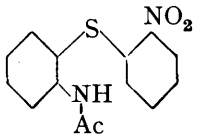
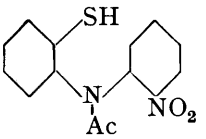
## 74. *A Rearrangement of* o-*Benzamido-sulphides.*

By Christian F. Wight and Samuel Smiles.

It has been shown (this vol., p. 181) that in alkaline media the acetyl and the 2-nitrobenzoyl derivative of 2-nitro-2′-aminodiphenyl sulphide undergo rearrangement, whereas under the same conditions the picryl and the benzenesulphonyl derivative yield only their alkali salts. This divergent behaviour was ascribed to the influence of the *N*-substituents and, taking the view that rearrangements of the type (I) → (II) are intramolecular displacements, it was pointed out that rearrangement should be favoured in cases such as the acetyl and the nitrobenzoyl derivatives where the acyl groups are provided by relatively weak acids. This requirement of theory has been further confirmed by examination of several other amides of the latter type; the behaviour of the formyl and the benzoyl derivatives may be recorded as typical. In presence of alkali hydroxide rearrangement of the formyl derivative is accompanied by deacylation, the thiol (III) being formed; this was isolated as the disulphide and *S*-methyl derivative. The benzamido-sulphide (I, Ac = $C_6H_5$·CO·) yielded the benzoyl derivative of (III), which was isolated after methylation; oxidation of the methyl



(I.)



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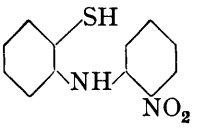
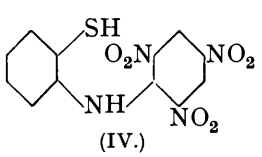
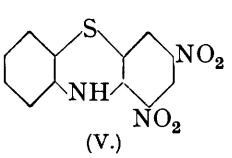


(III.)

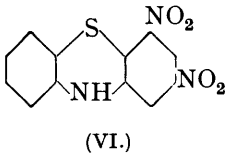
sulphide and subsequent hydrolysis of the *N*-benzoyl sulphone yielded a methyl sulphone of known structure. These examples serve to illustrate the fact that after rearrangement of the mononitro-sulphides (I) the simple thiols or their *N*-acyl derivatives (II) are generally obtained; but in cases derived from (I) by further substitution in the nitrophenyl nucleus the thiols may be rapidly converted into thiazines by loss of nitrous acid in the alkaline medium required for rearrangement. The picryl derivative (VII) affords an interesting example of this behaviour, since it was the subject of a controversy which remained unsettled. Kehrmann (*Ber.*, 1911, **44**, 3012) by reduction of bis-2-picramidophenyl disulphide obtained the corresponding thiol (IV), which with alkali yielded a dinitrothiodiphenylamine (V). Möhlau and his co-workers (*Ber.*, 1910, **43**, 927; 1912, **45**, 131), with the object of



(IV.)



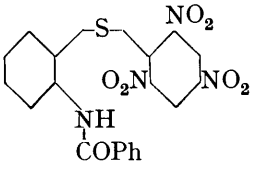
(V.)



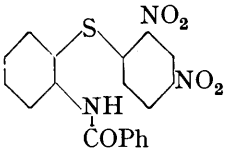
(VI.)

obtaining the isomeric dinitrothiodiphenylamine (VI), converted 2-benzamidophenylthiol into the *S*-picryl derivative by reaction with picryl chloride in presence of sodium acetate.

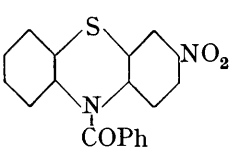
The product yielded with alkali the *N*-benzoyl derivative of a dinitrothiazine which was identical with (V). No satisfactory explanation of this unexpected result has hitherto been forthcoming; Kehrmann (*Ber.*, **1913**, **46**, 3014), however, found that the picryl derivative obtained by the method of Möhlau is impure and suggested that the chief product of the process is the *N*-benzoyl derivative of the thiol (IV). Re-examination of the material has now shown that it usually contains at least three substances in varying proportions, but the chief component, which is obtained in a purer state by the use of magnesium carbonate instead of sodium acetate, is neither a thiol nor a disulphide and has accordingly the structure (VII) assigned to it by Möhlau. The implied conclusion that picrylation of 2-benzamidophenylthiol takes place at sulphur in preference to the amido-nitrogen is confirmed by the fact that the dinitro-sulphide (VIII) is obtained either by benzoylation of 2 : 4-dinitro-2′-aminodiphenyl sulphide or from 2-benzamidophenylthiol by reaction with 2 : 4-dinitrochlorobenzene in presence of magnesium carbonate. It is now evident that the formation of the *N*-benzoyl-thiazine (compare V) by the method of Möhlau from the sulphide (VII) consists in a preliminary intramolecular change which yields the *N*-benzoyl derivative of the thiol (IV), followed by conversion of the latter into the thiazine by loss of



(VII.)



(VIII.)



(IX.)

nitrous acid in the alkaline medium as in Kehrmann's process. The 2-acetamidophenyl picryl sulphide (compare VII) similarly yields the dinitro-thiazine (V).

According to previous experiments (J., **1934**, 422) and others recently made with rearrangements of this general type, increase in the positive character of the carbon atom from which the sulphur is displaced greatly facilitates the process. Accordingly rearrangement of these sulphides containing the strongly positive picryl nucleus proceeds rapidly in the alkaline media provided by sodium acetate or pyridine, which are without effect on the mono- and di-nitro-derivatives. Thiazine formation is not restricted to the picryl sulphides. The thiol derived from the dinitro-sulphide (VIII) by rearrangement with alkali hydroxide could not be isolated in a pure condition, since it was converted by the reagent into a thiazine. The structure (IX) accordingly ascribed to the latter has since been confirmed in the course of another series of experiments.

## Experimental.

2-*Nitro*-2′-*formamidodiphenyl sulphide* was obtained by boiling a solution of the amine in formic acid (98%); it formed pale yellow needles from propyl alcohol, m. p. 143° (Found : C, 56·8; H, 3·8. $C_{13}H_{10}O_3N_2S$ requires C, 56·8; H, 3·6%). Alcoholic sodium ethoxide (*N*, 1 mol.) was added in small portions to a hot solution (10%) of this formyl derivative in alcohol; after each addition sufficient methyl iodide was added to remove the red colour previously produced by the alkaline reagent. When the solution was cooled, 2-*o*-nitrophenylaminophenyl methyl sulphide separated; this had m. p. 98° and was identified by comparison with an authentic sample (Found : C, 59·9; H, 4·6; N, 10·7. Calc. : C, 60·0; H, 4·6; N, 10·7%) and by oxidation to the corresponding sulphone (this vol., p. 186). Rearrangement of this formamido-sulphide was also conducted (1 mol. of *N*-alcoholic sodium hydroxide) without the addition of methyl iodide. When hydrogen peroxide was added to the diluted product, bis-2-*o*-nitrophenylaminophenyl disulphide (*loc. cit.*) separated (40% yield), m. p. 151° after purification from acetic acid (Found : C, 58·4; H, 3·8. Calc. : C, 58·7; H, 3·6%) and was identified in the usual way.

2-*Nitro*-2′-*benzamidodiphenyl sulphide* was obtained from the amine and benzoyl chloride in pyridine; it formed lemon-yellow needles from propyl alcohol, m. p. 106° (Found : C, 64·9; H, 4·0. $C_{19}H_{14}O_3N_2S$ requires C, 65·1; H, 4·0%). Rearrangement of this sulphide was effected in boiling alcohol by the gradual addition of alcoholic sodium hydroxide (*N*, 1·3 mols.), methyl iodide being added as in the case of the formyl derivative.

2-*o-Nitrophenylbenzamidophenyl methyl sulphide* separated when the reacting mixture was cooled, it gave methyl mercaptan when warmed with hydriodic acid and separated from acetic acid in yellow needles, m. p. 206° (Found : C, 65·8; H, 4·3; N, 7·7. $C_{20}H_{16}O_3N_2S$ requires C, 65·9; H, 4·4; N, 7·7%). A small quantity of 2-*o*-nitrophenylaminophenyl methyl sulphide (*loc. cit.*) was isolated from the residues of this process.

2-*o-Nitrophenylbenzamidophenylmethylsulphone* was obtained by oxidising the above methyl sulphide with hydrogen peroxide in the usual manner; it formed plates from acetic acid, m. p. 251° (Found : C, 60·6; H, 4·1. $C_{20}H_{16}O_5N_2S$ requires C, 60·6; H, 4·0%).

The preceding substance was also obtained from the rearrangement of 2-*nitro*-2′-*benzamidodiphenylsulphone*, which formed plates from acetic acid, m. p. 139°, and was isolated by oxidising the sulphide with excess of hydrogen peroxide in hot acetic acid (Found : C, 59·4; H, 3·7. $C_{19}H_{14}O_5N_2S$ requires C, 59·7; H, 3·6%). Rearrangement of this sulphone took place rapidly when an alcoholic solution containing sodium hydroxide (1·25 mols.) was boiled. The structure of the sulphinic acid thus formed was shown (a) by isolating it and removing the sulphinic group by successive treatment with mercuric chloride and hydrochloric acid (this vol., p. 181); the product had m. p. 76° and was identical with 2-nitrodiphenylamine; (b) by methylation in the alkaline solution obtained after rearrangement. The product of this process had m. p. 251° and was identical with the 2-*o*-nitrophenylbenzamidophenylmethylsulphone obtained by oxidising the sulphide; removal of the benzoyl group from this was effected by boiling the solution in acetic acid containing sulphuric acid (20%). The resulting material was identified as 2-*o*-nitrophenylaminophenylmethylsulphone by comparison with an authentic specimen (*loc. cit.*).

2 : 4-*Dinitro*-2′-*benzamidodiphenyl sulphide* (VIII) was obtained (a) when the amine and benzoyl chloride (1 mol.) were boiled in acetone (30 mins.). It formed pale yellow needles from acetic acid, m. p. 178° (Found : C, 57·3; H, 3·6; N, 10·6. $C_{19}H_{13}O_5N_3S$ requires C, 57·7; H, 3·3; N, 10·6%). The same substance was obtained in presence of pyridine or sodium acetate. (b) Bis-2-benzamidophenyl disulphide (1 mol.) was reduced in the usual way by a warm aqueous alkaline solution of sodium sulphide. The thiol was liberated from the alkaline solution and dissolved in chloroform. When alcohol containing 2 : 4-dinitrochlorobenzene (2 mols.) and sodium acetate (2 mols.) was added to this chloroform solution, the required sulphide (m. p. 178°) was soon formed (80%).

Rearrangement of this sulphide (4 g.) took place rapidly in boiling acetone (100 c.c.) to which an alcoholic solution of sodium hydroxide (*N*, 1 mol.) had been added. Attempts to isolate the thiol formed as the methyl sulphide by concurrent methylation failed on account of the rapid formation of the thiazine (IX). 3-*Nitro*-6-*benzoylthiodiphenylamine* was isolated (25%) by removing most of the acetone and adding cold alcohol to the residue; it separated from alcohol in yellow prisms, m. p. 161—162° (Found : C, 65·2; H, 3·5; N, 8·2. $C_{19}H_{12}O_3N_2S$ requires C, 65·5; H, 3·4; N, 8·0%).

2-*Benzamidophenyl Picryl Sulphide* (VII).—The product prepared by the method of Möhlau (*loc. cit.*) usually had m. p. 170—190°. Fractionation of this yielded (1) 2-benzamidophenyl disulphide, m. p. 141°, (2) 2 : 4-dinitro-6-benzoylthiodiphenylamine, m. p. 210° (Möhlau, *loc. cit.*), and (3) the required *sulphide*, which separated from acetic acid in orange needles, m. p. 213—214° (decomp.) (Found : C, 51·5; H, 3·1; N, 12·8; S, 7·1; *M*, 435. $C_{19}H_{12}O_7N_4S$ requires C, 51·8; H, 2·7; N, 12·7; S, 7·3%; *M*, 440). This was more readily obtained in a pure condition by adding a cold chloroform solution of 2-benzamidophenylthiol (1 mol.) to ether which contained picryl chloride (1 mol.) in presence of magnesium carbonate, free access of air to the mixture being prevented. After 1 hour, the insoluble material was collected and washed with acetic acid and then with water; the crude product remaining (50%) had usually m. p. about 208—211°. The substance did not exhibit the usual reactions of a thiol; in boiling alcohol it was converted by (1) pyridine (90% yield), (2) sodium acetate (92% yield), (3) sodium hydroxide (1 mol.) (80% yield) into 2 : 4-dinitro-6-benzoylthiodiphenylamine, m. p. 210° (Found : C, 57·9; N, 11·0. Calc. : C, 58·0; N, 10·7%), described by Möhlau (*loc. cit.*); conversion of the latter by hydrolysis into the 3 : 5-dinitrothiodiphenylamine (V, m. p. 189°) obtained by Kehrmann (*loc. cit.*) from 2-picramidophenylthiol was confirmed.

2-*Acetamidophenyl Picryl Sulphide*.—An alkaline aqueous solution of 2-acetamidophenylthiol was prepared from the disulphide by reduction with sodium sulphide in the usual manner. The thiol was liberated from the solution of the sodium salt by addition of dilute acid, care being taken to avoid excess of the latter; it was dissolved in chloroform and the cold solution was added to ether which contained picryl chloride and excess of magnesium carbonate. Access of air to the mixture was prevented; the product was slowly precipitated in the crystalline state.

Inorganic material was removed from the solid as usual and the residue was purified from ethyl acetate. It formed orange needles, m. p. 215—216° (decomp.) (Found : C, 44·5; N, 14·8; S, 8·3; *M*, 384. $C_{14}H_{10}O_7N_4S$ requires C, 44·4; N, 14·8; S, 8·5%; *M*, 378). A boiling solution of this substance in acetone which contained alcoholic sodium hydroxide (1 mol.) yielded the 3 : 5-dinitro-thiazine (V), deacetylation having taken place during the process. Prolonged treatment (2 hours) with a boiling alcoholic solution (20%) of pyridine yielded a small quantity of the thiazine (V) together with bis-2-picramidophenyl disulphide.

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