Dr. Abel is professor of paleobiology at the University of Vienna, a pupil of the great Belgian scientist Louis Dollo, and a leading authority in his profession. He is the author of two earlier text-books, "Paleobiologie" and "Die vorzeitlichen Säugethiere," the first of which was reviewed in SCIENCE some years ago.

The present volume treats of the origin and evolution of the various phyla ("Stämme") of vertebrates as shown in the paleontologic record. It is concerned almost wholly with extinct forms; and thanks to this limitation the author has been able to give an unusually full treatment and discussion, especially of the reptiles and Amphibia. The illustrations, while somewhat crude artistically, are excellent for teaching purposes, and its full discussion and fair treatment of recent foreign discoveries are remarkable in a volume prepared and published under war conditions. From first to last Dr. Abel has endeavored to discuss the evidence and give reasons for the conclusions adopted, leaving the way open for difference of opinion on many doubtful problems. A certain unevenness of treatment is manifest, both in the discussion and the taxonomic arrangement, and many details of presentation and classification are open to criticism, as is inevitable in a volume of such wide scope and fundamental treatment. From errors of fact the book is singularly free.

A classified list of the orders and families accepted, with characteristic genera, serves as a preliminary conspectus. To the fishes are allotted 160 pages, partly introductory and dealing chiefly with the early and primitive types. The vast variety of modern bony fishes are treated in a very cursory manner. The Amphibia cover 110 pages, devoted mostly to the Paleozoic types and their relations to the higher vertebrates. The extinct reptiles are quite fully treated, the discussion covering some 355 pages. The most serious criticisms to be made in this section are of the splitting of the pterodactyls into two distinct orders, and the attempt to limit the term dinosaurs to one of the two great orders of gigantic land reptiles that are now understood to be included in the old usage of the name. It would be better to retain it with the old scope but in a general unsystematic sense, like "pachyderms" among the mammals. On the other hand, the discussion of important researches and discoveries among fossil reptiles and their bearing on the evolution of the vertebrates affords an excellent synthesis of recent progress in the science. Birds are a rather minor group among fossil vertebrates, and 23 pages suffice to cover all the important types in their evolution.

The treatment of the Mammalia is relatively brief, covering 167 pages, passing very briefly and uncritically over some of the orders, and hardly touching upon the Primates, but more extended with other groups, and especially authoritative in the Cetacea, upon which the author has published several very valuable researches.

While by no means endorsing all of the author's views upon problems of evolution and classification, the present reviewer does not hesitate to commend Dr. Abel's work as highly authoritative and up to date, admirably presented as to form and reliable as to fact. The treatment of the subject differs widely from that in the new edition of Zittel's "Grundzüge der Paläontologie," recently revised by Schlosser and Broili, which affords in many ways an excellent supplement for Abel's volume, especially in its more comprehensive treatment of the Mammalia.

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SPECIAL ARTICLES

AN ULTRAMICROSCOPIC STUDY OF THE TWO STAGES OF BLOOD COAGULATION[1]

SCHMIDT[2] has described carefully the process of coagulation as it may be followed with the naked eye in the cell-free plasma of a slowly-clotting mammalian blood (horse). He drew attention to the fact that the process may be

[1] From the Physiological Laboratory of the Johns Hopkins University.

[2] Schmidt, "Zur Blutlehre," Leipsig, 1893, p. 262.

separated into two distinct stages from the standpoint of the changing physical properties and macroscopical appearance of the plasma during the progression of clot-formation. First, the fluid plasma is seen to be transformed into a definite but transparent coagulum of which, "on pressure between the fingers, almost nothing remains." This delicate coagulum marks the first visible or palpable stage in the development of the clot. On standing, the transparent, almost structureless, yellow coagulum is observed to become gradually more and more turbid; until at length the second stage is reached, in which the coagulum appears quite opaque and whitish, and assumes the typical characteristics of a firm, fibrin clot. By the use of paraffined vessels and low temperature, the coagulation of human or cat's blood may be delayed sufficiently to permit centrifugalization in order to obtain a clear, cell-free plasma for observation; or one may study the coagulation which follows the recalcification of a centrifugalized oxalted plasma. In either of such quickly-clotting plasmas it is, of course, more difficult, but nevertheless quite possible, to divide the progress of coagulation into the two stages described above.

The transparent-stage and the opaque-stage of blood-coagulation are certainly striking physical phenomena. The question accordingly presents itself: Has each of these stages a separate, underlying causal reaction, or do they represent gradations in a continuous transformation of a sol into a gel? Are the two separate stages superimposable upon separate reactions occurring between the coagulation factors, or does the transparency or opacity of the plasma, as well as its consistency, merely reflect the extent of fibrin-formation?

It seemed that this question might find immediate solution if it could be determined at what point fibrin first makes its appearance during the coagulation of a tube of plasma. In comparison with the appearance of the fibrin which we recognize in a firm, opaque clot, certainly the transparent-stage appears to be entirely fibrin-free. Now it is well known that during coagulation, the formation of fibrin needles can be followed from the beginning with the aid of the ultramicroscope. Howell[3] has described and figured this beautiful phenomena, in which "bright specks appear first as short rods, which exhibit a genuine saltatory movement, jumping abruptly into and out of focus, and quickly fusing to form longer rods and needles" of fibrin. It was at the suggestion of Dr. Howell that it was decided to use the ultramicroscope as a method of approach to the solution of the question outlined above. The Siedentopf and Zsigmondy slit ultramicroscope, with water-immersion objective was the instrument used; illumination was obtained from a carbon arc-light.

After trying various methods, the following procedure was found to yield the most satisfactory results: a horse was bled from the external jugular vein through a paraffined needle into a paraffined tube packed in ice. The blood was taken to the laboratory, filtered through a paraffined funnel surrounded by an ice-jacket, and the cell-free plasma caught in a second iced, paraffined tube. Plasma was then, by means of a chilled paraffined pipette, introduced in rapid succession into (1) the cell of the ultramicroscope; (2) a control cell of the same size and shape, not attached to the ultramicroscope, and (3) a homeopathic vial (into which ½ c.c. of plasma was placed in each experiment). These three containers could be filled within ten seconds, so that coagulation began in all three practically at the same moment. To eliminate any error of interpretation which might conceivably arise from the fact that one vessel was filled a few seconds before another, the order in which they were filled was varied in different experiments. There was, however, no evidence indicating that this theoretical source of error had the slightest influence upon the results in any experiment.

The rationale of using three plasma containers in these experiments may be here explained: (1) The cell of the ultramicroscope was observed closely after filling, in order to determine the time of appearance of the earliest visible needles of fibrin; (2) the homeopathic

[3] Howell, *Am. Jour. Phys.*, 1914, XXXV., 143.

vial served to hold a gross specimen of coagulating plasma in which the time of appearance of the transparent and opaque stages could be compared with that of the appearance of fibrin needles in the ultramicroscope cell. However, as it was found difficult to determine the earliest moment at which the viscous plasma could be considered to have entered the gel-stage, a more delicate criterion of the onset of this transparent stage was devised by using (3) the control cell. This cell, being of the same size and shape as the ultramicroscope cell and being filled at the same time, could be assumed to favor a progress of coagulation synchronous with that occurring within the cell of the ultramicroscope. The tubal prolongation of the control cell was immersed at frequent intervals beneath the surface of a normal saline solution, and a very small amount of plasma allowed to escape into this fluid. If the plasma at once diffused through the salt solution it is clear that it was still in a state of fluidity; if, however, it emerged from the tube in the form of a delicate, transparent "worm" which floated in the solution, preserving the contour of the tube, the plasma was considered to have entered the transparent gel-stage. This proved to be a very delicate test; transparent "worms" could be obtained at such an early stage that agitation of the liquid in which they were suspended would cause them to vanish into the solution—a degree of gel-formation too slight to be discerned by the observation of plasma contained within the homeopathic vial.

In each experiment, the time at which the containers were filled was recorded; likewise a note was made of the time at which fibrin-needles were first to be seen with the ultramicroscope, at which a transparent worm-like gel could first be obtained from the control cell, and at which an opaque clot appeared in the homeopathic vial. The point of interest lies, of course, in the time relation between the occurrence of the transparent gel-stage (as evidenced by the control tube) and the first appearance of fibrin needles under the ultramicroscope. A typical experiment will serve to exhibit this relation:

BLOOD OBTAINED FROM VEIN (HORSE) AT 2:25 P.M.; FILTERED AT 3:30 P.M.

Time	Ultramicroscope Cell	Control Cell	Homeopathic Vial
3:37 ...	Plasma introduced	Plasma introduced	½ c.c. plasma introduced
3:39 ...	No fibrin needles	Plasma liquid	Plasma liquid
3:41:30	Scanty fibrin needles	Plasma forms "worm"	No definite change
3:44 ...	Fibrin needles more numerous	Plasma forms firmer "worm"	Transparent gel present
3:50 ...	Fibrin needles very dense	.....	Opaque clot
4:04 ...	Refilled with plasma	Refilled with plasma	½ c.c. plasma introduced
4:06 ...	No fibrin needles	Plasma liquid	Plasma liquid
4:08 ...	No fibrin needles	Plasma liquid	Plasma liquid
4:09 ...	No fibrin needles	Plasma liquid	Plasma liquid
4:11 ...	Fibrin needles present	Plasma forms "worm"	Plasma liquid
4:12:30	Fibrin needles more dense	.....	Transparent gel present
4:16:30	Fibrin needles very dense	.....	Opaque clot

Such experiments demonstrate clearly that all of the reactions leading to the formation of fibrin have occurred before the transparent gel-stage appears; for fibrin needles are demonstrable in the coagulating plasma in the earliest stages of gel-formation. Indeed, in a number of experiments, a few scattered needles of fibrin were seen with the ultramicroscope before any gel-formation could be demonstrated in the plasma. Microscopically then, the only difference between the so-called transparent-stage and opaque stage of coagulation lies in the greater number of fibrin needles present in the latter. Their gradual development can be watched with the ultramicroscope, and many such experiments (in which the oxalated and unoxalated plasms of man, horse, cat and dog, were tested) prove clearly that the macroscopically observed transition of a liquid plasma through a transparent gel-stage into an opaque fibrin clot, represents merely a continuous progression of fibrin-formation.

SUMMARY

There is no reaction-basis for the division of the process of blood-coagulation into the

two stages (transparent and opaque) which appear so strikingly in slowly-clotting mammalian blood. These stages are superficial phenomena which merely reflect the extent of fibrin-formation. Coagulation is a gradual continuous process of fibrin-formation; and in the clotting of normal plasma, fibrin needles can be demonstrated in the earliest appreciable coagulum, however delicate, transparent or gel-like.

ARNOLD RICE RICH

THE KENTUCKY ACADEMY OF SCIENCE

THE seventh annual meeting of the Kentucky Academy of Science was held at the University of Kentucky, Lexington, on Saturday, May 8, President P. P. Boyd presiding. The secretary's report showed a membership of 110, and 24 new members were elected at this meeting. Resolutions were adopted accepting the terms of affiliation with the American Association for the Advancement of Science and establishing two classes of active members: national and local; and looking to cooperation with the American Ecological Society in preservation of natural conditions. The principal address, "The twentieth century's contribution to our knowledge of the atom" was delivered in the afternoon by Professor R. A. Millikan, who was afterwards elected an honorary member of the academy.

The following program of papers was rendered:

President's address. *The future of the Kentucky Academy:* DEAN PAUL P. BOYD, University of Kentucky. The speaker presented first the summaries of state academies given by Mr. D. D. Whitney in SCIENCE of December 5, 1919 and then told the results of a questionnaire which he had lately sent to secretaries of state academies, the object being to ascertain the future and the field of such organizations. He concluded that there is a definite need for them and urged that the Kentucky Academy begin a forward movement in order to fill more properly its field in the nation-wide organization of science. Some of his suggestions were that the academy cooperate more effectively with the national bodies; that membership be extended more widely to educational and industrial plants; that science clubs be organized throughout the state; that better science teaching in the high schools be promoted; that funds be solicited from the legislature and private sources for publication and research funds; that committees be formed for the study of important state problems and for state surveys; and that recommendations be formulated for presentation to the next legislature.

Blood lines of genetic value: W. S. ANDERSON, Kentucky Experiment Station. In the domestic breeds of live stock great sires seldom produce more than one or two sons that are greater progenitors than themselves. This means, in blooded stock, that the greatness of any given blood line is handed on by one or two in any one generation, the others of the generation merely add members. In support of the statement, the great sires of nine breeds of domestic animals were cited and the few sons of each were named who have been instrumental in handing on the breeds.

Failure of lettuce to head: A. J. OLNEY, and W. D. VALLEAU, Kentucky Experiment Station. The various physiological troubles associated with the failure of greenhouse head lettuce, including those known as rosette, tip-burn, black heart and elongation of the central stalk with the production of laterals (Rio Grande disease), have been found to be associated with a root rot apparently due to *Fusarium,* sp. Soil sterilization by steam and formaldehyde have only partially controlled the trouble, due probably to incomplete sterilization of the lower soil layers.

Variation in Abutilon Theophrasti Medici: CHARLES A. SHULL, University of Kentucky. This paper is a report of progress in an investigation of variability in the number of carpels in the ovaries of *A. Theophrasti.* The range of variability is from ten to seventeen, with the mode usually on fourteen or fifteen. The material shows a skewed frequency distribution, and tendency toward half Galton-curves. A number of plants have been found with half curves and the mode on 15. But whenever a number of plants are counted together, there are usually a small number falling on sixteen. Only three specimens in about 8,000 had seventeen carpels to the ovary. The mode falls on a lower number in material collected in Kansas than in similar material from Kentucky. The drier climate of Kansas is probably responsible for this difference. If plants from an unfavorable habitat are counted the mode is found to be depressed. The modifications of the variability curves noted are probably related rather directly to nutritional conditions. Heredity and suboptimal nutrition are believed to be responsible for the half-curve variability.

Some factors to be considered in attempting to communicate with supposed inhabitants of Mars: