Persulphate Oxidations. Part X.[1] Heterocyclic Synthesis by Oxidation of *ortho*-Substituted Phenoxyacetic Acids

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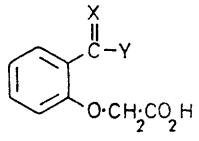
Photolysis of a series of *N*-(*o*-carboxymethoxybenzylidene)aniline *N*-oxides in the presence of persulphate yields the corresponding 4-aryl-2*H*-1,4-benzoxazin-3(4*H*)-ones as the principal products. Persulphate does not play an oxidative role in these reactions but is merely an indirect source of the protons which catalyse the rearrangement of the initial photoproduct, an oxaziridine.

Thermolytic and photolytic persulphate oxidation of *o*-formylphenoxyacetic acid gives mainly benzofuran-3-one; *o*-carboxyphenoxyacetic acid, its amide, and its anilide, give 1,3-benzodioxan-4-one.

o-PHENYLARYLOXYALKYL radicals, produced by persulphate oxidation of the corresponding aryloxyacetic acids, cyclise intramolecularly to yield dibenzopyrans in high yield.[2] We now describe attempts to effect new heterocyclic syntheses by analogous cyclisations of aryloxyalkyl radicals involving adjacent substituents containing multiple bonds. Of the several acids of type (1) which were investigated, nitrone acids (2) were the initial choice because of the known reactivity of free radicals towards the nitrone group, much exploited recently in ' spin-trapping ' studies.[3]

Nitrone Acids.—Oxidation of the nitrone acid (2; $R^1 = R^2 = H$, Ar = Ph) with persulphate in boiling aqueous solution (thermolytic oxidation) gave only a little (1%) of the dibenzofuranone (16), as the sole neutral cyclised product, accompanied by much azoxybenzene (40%). Photolytic oxidation with persulphate [irradiation of an aqueous solution of the sodium salt of the acid and persulphate (1 : 1) for 7 h, at room temperature] appeared at first to be similarly unrewarding, giving only small quantities of the dibenzofuranone (16), azobenzene, and azoxybenzene in the neutral fraction. However, when the sodium hydrogen carbonate-soluble fraction of the products was acidified and either left for some days at room temperature, or heated briefly, a neutral product ($C_{14}H_{11}NO_2$) separated (42%). This showed carbonyl i.r. absorption at 1710 cm^{-1} and n.m.r. signals from nine aromatic (δ 6·30—7·57) and two methylene protons (δ 4·71). The possibility that it was the benzoxazinone (3) was discounted after an independent synthesis of (3) from salicylanilide and methylene iodide yielded a product showing ν_{CO} 1675 cm^{-1} and δ 5·56 (2H).



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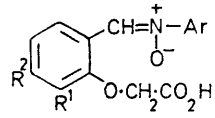

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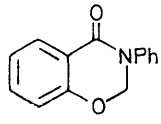

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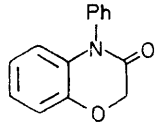


(4)

A one-proton multiplet at δ 8—8·15, attributable to H-5 adjacent to the carbonyl group, is absent from the n.m.r. spectrum of the photolysis product, suggesting that the carbonyl group is not attached to a benzene ring. Moreover the chemical shift of the methylene protons (δ 4·71) is characteristic of aryloxyacetic acids and their derivatives. Hence the photolysis product must be the isomeric benzoxazinone (4). This lactam is remarkably

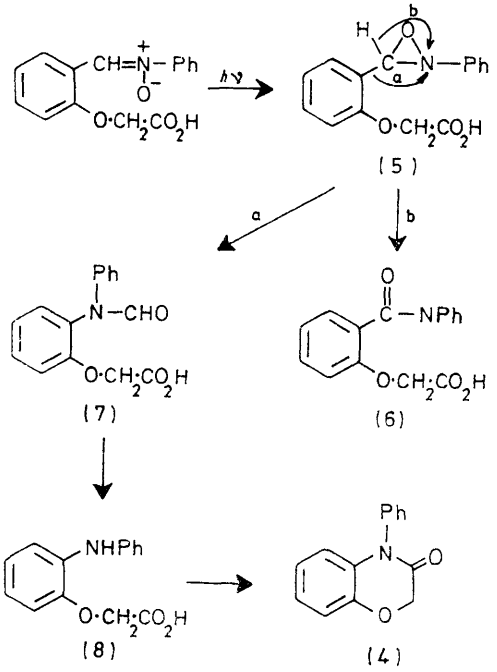
[1] Part IX, P. S. Dewar, A. R. Forrester, and R. H. Thomson, *J.C.S. Perkin I*, 1972, 2862.

[2] P. S. Dewar, A. R. Forrester, and R. H. Thomson, *J. Chem. Soc.* (*C*), 1971, 3950.

[3] E. G. Janzen, *Accounts Chem. Res.*, 1971, **4**, 31.

resistant to reduction by lithium aluminium hydride and to hydrolysis by boiling aqueous 5M-acid.

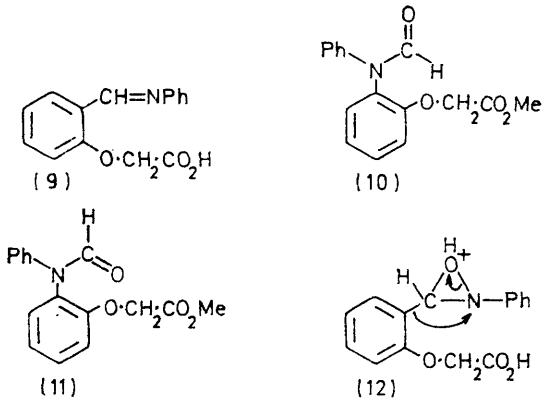
The conversion of the nitrone acid (1; $R^1 = R^2 = H$, Ar = Ph) into the benzoxazin-3-one (4) involves an interesting rearrangement. Significantly this rearrangement did not occur during thermolytic persulphate oxidation of the acid, nor on photolysis of the acid in the absence of persulphate. Nitrones are known to isomerise on irradiation to give the corresponding oxaziridines, most of which rearrange further to amides or other products.[4] Evidently this occurs with the nitrone acid (2; $R^1 = R^2 = H$, Ar = Ph) and the likely course of events is shown in the Scheme. The oxaziridine (5) is the initial photo-product, which rearranges to the amido-acid (7), hydrolysis of which yields the amino-acid (8) and thence the lactam (4). Thus the amido-acid (7) should be the sodium hydrogen carbonate-soluble precursor of the lactam (4), and by careful work-up of the photolysis reaction mixture it was in fact isolated, and characterised as the methyl ester. On heating in methanol–hydrochloric acid it was converted into the benzoxazinone (4)



SCHEME

(63%). The lactam (4) was also prepared in 61% yield from the imino-acid (9) by treatment with *m*-chloroperbenzoic acid [5] followed by heating the resulting oxaziridine (5) in acid solution.

The amido-acid (7) and its methyl ester provide further examples of compounds exhibiting hindered rotation about the C–N amide bond.[6] The ester shows three carbonyl bands at 1770, 1750, and 1700 cm^{-1} (CCl_4), and in the n.m.r. spectrum [$(CD_3)_2SO$] the formamide proton resonates as two unequal singlets at δ 8·72 and 8·32 (total 1H) which coalesce to a 1H singlet at δ 8·5 on heating to 80°. At the same time the two singlets (total 2H) at δ 4·88 and 4·79 due to the methylene protons collapse to a singlet at δ 4·83. Thus the amido-ester must exist in carbon tetrachloride solution as a mixture of the two rotamers (10) and (11). Similarly the amido-acid (7) showed two peaks from the formamide proton at δ 8·72 and 8·36, and at δ 4·74 and 4·63 for the methylene protons.



What then is the role of the persulphate in the conversion of the nitrone acid (2; $R^1 = R^2 = H$, Ar = Ph) into the lactam (4), since there is no oxidative step in Scheme 1, yet the conversion could not be effected in the absence of persulphate? The explanation was provided by an experiment in which dilute sulphuric acid (0·1 mol. equiv.) was slowly added to the nitrone acid during photolysis. After subsequent heating the lactam (4) was obtained in 18% yield accompanied by the anilide (6) (15%). The latter arises by hydride ion transfer (Scheme 1, path b) competing with aryl migration (path a), a known reaction of oxaziridines.[7] The ratio of the products is governed by the substituents present and is also influenced by the solvent. Hence it is the protonated oxaziridine (12) which rearranges in our reaction, the protons being generated by the persulphate. These are produced when other substrates [water, phenylhydroxylamine, and the formyl acid (1; X = O, Y = H)] are oxidised to give the other products of the reaction [oxygen, azoxybenzene, and benzofuranone (16), respectively] (see later) which do not arise by photolysis of the nitrone acid, *e.g.*,

$$SO_4^{-\cdot} + H_2O \longrightarrow {\cdot}OH + HSO_4^- \rightleftharpoons H^+ + SO_4^{2-}$$

Photolytic persulphate ' oxidation ' of the other nitrone acids listed in the Table followed by treatment of the sodium carbonate-soluble products with acid gave the corresponding benzoxazin-3-ones; thus the reaction

[4] J. S. Splitter and M. Calvin, *J. Org. Chem.*, 1958, **23**, 651; for a review see G. G. Spence, E. C. Taylor, and O. Buchardt, *Chem. Rev.*, 1970, **70**, 231.

[5] R. G. Pews, *J. Org. Chem.*, 1967, **32**, 1628.

[6] W. Walter, H. P. Kubersky, E. Schaumann, and K.-J. Reubke, *Annalen*, 1968, **719**, 210; W. Walter and R. F. Becker, *Tetrahedron*, 1972, **28**, 1705; W. Walter and R. F. Becker, *Annalen*, 1971, **753**, 187.

[7] J. S. Splitter and M. Calvin, *J. Org. Chem.*, 1965, **30**, 3427.

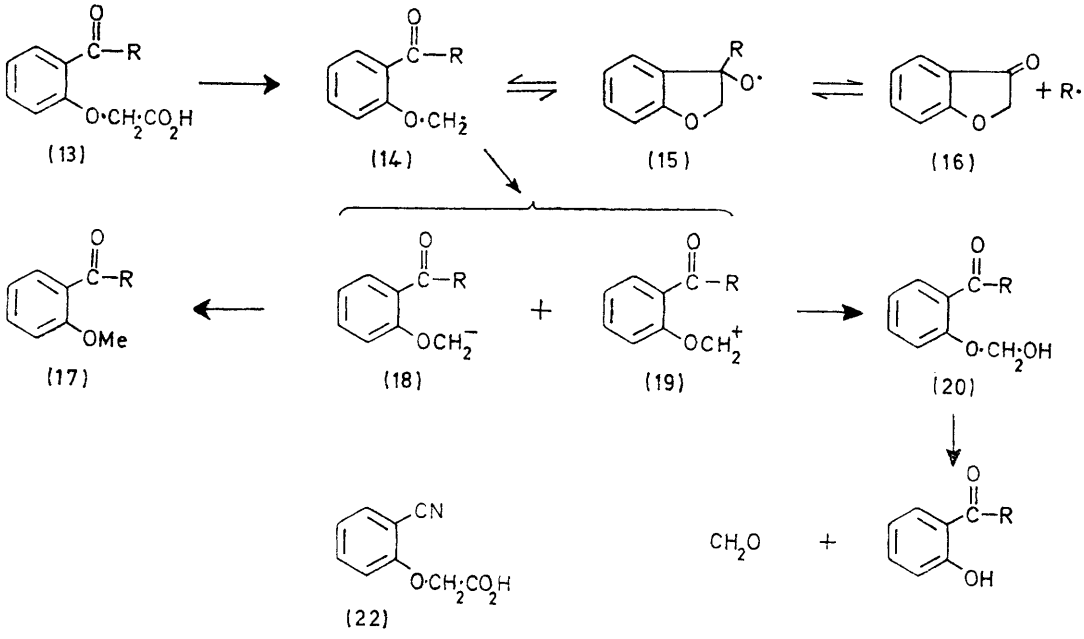
appears to be general although yields are variable. Several other methods [8] are available for the synthesis of 1,4-benzoxazinones, all of which involve cyclisation of *ortho*-aminophenol derivatives, but aryl derivatives such as (4) have not been obtained previously.

Yield of benzoxazinones obtained from nitrone acids

Nitrone acid	Benzoxazinone (%)
(2; $R^1 = R^2 = H$, Ar = Ph)	42
(2; R^1 = OMe, $R^2 = H$, Ar = Ph)	27
(2; $R^1 = R^2 = H$, Ar = *p*-ClC_6H_4)	33

o-Formyl-, Hydroxyiminomethyl-, and Acetyl-phenoxyacetic Acids.—The low yield of benzofuranone (16) obtained on oxidation (thermolytic or photolytic) of the nitrone acid (2; $R^1 = R^2 = H$, Ar = Ph) and also of the oxime acid (1; Y = H, X = N·OH) could arise by intramolecular addition of the corresponding phenoxymethyl radicals to the nitrone and imino-groups, respectively, followed by oxidation and hydrolysis, *or* by initial hydrolysis to the formyl acid (13; R = H), intramolecular cyclisation of the aryloxyalkyl radical (14; R = H) derived from this acid, and final oxidation, *e.g.* (14) ⟶ (15) ⟶ (16). The azoxybenzene produced on oxidation of the nitrone acid is an oxidation product of phenylhydroxylamine which is formed at the hydrolysis stage. This was confirmed in a separate experiment. Accordingly the formyl acid (13; R = H) was oxidised photolytically and thermolytically with persulphate and found to give useful yields of the benzofuran-3-one (16) (54 and 43%, respectively). The low yield of benzofuran-3-one (16) (<1%) obtained from the keto-acid (13; R = Me) we attribute to the potential reversibility of the addition–fragmentation steps [(14) ⇌ (15) ⇌ (16)], the equilibrium favouring production of the more stable radical [9] (aryloxymethyl *versus* methyl). Formation of the methoxy-ketone (17; R = Me) (14%), *o*-hydroxyacetophenone (21; R = Me), and formaldehyde indicates that under the reaction conditions the aryloxymethyl radical (14; R = Me) preferentially disproportionates [(14) ⟶ (19) + (18) ⟶ (17)] and is further oxidised by persulphate [(14) ⟶ (19) ⟶ (20) ⟶ (21)]. Surprisingly the nitrile acid (22) gave no benzofuranone on oxidation with persulphate, merely polymeric material. The above method for the preparation of the benzofuranone (16) from the formyl acid has advantages over several of the other available methods,[10,11] and is certainly superior to the direct cyclisation of phenoxyacetic acid with phosphorus pentaoxide in benzene,[11] which in our hands gave only an 11% yield.

o-Carboxyphenoxyacetic Acid and its Amides.—The major neutral oxidation product from the diacid (1; X = O, Y = OH) was 1,3-benzodioxan-4-one (25) (43% by the thermolytic and 28% by the photolytic method), recognised from its spectroscopic properties, and ease of hydrolysis to salicylic acid and formaldehyde. No attempt has been made to extend the scope of this preparation (nor to optimise the yield) to other dioxanones but it may have some synthetic value (*cf.* ref. 12). Formation of the dioxanone probably proceeds by



[8] G. Newbery and M. A. Phillips, *J. Chem. Soc.*, 1928, 3046; W. G. Christiansen, *J. Amer. Chem. Soc.*, 1926, **48**, 460; J. W. Cook, J. D. Loudon and P. McCloskey, *J. Chem. Soc.*, 1952, 3904.

[9] P. Gray and A. Williams, *Chem. Rev.*, 1959, **59**, 239; E. J. Baum and R. O. C. Norman, *J. Chem. Soc.* (*B*), 1968, 227.

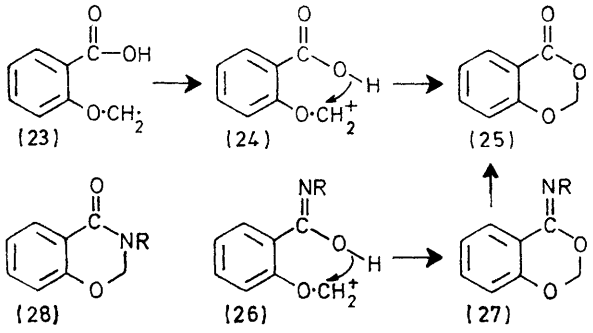
[10] A. K. Bose and P. Yates, *J. Amer. Chem. Soc.*, 1952, **74**, 4703; D. C. Schroeder, P. O. Corcoran, C. A. Holden, and M. C. Mulligan, *J. Org. Chem.*, 1962, **27**, 586; J. C. Anderson and C. B. Reese, *Tetrahedron Letters*, 1962, 1.

[11] R. Stoermer and F. Bartsch, *Ber.*, 1901, **33**, 3175.

[12] F. Calvet, M. C. Carnero, and D. L. Mosquera, *Anales real Soc. espaň. Fis. Quim.*, 1932, **30**, 445 (*Brit. Chem. Abs.*, 1932, *A*, 949); D. T. Mowry, W. H. Yanko, and E. L. Ringwald, *J. Amer. Chem. Soc.*, 1947, **69**, 2358.

oxidation of the aryloxymethyl radical (23) to the cation (24), which may cyclise before or after solvolysis.

The amides (1; X = O, Y = NH_2 or NHPh) also gave the dioxanone (25) on thermolytic persulphate oxidation



(20 and 10%, respectively). Reaction could proceed either by formation of the carbonium ion (26), and cyclisation onto the oxygen of the amide function followed by hydrolysis, or by initial hydrolysis to the diacid (1; X = O, Y = OH) and further reaction as before. In fact when the amides were separately refluxed for 45 min in a solution made acidic by prior decomposition of the appropriate amount of potassium persulphate they were virtually unchanged. Thus the benzodioxanone (25) is formed *via* (26) but it is surprising that cyclisation apparently occurs exclusively on oxygen, since in related cases [13] cyclisation is known to occur on both nitrogen and oxygen. The possibility remains that cyclisation does occur on nitrogen but that the resulting benzoxazinones (28) do not survive.

EXPERIMENTAL

Unless otherwise stated, spectroscopic measurements were made on solutions in ethanol (u.v.), Nujol mulls (i.r.), and solutions in deuteriochloroform (n.m.r.). Petrol refers to light petroleum (b.p. 40—60°). Known compounds were identified by comparison (i.r., m.p.) with authentic specimens.

Phenoxyacetic Acids.—These were prepared [14] from the appropriate phenol (0·2 mol), chloroacetic acid (0·33 mol), and 2M-sodium hydroxide (300 ml) by heating under reflux with stirring for 1 h. Salicylaldehyde gave *o*-formylphenoxyacetic acid, m.p. 129—131° (lit.,[15] 132°); *o*-vanillin gave *2-formyl-6-methoxyphenoxyacetic acid*, m.p. 119—121° (from chloroform–petrol) (Found: C, 57·0; H, 5·1. $C_{10}H_{10}O_5$ requires C, 57·1; H, 4·8%); *o*-hydroxyacetophenone gave *o-acetylphenoxyacetic acid*, m.p. 117—119° (from chloroform–petrol) (Found: C, 62·0; H, 5·2. $C_{10}H_{10}O_4$ requires C, 61·9; H, 5·2%); *o*-cyanophenol gave *o*-cyanophenoxyacetic acid, m.p. 185—187° (lit.,[16] 183—184°); salicylanilide gave *o-phenylcarbamoylphenoxyacetic acid*, m.p. 168—170° (from chloroform–petrol) (Found: C, 66·2; H, 5·0; N, 5·5; $C_{15}H_{13}NO_4$ requires C, 66·4; H, 4·8; N, 5·2%); salicylamide gave *o*-carbamoylphenoxyacetic acid, m.p. 218—220° (from methanol) (lit.,[17] 221°). Hydrolysis of this amido-acid (1 g) by heating under reflux for 3 h with 2M-hydrochloric acid gave *o*-carboxyphenoxyacetic acid (0·75 g), m.p. 191—193° (from water) (lit.,[18] 192°).

Nitrone phenoxyacetic acids were obtained from the appropriate *o*-formylphenoxyacetic acids by condensation with arylhydroxylamines. *o*-Formylphenoxyacetic acid and phenylhydroxylamine gave N-(*o-carboxymethoxybenzylidene*)*aniline* N-*oxide*, m.p. 185—186° (from ethanol) (Found: C, 66·2; H, 4·8; N, 5·1%; *M*, 271·0809. $C_{15}H_{13}NO_4$ requires C, 66·4; H, 4·8; N, 5·2%; *M*, 271·0844). $\nu_{max.}$ 3090 and 2530 cm^{-1}, $\lambda_{max.}$ 238 and 344 nm (log ε 4·08 and 4·18), δ [$(CD_3)_2SO$] 8·48 (1H, s, CH=N), 7·95—6·95 (9H, m, ArH), and 4·80 (2H, s, CH_2); 2-formyl-6-methoxyphenoxyacetic acid and phenylhydroxylamine gave N-(*2-carboxymethoxy-3-methoxybenzylidene*)*aniline* N-*oxide*, m.p. 171—173° (from ethanol) (Found: C, 63·8; H, 5·3; N, 4·8. $C_{16}H_{15}NO_5$ requires C, 63·8; H, 5·0; N, 4·7%), $\nu_{max.}$ 3110—2750 and 1715 cm^{-1}, $\lambda_{max.}$ 238·5 and 324 nm (log ε 4·08 and 4·28), δ [$(CD_3)_2SO$], 8·96 (1H, s, CH=N), 8·05—7·15 (8H, m, ArH), 4·75 (2H, s, CH_2), and 3·86 (3H, s, OMe); *o*-formylphenoxyacetic acid and *p*-chlorophenylhydroxylamine gave N-(*o-carboxymethoxybenzylidene*)-p-*chloroaniline* N-*oxide*, m.p. 207—209° (from ethanol) (Found: C, 58·7; H, 4·2; Cl, 11·6; N, 4·6. $C_{15}H_{12}ClNO_4$ requires C, 58·9; H, 3·9; Cl, 11·6; N, 4·6%), $\nu_{max.}$ 3100—2740 and 1720 cm^{-1}, $\lambda_{max.}$ 242·5 and 348 nm (log ε 4·04 and 4·15), δ [$(CD_3)_2SO$] 8·50 (1H, s, CH=N), 8·00—6·90 (8H, m, ArH), and 4·82 (2H, s, CH_2).

General Procedures for Oxidations with Persulphate.—(a) *Thermolysis.* Potassium persulphate (2·71 g, 0·01 mol) in water (100 ml) was added, dropwise with stirring during 15 min, to a solution of the acid (0·01 mol) in 0·1M-sodium hydroxide (100 ml) at 100°. The solution was then stirred for a further 45 min, cooled, and extracted with chloroform. The extracts were washed with sodium hydrogen carbonate solution and water, dried ($MgSO_4$), and evaporated. The residue was chromatographed on silica gel with petrol–ether (95 : 5) as eluant.

(b) *Photolysis.* Potassium persulphate (2·71 g, 0·01 mol) in water (400 ml) was added to a solution of the acid (0·01 mol) in 0·1M-sodium hydroxide (100 ml). The resulting mixture was irradiated under nitrogen for 7 h in a quartz vessel with a Hanovia S500 medium pressure mercury-vapour lamp. The product mixture was worked up as in (a).

Thermolytic Persulphate Oxidations.—(i) N-(*o*-Carboxymethoxybenzylidene)aniline *N*-oxide (2·71 g) gave azoxybenzene (400 mg, 40%) and benzofuran-3-one (11 mg, 1%).

(ii) *o*-Formylphenoxyacetic acid (1·8 g) gave benzofuran-3-one (571 mg, 43%).

(iii) *o*-Hydroxyiminomethylphenoxyacetic acid (1·95 g) gave benzofuran-3-one (96 mg, 7%).

(iv) *o*-Acetylphenoxyacetic acid (1·94 g) gave *o*-hydroxyacetophenone (193 mg, 14%), benzofuran-3-one (5·5 mg), starting material (271 mg), and formaldehyde (chromotropic acid test).

(v) *o*-Carbamoylphenoxyacetic acid (1·95 g) gave 1,3-benzodioxan-4-one (305 mg, 20%), m.p. 49—51° (Found: *M*, 150·0315. $C_8H_6O_3$ requires *M*, 150·0316), $\nu_{max.}$ 1740 cm^{-1}, δ 8·01—6·95 (4H, m, ArH) and 5·65 (2H, s, CH_2).

(vi) *o*-Phenylcarbamoylphenoxyacetic acid (2·71 g) gave

[13] A. R. Forrester, A. S. Ingram, and R. H. Thomson, *J.C.S. Perkin I*, 1972, 2853.
[14] C. F. Koelsch, *J. Amer. Chem. Soc.*, 1931, **53**, 304.
[15] A. I. Vogel, 'Practical Organic Chemistry,' Longmans, London, 1966, p. 686.
[16] N. V. Hayes and G. E. K. Branch, *J. Amer. Chem. Soc.*, 1943, **65**, 1555.
[17] R. W. Merriman, *J. Chem. Soc.*, 1913, **103**, 1838.
[18] A. Rössing, *Ber.*, 1884, **17**, 2988.

1,3-benzodioxan-4-one (156 mg, 10%), salicylanilide (138 mg, 7%), and the starting acid (753 mg).

(vii) *o*-Carboxyphenoxyacetic acid (1·96 g) gave 1,3-benzodioxan-4-one (645 mg, 43%) and a complex mixture of acidic materials (665 mg) which was not further investigated.

(viii) Phenylhydroxylamine (1·09 g) gave azoxybenzene (330 mg, 33%).

Photolytic Persulphate Oxidations.—(*ia*) *N*-(*o*-Carboxymethoxybenzylidene)aniline *N*-oxide (2·71 g) gave azoxybenzene (40 mg, 4%), azobenzene (55 mg, 6%) and benzofuran-3-one (14 mg, 1%). The sodium hydrogen carbonate extracts were acidified and set aside for 2 weeks. Extraction with chloroform then yielded 4-*phenyl*-2*H*-1,4-*benzoxazin*-3(4H)-*one* (4; $R^1 = R^2 = H$, Ar = Ph) (935 mg, 42%), m.p. 98—99·5° (from benzene–petrol) (Found: C, 75·0; H, 5·1; N, 6·3%; *M*, 225·0784. $C_{14}H_{11}NO_2$ requires C, 74·7; H, 4·9; N, 6·2%; *M*, 225·0789), $\nu_{max.}$ 1714 and 1685 cm^{-1}, $\lambda_{max.}$ 247 and 295sh nm (log ε 3·90 and 3·44), δ_H 7·57—6·30 (9H, m, ArH) and 4·71 (2H, s, CH_2), δ_C 68·1 (CH_2), 130·5 and 135·8 (Ph), 144·9 (C_6H_4), and 164·1 (N–C=O).

The oxidation was repeated as before but the sodium hydrogen carbonate extracts were acidified and extracted immediately with chloroform. Evaporation of the latter extracts left an oil which was treated with diazomethane [from *N*-nitroso-*N*-methylurea (1·2 g)]. The product was chromatographed on silica, first in chloroform then in petrol–methyl ethyl ketone (3 : 2) to give N-(*o-methoxycarbonylmethoxyphenyl*)*formanilide* (343 mg, 12%), m.p. 63—64° (from chloroform–petrol) (Found: *M*, 285·0999. $C_{16}H_{15}NO_4$ requires *M*, 285·1001), $\nu_{max.}$ 1770 and 1685 cm^{-1} (for δ see Discussion section). On heating this ester (100 mg) in 2M-hydrochloric acid (3 ml) and methanol (3 ml) under reflux for 12 h, 4-phenyl-2*H*-1,4-benzoxazin-3(4*H*)-one (50 mg, 63%) was obtained.

The oxidation was again repeated and the acid obtained by chloroform extraction was crystallised directly from chloroform–petrol to give N-(*o-carboxymethoxyphenyl*)-*formanilide*, (250 mg, 9%), m.p. 164—166° (Found: C, 66·1; H, 5·0; N, 5·3. $C_{15}H_{13}NO_4$ requires C, 66·4; H, 4·8; N, 5·2%), $\nu_{max.}$ 3100—2620, 1740, and 1635 cm^{-1} (for δ see Discussion section). Methylation with diazomethane gave the ester already described.

(*ib*) The nitrone (2·71 g) in 0·1M-sodium hydroxide (100 ml) was diluted with water (300 ml) and irradiated for 3 h while 0·1M-sulphuric acid (100 ml) was added dropwise during 1·5 h. The solution was extracted with chloroform and the extracts were shaken with sodium hydrogen carbonate solution. The latter solution was acidified and heated under reflux for 2 h. Chloroform extraction yielded 4-phenyl-2*H*-1,4-benzoxazin-3(4*H*)-one (398 mg, 18%).

(*ic*) The nitrone (2·71 g) in ethanol (500 ml) was irradiated for 3 h. The ethanol was removed and the residue was dissolved in chloroform which was extracted with sodium hydrogen carbonate solution. Treatment of the extracts as in (*ia*) gave 4-phenyl-2*H*-1,4-benzoxazin-3(4*H*)-one (84 mg, 4%).

(ii) *N*-(2-Carboxymethoxy-3-methoxybenzylidene)aniline *N*-oxide (3·01 g) gave a complex mixture of neutral products which was not further investigated. The sodium hydrogen carbonate extracts were acidified and heated under reflux for 2 h. The solution was cooled and extracted with chloroform, which was then washed with sodium hydrogen carbonate solution. Acidification yielded 2-formyl-6-methoxyphenoxyacetic acid (474 mg, 23%). The chloroform solution yielded 8-*methoxy*-4-*phenyl*-2H-1,4-*benzoxazin*-3(4H)-*one* (675 mg, 27%), m.p. 148·5—150° (from benzene–petrol) (Found: C, 70·8; H, 5·3; N, 5·3. $C_{15}H_{13}NO_3$ requires C, 70·6; H, 5·1; N, 5·5%), $\nu_{max.}$ 1695 cm^{-1}, $\lambda_{max.}$ 270sh nm (log ε 3·69), δ 7·60—5·95 (8H, m, ArH), 4·80 (2H, s, CH_2), and 3·90 (3H, s, OMe).

(iii) *N*-(*o*-Carboxymethoxybenzylidene)-*p*-chloroaniline *N*-oxide (3·06 g) gave a complex mixture of neutral products. The sodium hydrogen carbonate extracts were treated as in (*ia*) to give acidic material and 4-(p-*chlorophenyl*)-2H-1,4-*benzoxazin*-3(4H)-*one* (857 mg, 33%), m.p. 160—162° (from benzene–petrol) (Found: C, 64·4; H, 3·8; C, 13·2; N, 5·6. $C_{14}H_{10}ClNO_2$ requires C, 64·7; H, 3·9; Cl, 13·7; N, 5·4%), $\nu_{max.}$ 1680 cm^{-1}, $\lambda_{max.}$ 250 and 292sh nm (log ε 4·00 and 3·53), δ 7·55—6·25 (8H, m, ArH), and 4·68 (2H, s, CH_2).

(iv) *o*-Formylphenoxyacetic acid (1·8 g) gave benzofuran-3-one (725 mg, 54%).

(v) *o*-Hydroxyiminomethylphenoxyacetic acid (1·95 g) gave benzofuran-3-one (14 mg, 1%).

(vi) *o*-Acetylphenoxyacetic acid (1·94 g) gave *o*-hydroxyacetophenone (68 mg, 5%), *o*-methoxyacetophenone [19] (204 mg, 14%), and unchanged acid (103 mg).

(vii) *o*-Carbamoylphenoxyacetic acid (1·95 g) gave 1,3-benzodioxan-4-one (57 mg, 4%) and unchanged acid (413 mg).

(viii) *o*-Phenylcarbamoylphenoxyacetic acid (2·71 g) gave salicylanilide (40 mg, 2%) and unchanged acid (2·3 g).

(ix) *o*-Carboxyphenoxyacetic acid (1·96 g) gave 1,3-benzodioxan-4-one (418 mg, 28%).

Synthesis of Benzoxazin-3-ones.—(i) 4-*Phenyl*-2H-1,4-*benzoxazin*-3(4H)-*one*.[4] A solution of *o*-formylphenoxyacetic acid (900 mg) and aniline (465 mg) in aqueous acetic acid (9 : 1) (5 ml) was shaken for 10 min and then extracted with chloroform. The dried extracts were evaporated to give N-(*o-carboxymethoxybenzylidene*)*aniline* (9) (846 mg, 83%), m.p. 126·5—128° (from chloroform–petrol) (Found: C, 70·7; H, 5·2; N, 5·2. $C_{15}H_{13}NO_3$ requires C, 70·6; H, 5·1; N, 5·5%), $\nu_{max.}$ 3170—2320 and 1695—1645 cm^{-1}, $\lambda_{max.}$ 250 and 321 nm (log ε 4·07 and 3·62), δ [$(CD_3)_2SO$] 8·93 (1H, s, CH=N), 8·15—6·90 (9H, m, ArH), and 4·81 (2H, s, CH_2).

This imino-acid (510 mg) in dichloromethane (20 ml) was treated dropwise and with stirring with a solution of *m*-chloroperbenzoic acid (378 mg) in dichloromethane (20 ml). After 3 h the solution was extracted with aqueous sodium hydrogen carbonate, and the extract was acidified and heated under reflux for 2 h. After cooling, the product was extracted with chloroform, freed from acid with sodium hydrogen carbonate, and crystallised from chloroform to give the benzoxazinone (275 mg, 61%), identical with that obtained by photolytic persulphate oxidation described in (*ia*).

(ii) 3-*Phenyl*-2H-1,3-*benzoxazin*-4(3H)-*one* (3). Salicylanilide (532 mg) in sodium ethoxide solution [from sodium (115 mg) in ethanol (50 ml)] was heated under reflux for 4 h. Methylene iodide was added and the solution was heated under reflux for a further 12 h. After removal of ethanol the product was freed from acidic material, and then chromatographed on silica with chloroform to give the benzoxazin-4-one (108 mg, 19%), m.p. 91—93° (from benzene–petrol) (lit.,[20] 90—92°) (Found: C, 74·7; H, 5·3; N, 6·1. Calc. for $C_{14}H_{11}NO_2$: C, 74·7; H, 4·9; N, 6·2%), $\nu_{max.}$ 1675 cm^{-1}, δ 8·15—6·92 (9H, m, ArH) and 4·44 (2H, s, CH_2).

[19] K. v. Auwers, *Annalen*, 1915, **408**, 212, 246.
[20] J. Finkelstein and E. Chiang, *J. Medicin. Chem.*, 1968, **11** 1038.

'*Hydrolyses*.'—In separate experiments (i) *N*-(*o*-carboxymethoxybenzylidene)aniline *N*-oxide (2·71 g), (ii) *o*-carbamoylphenoxyacetic acid (1·95 g), and (iii) *o*-phenylcarbamoylphenoxyacetic acid (2·71 g) in 0·1M-sodium hydroxide (100 ml) were heated under reflux for 45 min with a solution rendered acidic by prior decomposition of potassium persulphate (0·01 mol) in water (100 ml). Work-up gave (i) azoxybenzene (90 mg, 9%), (ii) unchanged acid (1·4 g), and (iii) unchanged acid (2·6 g).

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