led from the ancestral gene arrangement to the present configuration. The gene arrangements are a morphological character which has two unique advantages over the conventional characters used by the taxonomist. First, the actual genetic basis is studied and not merely a phenotype, and second, the phylogenetic history of each arrangement can be established beyond reasonable doubt.

The mapping of the fifteen known gene arrangements on the third chromosome of *pseudoobscura* and of the seven of *persimilis,* together with a determination of their frequency (in per cent.) throughout the range of the two species allows many interesting conclusions. The theoretically ancestral arrangement *Hypothetical* has not yet been found. Why it should have been replaced by the younger arrangements is an unsolved puzzle. The arrangement *Standard* is the only one that is found jointly in both species, indicating that it was present before *pseudoobscura* and *persimilis* split into two species. Some of the arrangements are apparently very recent since they are still quite localized. The ratio of homozygotes and heterozygotes is so close to the calculated one that random mating and equal viability of the gene arrangements must be expected.

In the final section Epling attempts to correlate the present distribution of the gene arrangements (particularly those with discontinuous ranges) with the geological and climatic history of western North America. He suggests that many of the arrangements are very old and "were in existence during Miocene times or perhaps earlier." This, as it seems to me, highly unlikely conclusion is a striking illustration of the contradictory nature of many of the *D. pseudoobscura* data. On one hand, there is a comparatively high rate of active migration as well as of passive dispersal; on the other hand, there is an almost unbelievable localization of populations as indicated by genetic differences between populations less than a mile apart. On one hand, there are clinal changes of frequency in the *Klamath, Standard, Arrowhead* and *Pikes Peak* arrangements, which seem to parallel closely climatic changes. On the other hand, some arrangements are equally at home in such contrasting climatic provinces as the interior of British Columbia, the mountains along Death Valley and the plains of Texas. I can not escape the feeling that a joker is hidden somewhere in this deck of cards. Perhaps this discrepancy can be explained by assuming an even greater selective significance of small genetic differences than was previously realized. This would counterbalance the swamping that undoubtedly must take place continuously. A study of the endemic Drosophilidae of the oceanic Hawaiian Islands might shed some light on the passive dispersal facilities of this family. Finally, the absence of the *Santa Cruz* arrangement from the most arid section of the southwestern deserts, as well as the seasonal fluctuation of the gene arrangements in at least two localities in California indicate that some inversions may have different selective values in different environments. To be sure, as Dobzhansky himself points out (*Genetics,* 28: 179, 1943), it is not the inversions themselves that produce these effects, but rather the genes that are variously associated with them at each locality. The possible role of a position effect of such breaks should not be overlooked. Perhaps the reduction of crossing over permits the development of stabilized gene complexes with very specific properties.

This work has all the earmarks of one of the classics of the field of genetics. It is rich in fact and rich in thought-provoking discussions. It is pioneering in its employment of new methods and exemplary in its coordination of the three fields of genetics, taxonomy and systematics.

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SYNTHETIC RUBBER

Synthetic Resins and Rubbers. By PAUL O. POWERS. New York: John Wiley and Sons, Inc. 296 pages. $3.00.

EVER since the Japanese invaded Malaya, every one has been aware that the source of supply of natural rubber was cut off from us. It is also a well-known fact that colossal strides have been made by technologists to fabricate various types of synthetic rubber out of raw materials available in this country. A book, therefore, which discusses the chemistry of synthetic rubbers is timely.

As the title indicates, the subject of this book is both resins and rubbers. Rubber, synthetic or natural, is but one of a large class of organic compounds. Other products which likewise fall into this category are plastics, synthetic resins, adhesives, coating compositions, paints, varnishes and lacquers and synthetic fibers. One fundamental property which all these materials possess is that they are very large and complex organic molecules. It follows that, since these materials are fundamentally related, their uses are also often interchangeable. For example, natural rubber has been used as an adhesive, as a fiber, as a coating composition and as a molding compound. Conversely, certain resinous materials may be used as rubbery materials and as fibers.

Under appropriate conditions, a great many simple organic compounds can be transformed into derivatives whose molecular weight varies from 500 to 500,000 and perhaps even much higher. Compared to simple chemical compounds, these products are giants from 30 to 30,000 times as heavy as a molecule of water.

It is the purpose of this book to describe methods by which this chemical transformation or polymerization may be achieved. The description is limited to those products which have achieved commercial importance. Theories of polymer formation (52 pages), condensation polymers (62 pages), vinyl polymers (59 pages), synthetic rubbers (57 pages), resins derived from natural products, particularly rubber and cellulose (37 pages), and application of synthetic resins (24 pages), are adequately treated. The author uses the pragmatic approach and makes a distinction between polymers formed by condensation and those secured by polymerization. This method is useful and adds to the ready presentation of those products where both types of reaction mechanisms are used to bring about an increase in the molecular weight. To each chapter is appended a series of review questions and a good selection of special and, where possible, general references.

The book is recommended to any one who desires a concise summary of the chemistry of synthetic resins and rubbers.

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SPECIAL ARTICLES

AGGREGATION IN SOLUTION OF A SYNTHETIC HAPTEN

A synthetic hapten which precipitated specifically with antibody was first produced by Landsteiner and van der Scheer.[1] Later Marrack[2] pointed out that if a theory of serological reactions which we may refer to as the "alternation" (or "framework") hypothesis[3] is correct, any compound containing as many as two specific groups capable of combining with antibody should be able to form a precipitate; and this prediction was later tested by Hooker and Boyd,[4] by Pauling and collaborators[5] and by Boyd.[6] In some of these experiments precipitation of hapten by antibody was observed, and Pauling has stated that he considers that these "phenomena provide strong support for the framework theory of serological precipitates. . . ."

It should be recalled, however, that Landsteiner[7] considered that the precipitability of the haptens studied by him was due to their being aggregated in solution, and Hooker and Boyd[4] pointed out that if the haptens studied by Pauling were aggregated under the conditions of the tests this would considerably weaken the support given the theory by this evidence. They further reported observing differences in diffusibility into gelatin of precipitable and non-precipitable haptens, which did in fact suggest that the precipitable ones were aggregated.

We have attempted to study the question of the degree of aggregation in solution of such precipitable haptens, and wish to report here observations made on an arsanilic-phloroglucinol derivative, designated as "VII" in Pauling's earlier paper and in the paper by Boyd[6] and as "XI" in Pauling's later papers. To estimate the degree of aggregation we made measurements of the diffusion coefficient, using the sintered glass disk technic as employed by Northrop and Anson,[8] McBain and others,[9] Lehner and Smith,[10] and Mehl and Schmidt.[11] The disks used were calibrated with both KCl and sucrose.

For hapten "VII" ("XI") we have found a diffusion coefficient at 25° of about 0.109 cm^2/day, which would indicate, if the particles are spherical, a particle size in the neighborhood of 12,500. Since the formula weight is 1,122, this would indicate that the hapten is aggregated in solution to the extent of about 10–12 molecules per particle. Details will be published elsewhere.

If other precipitable haptens are aggregated in solution, as we suspect at least some of them are, it is evident that the fact of their precipitabiliy is no stronger evidence for the "alternation" theory than is the precipitation of any antigen, since it seems likely that each particle of the aggregate will have quite a number of accessible specific reacting groups, just as ordinary antigens do. It is evident therefore that we shall in that case have to reexamine most of the conclusions which have been drawn by Pauling and others from experiments with such substances. In particular Pauling's calculations of antibody valence become doubtful.

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[1] *Proc. Soc. Exp. Biol. and Med.*, 29: 747, 1932; *Jour. Exp. Med.*, 56: 399, 1932.

[2] "The Chemistry of Antigens and Antibodies," H.M. Stationery Office, London, 1938.

[3] S. B. Hooker and Wm. C. Boyd, *Jour. Immunol.*, 42: 419, 1941.

[4] *Arch. Path.*, 28: 754, 1939; *Jour. Immunol.*, 42: 419, 1941.

[5] *Proc. Nat. Acad. Sci.*, 27: 125, 1941; *Jour. Am. Chem. Soc.*, 64: 2994, 1942.

[6] *Jour. Exp. Med.*, 75: 407, 1942.

[7] "The Specificity of Serological Reactions," Springfield, 1936.

[8] *Jour. Gen. Physiol.*, 12: 543, 1928–29.

[9] *Jour. Am. Chem. Soc.*, 53: 59, 1931.

[10] *Jour. Am. Chem. Soc.*, 57: 497, 1935.

[11] *Univ. of Calif. Pub. in Physiol.*, 8: 165, 1937.