae. Papers from a symposium, Reading, England, July 1975. V. H. HEYWOOD, J. B. HARBORNE, and B. L. TURNER, Eds. Academic Press, New York, 1977. In two volumes, illus. xiv pp. + pp. 1-620 and xivv pp. + pp. 621-1190. Each volume, $53.75.

The appearance of the first major review of the flowering plant family Compositae (Asteraceae) in over a century is an event of general importance since this family, with some 1300 genera and 22,000 species, comprises about 10 percent of all flowering plants. Although it is poorly represented in the lowland tropics, it often constitutes a prominent part of the vegetation elsewhere, and the species of the family are frequent on all continents.

Considering the size of the family, the 42 chapters in the book appear to do a reasonable job of pulling together the available information. Some of the chapters—notably the beautifully illustrated paper by Skvarla and his co-workers on palynology—also present a great deal of original information, and the book lays the foundation for a synoptic review of the genera of the family.

The role of relationships with insects in the evolution of the capitulum is discussed with respect to attacks by insects on achenes (Burtt) and insects involved in pollination systems (Leppik). Burtt also provides useful insight into the evolutionary diversification of the capitulum in one of the most interesting chapters of the book.

Compositae have been particularly well studied chemically. Information on about 10 percent of the species is available and indicates that the group is very distinctive. Compositae contain many substances that are toxic or show significant physiological activity. Hegnauer reviews the results of chemical studies since 1964. Of particular interest are the sesquiterpene lactones, with over 100 structures characterized (Herz). Many of these often bitter-tasting, colorless, lipophilic compounds cause contact dermatitis in humans. Composite polyacetylenes are likewise well distributed (Sørensen) and systematically interesting, especially in view of their occurrence in Umbelliferae, Araliaceae, and a few other families. "The combined occurrence of sesquiterpene lactones, acetylenic compounds and inulin-type fructans is almost as characteristic of the Compositae as their headlike inflorescences" (Hegnauer, p. 284). The flavonoids appear to be less distinctive, yet they are highly diverse and richly deserving of further study.

There are no generally accepted examples of Compositae in the fossil record prior to the Miocene. On the basis of matching outlines, a number of such examples were reported up to about 1920, but none has been confirmed. (For example, W. L. Crepet and T. F. Stuessy, *Brittonia* **30**, 483 [1978], have recently shown that one critical Oligocene fossil may easily not be a composite.) As the results of Skvarla and his co-workers amply demonstrate, "composite-like" pollen may belong to any of several families, stratigraphic problems aside. An unfortunate emphasis on early, unconfirmed literature reports has caused Turner to attempt in his paper to push the age of the family back beyond the earliest records for any existing family of flowering plants. As Leppik points out, the very degree and kind of floral organization in Compositae are a phenomenon of the mid-Tertiary. The only existing evidence that the family might be older than the Oligocene lies in its distinctiveness, especially with respect to cytochrome c, but much more investigation and evaluation are needed, as several authors point out.

Many uncritical statements about age and geography are made in the book. For example, links between Africa and Australia are discussed by Turner and by Sørensen as if they are related to events occurring well before the probable time of origin of the angiosperms. These authors ignore the fact that only 20 million years ago Australia was, as it had been for at least 60 million years, enurely covered with temperate evergreen rain forest—hardly a likely place for the occurrence, much less diversification, of desert and scrubland Compositae.

The relationships of Compositae have long been of great interest. Stebbins, in a review of developmental and comparative anatomy in the family, concludes that little evidence exists for links with any other family but calls for palynological and biochemical evidence to resolve the matter. Such evidence is presented in other chapters of the book. Detailed similarities in the pollen seem clearly to indicate a close relationship with Calyceraceae and a more distant but clear relationship with Valerianaceae, Dipsacaceae, Brunoniaceae, Goodeniaceae, and Umbelliferae. Chemical evidence summarized in the book by Mabry and Bohlmann also indicates a direct relationship with Umbelliferae and a link with Campanulaceae (very different in pollen) but suggests that Calyceraceae, which contain seco-iridoids, are totally unrelated to these families. Evidence reviewed by various authors suggests that there is no relationship between Rubiaceae and Compositae or between Dipsacaceae and Compositae. The exact relationships of Calyceraceae appear to need further attention. One of the most impressive achievements of this book is the clear demonstration of a link between Compositae and Umbelliferae, which was postulated by Hegnauer in 1966 and later reflected in the general classification system of R. F. Thorne.

Solbrig, who provides a comprehensive review of chromosomal cytology and evolution in Compositae, concludes, like most of the authors who consider individual tribes, that the common ancestor of the family had a gametic chromosome number of $n = 9$.

Although of limited interest to a nonspecialist, the tribal structure of Compositae and the proper assignment of individual genera receive the most attention in the book. Although the existence of many problems is recognized, the reassignment of the 71 genera of "Helenieae" to other groups (Turner and Powell), the acceptance of a new tribe, Liabeae, and the greatly improved organization of several tribes, especially Heliantheae, Eupatorieae, Mutisieae, and Senecioneae, represent significant achievements.

It is unfortunate that more overall editing and coordination of the volumes was not possible. Perhaps at this stage the