

Synthesis in Biphenyls. Part I

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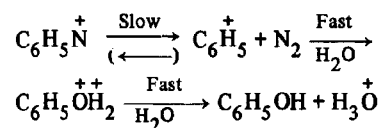
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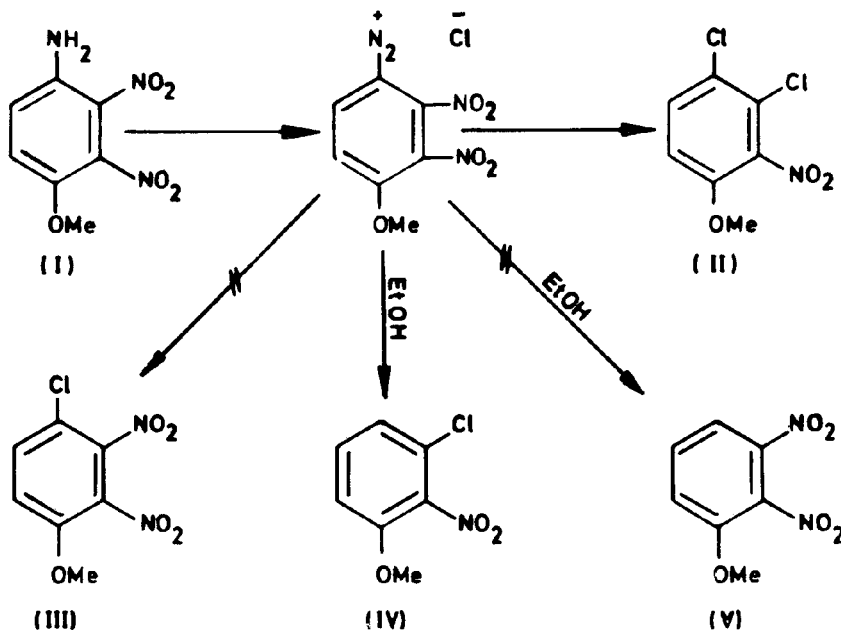
Summary: A number of dinitroacetanilides have been converted into their *N*-nitrosoderivatives which on decomposition in benzene have afforded unusual biphenyls with two nitro-groups in *ortho* or *para* position to each other in one of the rings. The mechanism of their formation has been discussed.

These laboratories were in need of somewhat unusual biphenyls which were unsubstituted in one of the benzene rings and had two nitro groups in *ortho* or *para* position to each other in the other ring. A survey of literature indicated that of all the methods which have been used for the preparation of substituted biphenyls (i) diazotisation of arylamines¹ followed by basification and extraction into benzene and the thermal decomposition of the resulting diazo-hydroxides (from the diazonium salts) in benzene solution of *N*-acyl-*N*-nitroso derivatives¹ of aromatic amines, would offer themselves as the best and the easiest methods for the preparation of the desired unusual dinitro-biphenyls. In both of these methods arylamines are the starting materials, and it is well documented that dinitroanilines²⁻⁷ which bear nitro groups in *ortho* or *para* position to each other are easy to prepare in very good yields.

The mechanism involved in both cases is a dediazotiation. In aqueous acid medium diazonium salts have been reported⁸ to lose nitrogen, and react with water as follows;



It has also been reported² that anilines having two nitro groups in *ortho* or *para* position to each other lose the nitro-group adjacent (or in *para* position) to the strongly polar (and hence strongly electron-attracting) diazonium group, particularly in the presence of a nucleophile. Thus 2,3-dinitro-4-methoxy-aniline (I) when diazotised in a mixture of acetic acid and aqueous hydrochloric acid and decomposed in presence of cup-



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rous chloride gives 3,4-dichloro-2-nitroanisole (II) instead of the expected 4-chloro-2,3-dinitroanisole (III), and when the same diazonium salt is allowed to decompose in the presence of ethyl alcohol, 3-chloro-2-nitroanisole² (IV) is formed instead of the expected 2,3-dinitroanisole (V).

Similarly it has been reported⁹ that 2-methoxy-4,5-dinitroaniline (VI) when diazotised in 50 percent (by volume) aqueous sulphuric acid (a weaker nucleophile), does not give the normal expected 2-methoxy-4,5-dinitrophenol (VII), and instead a nitro-group which is *para* to the diazonium group, and which is further activated by a second nitro-group in its *ortho* position, gets nucleophilically replaced by a phenolic group. The hydroxybenzene diazonium salt (VIII) so formed results in the formation of 2-methoxy-5-nitrobenzene diazoxide⁹ (IX), as expected in such cases.

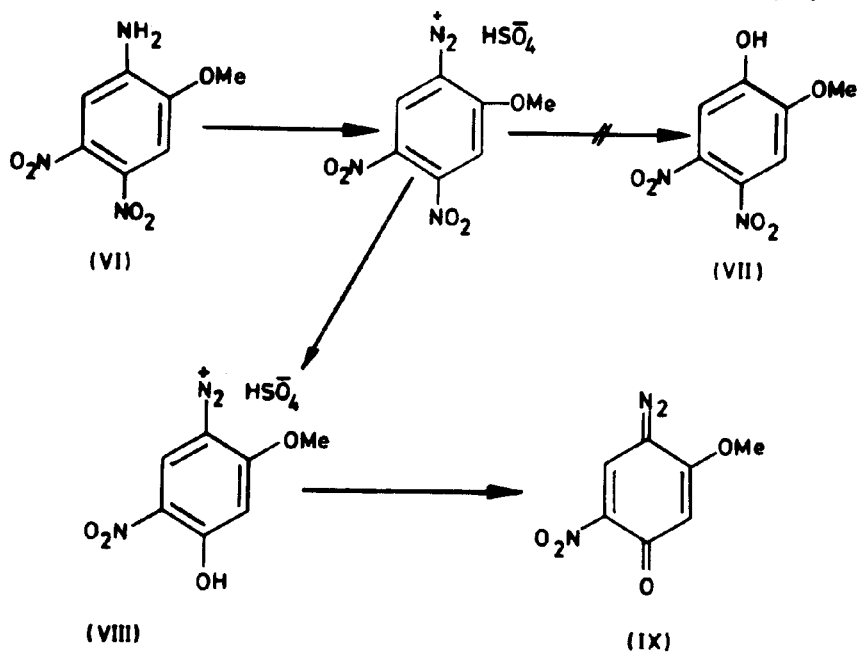
This diazo oxide is formed in the above reaction even if this diazotisation is carried out in aqueous hydrochloric acid⁹.

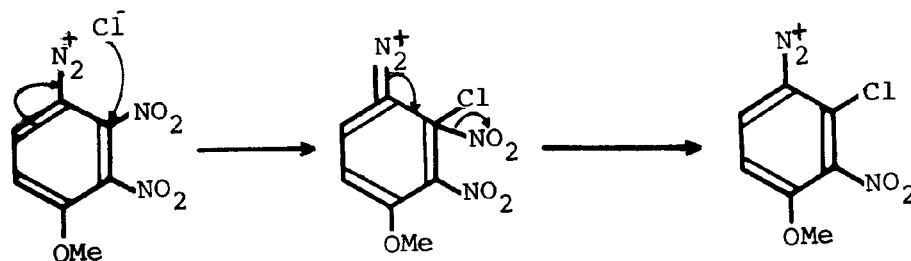
We have observed that such diazotisations get completed even if only a fraction of the needed nitrite salt is added, as after initiation of the diazotisation, progressive liberation of the nitrite ion in the aqueous acidic medium keeps the reaction going until complete (intramolecular) diazotisation has taken place.

The preparation of biphenyls through diazohydroxides,¹ also involves in the first stage diazotisation of the aromatic amines in a strongly aqueous-acid medium,

the diazonium salts are then basified at low temperature, and the resulting diazohydroxides are extracted with benzene, wherein they decompose to give biphenyls on warming the benzene solution. The application of this method in the case of the above dinitroanilines would have resulted in the displacement of one of the nitro-groups before the reaction could be basified for conversion into diazohydroxides. If instead of the use of alkali for basification alkali acetate is used then aryldiazoacetates¹⁰ are formed, and they can then be extracted into benzene, and on warming the benzene solution decompose in it, resulting in the formation of biphenyls. Aryldiazoacetates are isomeric with *N*-nitroso-*N*-acylarylamines¹¹, which can also be prepared by the nitrosation of acyl derivatives of arylamines. In this case the arylamines do not have to pass through the strongly polar diazonium salt state. Hence we thought that if the nitroso derivatives of acetanilides having two nitro-groups in *ortho* or *para* position to each other could be prepared, these on decomposition in benzene solution would give the desired biphenyls. And indeed this proved to be the case. All such acetanilides (Table below), were smoothly converted to the corresponding *N*-nitroso derivatives, which were isolated in high yields. All of them decomposed on warming of their benzene solutions, and were converted into unsymmetrical biphenyls without the loss of any of the nitrogroups.

This study gave an added conclusive support to the hypothesis that *N*-nitroso-*N*-acylarylamines (which are





Acetanilide	N-Nitroso-acetanilide m.p.	(Yield)	m.p.	Biphenyl (Yield)
2,3-Dinitro-	93°d	(80%)	105-106°	(48%)
3,4-Dinitro-	Yellow oil (d)		66-67°	(15%)
2,3-Dinitro-4-ethoxy-	90°d	(77%)	147-149°	(25%)
2,5-Dinitro-4-ethoxy-	86°d	(72%)	153-154°	(21%)
2,3-Dinitro-4-methoxy-	99°d	(86%)	139-140°	(25%)
2,5-Dinitro-4-methoxy-	88°d	(85%)	128-129°	(21%)
4,5-Dinitro-2-methoxy-	90°d	(82%)	122-123°	(47%)

isomeric with acylaryldiazoacetates) decompose homolytically¹² as shown below.

They generate aryl free radicals which readily react with the surrounding aromatic bases to give the biphenyls. The intermediacy of very polar diazonium salts (and hence of aryl cations) is not involved, as otherwise loss of the nitro-group adjacent (or *para*) to diazonium group (and further activated by the second nitro-group (and further activated by the second nitro-group in *ortho* or *para* position to it) would have occurred, and the desired dinitrobiphenyls could not have been obtained. IR, UV and NMR spectral data has also been recorded in the experimental section in support of the structures of dinitrobiphenyls being reported in this paper.

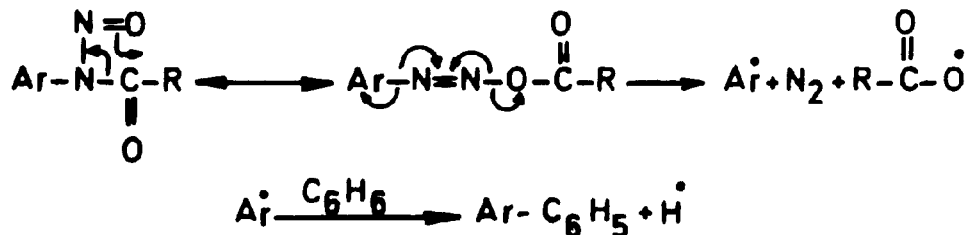
Experimental

The melting points are uncorrected. IR spectra were measured in KBr using Jasco infrared spectrophotometer Model IBA-I. UV and NMR spectra were recorded with

SP800A and JNM-PMX-60 respectively. The light petroleum was of the b.p. 60-80°. Brockmann alumina (activity I) was used for chromatographic separation of biaryls. The nitroso derivatives being unstable were quickly purified at low temperature for analytical purposes. The yields of nitroso derivatives recorded in Table-I are those of crude products, while those of biphenyls are of pure compounds as obtained after column chromatography and have been calculated on the amount of corresponding acetanilides used.

2,3-Dinitro-N-nitroso-acetanilide (General Procedure A):

Nitrosyl sulphuric acid¹³ (2.6g) was added dropwise to a well stirred mixture of 2,3-dinitroacetanilide⁷ (2g), fused sodium acetate (5g), acetic anhydride (25 ml), and phosphoric oxide (0.5g) at 0-5°. After stirring for 15 min. the yellow paste was pured over ice containing enough alkali to neutralize the acids. The yellow oil thus obtained soon solidified. It was quickly filtered



off, washed with cold water, and dried over P_2O_5 at 5° . Yield 80% Crystallisation of a small portion from ether (charcoal) gave 2,3-dinitro-*N*-nitroso-acetanilide as yellow needles, m.p. 83° (dec.).

Anal. Calc. for $C_8H_6N_4O_6 \cdot H_2O$: N, 20.02; Found: N, 20.4%.

2,3-Dinitrobiphenyl (General procedure B):

A solution of above nitroso compound in benzene was heated under reflux ($CaCl_2$ guard tube) for 4 hrs. during which nitrogen was evolved. The benzene was removed by distillation under reduced pressure and the residue (2.03g) was dissolved in minimum quantity of benzene and chromatographed on alumina. Elution with light petroleum gave 2,3-dinitrobiphenyl (1.02g, 48%) as yellow solid. Recrystallization from a mixture of benzene and light petroleum afforded the pure compound as pale yellow prisms, m.p. $105-106^\circ$; IR spectra (KBr): γ_{max} 1560 cm^{-1} (C-NO₂ asymmetric stretching), 1340 cm^{-1} (C-NO₂, symmetric stretching), 870 cm^{-1} (C-N stretching vibrations); UV spectra (CH₃OH): λ_{max} 235; λ_{min} 300; NMR spectra (CDCl₃): δ 7.2 – 8.3 (m, 8H, *arom*).

Anal. Calc. for $C_{12}H_8N_2O_4$: N, 11.4; Found: N, 11.3%.

The above general procedure A was used for the preparation of *N*-nitroso compounds and general procedure B for the preparation of biphenyls being reported below: 2,3-Dinitro-4-methoxybiphenyl:

2,3-dinitro-4-methoxy acetanilide² gave 2,3-dinitro-4-methoxy-*N*-nitroso-acetanilide as pale yellow solid, m.p. 99° (dec); (86%).

Anal. Calc. for $C_9H_8N_4O_7 \cdot H_2O$: N, 18.54; Found: N, 18.51%. Thermal decomposition of the nitroso-com-

Thermal decomposition of the nitroso-compound in benzene gave 2,3-dinitro-4-methoxy biphenyl (0.52g, 25%), as pale yellow needles from methanol, m.p. $139-140^\circ$. IR spectra (KBr): λ_{max} 1535 cm^{-1} (C-NO₂, asymmetric stretching), 1340 cm^{-1} (C-NO₂ symmetric stretching), 890 cm^{-1} (C-N stretching vibrations); UV spectra (CH₃OH): λ_{max} 212, 230, 298, 340; λ_{min} 222, 262, 323; NMR spectra (CDCl₃): δ 4.05 (s, 3H, OCH₃), δ 7.0 – 8.3 (m, 7H, *arom*).

Anal. Calc. for $C_{13}H_{10}N_2O_5$: N, 10.2; Found: N, 9.83.

2,5-Dinitro-4-methoxybiphenyl:

2,5-dinitro-4-methoxy acetanilide⁶ gave 2,5-dinitro-4-methoxy-*N*-nitroso-acetanilide (85%) as a yellow solid m.p. 88° (decomp.).

Anal. Calc. for $C_9H_8N_4O_7 \cdot H_2O$: N, 18.5; Found: N, 18.4%. The nitroso derivative with benzene gave 2,5-dinitro-4-methoxybiphenyl (0.452g, 21%) as yellow needles from methanol, m.p. $128-129^\circ$. IR spectra (KBr): λ_{max} 1530 cm^{-1} (C-NO₂, asymmetric stretching), 1345 cm^{-1} (C-NO₂, symmetric stretching), 845 cm^{-1} (C-N stretching vibrations); UV spectra (CH₃OH): λ_{max} 212, 235, 342; λ_{min} 218; NMR spectra (CDCl₃): δ 4.05 (s, 3H, OCH₃), δ 7.0 – 8.3 (m, 7H, *arom*).

Anal. Calc. for $C_{13}H_{10}N_2O_5$: N, 10.2; Found: N, 10.2%.

4,5-Dinitro-2-methoxybiphenyl:

4,5-dinitro-2-methoxyacetanilide³ gave 4,5-dinitro-2-methoxy-*N*-nitrosoacetanilide (82%), m.p. 90° (decomp.) as a pale yellow solid.

Anal. Calc. for $C_9H_8N_4O_7 \cdot H_2O$: N, 18.5; Found: N, 18.3%.

The nitroso-anilide with benzene gave 4,5-dinitro-2-methoxy-biphenyl (0.987g; 47%) as pale yellow prisms from methanol, m.p. $122-123^\circ$. IR spectra (KBr): λ_{max} 1535 cm^{-1} (C-NO₂, asymmetric stretching), 1335 cm^{-1} (C-NO₂, symmetric stretching), 855 cm^{-1} (C-N stretching vibrations); UV spectra (CH₃OH): λ_{max} 219, 233, 262, 305 (s), 340; λ_{min} 222, 287; NMR spectra (CDCl₃): δ 3.99 (s, 3H, OCH₃), δ 6.65 – 8.2 (m, 7H, *arom*).

Anal. Calc. for $C_{13}H_{10}N_2O_5$: N, 10.2; Found: N, 10.27%.

2,3-Dinitro-4-ethoxybiphenyl:

2,3-dinitro-4-ethoxyacetanilide⁵ gave 2,3-dinitro-4-ethoxy-*N*-nitrosoacetanilide (77%) m.p. 90° (decomp.) as a yellow solid.

Anal. Calc. for $C_{10}H_{10}N_4O_7$: N, 18.7; Found: N, 18.3.

The nitroso-derivative with benzene yielded 2,3-dinitro-4-ethoxy biphenyl (0.752g; 30%) as pale yellow needles from benzene and light petroleum mixture, m.p. $147-149^\circ$. IR spectra (KBr): λ_{max} 1535 cm^{-1} (C-NO₂, asymmetric stretching), 1350 cm^{-1} (C-NO₂, symmetric stretching), 870 cm^{-1} (C-N stretching vibrations); UV spectra (CH₃OH): λ_{max} 213, 234, 340; λ_{min} 218; NMR spectra (CDCl₃): δ 1.45 (t, 3H, CH₂-CH₃), δ 4.24 (q, 2H, CH₂-CH₃), δ 7.0 – 8.2 (m, 7H, *arom*).

Anal. Calc. for $C_{14}H_{12}N_2O_5$: N, 9.7; Found: N, 9.3%.

2,5-Dinitro-4-ethoxybiphenyl:

2,5-dinitro-4-ethoxyacetanilide⁵ gave 2,5-dinitro-4-ethoxy-*N*-nitroso-acetanilide (72%), m.p. 86° (decomp.).

Anal. Calc. for $C_{10}H_{10}N_4O_7$: N, 18.7; Found: N, 18.5%.

The nitroso-derivative with benzene gave 2,5-dinitro-

4-ethoxy-biphenyl (0.445g; 21%) as pale yellow micro-needles from benzene and light petroleum mixture, m.p. 153 – 154°. **

Anal. Calc. for $C_{14}H_{12}N_2O_5$: N, 9.7; Found: N, 9.4% 3,4-Dinitrobiphenyl:

3,4-Dinitrobiphenyl:

3,4-dinitroacetanilide⁷ gave an unstable oil as the nitroso-derivative which was decomposed in benzene *in situ* to get, 3,4-dinitrobiphenyl (0.34g; 15%) as cream coloured flakes from light petroleum m.p. 66-67°. IR spectra (KBr): λ_{max} 1570 cm^{-1} (C-NO₂, asymmetric stretching), 1330 cm^{-1} (C-NO₂, symmetric stretching), 875 cm^{-1} (C-N, stretching vibrations); UV spectra (CH₃OH); λ_{max} 215, 291; λ_{max} 249; NMR spectra (CDCl₃); δ 7.3 – 8.5 (m, 8H, *arom*).

Anal. Calc. for $C_{12}H_8N_2O_5$: N, 11.5; Found: N, 11.9.

Acknowledgement

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**Since the compound was not available in sufficient amount, hence the spectral analysis of this compound could not be recorded.