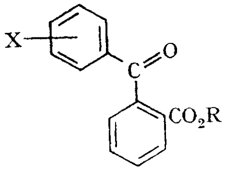
Mechanism of the Alkaline Hydrolysis of Methyl 2-Benzoylbenzoates

By K. BOWDEN* and G. R. TAYLOR
(*Department of Chemistry, University of Essex, Colchester*)

INTRAMOLECULAR catalysis of the alkaline hydrolysis of certain methyl 2-acylbenzoates has been postulated.[1,2] In an attempt further to delineate the extent and details of such a pathway, a study of the reactivity of the 3'- and 4'-substituted 2-benzoylbenzoic system (I) has been made. The effect of substitution has been assessed by use of the Hammett equation.[3] The reaction constant, ρ, for the hydrolysis of the methyl 2-benzoylbenzoates (Ia) in 70% v/v dioxan–water at 30·0° and for the ionization of the acids (Ib) in 80% w/w 2-methoxyethanol–water at 25° are shown in the Table, together with the reaction constants for the hydrolysis of methyl benzoates and the ionization of benzoic acids under identical conditions. A reasonable estimate[4] of the reaction constant ratio, ρ/ρ_0, for the transmission of substituent effects from the benzoyl carboxylate reaction site is 0·3. This is in good agreement with that found for the ionization reaction; *i.e.*, $\rho/\rho_0 = 0{\cdot}34$. However, the reaction-constant ratio found for the hydrolysis reaction is very much greater, *i.e.*, $\rho/\rho_0 = 0{\cdot}94$, and cannot be due to the transmission of the polar substituent effects to the carboxylate reaction site. The mechanism shown† right has been suggested for the alkaline hydrolysis of methyl 2-formylbenzoate[1] and for methyl 2-benzoyl-6-methylbenzoate.[2] The magnitude and sign of the reaction constant for hydrolysis found for the system (Ia)



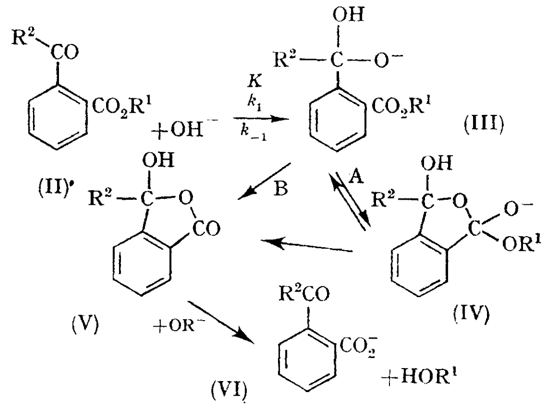
(I) a; R=Me
b; R=H

TABLE

Hammett reaction constants, ρ

	3- and 4-substituted benzoic system	3'- and 4'-substituted 2-benzoyl benzoic system
Hydrolysis of methyl esters in 70% v/v dioxan–water at 30·0°	2·20	2·07
Ionization of acids in 80% w/w 2-methoxyethanol–water at 25°	1·68[a]	0·58

[a] Calculated from literature data (ref. 6).



---

† Either by route A (formation of cyclic intermediate IV), or by route B (direct displacement to form V).

is in accord with the intramolecular hydrolysis mechanism shown being the major route for the 2-benzoyl esters in this study. The rate-determining step could be equal to the rate of hydration, k_1, or the product of the pre-equilibrium involving hydration and the rate of an intramolecular step, $k_{obs} = kK$. A number of reactions, which involve a rate-determining attack by a negatively charged nucleophile on a carbonyl group directly bonded to the substituted phenyl group, have reaction constants in this range; *e.g.*, ρ for alkaline hydrolysis of benzoic esters 2·1—2·7, for methoxide-catalysed methanolysis of benzoic esters 2·65, for borohydride reduction of acetophenones 3·06. The steric accelerating influences of 6-substituents on methyl 2-benzoylbenzoates have been confirmed recently by Newman and his co-workers.[2,5] The interpretation given is that a steric effect facilitating the intramolecular attack occurs and the intramolecular mechanism shown *only* is significant for the 6-substituted esters. The latter seems to be precluded by the evidence given here.

(*Received, August* 21*st*, 1967; *Com.* 895.)

[1] M. L. Bender, J. A. Reinstein, M. S. Silver, and R. Mikulak, *J. Amer. Chem. Soc.*, 1965, **87**, 4545.
[2] M. S. Newman and S. Hishida, *J. Amer. Chem. Soc.*, 1962, **84**, 3582.
[3] See *e.g.*, H. H. Jaffe, *Chem. Rev.*, 1953, **53**, 244.
[4] K. Bowden, *Canad. J. Chem.*, 1963, **41**, 2781.
[5] M. S. Newman and A. Leegwater, personal communication.
[6] W. Simon, A. Morikofer, and E. Heilbronner, *Helv. Chim. Acta*, 1957, **40**, 1918.