and anthracene[9] are plotted in Figure 1 against the respective localization energies. The slope of this correlation, determined by the method of least squares, corresponds to $\beta = -8.0 \pm 0.8$ kcal. at the 0.95 confidence level.[12] Since the partial rate factors for phenylation of naphthalene and anthracene are correlated by $\beta = -7.8 \pm 0.8$ kcal.,[9] we conclude that biphenylene possesses "normal" reactivity in homolytic phenylation.[13]

Recently Streitwieser and Schwager[5] measured rates of tritiodeprotonation of biphenylene in tritiated trifluoroacetic acid–70% perchloric acid at 25° and concluded that their findings were in serious quantitative disagreement with molecular orbital predictions. This conclusion was based upon a comparison of the found ratios of reactivities at the two sites in biphenylene ($k_2/k_1 = 64$) with a predicted ratio of 4. The latter ratio appears to have been calculated from localization energies and a reaction constant based on deuteriodeprotonation in a different medium. Blatchly and Taylor[6] have also studied rates of detritiation of labeled biphenylenes in anhydrous trifluoroacetic acid at 70° and have found a rate ratio (k_2/k_1) of 135. The most extensive data for this type of electrophilic aromatic substitution are those of Eaborn and Taylor,[14] who measured rates of detritiation of biphenyl and naphthalene at 25° in a trifluoroacetic acid–perchloric acid medium. A plot of these data and those of Streitwieser and Schwager for biphenylene against the respective localization energies exhibits such enormous scatter that one is tempted to speculate that solvation effects are position dependent and that any correlations are reaction-site dependent.

In view of the problems associated with interpreting rate data for this simple example of electrophilic aromatic substitution, it appears that homolytic aromatic substitution is the preferred reaction for evaluating predications based on molecular orbital calculations.

(12) C. A. Bennett and N. L. Franklin, "Statistical Analysis in Chemistry and the Chemical Industry," John Wiley and Sons, Inc., New York, N. Y., 1954, Chapter 6.

(13) Examination of Figure 1 reveals small deviations from linearity which could be ascribed to steric factors. Discussion of this and other considerations is deferred to full publication.

(14) C. Eaborn and R. Taylor, J. Chem. Soc., 1012 (1961).

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A New Synthesis of Phosphatidic Acids by Direct Acylation of DL-α-Glycerophosphate

Sir:

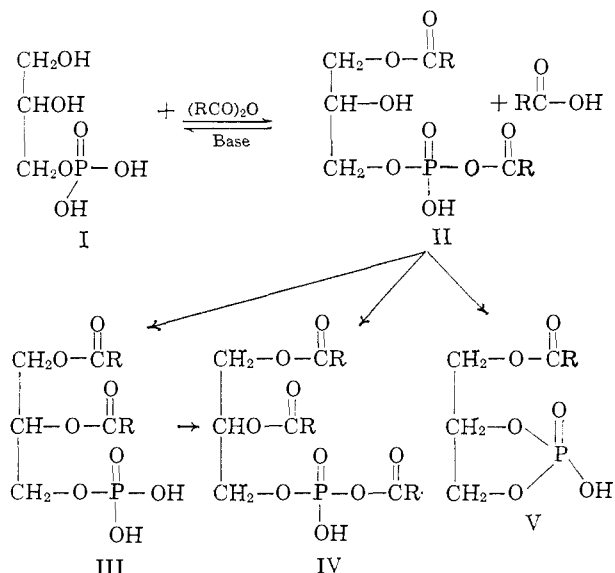Diacyl glycerophosphates are conventionally synthesized by phosphorylation of diglycerides.[1-5] At-

(1) E. Baer, J. Biol. Chem., 189, 235 (1951).

(2) J. H. Uhlenbroek and P. E. Verkade, Rec. Trav. Chim., 72, 395 (1953).

(3) L. W. Hessel, I. D. Morton, A. R. Todd, and P. E. Verkade, ibid., 73, 150 (1954).

(4) E. Baer and D. Buchnea, Arch. Biochem. Biophys., 78, 294 (1958).

(5) N. Z. Stanacev and M. Kates, Can. J. Biochem. Physiol., 38, 297 (1960).

tempts at direct acylation of glycerophosphate failed to give pure diacylglycerophosphate[6,7] since now we know that large amounts of cyclic phosphate (V) are formed in such a reaction. It is known that the reaction of an acylation agent with phosphomonoesters rapidly gives an acyl phosphate.[8] In the case of α-glycerophosphate (I) the corresponding acyl phosphate (II) could give 1′,2′-cyclic phosphate (V)[9] or alternatively it could cause acylation of the neighboring 2′ hydroxyl group to give III (the latter would then again rapidly form the mixed anhydride IV). The acylation of the primary hydroxyl group will occur in the normal fashion. Acylation of the 2′-hydroxyl group would probably also occur by direct attack of the acid anhydride on II. Intramolecular cyclic phosphate diester formation is a property of a variety of phosphate esters which bear a hydroxyl group adjacent to the phosphate such as ribonucleoside 2′- (or 3′-) phosphates and sugar phosphates.[10] Lapidot and Khorana[11-13] found that acetylation and benz-

oylation of ribonucleoside 3′-phosphates with the corresponding anhydrides in the presence of tetraethylammonium salt produce 2′,5′-diacyl ribonucleoside 3′-phosphate as a sole product, and no cyclic phosphate could be detected. A similar approach has been applied in the present work for the development of a simple method for the preparation of phosphatidic acids by direct acylation of DL-α-glycerophosphate with fatty acid anhydrides in the presence of the appropriate tetraethylammonium salt. Thus, dicaproyl, dipalmitoyl, and dioleyl DL-α-glycerophosphate were prepared in good yields (70–80%).

In a typical experiment, a mixture of pyridinium DL-α-glycerophosphate (0.4 mmole) and tetraethylammonium palmitate (4 mmoles) was rendered anhydrous by repeated addition of dry pyridine and subse-

(6) I. Kabashima, Ber., 71, 1073 (1938).

(7) H. Arnold, ibid., 74, 1736 (1941).

(8) A. W. D. Avison, J. Chem. Soc., 732 (1955).

(9) T. Ukita, N. A. Bates, and H. E. Carter, J. Biol. Chem., 216, 867 (1955).

(10) H. G. Khorana, "Some Recent Developments in the Chemistry of Phosphate Esters of Biological Interest," John Wiley and Sons, Inc., New York, N. Y., 1961.

(11) Y. Lapidot and H. G. Khorana, Chem. Ind. (London), 166 (1963).

(12) D. H. Rammler, Y. Lapidot, and H. G. Khorana, J. Am. Chem. Soc., 85, 1989 (1963).

(13) Y. Lapidot and H. G. Khorana, ibid., 85, 3857 (1963).

quent evaporation. Palmitic anhydride (4 mmoles) was added, and the sealed reaction mixture was kept at 70–80° for 24 hr. Chloroform (20 ml) was added and the solution was shaken with Dowex 50 (pyridinium) ion-exchange resin (15 g. of dry resin) for 5 hr. The resin was removed by filtration, and the solution was passed through a column of the same resin (10 g.) to ensure removal of the tetraethylammonium ions. The chloroform was removed by evaporation and a mixture of chloroform–methanol (2:1, 15 ml.), pyridine (13 ml.), and water (3 ml.) was added to hydrolyze the anhydrides. After 15 hr. at room temperature all the solvents were removed by evaporation *in vacuo*, and the residue was dried *in vacuo* over phosphorus pentoxide. The dry product was dissolved in chloroform (20 ml.) and passed through a column (36 × 2 cm.) of silicic acid (Unisil). The column was eluted with chloroform (500 ml.) to remove the palmitic acid, and then with 10% methanol in chloroform (300 ml.). The second fraction containing the product was analyzed for ester linkages by the hydroxamic acid test[14] and for phosphorus according to King,[15] giving a ratio of ester:phosphorous of 2:1

(14) B. Shapiro, *Biochem. J.*, **53**, 663 (1953).
(15) E. J. King, *ibid.*, **26**, 292 (1932).

(yield 80%). The product gave one spot on thin-layer chromatography in two solvent systems (chloroform–methanol–acetic acid (85:5:2) and ether–ethanol–HCl–acetic acid (150:3:2:2)). The thin-layer plates were coated with silica gel without $CaSO_4$, and visualization of the spots was obtained by direct charring with 50% H_2SO_4. Treatment of the acylation product with 7 M ammonium hydroxide yielded α-glycerophosphate as the sole product, whereas material obtained by acylation in the absence of tetraethylammonium salt yielded a mixture of glycerophosphate and the cyclic phosphate. The glycerophosphate (R_f 0.15) and the cyclic phosphate (R_f 0.50) were detected by paper chromatography using 2-propanol–ammonia–water (7:1:2) as the solvent. Elemental analysis of the dipalmitoyl DL-α-glycerophosphate gave the expected results. *Anal.* Calcd. for $C_{35}H_{68}O_8P$ (648.6): C, 64.75; H, 10.73; P, 4.78. Found: C, 64.89; H, 10.98; P, 4.85.

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Book Reviews

Molecular Orbital Theory. An Introductory Lecture Note and Reprint Volume. By C. J. BALLHAUSEN, Kobenhavns Universitet, and HARRY B. GRAY, Columbia University. W. A. Benjamin, Inc., 1 Park Ave., New York, N. Y. 1964. ix + 273 pp. 16 × 23.5 cm. $4.95.

When reviewing a book written by two friends of high professional stature and undoubted ability, it is most agreeable to be able to express sustained enthusiasm for their work. I am very sorry to have to say that while much of this book does arouse my admiration, I find myself somewhat dissatisfied with the part which, though small, represents in my judgment the heart of the book.

There is, of course, the general question of what critical standards are supposed to be applied to a book which implicitly begs off being a *book* and calls itself instead "An Introductory Lecture Note and Reprint Volume." This is, of course, a clever *finesse* by the publisher, since it enables him to corral busy authors who could not be persuaded to write a *book*. Instead their "lecture notes" are published as a...what? Unbook? In fairness, there are merits to the scheme, beyond the aggrandizement of the publisher. It can and often does make available to a wide audience the personal approach which some specially gifted or expert people bring to their subjects. Moreover, it may—already or in the future—have the advantage that less effort and expense will be devoted to some material of limited or transient interest.

If, for such reasons, one accepts the "half a loaf is better than none" philosophy, one is bound to say that these unbooks should not be criticized for a certain choppiness, a certain roughhewn

quality in their style. That, within reasonable limits, is what one expects in "lecture notes."

I do think, however, that no matter what a book (or unbook) is called, there can be no exemption from the normal standards of scholarship in regard to rigor within the declared or implied level of discussion, fairness, and a critical attitude which draws attention to the limitations and failings as well as to the advantages and successes of whatever procedures and approximations are described. In reviewing this book, the foregoing considerations were in my mind.

There are three relatively distinct parts of the book, about which rather different things must be said. The most voluminous part is the collection of reprints. Considered in relation to the material covered in the text, the selection is good. Probably each of us might think of one or another article we would like to have seen included, but it would be hard to fault the selection as far as it goes. My own suggestion would have been to include a few more papers containing tables of overlap integrals (such as Jaffé's several papers on d orbitals) to supplement the tables of Mulliken, Rieke, Orloff, and Orloff (covering s and p orbitals only) which are included.

Inspection of some of the reproduced pages which have been reduced approximately to half their original size does raise questions about the reprint idea in general, or at least about its practical implementation. One might, of course, question the justification for such reprint collections in this age of the Xerox machine, at least in the United States. Even in less developed parts of the world, it has become relatively easy to obtain photocopies of