384. *The Action of Halogens upon the Nitrophenylazobenzoylacetones.*

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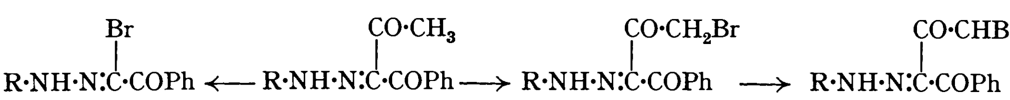
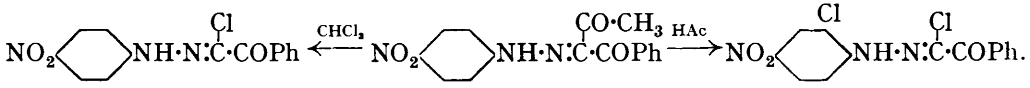
As in similar reactions (this vol., pp. 475, 1143), the action of chlorine or bromine upon the *nitrophenylazobenzoylacetones* alters with the medium in which the action occurs. In acetic acid in the presence of crystalline sodium acetate bromine replaces the acetyl group, yielding *ω-bromophenylglyoxalnitrophenylhydrazones* (I). In boiling glacial acetic acid or chloroform it substitutes in the acetyl group, yielding first *δ-bromo-*, then *δδ-dibromo-*



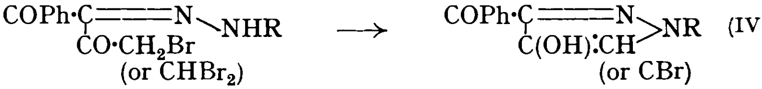
$$\underset{\text{(I.)}}{R\cdot NH\cdot N{:}\overset{\overset{Br}{|}}{C}\cdot COPh} \longleftarrow R\cdot NH\cdot N{:}\overset{\overset{CO\cdot CH_3}{|}}{C}\cdot COPh \longrightarrow \underset{\text{(II.)}}{R\cdot NH\cdot N{:}\overset{\overset{CO\cdot CH_2Br}{|}}{C}\cdot COPh} \longrightarrow \underset{\text{(III.)}}{R\cdot NH\cdot N{:}\overset{\overset{CO\cdot CHBr_2}{|}}{C}\cdot COPh}$$

αβγ-triketo-α-phenylbutane-β-nitrophenylhydrazones (II and III), the halogen not entering the nucleus in either case.

Chlorine, in chloroform or in acetic acid, either in the presence or absence of sodium acetate, always replaces the acetyl group, chlorine also entering the nitrophenyl nucleus when the reaction is carried out in acetic acid solution; *e.g.*,



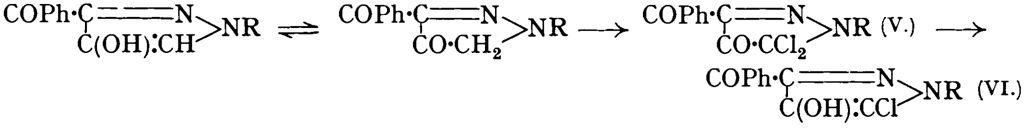
The action of alcoholic potassium acetate upon the δ-bromo- and the δδ-dibromo-αβγ-triketo-α-phenylbutane-β-nitrophenylhydrazones causes loss of hydrogen bromide with subsequent ring closure and formation of 4-hydroxy- and 5-bromo-4-hydroxy-3-benzoyl-1-*p*-nitrophenylpyrazoles (IV).



$$\begin{array}{l}\mathrm{COPh{\cdot}C{=\!=\!=}N\diagdown NHR}\\ \mathrm{CO{\cdot}CH_2Br}\\ \mathrm{(or\ CHBr_2)}\end{array} \longrightarrow \begin{array}{l}\mathrm{COPh{\cdot}C{=\!=\!=}N\diagdown}\\ \mathrm{C(OH){:}CH\diagup}\ \mathrm{NR}\\ \mathrm{(or\ CBr)}\end{array}$$

(IV.)

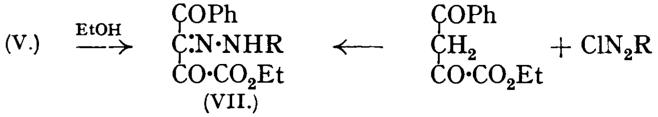
The action of chlorine upon these 4-hydroxypyrazoles is similar to its action upon the analogous 4-hydroxy-3-carbethoxypyrazoles (this vol., p. 1389), two atoms of chlorine substituting in the 5-position in the keto-form of the hydroxypyrazole and forming 5 : *5-dichloro-3-benzoyl-1-nitrophenyl-4-pyrazolones* (V).



$$\begin{array}{l}\mathrm{COPh{\cdot}C{=\!=\!=}N\diagdown}\\ \mathrm{C(OH){:}CH\diagup}\ \mathrm{NR}\end{array} \rightleftharpoons \begin{array}{l}\mathrm{COPh{\cdot}C{=\!=}N\diagdown}\\ \mathrm{CO{\cdot}CH_2\diagup}\ \mathrm{NR}\end{array} \longrightarrow \begin{array}{l}\mathrm{COPh{\cdot}C{=\!=}N\diagdown}\\ \mathrm{CO{\cdot}CCl_2\diagup}\ \mathrm{NR}\ \mathrm{(V.)}\end{array} \longrightarrow \begin{array}{l}\mathrm{COPh{\cdot}C{=\!=\!=}N\diagdown}\\ \mathrm{C(OH){:}CCl\diagup}\ \mathrm{NR}\ \mathrm{(VI.)}\end{array}$$

One of the chlorine atoms in the dichloro-compounds is very reactive and is readily replaced by hydrogen on treatment with aqueous hydriodic acid, the pyrazolones reverting to the enolic form with the formation of *5-chloro-4-hydroxy-3-benzoyl-1-nitrophenylpyrazoles* (VI).

When these 5 : 5-dichloro-4-pyrazolones are heated with alcohols, the ring opens with the formation of *hydrazones* of *αβγ-triketo-γ-phenylbutyric esters* (VII), identical with the compounds produced by coupling the appropriate diazonium salt with benzoylpyruvic ester (Beyer and Claisen, *Ber.*, 1887, **20**, 2187).



$$\mathrm{(V.)} \xrightarrow{\mathrm{EtOH}} \begin{array}{l}\mathrm{COPh}\\ \mathrm{C{:}N{\cdot}NHR}\\ \mathrm{CO{\cdot}CO_2Et}\\ \mathrm{(VII.)}\end{array} \longleftarrow \begin{array}{l}\mathrm{COPh}\\ \mathrm{CH_2}\\ \mathrm{CO{\cdot}CO_2Et}\end{array} + \mathrm{ClN_2R}$$

The action of dilute alkalis upon these 4-pyrazolones also results in the fission of the pyrazole ring and formation of *β-hydrazones* of *αβγ-triketo-γ-phenylbutyric acid*; the yield, however, is very small.

EXPERIMENTAL.

p-*Nitrophenylazobenzoylacetone.*—14 G. of *p*-nitroaniline were diazotised with 7 g. of sodium nitrite in 80 c.c. of concentrated hydrochloric acid, and the filtered diazonium solution slowly run into a mixture of 18 g. of benzoylacetone and 120 g. of crystalline sodium acetate in 100 c.c. of alcohol. p-*Nitrophenylazobenzoylacetone* separated at once in quantitative yield. It crystallised from acetic acid in yellow, large, flattened, rectangular prisms with domed ends, m. p. 143° (Found: N, 13·3. $C_{16}H_{13}O_4N_3$ requires N, 13·5%). The corresponding o-*nitro*-compound crystallised from acetic acid in yellow, long, slender, flattened prisms, m. p. 145° (Found: N, 13·4%).

ω-*Bromophenylglyoxal*-p-*nitrophenylhydrazone* (I).—1·2 G. of bromine in 5 c.c. of acetic acid were added to a solution of 2·25 g. of *p*-nitrophenylazobenzoylacetone and 2 g. of crystalline sodium acetate in 100 c.c. of acetic acid at 40°, and the whole left for an hour. On careful addition of water ω-*bromophenylglyoxal*-p-*nitrophenylhydrazone* separated. It crystallised from acetic acid in a felted mass of pale yellow, slender prisms, m. p. 247° (decomp.) (Found: Br, 23·3. $C_{14}H_{10}O_3N_3Br$ requires Br, 23·0%).

ω-Chlorophenylglyoxal-p-*nitrophenylhydrazone*, obtained when 1 g. of *p*-nitrophenylazobenzoylacetone was suspended in 15 c.c. of dry chloroform, chlorine passed for 15 minutes, and the chloroform removed, crystallised from acetic acid in pale yellow, hair-like prisms, m. p. 243° (Found : Cl, 11·9. $C_{14}H_{10}O_3N_3Cl$ requires Cl, 11·7%). The corresponding o-*nitro*-compound crystallised from alcohol in yellow, very long, slender prisms, m. p. 151° (Found : Cl, 11·8%).

ω-Chlorophenylglyoxal-2-chloro-4-nitrophenylhydrazone.—2 G. of *p*-nitrophenylazobenzoylacetone were dissolved in 50 c.c. of acetic acid at 40°, and chlorine passed for ½ hour. On careful addition of water *ω-chlorophenylglyoxal-2-chloro-4-nitrophenylhydrazone* separated. It crystallised from acetic acid as a labile form in pale yellow, hair-like prisms, which gradually redissolved whilst yellow rhombic plates of the stable form separated; m. p. 183° (Found : Cl, 21·3. $C_{14}H_9O_3N_3Cl_2$ requires Cl, 21·0%). The *4-chloro-2-nitrophenylhydrazone*, similarly prepared, crystallised from alcohol as a labile form in pale yellow, hair-like prisms, which gradually redissolved whilst yellow rectangular prisms with domed ends, exhibiting dendritic twinning, of the stable form separated, m. p. 157° (Found : Cl, 21·2%).

δ-Bromo-αβγ-triketo-α-phenylbutane-β-p-*nitrophenylhydrazone* (II).—2·4 G. of bromine in 3 c.c. of acetic acid were added to a solution of 4·5 g. of *p*-nitrophenylazobenzoylacetone in 40 c.c. of boiling acetic acid. On cooling, the *hydrazone* (II) separated in quantitative yield. It crystallised from alcohol in yellow, long, hair-like needles, m. p. 172° (decomp.) (Found : Br, 20·2. $C_{16}H_{12}O_4N_3Br$ requires Br, 20·5%). The corresponding o-*nitro*-compound crystallised from acetic acid in yellow, long, slender prisms, m. p. 155° (decomp.) (Found : Br, 20·3%). Similarly, by using 2 mols. of bromine, was obtained *δδ-dibromo-αβγ-triketo-α-phenylbutane-β*-p-*nitrophenylhydrazone*, which crystallised from alcohol in yellow, long, slender, rectangular prisms, m. p. 190° (decomp.) (Found : Br, 33·7. $C_{16}H_{11}O_4N_3Br_2$ requires Br, 34·1%).

4-Hydroxy-3-benzoyl-1-p-*nitrophenylpyrazole* (IV).—1 G. of potassium acetate was added to 4 g. of δ-bromo-αβγ-triketo-α-phenylbutane-β-*p*-nitrophenylhydrazone suspended in 100 c.c. of boiling alcohol. A clear solution was obtained, from which *4-hydroxy-3-benzoyl-1*-p-*nitrophenylpyrazole* separated almost at once. It crystallised from acetic acid as a labile form in felted masses of yellow hair-like prisms, which gradually redissolved whilst yellow, large, rectangular, flattened prisms of the stable form separated, m. p. 211·5° (Found : N, 13·4. $C_{16}H_{11}O_4N_3$ requires N, 13·6%). The corresponding o-*nitro*-compound crystallised from alcohol in yellow, large, compact, irregular prisms, m. p. 121° (Found : N, 13·6%). Similarly, from δδ-dibromo-αβγ-triketo-α-phenylbutane-β-*p*-nitrophenylhydrazone was obtained *5-bromo-4-hydroxy-3-benzoyl-1*-p-*nitrophenylpyrazole*, which crystallised from acetic acid as a labile form in bright yellow, short, slender prisms, which gradually redissolved whilst yellow, fragile, rhombic plates of the stable form separated, m. p. 167° (Found : Br, 20·4. $C_{16}H_{10}O_4N_3Br$ requires Br, 20·6%).

5 : *5-Dichloro-3-benzoyl-1*-p-*nitrophenyl-4-pyrazolone* (V).—2 G. of 4-hydroxy-3-benzoyl-1-*p*-nitrophenylpyrazole were suspended in 15 c.c. of chloroform, and chlorine passed for 15 minutes. On removal of the chloroform from the resulting orange solution, 5 : *5-dichloro-3-benzoyl-1*-p-*nitrophenyl-4-pyrazolone* remained. It crystallised from chloroform–light petroleum in orange, dense, rectangular prisms, m. p. 145° (Found : Cl, 18·6. $C_{16}H_9O_4N_3Cl_2$ requires Cl, 18·8%). The corresponding o-*nitro*-compound crystallised in yellow, compact, rectangular prisms, m. p. 166° (Found : Cl, 18·7%).

Formation of 5-Chloro-4-hydroxy-3-benzoyl-1-p-*nitrophenylpyrazole.*—2 G. of potassium iodide were dissolved in 10 c.c. of water and 5 c.c. of acetic acid and added to a solution of 1·5 g. of 5 : 5-dichloro-3-benzoyl-1-*p*-nitrophenyl-4-pyrazolone in 10 c.c. of acetic acid. On gentle warming, iodine was liberated and *5-chloro-4-hydroxy-3-benzoyl-1*-p-*nitrophenylpyrazole* separated. It crystallised from alcohol in pale yellow, long, slender prisms, m. p. 177° (Found : Cl, 10·5. $C_{16}H_{10}O_4N_3Cl$ requires Cl, 10·3%). The corresponding o-*nitro*-compound crystallised from alcohol in pale yellow, large, fragile rhombic plates, m. p. 120° (Found : Cl, 10·3%).

Formation of Ethyl αβγ-Triketo-γ-phenyl-n-*butyrate-β*-p-*nitrophenylhydrazone* (VII).—(1) 1 G. of 5 : 5-dichloro-3-benzoyl-1-*p*-nitrophenyl-4-pyrazolone was boiled for 5 minutes with 10 c.c. of alcohol. On cooling, the *ester* (VII) separated. It crystallised from alcohol in yellow, long, slender prisms, m. p. 135° (Found : N, 11·5. $C_{18}H_{15}O_6N_3$ requires N, 11·4%).

(2) 2 G. of *p*-nitroaniline were diazotised and the diazonium solution was run into a cooled well-stirred mixture of 4 g. of ethyl sodiobenzoylpyruvate and 25 g. of crystalline sodium acetate in 150 c.c. of water. The yellow solid which separated at once was shown on crystallisation to be identical with the above.

By a similar method to (1) above have been prepared : *ethyl αβγ-triketo-γ-phenyl*-n-*butyrate-β*-o-*nitrophenylhydrazone*, yellow, somewhat flattened prisms from alcohol, m. p. 108° (Found : N, 11·3%), and *methyl αβγ-triketo-γ-phenyl*-n-*butyrate-β*-o-*nitrophenylhydrazone*, yellow, long, slender, four-sided prisms from alcohol, m. p. 119° (Found : N, 11·9. $C_{17}H_{13}O_6N_3$ requires N, 11·8%).

*αβγ-Triketo-γ-phenyl-*n*-butyric acid-*β-p-*nitrophenylhydrazone*.—2 G. of finely powdered 5 : 5-dichloro-3-benzoyl-1-*p*-nitrophenyl-4-pyrazolone were shaken for 15 minutes with 2 g. of sodium hydroxide in 150 c.c. of water. Much decomposition occurred, but on acidification of the filtered solution with dilute hydrochloric acid the above *acid* was obtained in 10—15% yield. It crystallised from chloroform–light petroleum in yellow, short, flattened prisms, m. p. 154° (Found : N, 12·4. $C_{16}H_{11}O_6N_3$ requires N, 12·3%).

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