To check these field observations, 23 oyster drills and three moon snails were placed together in a laboratory aquarium. At the end of 4 mo, one moon snail and one oyster drill were alive. The other two moon snails and 22 drills had been eaten by the moon snail(s).

It is possible that some cases of drill death previously attributed to cannibalism were cases of moon snail predation.

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4 June 1954.

Brochosomes and Leafhoppers

Brochosomes (Gr. βρόχος, mesh of a net; σῶμα, body) are hollow spheroids varying in diameter from 240 to 600 mμ which, because of a fixed arrangement of high and low electron-scattering areas, appear as netted bodies. They are found on the wings, wing scales, and hairs of many insects [G. S. Tulloch and J. E. Shapiro, *Bull. Brooklyn Ent. Soc.* **48** (3), 57 (1953)]. Their regular occurrence on a large number of leafhoppers representing several species from widely separated areas in the United States suggested that the brochosome-leafhopper association was not a casual one. Further studies dealing with the geographic range of this relationship are reported here along with data obtained by following the development of one species of leafhopper from egg to adult.

Leafhoppers were obtained from many sources throughout the world and prepared for examination under the electron microscope in the following manner. Wings were removed and placed in a drop of water on Formvar-filmed 200-mesh screening and allowed to dry at room temperature. By this technique, the wing is flattened and fixed to the film and some of the brochosomes, which are easily dislodged, are pulled to the periphery of the drop of water and there become fixed to the clear film. As a result of this survey, leafhoppers positive for brochosomes have been recorded from the United States, Mexico, Panama, Cuba, Jamaica, Peru, Belgian Congo, India, Pakistan, and China. Thus far, not a single leafhopper, regardless of its geographic origin, has been found free of brochosomes. Although material from Europe and Australia has not been examined, there is good indication from the available data of the universal nature of the brochosome-leafhopper association.

Other studies have been concerned with the presence or absence of brochosomes in the egg and in the several instars found in the development of the aster leafhopper, *Macrosteles divisus,* obtained from a laboratory colony. The eggs were removed from the host-plant tissues and from the female, macerated in a drop of water, and allowed to dry on the Formvar film. Since the early instars lack wings or wing pads, body fluids were utilized by employing the smear technique. For the older instars, the wings were mounted directly on the Formvar. Examination of these preparations under the electron microscope revealed that (i) eggs removed from the female as well as those dissected from plant tissues 1 and 8 days following deposition were negative; (ii) all specimens from the different instars, prepared either from body fluids or wing surfaces, were positive, although the body fluid material (instars I and II) gave a smaller brochosomal yield than the wings of the later instars.

The close association of brochosomes and leafhoppers both geographically and developmentally indicates that this relationship is not fortuitous. The presence of brochosomes in the body fluids suggests that they may be metabolic derivatives which reach the surface of the body through the pore canals.

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Limitations of the Symmetry Criteria for Optical Inactivity and Resolvability

Renewed interest in the subject of optical inactivity (*1*) has stimulated the present inquiry into the generality of symmetry criteria.

The criteria employed for predicting optical activity or nonactivity from a knowledge of the structure of a compound have evolved, in the historical sense, from Pasteur's original broad recognition of molecular dissymmetry, through Le Bel and van't Hoff's somewhat more restrictive theory of the asymmetric carbon atom, to the presently accepted view that from symmetry properties of the molecule alone one may be able to predict resolvability or the lack thereof (*2*). These views, in their modern context, may be stated briefly as follows.

Given the structural formula of a compound and some understanding of the energy barriers restricting bond distortion, it may be supposed that each molecule in the statistically significant aggregate is capable of assuming a number of reasonable conformations which, through bond rotation and distortion, are mutually interconvertible. In all cases so far considered, without exception, there exists at least one conformation (the "symmetry conformation") that possesses reflection symmetry—mirror-axes, for example, point, plane, or four n-fold alternating axis of symmetry; this conformation can be superimposed on its mirror image by the application of symmetry operations alone. The remaining dissymetric conformations are evenly distributed between nonsuperimposable enantiomers, representing in their totality a large number of transient dl-pairs. According to the presently accepted symmetry criteria, the availability of any symmetry conformation(s) is deemed sufficient basis for declaring the molecular aggregate optically inactive and nonresolvable. Thus, for example, the fact that one symmetry conformation may ordinarily be written for 2,2′diphenic acid, or two for meso-tartaric acid, is enough to predict the optical inactivity of either compound. Conversely, the absence of symmetry conformations permits the prediction of optical activity, or resolvability in the case of racemic mixtures.

The usefulness of symmetry criteria is evident, yet it is a remarkable fact that apparently no cases constituting exceptions to this doctrine have heretofore been considered as such. Since the sole necessary criterion for optical inactivity is the presence, in the molecular system, of an equal number of conformational and/or configurational enantiomers, it was tempting to postulate a case of an optically inactive and configurationally pure compound not possessing a symmetry conformation. Consider, for example, the hypothetical structure shown in Fig. 1. It may be assumed that rotation is virtually free about bonds *a*, whereas rotation about bond *b* is effectively restricted to eliminate conformations containing a planar biphenyl system. Compounds possessing the structural features illustrated may exist in three stereoisomeric modifications: d,l, and meso. It must now be emphasized that *no conformation conceivable for the meso modification possesses reflection symmetry*; that is, the symmetry criteria are here no longer applicable. Although any given conformation having the planes of the phenyl rings at right angles to one another cannot possibly be superimposed upon its enantiomer through the application of symmetry operations alone, an interconversion between the enantiomers will still take place by virtue of rotation around bonds *a*. In consequence, the molecular aggregate, consisting exclusively of transient dl-pairs, is optically inactive and not resolvable, in the operational sense that meso-tartaric acid is not resolvable.

It must be noted that this case is dissimilar to superficially analogous cases such as $(a^+)(a^+)C(a^-)(a^-)$, where a^+ and a^- represent dissymetric groupings (for example, sec.-butyl) of opposite configuration: such a compound possesses a symmetry conformation having a fourfold alternating axis of symmetry.

One additional aspect of interest in the situation here outlined is that conformational racemization, in

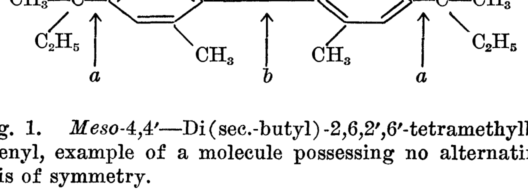

Fig. 1. *Meso*-4,4′—Di(sec.-butyl)-2,6,2′,6′-tetramethylbiphenyl, example of a molecule possessing no alternating axis of symmetry.

the case of this type of compound, cannot proceed via a symmetric intermediate. It follows that in general a symmetric intermediate need not, and sometimes cannot, be invoked to account for racemization.

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1. See, for example, C. R. Noller, *Science* **102**, 508 (1945); G. W. Wheland, *Advanced Organic Chemistry* (Wiley, New York, ed. 2, 1949), pp. 147, 191; K. Mislow, *Science* **112**, 26 (1950); R. W. Hakala, *ibid.* **113**, 15 (1951); D. F. Mowery, Jr., *J. Chem. Educ.* **29**, 138 (1952); R. L. Bent, *ibid.* **30**, 328 (1953).
2. See F. M. Jaeger, *Spatial Arrangements of Atomic Systems and Optical Activity* (McGraw-Hill, New York, 1930), chaps. 1–4.

27 May 1954.

Some Problems Concerning the Distribution of the Late Paleozoic Gastropod *Omphalotrochus**

The genus *Omphalotrochus* Meek is a wide-ranging stratigraphically significant gastropod. Its importance has received acknowledgment in designation of the *Omphalotrochus* zone in the Moscow basin of Russia. This zone is classified by most Russian geologists as Upper Carboniferous and is correlated with beds underlying the *Pseudoschwagerina* zone (*1*). The base of the *Pseudoschwagerina* zone is considered by some Russian and many American geologists to mark the base of the Permian system.

In other areas of Russia, *Omphalotrochus* occurs in the *Pseudoschwagerina* zone. For this reason, and because *Omphalotrochus* had not been reported from beds below those correlated with the American Wolfcamp formation, Knight suggested that the "*Omphalotrochus* beds of the Timan arch [Russia] should be included with the *Pseudoschwagerina* beds and that they, together with the intervening *Cora* beds, are the Russian equivalent of the American Wolfcamp series" (*2*). He tentatively referred the entire interval to the basal Permian, but so far as is known, this suggestion has not been adopted by Russian geologists. The purpose of this note is to record other occurrences of *Omphalotrochus* and to mention the implications of these findings in correlation of strata of late Paleozoic age.

The west Texas Wolfcamp formation contains, among other fossils, *Pseudoschwagerina* and *Omphalotrochus*. *Omphalotrochus* has been collected recently from the upper part of the *Uddenites* zone, directly below the Wolfcamp formation, but *Pseudoschwagerina* appears to be lacking from this zone.

Most American geologists dealing with upper Paleozoic stratigraphy consider the Wolfcamp formation to be the approximate equivalent of the Russian *Pseudoschwagerina* zone and classify it as lower Permian or Permian (*?*). The age of the *Uddenites* zone has been a controversial subject, some stratigraphers