5. *Bulimus* (——) *ventrosus* Fer.
6. *Helicodiscus lineatus* Say.
7. *Cochlicopa lubrica* Müll.
(= *Ferrussaccia subcylindrica* Linn.)

of Europe, and

8. *Ostrea Virginica* Gmelin.
9. *Mya arenaria* Linn.
10. *Modiola plicatula* Lam.
11. *Urosalpinx cinereus* Say.
12. *Crepidula convexa* var. *glauca* Say.

of the Atlantic seaboard.

With the exception of numbers 2 and 7 examples of the foregoing have been placed in the National Museum.

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SCIENTIFIC BOOKS.

MANUAL AND MECHANICAL PRODUCTIVITY.*

THE report of the United States Commissioner of Labor, Mr. Carroll D. Wright, recently issued, on 'Hand and Machine Labor,' * like all our reports from that source, is rich in facts and data. This report has, naturally, in consequence of its intrinsic importance, as well its admirable form and wealth of information, attracted much attention. Mr. Wright has himself given a resumé of the work in the March issue of *Gunton's Magazine;* London *Engineering* and the *Scientific American* devote space to a summary and we now find in the February number of the *Bulletin de la Société d'Encouragement, pour l'Industrie nationale*, an elaborate article by the distinguished French writer, M. E. Levasseur, in which the abstract of Mr. Wright's report constitutes the *pièce de résistance.* The facts illustrated in this remarkable document are, in substance, the following:

The comparison made is, in general, with the methods of the earlier times, antedating the present system of machine-production in which the hands and even the brains of the workmen are reinforced and made enormously more productive by the employment of machinery of great power, activity, accuracy and endurance. It is the comparison of the work and productivity of the days of unaided manual labor of the last century with the production of our own time of labor-aiding machinery and of industrial organization. The real progress described, surprising as it may seem, has actually taken place mainly in the last half century, and in large proportion since about 1870, the date of initiative assumed in Mr. Wells' famous 'Recent Economic Changes.' Within this period, the changes have been studied in eighty-eight principal industries and about seven hundred subsidiary lines. All the data are tabulated in convenient form and the presentation thus made is most admirably adapted for the purposes of the economist, the engineer and the manufacturer interested in the principles of economics controlling his art.

The general deductions are that, while the number of operations in the production of each article has usually considerably increased, and while the machine with its attendant turns out enormously larger product than the unaided workman, the time required for the production of a given amount of product has quite as extraordinarily decreased; the costs of prodnct have proportionally decreased; the market has been enormously expanded and, unexpected but true, the number of workmen has very greatly increased in each industry thus aided and their wages have followed the upward trend of production. Thus, lower prices of product, and larger production with rising wages for more workmen employed, have been consequent upon the work of the inventor and the genius of the 'entrepreneur,' as the economists, curiously, often denominate the manufacturer and the organizer of industries. Invention has immensely augmented, rather than displaced, labor in every manufacturing industry; not even excepting agriculture, where the inventor has supplied the mower and the reaper, the seeder and threshing machine to increase the effectiveness of the manual worker ten times over.

M. Levasseur, in his extended study of such comparisons of the work of the unaided hand with the work of that machine-assisted, traces the history of the introduction of inventions and machinery, with the gradual rise and more gradual fall of the ignorant prejudice of

* Thirteenth Annual Report; Washington Gov't Print. 1899. 2 Vols. Pp. 1597.

the people most advantaged by improvements made by the inventor, and shows, ultimately, that what he calls the 'Economic Paradox' finds place in all machine-reinforced industries. This principle is: the costs being given in detail, it will be found that, with stated costs, there is a certain production which will give the largest dividends. There is a 'golden mean,' as the writer has been accustomed to call it, when developing a similar principle in the production of power from the heat-engines, departing from which, in any direction, efficiency will be sacrificed and the returns on the investment reduced. This is probably true of any one element of production, varying alone. This economic law is well illustrated in the preceding case by the reversal of the 'law of supply and demand,' as usually stated without qualification, by the progress of invention and organization; giving increased employment by giving one man the power to do the work of many, by raising wages while increasing production and giving enlarged profits while reducing prices; extending markets faster than increased production by labor-assisting machinery can supply them and affording employment to increasing numbers of workmen; elevating them from the lower to the higher strata, while giving work of any stated amount, in product, to a fraction of the number of men formerly required.* The cost of plows, for example, as given by Mr. Wright in his report, has fallen from $54 to $8 and less, each; while the time demanded for production per unit, is reduced from 1180 hours to less than 40. Meantime wages have doubled and quadrupled, and, even at the higher price, labor is eight times as effective as formerly. The user of the plow reduces cost of labor, per acre of ground cultivated, from $3.55 to $0.66 reinforcing his own strength by the machine in nearly every operation, from seedtime to harvest.

The agriculturist, with the aid of machinery, supplies butter of a perfectly uniform and better quality, as an average, by the use of machinery, reducing costs, per 500 pounds, from $10.66 to $1.78. The number of butter-makers has been enormously increased in this period, while the product is made in one-tenth the time and at one-sixth the cost of that of our grandfathers.

Four hundred carriage-axles once cost, for labor, $56.97, and now cost $8.20. Many more men are employed in the industry and the work is done ten times as fast and at one-seventh the cost for work. Similarly, 1000 watch-movements once cost $80,822, and now cost less than $1800; while the number of operations has been quadrupled and the time reduced to one-thirtieth. Five hundred yards of cloth, once costing $135, hand-made, now cost $6.81; 100 pairs of boots then cost $408, and now $35, hand-made and machine-made, respectively; time required is reduced, on the cloth, to one-half of one per cent. of its former value and, in the case of the boots, to ten per-cent. On 20,000 nails, $20 were once expended and now but 29 cents; while the time was then 150 times as great and the cost about 100 times as large as to-day. These are examples of the drift of the inquiry and its outcome.

It is thus evident that the use of labor-assisting machinery—less appropriately called 'labor-saving'—has permitted an enormous increase in the number of people employed in manufacturing, and, while increasing the number of operations in the making of each article, has reduced the time required to a fraction, often a minute fraction, of that formerly demanded, and has decreased the costs of product enormously. Meanwhile, it is known that the wages paid for labor in these directions have greatly increased and, with reduction of costs, their purchasing power has been, at the same time, immensely enlarged. Similar observations in France, reported by M. Levasseur, give precisely the same general results.

"*Abondance, puissance, économie: voila donc trois effets de l'emploi des machines qui sonts évidents,*" concludes M. Levasseur.

Mr. Wright's own summary of his work in this field adds the following deductions: "Machinery has established, or brought into activity, new principles in statute law; it has wrought many changes in common-law doctrine. It has increased opportunities to enjoy art and

* This principle was illustrated admirably in the case of copper-production, where rising wages and falling prices have continued for now many years. See SCIENCE, Dec. 4, 1896, page 817.—R. H. T.

literature, has lessened the frequency and the possibilities of famines, has increased longevity by making life safer and more comfortable. It has extended marvelously the power of production, and, consequently, of consumption. It has made the world cosmopolitan, upsetting old ideas and old customs. It has lifted struggling humanity to a higher plane and has stimulated a higher intelligence."

In agriculture our 45,000 workers are aided by the equivalent, in brain-power, crystallized in machinery, of over 300,000 men. Our 225,000 workers in cotton manufacture are aided by the equivalent of about three millions, by the multiplication of their productive power by use of their labor-assisting machinery. In flouring mills, 65,000 workers in the United States are made equal to nearly five millions. In paper-making, 30,000 men become equal to a million and a half. These workers of the United States, four and a half millions of men, with machinery at their finger-ends, turn out a product that it would require nearly forty millions of men to produce by hand. Locomotives, alone give us the equivalent of the working power, if unaided, of three hundred and fifty millions of men. Our own people derive about twice as great advantage from labor-assisting machinery as do European nations; the population of the United States being equal in productive power to 150,000,000 Europeans. Says Mr. Wright:

"The reflection comes that a labor-saving machine is best defined as a contrivance by which the dead still work. For the motive power of steam is the stored heat of the sun converted into present power. That heat gives force to the present era; while the intelligence of the inventors of motive power, or of the machines which control it, and their workmen are still working in unconscious iron and converting the heat into motion and doing the work of the world." Thus the machine "has practically enabled one generation of men to do the work of four or five generations."

The deduction of the editor of the *Scientific American* is that machinery, by raising wages, increasing their purchasing power, also thus lowering costs of all the necessaries of life, has become recognized "not, as the agitator will even yet suggest, the enemy of labor, but in every respect its best friend."

R. H. THURSTON.

Outlines of the Comparative Physiology and Morphology of Animals. By JOSEPH LE CONTE. New York, D. Appleton & Co. 1900. Pp. xviii + 492.

The impression given by the general appearance of this book is very favorable; print, illustrations, paper and binding are all good. A rapid turning over of the pages at first confirms this impression for the general plan of the work is most admirable. Function is the basis of the work and structure is described only so far as is necessary for the proper understanding of function. In short it continually reminds one of that admirable volume of a generation ago, the Principles of Zoology which was prepared by Agassiz and Gould and which served as the inspiration of many a youth.

In his treatment Professor Le Conte begins with some general accounts of life, cells and histology and then follows a general account of the organs and functions of animals, classifying them as the animal and the vegetative functions. In the treatment throughout man is made the type and the subject is treated in the descending scale.

A work built on these lines might be made almost ideal as a text-book for our schools, but not with our present knowledge. There are too many unknown quantities upon the physiological side. Professor Le Conte's book has also another shortcoming. It contains too many inaccurate statements. On the whole it is better upon the physiological side than where it attempts to deal with morphology, yet here it is far from free from error and ambiguity. Thus the account (p. 5) of the characteristics of plants is true only of the chlorophyl bearing forms; thus, again, the only suggested function of motor nerves is to cause muscular contraction; thus (p. 65) the electrical organs of a fish are stated to be organs for the conversion of nerve force into electricity just as a muscle is a structure for converting nerve force into mechanical power. On p. 58, along with an erroneous conception of the paths of sensory conduction, the ganglion cells of the dorsal roots are placed in

the posterior cornua of the cord. On p. 94 we find the statement that the fibers of olfactory and optic nerves are specialized for recognition of odors and light. Is not this rather a matter of nerve termination? In treating of the ear we find the statement that "in the vestibular sac and attached to the hair-like nerve terminals there are several little sand-like grains of carbonate of lime (otoliths)" and here and elsewhere the author seems to regard the sensory hairs as the terminations of nerves. On p. 218 it is stated that animals lower than hexapods are not known to make sounds intended to be heard. What shall be said of the stridulation of spiders and crabs? On p. 399 the aëration of the crustacean gill is in part attributed to ciliary action regardless of the fact that cilia are unknown in arthropods. The scaphognathite of the decapods is ignored. P. 342, the function of the echinid pedicellariæ is stated to be to convey food to the mouth. In the account of the evolution of the ruminant stomach (p. 317) the author is again at fault, for this complicated structure is not derived by simple division of a stomach like that of man, but by the incorporation of a part of the œsophagus into the organ. Again (p. 435), renal organs are stated to occur only in vertebrates, molluscs and arthropods. Where is the nephridial system of the worms, and have not the contractile vacuoles of the ciliates been shown to void sodium urate? P. 404, the respiration of the star-fish is said to be produced by drawing water into the perivisceral cavity through a multitude of pores but the branchiæ are ignored; while *Echinus* is stated to have tufted external gills around the mouth. The worst feature, physiologically, of the book is the recognition of a vital force.

On the morphological side the errors are far more numerous and we can only call attention to a few. Thus (p. 7) 'all animals must have a stomach"; how about tapeworms? P. 85, 'It is difficult, indeed impossible, to conceive how the vertebrate nervous system could have been evolved out of that of the articulates." Cannot exact homologies be shown between the two? Cannot we compare the distribution of white and gray matter and the origin of the ganglionated roots in both? On p. 91 a pedal ganglion is denied to the oyster. On p. 165 the optic ganglion is stated to act as a retina in the arthropod eye. On p. 172 the vertebrate lens is stated to be comparable to the invertebrate eye. Amphibians are stated (p. 184) to lack a middle ear; this is not true of Anura. On p. 186 the mosquito is credited with two pairs of antennæ. On p. 247 it is stated that we cannot trace homologies except within the primary branches —vertebrates, articulates, molluscs and radiates. What has become of Huxley's comparisons of ectoderm and entoderm of coelenterates and mammals, to say nothing about such homologies as can be drawn between nervous system, nephridia, cœlom and the like? Here and there we meet with statements regarding a radiate type of structure and a recognition of close affinities between coelenterates and echinoderms.

Again, the vertebral theory of the skull is maintained in several places, although it is stated that there is 'some doubt' if it be strictly true. Then there is no recognition of the fact that ribs are not homologous throughout the vertebrates. At various places it is stated that serial homology (metamerism) is mostly limited to the skeleton and the nervous system and is denied to the organs of vegetative life. There is no recognition of the fact that metamerism is mesodermal in origin; and none of metamerism in nephridia, blood vessels, gonads, etc. In the final section we meet this astounding statement (p. 481): "On the east coast of the United States we have two abrupt changes of coast fauna, one at Cape Cod and the other at Cape Hatteras. Scarcely a single species passes from north to south of these points, or *vice versa*."

The foregoing errors have been selected to emphasize the charge of inaccuracy, but a more serious fault is the lack of a broader grasp of the results of recent morphological and physiological research. This is not easy to illustrate, but is very apparent on reading the pages.

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BOOKS RECEIVED.

The Norwegian North Polar Expedition, 1893–1896 Scientific Results, Edited by Fridtjof Nansen. New York, London and Bombay. Longmans, Green & Co., 1900. Vol. I. Pp. viii+141, 44 plates. $15.00.