

Formation of Benzanilides from Pirylium Salts and 2-Phenyl- Δ^2 -oxazolin-5-one

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The base-catalysed reaction of 2-phenyloxazolin-5-one with five tri- or tetra-substituted pyrylium perchlorates yielded derivatives of benzanilide; intermediate unsaturated azlactones were isolated in two cases. 2,6-Diphenylpyrylium perchlorate gave a 4-pyranylideneoxazolinone.

PYRYLIUM salts undergo a variety of ring transformations on treatment with nucleophiles.¹ The formation of six-membered aromatic rings typically involves the incorporation of one atom of the reagent in the new ring; thus amines yield pyridine compounds,¹ hydrogen sulphide thiopyrylium salts,² and carbanions benzene derivatives.¹ Three reactions are known, however, in which the nucleophile supplies two atoms to the resulting six-membered rings: Dimroth and Neubauer³ observed the formation of the benzophenones (1) and (2) in the reaction of 2,4,6-triphenylpyrylium fluoroborate with diethyl malonate and malononitrile, respectively, and we recently obtained 2-amino-3-aryloxy-pyridines (3) from 2,4,6-triarylpyrylium perchlorates and cyanamide.⁴ It occurred to us that Δ^2 -oxazolin-5-ones, because of their dual reactivity as nucleophiles and electrophiles, might undergo an analogous reaction with pyrylium salts to give acylamino-substituted phenolic ketones (19) (path A; see Scheme) and we accordingly investigated the action of 2-phenyloxazolinone (5) on a number of pyrylium salts.

The oxazolinone was generated from its hydroperchlorate⁵ by treatment with triethylamine; addition of 2,4,6-triphenylpyrylium perchlorate (4a) gave a deep-yellow solid (21%) whose colour, i.r. spectrum [1788, 1765 (azlactone), and 1680 cm^{-1} (ketone)], and

analytical figures showed it to be the oxazolinone (6a). We prefer this formula to the less conjugated structure (7a) because the compound absorbs at a considerably greater wavelength (400 nm) than does 4-benzylidene-2-phenyloxazolin-5-one (379 nm),⁶ a reasonably close model for the tautomer (7a). When the oxazolinone (6a) was briefly warmed with aqueous sodium hydroxide the colour was discharged and a neutral compound separated in 66.5% yield which was shown by analysis and i.r. spectroscopy (3220 and 1645 cm^{-1}) to be *N*-benzoyl-2,4,6-triphenylaniline (8a), rather than the phenol (19). Treatment of 4-*p*-chlorophenyl-2,6-diphenylpyrylium perchlorate (4b) with the oxazolinone (5) and triethylamine at room temperature similarly gave the yellow azlactone (6b) in low yield; but when the reaction mixture was heated for several hours the benzanilide (8b) was formed. From 4-phenyl-2,6-di-*p*-tolylpyrylium perchlorate (4c) the amide (8c) was obtained; isolation of the azlactone intermediate was not attempted in this case. Two pyrylium salts having alkyl substituents were condensed with the phenyloxazolinone: 2,4,6-trimethylpyrylium perchlorate (4d) gave the known *N*-benzoyl-2,4,6-trimethylaniline (8d) (62.5%) and the bicyclic pyrylium salt (9) yielded the benzamidoindane (10).

The formation of the azlactone intermediate (6) is readily explained in terms of the proposed¹ mechanism

* G. V. Boyd and S. R. Dando, *J. Chem. Soc. (C)*, 1971, 3873.

⁵ G. V. Boyd, *Chem. Comm.*, 1968, 1410; G. V. Boyd and P. H. Wright, *J.C.S. Perkin I*, 1972, 909.

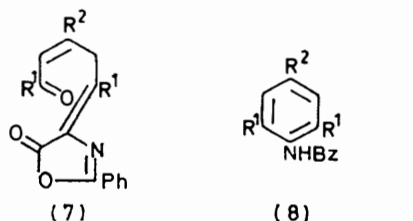
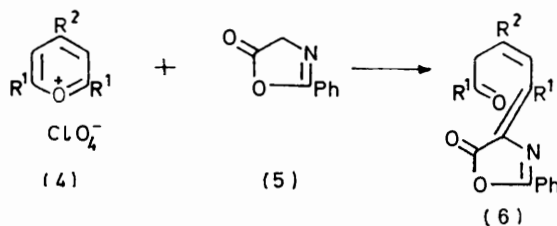
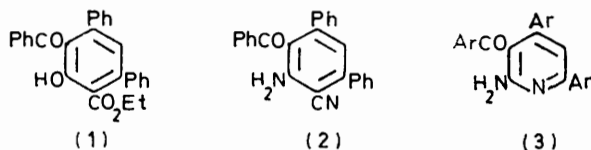
⁶ D. A. Bassi, V. Deulofeu, and F. A. F. Ortega, *J. Amer. Chem. Soc.*, 1953, 75, 171.

¹ K. Dimroth and K. H. Wolf, in 'Newer Methods of Preparative Organic Chemistry,' ed. W. Foerst, vol. III, Academic Press, New York, 1964, p. 357.

² R. Wizinger and P. Ulrich, *Helv. Chim. Acta*, 1956, 39, 207, 217.

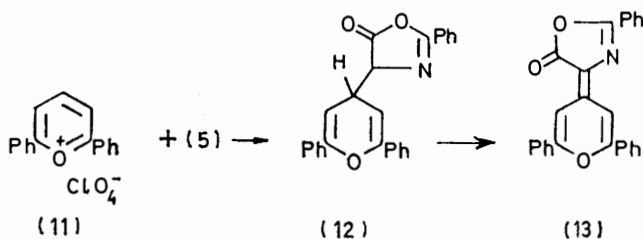
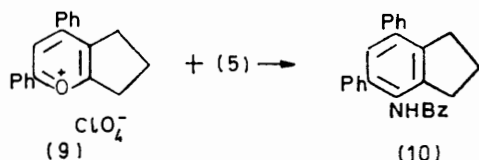
³ K. Dimroth and G. Neubauer, *Chem. Ber.*, 1959, 92, 2046.

of the reaction of pyrylium salts with nucleophiles (see Scheme), *i.e.* addition of the oxazolinone anion to C-2 of the pyrylium ring to give the pyran (14), followed by electrocyclic ring-opening to give the valence-isomer



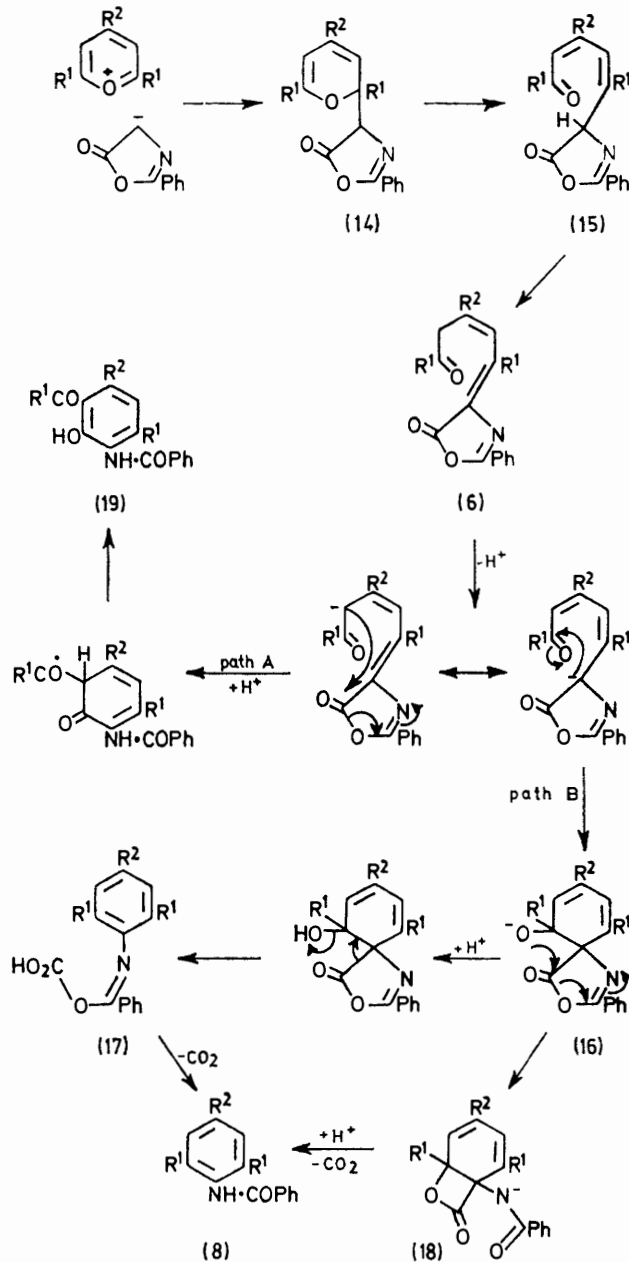
- a; R¹ = R² = Ph
 b; R¹ = Ph, R² = *p*-ClC₆H₄
 c; R¹ = *p*-MeC₆H₄, R² = Ph
 d; R¹ = R² = Me

(15), which then tautomerises to the unsaturated azlactone (6). In order to account for the base-catalysed



conversion of the latter into the benzamide (8) and the accompanying decarboxylation we suggest that the reaction proceeds along path B to give the spiro-oxide (16), which can exist in two geometrically isomeric forms. The spiro-intermediate can form the anilide *via* the enol hydrogen carbonate (17); but the stereochemistry of the isomer in which the oxide and carbonyl functions are on the same side of the six-membered ring is suitable for formation of the β -lactone (18), which

can collapse to the product by extrusion of carbon dioxide.



SCHEME

The reaction of 2-phenyloxazolinone with a pyrylium salt lacking a substituent at C-4, namely 2,6-diphenylpyrylium perchlorate (11), took a different course: the pyranideneoxazolinone (13) was produced. This compound had been prepared previously⁷ by the condensation of 2,6-diphenyl-4-pyrone with hippuric acid in the presence of acetic anhydride. The formation of the pyran involves attack of the oxazolinone anion at the vacant 4-position of the pyrylium nucleus, a reaction that is frequently observed⁸ with 2,6-diphenylpyrylium

⁷ F. Eiden and A. Engelhardt, *Arch. Pharm.*, 1967, **300**, 211.

⁸ Ref. 1, p. 369.

salts. The spontaneous dehydrogenation of the initial adduct (12), possibly by hydride transfer to unchanged pyrylium salt, has precedent.⁹

EXPERIMENTAL

M.p.s were determined with a Kofler hot-stage apparatus; i.r. spectra refer to Nujol mulls.

Reaction of 2,4,6-Triphenylpyrylium Perchlorate (4a) with 2-Phenyl- Δ^2 -oxazolin-5-one (5).—Triethylamine (1.5 g) was added to a suspension of the pyrylium salt¹⁰ (2.04 g) and 5-oxo-2-phenyl- Δ^2 -oxazolinium perchlorate⁵ (1.4 g) in acetonitrile (10 ml). The mixture was set aside for 1 h and the precipitated 4-(5-oxo-1,3,5-triphenylpent-2-enylidene)-2-phenyl- Δ^2 -oxazolin-5-one (6a) (0.5 g, 21%) was collected; it formed yellow needles (from acetonitrile-ethanol), m.p. 164—166°, ν_{\max} . 1788, 1765, 1680, and 1624 cm^{-1} , λ_{\max} . (EtOH) 400 nm (ϵ 20,000) (Found: C, 81.6; H, 5.1; N, 2.95. $\text{C}_{32}\text{H}_{23}\text{NO}_3$ requires C, 81.85; H, 4.95; N, 3.0%). The filtrate from the foregoing preparation was evaporated and the residue was warmed for 3 min with a mixture of 2N-sodium hydroxide (20 ml) and ethanol (20 ml); N-benzoyl-2,4,6-triphenylaniline (8a) (0.3 g) separated; m.p. 280—280.5° (from acetonitrile-ethanol), ν_{\max} . 3220, 1645, 1600, and 1580 cm^{-1} (Found: C, 87.4; H, 5.35; N, 3.3. $\text{C}_{31}\text{H}_{23}\text{NO}$ requires C, 87.5; H, 5.45; N, 3.3%). The anilide (0.6 g, 66.5%) was obtained when the oxazolinone (6a) (1.0 g) was warmed on a steam-bath with aqueous ethanolic sodium hydroxide for 3 min.

4-(3-p-Chlorophenyl-5-oxo-1,5-diphenylpent-2-enylidene)-2-phenyl- Δ^2 -oxazolin-5-one (6b) (0.2 g, 7.8%) separated when the solution prepared from triethylamine (1.5 g), 4-p-chlorophenyl-2,6-diphenylpyrylium perchlorate (4b)¹¹ (2.25 g), 2-phenyloxazolinone hydroperchlorate (1.3 g), and acetonitrile (10 ml) was kept at 0° for 2 h. It formed yellow needles (from acetonitrile-ethanol), m.p. 169—171°, ν_{\max} . 1789, 1765, 1681, 1625, 1600, and 1580 cm^{-1} (Found: C, 76.3; H, 4.5; N, 2.7. $\text{C}_{32}\text{H}_{22}\text{ClNO}_3$ requires C, 76.25; H, 4.4; N, 2.8%). Triethylamine (1.5 g) was added to a suspension of the pyrylium salt (4b) (1.8 g) and 2-phenyloxazolinone hydroperchlorate (1.8 g) in acetonitrile (20 ml) and the mixture was heated under reflux overnight. The filtered solution deposited N-benzoyl-4-p-chlorophenyl-2,6-diphenylaniline (8b) (0.6 g, 32%) on cooling; m.p. 265—265.5° (from ethanol), ν_{\max} . 3230, 1644, 1603, and 1580 cm^{-1} (Found: C, 81.2; H, 4.85; N, 2.95. $\text{C}_{31}\text{H}_{22}\text{ClNO}$ requires C, 80.9; H, 4.85; N, 3.05%).

⁹ K. Dimroth and K. H. Wolf, *Angew. Chem.*, 1960, **72**, 777.

¹⁰ W. Dilthey, *J. prakt. Chem.*, 1916, **94**, 53.

¹¹ K. Dimroth, C. Reichardt, T. Siepmann, and F. Bohlmann, *Annalen*, 1963, **661**, 1.

N-Benzoyl-4-phenyl-2,6-di-p-tolylaniline (8c).—A suspension of 4-phenyl-2,6-di-p-tolylpyrylium perchlorate (4c)¹² (2.0 g) and 2-phenyloxazolinone hydroperchlorate (1.4 g) in acetonitrile (10 ml) was treated with triethylamine (1.5 g). After 30 min the solvent was removed and 2N-sodium hydroxide (10 ml) and ethanol (10 ml) were added to the residue. The mixture was briefly warmed, whereupon the product separated (1.1 g, 53%), m.p. 285.5—286° (from acetonitrile), ν_{\max} . 3240, 1645, 1596, and 1582 cm^{-1} (Found: C, 86.9; H, 5.95; N, 3.0. $\text{C}_{33}\text{H}_{27}\text{NO}$ requires C, 87.35; H, 6.0; N, 3.1%).

N-Benzoyl-2,4,6-trimethylaniline (8d).—The solution obtained from 2,4,6-trimethylpyrylium perchlorate (4d)¹³ (1.11 g), the oxazolinone hydroperchlorate (1.3 g), acetonitrile (10 ml), and triethylamine (1.5 g) was kept for 30 min and then evaporated. The residual oil was stirred with aqueous ethanolic sodium hydroxide whereupon the anilide (0.75 g, 62.5%) separated, m.p. 204—205° (from ethanol), ν_{\max} . 3275, 1640, 1610, and 1580 cm^{-1} , identified by comparison with an authentic specimen of m.p. 204—205°.

4-Benzamido-5,7-diphenylindane (10) (0.8 g, 41%) separated when the solution prepared from 6,7-dihydro-5H-2,4-diphenylcyclopenta[b]pyrylium perchlorate (9),¹⁴ phenyloxazolinone hydroperchlorate (1.3 g), acetonitrile (10 ml), and triethylamine (1.5 g) was set aside for 30 min; m.p. 218° (from acetonitrile), ν_{\max} . 3260, 1635, 1602, and 1576 cm^{-1} (Found: C, 86.4; H, 5.9; N, 3.6. $\text{C}_{28}\text{H}_{23}\text{NO}$ requires C, 86.36; H, 5.95; N, 3.6%).

4-(2,6-Diphenylpyran-4-ylidene)-2-phenyl- Δ^2 -oxazolin-5-one (13).—A suspension of 2,6-diphenylpyrylium perchlorate (11)¹⁵ (1.66 g) and phenyloxazolinone hydroperchlorate (1.4 g) in acetonitrile (10 ml) was treated with triethylamine (1.5 g); the resulting solution deposited the orange product (0.4 g, 20.5%) during 1 h; m.p. 242—243° (from acetonitrile), ν_{\max} . 1770, 1740, 1650, 1600, and 1582 cm^{-1} [lit.,⁷ m.p. 244°, ν_{\max} . (KBr) 1765, 1740, 1650, and 1600 cm^{-1}] (Found: C, 79.5; H, 4.3; N, 3.9. Calc. for $\text{C}_{26}\text{H}_{17}\text{NO}_3$: C, 79.8; H, 4.4; N, 3.6%).

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¹² H. E. Johnston and R. J. W. LeFèvre, *J. Chem. Soc.*, 1932, 2900.

¹³ O. Diels and K. Alder, *Ber.*, 1927, **60**, 716.

¹⁴ C. F. H. Allen and H. R. Sallans, *Canad. J. Res.*, 1933, **9**, 578.

¹⁵ H. Stetter and A. Reischl, *Chem. Ber.*, 1960, **93**, 1253.