peared to scoop his ideas in June 1858, Darwin's illness was not exacerbated, as Colp notes. Even when he was writing the *Origin of Species*, his illness was much less severe than it was in the late 1840's when his father died and he was working on barnacles, or in 1863–65 when he was working on *The Variation of Animals and Plants under Domestication*. During the period 1866 to 1872 he finished and published not only three extensively rewritten editions of the *Origin* but also three other books related to it: *The Variation of Animals and Plants* (1868), *The Descent of Man* (1871), and *The Expression of the Emotions in Man and Animals* (1872). Only once during these four years did severe illness interrupt his daily work schedule.

Colp argues that during the last decade of his life Darwin's health improved because he "gave up writing on theoretical and controversial issues" and steered clear of the idea of natural selection. I would argue that books such as *Insectivorous Plants* (1875) or *Effects of Cross and Self Fertilization of Plants* (1876) were actually deeply related to Darwin's idea of evolution by natural selection. But they did not seem to make Darwin sick.

In short, Colp's major thesis is appealing but has little basis in the evidence he has meticulously compiled. The evidence indicates that the idea of evolution by natural selection made Darwin no sicker than his father's death or working on the formation of coral reefs or the taxonomy of barnacles.

If Colp's thesis fails, his book surely does not. It unquestionably is the definitive account of Darwin's illness in all its manifestations, and it provides an instructive case study of medical practice and attitudes toward medicine in Victorian England.

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Innovation in the 19th Century

Harpers Ferry Armory and the New Technology. The Challenge of Change. MERRITT ROE SMITH. Cornell University Press, Ithaca, N.Y., 1977. 364 pp., illus. $17.50.

This important book challenges a number of long-held beliefs about the mechanization of American industry. Many of us have assumed that all American workmen eagerly adopted labor-saving machinery and that the resulting mechanized production was much less costly than labor-intensive production. Not so, says Smith, who cites the continued resistance at Harpers Ferry Armory to machines already in use at the armory in Springfield, Massachusetts, and shows that for 35 years the labor-intensive methods at Harpers Ferry were competitive with the mechanized production system at the Springfield Armory.

Economic historians have assumed that the mass production of clocks and guns always entailed interchangeable parts, and that this was the feature of the system that led to cost savings. Not so, says Smith. The notion of interchangeable parts was an engineering ideal, prohibitively expensive for anything except army muskets and rifles. Only the federal customer could afford to insist that the ideal be attained.

The thread that holds the book together is a narrative of the Harpers Ferry Armory between its founding in 1798 and its destruction in 1861, but Smith deals also with the larger issues of industrialization and mechanization. He would have us see that our focus has been too narrow and that our conclusions regarding American manufacturing methods have been colored by our unexamined assumptions. Furthermore, he reminds us that we have overlooked almost totally the relationships between agencies of social control—schools, churches, business and civic groups—and industrial progress.

The armory was located at Harpers Ferry because President George Washington wanted it there. When a War Department report in 1795 failed to mention Harpers Ferry as a viable site for an armory, Washington had the report rewritten to conform to his wishes. Harpers Ferry was to be the "Mother Arsenal," larger and more important than the already operating Springfield Armory or the other proposed armory in North Carolina.

Harpers Ferry Armory was not unimportant, despite the fact that Smith is the first scholar to study it carefully. The famous gun-stock shaping machine of Thomas Blanchard was first erected there, and in the 1820's John Hall's rifle shops, located in Harpers Ferry and sharing government funds with the armory proper, produced the first fully interchangeable guns to be made in America.

Yet its important contributions were not typical of its normal performance. Both Blanchard and Hall were New Englanders who were sent there by the War Department. James Stubblefield, a well-connected Virginian who was superintendent for 22 years, set a pattern of resistance to change and quiet disregard of prodding by the War Department to adopt machines and processes already in use at Springfield. Through a network of relatives and influential friends, Stubblefield effectively controlled the town and region of Harpers Ferry, supporting the expectations of his gunsmiths that change would not be permitted in armory operations and effectively excluding both new people and new ideas by economic and social pressures on strangers and dissidents.

In the main, Smith is convincing. At any rate he raises objections to standard interpretations that cannot be lightly dismissed. Scholars who deal with American manufacturing in the 19th century will have to take Smith's conclusions and admonitions into account.

On the other hand, I wonder if the reluctance of craftsmen to adopt new methods was not due as much to an unprogressive superintendent as to their own conservatism. John Hall was able to find workmen in Harpers Ferry who would build the precise and elaborate machines he required for his highly mechanized rifle works. His workmen must have known that Hall intended to use unskilled operators (boys, actually) to run the machines they were building for him. The enthusiasm of an innovative supervisor apparently overcame scruples against replacing skilled gunsmiths.

Smith's observation that few historians have considered the relationships between agencies of social control and technological progress comes near the end of the book. His concern with social control appears to have grown out of his study rather than to have been a part of this initial program of inquiry; but it is nonetheless important. The idea is provocative and the need to pursue it is evident. As we seek the roots of technological change, we must be conversant with the technology itself, as Smith is, and we must also recognize that acceptance of new technology is somehow connected with social conditioning, which in turn requires schools and churches and civic organizations that promulgate and reinforce the notions of diligence, efficiency, and progress.

This book was recently awarded the prestigious Frederick Jackson Turner award of the Organization of American Historians, placing first in a field of 24 entries, one entry only being accepted from each university press. Historians of technology who have been trying to interest general historians in their field

have something to learn from the way this book is constructed, for Smith has written a work in the history of technology that is regarded by a jury of American historians as a superior example of American history.

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Microfossils

Conodont Paleoecology. Proceedings of a symposium, Waterloo, Ontario, May 1975. C. R. BARNES, Ed. Geological Association of Canada, Waterloo, 1976 (available from Business and Economic Service Ltd., 111 Peter St., Toronto). viii, 324 pp., illus. $12 Canadian; to GAC members, $10. Geological Association of Canada Special Paper No. 15.

The calcium phosphate hard parts called conodont elements do not occur in any living organism and are last known in the Triassic. Thus the traditional way of answering the perennial question "What are conodonts?" is to say, "No one knows." A better way of answering it is to tell what we know about their general morphology (several pairs of serially arranged elements of right- and left-handed forms, indicating an elongate, bilaterally symmetrical animal), their biogeography (they define faunal provinces in the marine realm), their place in the water column (most floated or swam, some were more nearly sessile), and their size and abundance (in the range of modern zooplankton), and what we can reasonably infer about the dominant function of the elements themselves (grasping, in my view). Species of the modern phylum Chaetognatha provide perhaps the best ecologic analog to conodonts. On the basis of these morphologic and ecologic traits the question "What are they?" can be answered as well for conodonts as it can for most other fossil groups.

The purpose of the volume under review is to tell what conodonts are in terms of which species occur in which formations (Ordovician through Triassic) and what can be inferred about their living environment from that information. Sixteen of the 18 chapters document which species occur in sediments of lagoon, reef, shelf, or open-ocean environments. A really excellent contribution is that by S. M. Bergström and J. B. Carnes, who begin by documenting the distinctive associations of species found in calcilutite tidal flat deposits, lagoonal beds, and shallow subtidal, deeper subtidal, and basinal deposits of the Middle Ordovician of Tennessee. The conodont associations of the basinal deposits of Tennessee are the same ones that occur in shallow subtidal deposits of the Baltic shield. Therefore, if these conodonts were benthic they would have had to encompass an enormous range of ecologic conditions; more likely, as Bergström and Carnes prefer, and as the evidence supports, they had a mode of life in the water column.

Many other papers rely on the assertion that if conodonts are found to change with lithology, then a benthic mode of life is indicated, whereas in fact the variation could be due to a change in the water column overlying the sediments or could reflect preservational differences (see below). Missing is any discussion of the modern transition from continental shelf to continental slope, with attendant changes in water as well as in sediments, and the quite different faunas one finds as one moves seaward. Such changes are due to the patterns of normal shelf and oceanic circulation and would yield patterns of animal distribution very much like some of the onshore-offshore transitions mentioned in the text. This hypothesis is difficult for the reader to test owing to the virtual absence from the book of paleogeographic charts on which patterns of ocean currents might be placed.

Special note should be given to Jeppsson's life table for a Late Silurian conodont, and specialists will need to evaluate Kozur's claim that the assemblage of elements in an individual animal changed as the animal got older. Nicoll failed to find conodonts in marine high-latitude rocks of the age of the extensive Carboniferous-Permian glaciations, an indication that conodonts of that time were tropical- and temperate-latitude beasts. Three papers report that large, robust conodont elements, with "variable denticulation," are preferentially found in the littoral environment. Several chapters comment on the paucity of conodonts in algal, coral reef, and hard-bottom facies, although whether this reflects initial distributions or merely the preservation potential of conodonts in those environments is not at all clear. Too much is claimed (in my opinion) without independent evidence. For example, it is stated that conodonts responded dramatically to salinity changes (the authors assert confirmation by the boron method but don't give any data) and that some conodonts were even more stenohaline than crinoids; unscaled graphs are presented to document "considerable variation in salinity"; and "semirestricted" environments are differentiated from "very slightly restricted" ones.

Most of those writing in this book have been concerned in their previous work with problems of geologic correlation. I look forward to their further use of ecologic and oceanographic literature in search of explanations for distributional patterns. Future volumes on the theme of conodont paleoecology may owe their success in no small measure to the pioneer efforts presented in this one.

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(Continued on page 1478)