A rather sinister possibility of injury to trees in flooded areas, which at the present time may only be speculated, is injury from chemicals such as gasoline, which would leave no perceptible trace on trees, but which nevertheless might effectively kill all plants.

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FISH MORTALITY

IN the issue of SCIENCE dated November 1, 1935, Mr. David Tomlinson reported a case of sudden death of fishes in a shallow pool under the title "Rare Aquatic Phenomena" and stated that the phenomenon has been "only recorded in a very few places throughout the world during the past 50 years." I may state that in the plains of India this phenomenon seems to be of frequent occurrence. In Calcutta, when the writer was working there, a sudden epidemic of fish mortality occurred in an acute form twice (and in mild form several times) in the same pool within five years (1926–31). Though on both occasions the epidemic was investigated and the results obtained were published, Mr. Tomlinson apparently does not seem to be acquainted with this happening. In 1926 it was investigated by Seymour Sewell,[1] who concluded that the cause of the epidemic was the sudden accumulation of CO_2 brought about by abrupt changes in the meteorological conditions. In 1931, when the phenomenon occurred again in a severe form, the writer of this note investigated its various aspects and published the results.[2] It was concluded that the epidemic of mortality in the pool was due to the complete exhaustion of dissolved oxygen in the bottom layers of the water as a result of the rapid decay of the accumulated organic matter there. The writer is therefore very much interested to learn that the cause of the catastrophe observed by Mr. Tomlinson in Connecticut, U. S. A., though only superficially investigated, was also associated with almost complete exhaustion of the oxygen content of the water.

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SCIENTIFIC BOOKS

INSECT MORPHOLOGY

Principles of Insect Morphology. By R. E. SNODGRASS. 667 pages, with 319 figures, the majority of which carry two to several illustrations. Published by the McGraw-Hill Book Company, Inc., New York and London. 1935. Price $6.00.

THIS is a volume of interest to zoologists as well as to entomologists. From the wealth of material it contains will be drawn a few samples of interest to both.

The work opens with a forty-page synopsis of the more general features of insectean embryology. In the Collembola, a primitive, wingless group which some authors set off as a class, cleavage of the egg is holoblastic. This is probably not the primitive type of cleavage for other insects as the Collembola are further peculiar in having but six segments in the abdomen, though otherwise their body-structure is insectean. In all other orders, excepting some highly specialized parasitic forms, the egg is loaded with a dense yolk which conditions a meroblastic or superficial cleavage. Cleavage is further evidenced distinctive in the early differentiation of the germ cells at the posterior pole. As a result, insect eggs have been one of the favorite subjects of study by students of the differentiation and migration of these cells. In many insect eggs they can be easily recognized as they are slightly different from the surrounding cells in structure of nucleus and in the presence of dark-staining granules.

Gastrulation, because of the dense yolk, deviates from the terms of the general gastrulation theory, for in most insects the endoderm is formed from anterior and posterior rudiments which arise at the ends of the mesodermal rudiment. In a few instances a strand of endodermal cells may connect these temporarily. Usually the strand cells migrate very shortly into the yolk and become vitellophags. The coelomic sacs are formed by a splitting of the mesoderm, which later by fusion form a haemocoele. The body-wall of the embryo is a single layer of cells which later become glandular and secrete the exoskeleton.

In the basic plan of the insect body Snodgrass, following Holmgren and Hanström, takes the view that it is composed of a preoral or prostomial region followed by eighteen segments enervated from as many pairs of ventral ganglia and ending in a periproct (telson in the Malacostraca) which bears the anus. Thus the procephalon, which bears the compound eyes and antennae, has been derived from a prostomial region enervated from a supraoral brain (protocerebrum plus deutocerebrum). The tritocerebrum is a distinct pair of ganglia arising laterad of the oral opening and with a commisure behind the mouth. The tritocerebrum enervates the oral and labral regions and the second antennae (embryonic). By this theory,

[1] *Jour. Asiatic Soc. Bengal,* 22: pp. 177–201, 1926–27.
[2] *Internat. Rev. Hydrol. Hydrog.,* 26: 1932.

the tritocerebral ganglia are the first pair of ventral ganglia posterior to the oral opening, though usually associated with the sides of the supraoral brain. If ever segmentally distinct in the past as a segment with its paired appendages the second antennae, the tritocerebral segment has become completely fused with the prostomial region. Behind the tritocerebral segment are three poststomial segments, mandibular, maxillary and labial, which are enervated from three pairs of ventral ganglia fused into the "suboesophageal ganglion." The thorax contains three segments, each carrying a pair of legs; the abdomen is composed of eleven segments plus the periproct or telson. Counting the prostomial region and periproct as "segments," the Holmgren theory accounts for twenty segments in the arthropod body instead of twenty-one, as usually stated.

Snodgrass derives the Insecta from some Chilipod-like ancestor through the loss of abdominal legs. He gives a painstaking discussion of the evolution of the attachment of the legs in the Chilopoda and related forms, and in such primitive insects as the Protura, Collembola and Thysanura. He presents much evidence for the theory of Heymons and Börner that each side or pleural region of a thoracic segment has been evolved by a flattening out of a subcoxal joint of a leg. The flattened subcoxa evolved into a brace between tergum and sternum, gained attachments to these and was eventually differentiated into the episternum, epimeron and trochantin of the side of the thoracic segment. Thus arose the pleurite and the definitive joint between the insectean coxa and the body.

The attachment of the wings has always interested Snodgrass and has been a subject which has attracted little attention from other anatomists. He presents the theory, which is generally accepted, that the wings are paranotal expansions of the tergum. This involves a study of their growth and attachments, out of which has come confirmation of and additions to the recent developments in the theory of the homologies of wing veins from order to order.

The wing veins have been given a thorough study in which much evidence hitherto overlooked by other students of the subject has been introduced. The new evidence is from the association of the veins with the several small sclerites in the wing hinge. Snodgrass recognizes, precosta (in early fossil insects), costa, subcosta with two branches and radius with five branches. Media in the archetype had two main branches, *media anterior* (MA), which had two branches (MA_1 and MA_2), and *media posterior* (MP), which has persisted in modern forms with four branches (M_1, M_2, M_3 and M_4). In Ephemerida both branches are retained. In Odonata only MA is retained. In all other modern winged insects MA is lost and MP (with MA lost now called M) with its four or fewer branches is retained. Cubitus has two branches (Cu_1 and Cu_2), but the fork is in the base of the wing. As has been shown by Tillyard and others, Cu_1 is two-branched. Its two branches are Cu_1 and Cu_2 of the Comstock-Needham system for the orders Hymenoptera, Trichoptera and Lepidoptera, while the proper Cu_2 of the system followed by Snodgrass in these orders is first anal in the Comstock-Needham system. In other orders, Snodgrass uses the term postcubitus for the first anal of the Comstock-Needham system. Next are the vannal veins (iV to nV), which may vary from one to twelve in number and are anal veins in the Comstock-Needham system. Behind these in the jugal membrane may occur one or two jugal veins (J).

In various papers and summarized in this work, Snodgrass has given us what is probably the best analysis of the homologies of the external genitalia yet published. These chapters are of particular interest to entomologists, as it has been found that these organs, especially in the male sex, carry the most reliable structural characters for species determination in taxonomic work. The general evidence is that the female of the archetype insect bore an ovipositor near the tip of the abdomen with which she secreted her eggs in crevices and in later evolution with its better development in soft tissues. This organ on the eighth and ninth segments of the abdomen became rudimentary or entirely disappeared in some later forms, while in others, as in the higher Hymenoptera, it was modified into a sting or developed into a needle-like drill as in species ovipositing in timber. Ovipositors in many groups give characters separating species, but in the majority of insects the first parts examined by the experienced taxonomist to determine the species are the male genitalia. The problem of the homologies of the parts of the male external sexual organs, which vary from species to species in the majority of the six hundred thousand insects described, was one of such difficulty that it was one of the last areas of insect anatomy reviewed by the author in preparation for the writing of the present volume. However, based on work already done by embryologists and morphologists, he appears to have brought the apparent conflicts into agreement and gives us a chapter which is probably a correct homologization of these parts.

The presentation of material is from the evolutionary or comparative anatomy standpoint which introduces matter dealing with generalized forms and connecting links. Consideration of function is interwoven with the discussion of structure. The use of the two sources of evidence is most noticeable in the author's analysis of skeletal parts all of which are identified by and related to their proper musculature. The study of muscles in relation to skeletal parts is the approved method of homologization of the parts of the exoskeleton. Because the exoskeleton is completely resecreted after each ecdysis evolutionary changes in skeletal areas occur in bewildering variety. Primitive sutures fuse and primitive plates later become sutured. The attachments of muscles are frequently more reliable evidence of homology than are the edges of sclerites. They are attached to the inside of the cellular wall, which in some ways is a more stable condition phylogenetically than that of the exoskeleton, which is merely a hardened secretion.

The discussions in general are confined to adult insects, although very few of the insects that the professional entomologist meets in the field are adults. At times the author touches on the structure of larval stages, but in no part of the book does he discuss pupal stages and metamorphosis. Because of lack of space in even six hundred pages, Snodgrass has been compelled to omit the many curious and unusual specializations of structure found in all orders of insects.

One of the general characteristics of the Insecta is the morphological adaptability of the group. At each of the several or many ecdyses the body wall becomes embryonic, not one embryonic period to an ontogeny but several, in any of which profound changes of structure may be introduced. On this substratum of repeated embryonic periods has been built the supermechanism of complete metamorphosis. Hardly anything in the general phenomenon of organic growth is more strange than the development of the fly's head, inside out, in a sack opening into the mouth cavity of the maggot. On pupation the sack everts which brings the various head organs into position on the outside as found in the adult. The high development of special larval organs which in a few days' time are digested and have their substance rebuilt into the adult organs, is another commonplace of the protean adaptability of insects. The study of the great variety of adult and larval organs is a biological goldmine. It is these high specializations which Snodgrass is compelled to omit. These omissions suggest to the reader the extent of the problems of insect anatomy and more than anything else impress upon him that this work deals only with the more far-reaching fundamentals.

An elaborate terminology has been avoided, and such terms as are used have been chosen as far as possible to agree with the terminology of current writings on the subject. The volume has freshness of ideas and style, due largely to the fact that nearly every point discussed has been studied in actual insect material by the author himself, who has devoted his time almost without interruption for over thirty years to a study of insect anatomy. Further, it is well written from cover to cover. It is not a volume expanded from a few chapters of lecture notes, but the last chapter is as carefully written as is the first.

The illustrations are a striking feature of the work, as the majority are by the author, while those borrowed have all been redrawn in a style uniform throughout the volume. It is this remarkable ability to see things, then to draw them in a superb style that makes an outstanding anatomist. Snodgrass is one land zoologist who did not rush to the seashore, but who by patient exploration found greater riches in the common insects all about on land. This ability to see the riches in the common and abundant, to organize and interpret the commonplace is one of the characteristics of genius.

CLARENCE HAMILTON KENNEDY

THE PUNCHED-CARD METHOD

Practical Applications of the Punched Card Method in Colleges and Universities. Edited by G. W. BAEHNE. xxii + 442 pp., 7 by 10 inches. Columbia University Press, New York, 1935. $4.50.

THE principle of the punched-card method of tabulation goes back to the beginning of the nineteenth century when Babbage invented his "analytical engine." The modern method as used on the machines of the International Business Machines Corporation has grown out of the perfections introduced by Dr. Herman Hollerith. For fifty years the punched-card method of tabulating and accounting has been used with increasing success by government and business. More recently it has found application in colleges and universities, in administration offices as well as for research purposes.

The tabulating card consists of 80, or 45, numbered equidistant columns, each having twelve punching positions. These are numbered from zero to nine, with two additional positions at the top of the card. With the use of an electric punching machine having a keyboard of twelve keys the operator can punch holes in any punching position of any column. In each application the card is divided into fields consisting of a single column or of groups of columns each of which is to contain a particular type of information. Any information that can be expressed in numbers can be so recorded, if necessary by special codes.

The two essentials are a sorting machine and a tabulator. In all cases the operating principle is the same, with different details in different machines. In the case of the sorter:

> A tabulating card, acting as an insulator, passes between a wire brush and a brass roller. A hole punched into the card causes the brush and the brass plate to make contact and closes an electric circuit which, in