CLXXVIII.—*The Reactivity of Doubly-conjugated Unsaturated Ketones. Part II. The Action of Hydroxylamine, Semicarbazide, and Phenylhydrazine on 4'-Dimethylamino-2-hydroxydistyryl Ketone and its Methyl Ether.*

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It has been shown in the preceding paper that the high degree of reactivity exhibited by 4'-dimethylamino-2-hydroxydistyryl ketone may be satisfactorily explained by assuming inner complex formation involving the carbonyl oxygen atom and the hydroxyl group, the effect of this being to enhance the free residual affinity of the external carbon atom of the conjugated system included in the complex. In the present paper, further evidence is adduced strongly supporting this hypothesis.

Action of Hydroxylamine.—By the action of hydroxylamine hydrochloride upon the hydroxy-ketone in presence of excess of calcium carbonate in the cold, a bright red, labile additive product (I), analogous to the solvates already described, can be isolated. This additive compound very readily loses its hydroxylamine addendum, with formation of the free ketone. If, however, more vigorous methods are employed, such as heating the reactants in concentrated alkaline solution for a short time, in place of the labile additive product, the true hydroxylamino-derivative (II) is

produced in the form of almost colourless needles melting at 218°. Finally, an hydroxylamino-oxime (III) can be prepared by the action of hydroxylamine acetate on the ketone in the cold, but whereas the first two substances are rapidly prepared, this compound requires several days for its formation. With the methyl ether, on the other hand, only an hydroxylamino-oxime is produced. It is thus evident that the reaction takes place in successive stages, the first being labile addition by means of subsidiary valence linkings, followed by the strengthening of the partial linkings, finally resulting in the disruption of the double bond. Once this has taken place, the doubly conjugated system has ceased to exist, and, with it, the anomalous behaviour of the carbonyl group also vanishes, and consequently an oxime of the hydroxylamino-compound is obtained. It is likewise assumed that the reaction with hydroxylamine acetate follows the same course, as illustrated by the scheme :

Action of Semicarbazide.—The action of this base upon the hydroxy-ketone in presence of pyridine or of semicarbazide acetate itself results in the direct formation of a semicarbazido-semicarbazone, no intermediate compounds having been isolated. During the course of this investigation an interesting paper by Auwers has appeared (*Ber.*, 1921, **54**, [B], 987) in which it is pointed out that the conclusions arrived at by Rupe and his collaborators (*Ber.*, 1903, **36**, 1903; 1907, **40**, 4764), that it is only in the aliphatic group that semicarbazido-semicarbazones are obtainable, must be modified. Auwers, starting from phenyl propenyl ketone, *p*-anisyl propenyl ketone, and *p*-methoxy-*o*-tolyl propenyl ketone, readily obtained semicarbazido-semicarbazones, and concluded that whereas ketones of the type (A), probably owing to their spatial configura-

tion, could only form semicarbazones, ketones of the type (B) examined by him, where the inhibiting influence of the phenyl group was removed, were not so restricted.

(A) $C_6H_5 \cdot CH:CH \cdot COR$ (B) $C_6H_5 \cdot CO \cdot CH:CHR$ (R = aliphatic group).

It is evident, however, from the above, that even compounds containing the ethylenic double bond adjacent to the phenyl group can, under certain conditions, react to yield semicarbazido-semicarbazones. Such a condition would be the strengthening of the necessary subsidiary valencies, which effect occurs, according to our postulate, in 4'-dimethylamino-2-hydroxydistyryl ketone. That, however, the addition of semicarbazide to an ethylenic linking under normal conditions takes place with more difficulty than the addition of hydroxylamine is illustrated by the action of 4'-dimethylamino-2-methoxydistyryl ketone, which only forms a simple semicarbazone. We regard this as a direct proof both of the presence of increased free valency on carbon atom C (1) and that the carbonyl group of the hydroxy-ketone remains inoperative until the complex partial valency system has been fundamentally altered by addition at the double bond.

Action of Phenylhydrazine.—A phenylhydrazone is obtained by the action of this base on either the hydroxy-ketone or its methyl ether. That, however, this is in no way contrary to the views just expressed is indicated by the fact that the reaction only takes place in presence of excess of pyridine, and that the phenylhydrazone contains, especially in the case of the hydroxy-ketone, one molecule of pyridine firmly attached. It is evident that the pyridine first forms a "solvate" with the ketone, analogous to the action of hydroxylamine in the formation of the hydroxylamine additive product, and that this occasions a rupture of the ring system, which then reacts to yield the phenylhydrazone-pyridine compound in the ordinary manner. Numerous experiments were carried out with the object of obtaining phenylhydrazine derivatives in the absence of pyridine, but without success, as oils which could not be purified invariably separated out. There can, however, be little doubt that such oils actually contained the phenylhydrazino-additive product analogous to the hydroxylamino-compound.

EXPERIMENTAL.

Additive Product of 4'-Dimethylamino-2-hydroxydistyryl Ketone with Hydroxylamine, $OH \cdot C_6H_4 \cdot CH:CH \cdot CO \cdot CH:CH \cdot C_6H_4 \cdot NMe_2 \cdot NH_2 \cdot OH$.

2.8 Grams of the ketone (benzene additive product) were treated in alcoholic solution with 1.1 grams of an aqueous solution of

hydroxylamine hydrochloride, and the mixture, after being neutralised with powdered calcium carbonate, was immediately filtered. On dilution with water, the additive product rapidly separated as bright scarlet flocks, from which the hydroxylamine addendum was easily removed by keeping over concentrated sulphuric acid (Found : on immediate analysis, $N = 8.4$. $C_{19}H_{19}O_2N \cdot NH_2 \cdot OH$ requires $N = 8.6$ per cent. Found : after two days in exsiccator, $N = 4.7$. $C_{19}H_{19}O_2N$ requires $N = 4.8$ per cent.).

Hydroxylamino-derivative of 4'-Dimethylamino-2-hydroxydistyryl Ketone.

8.4 Grams of the ketone-chloroform product, dissolved in 15.0 c.c. of 30 per cent. potassium hydroxide solution (4 mols.), were treated with 5.5 grams of hydroxylamine hydrochloride dissolved in 40 c.c. of water, and 20 c.c. of alcohol added to the mixture. The whole was boiled for a few minutes, when the solution changed colour, becoming orange-yellow. The hydroxylamino-compound rapidly separated and was purified by repeated crystallisation from absolute alcohol. It forms almost colourless needles, melting with decomposition at 218° (rapid heating). It is somewhat sparingly soluble in most organic solvents, and is slowly decomposed on boiling with hydrochloric acid or aqueous alkali (Found : $C = 69.6$; $H = 6.9$; $N = 8.5$. $C_{19}H_{22}O_3N_2$ requires $C = 69.9$; $H = 6.8$; $N = 8.6$ per cent.).

Hydroxylamino-derivative of 4'-Dimethylamino-2-hydroxydistyryl Ketoxime.

8.2 Grams of the ketone-chloroform product, dissolved in 50 c.c. of alcohol, were treated with 3 mols. of hydroxylamine acetate. The mixture was allowed to stand for three days, and the hydroxylamino-oxime precipitated by dilution with water. The dark tarry product was repeatedly crystallised from alcohol, after decoloration with animal charcoal. It forms pale yellow, silky leaves, which darken above 200° and finally melt with decomposition at 212° (Found : $C = 66.7$; $H = 7.0$; $N = 12.3$. $C_{19}H_{23}O_3N_3$ requires $C = 66.9$; $H = 6.7$; $N = 12.3$ per cent.).

Hydroxylamino-derivative of 4'-Dimethylamino-2-methoxydistyryl Ketoxime.

2.8 Grams of hydroxylamine hydrochloride (4 mols.), dissolved in the minimum quantity of water, were added to a solution of

3.1 grams of the methyl ether dissolved in 15 c.c. of pyridine. The mixture was kept for five days, and then diluted largely with water, when a yellow, oily mass was precipitated. After recrystallisation from a mixture of alcohol and pyridine, it was obtained in glistening, colourless needles melting at 214° . This compound may also be obtained by an analogous method to that employed in the preparation of the hydroxylamino-oxime of the hydroxyketone, a less favourable yield, however, being obtained (Found: C = 67.3; H = 7.3; N = 11.9. $C_{20}H_{25}O_3N_3$ requires C = 67.6; H = 7.1; N = 11.8 per cent.).

Semicarbazide Derivative of 4'-Dimethylamino-2-hydroxydistyryl Ketone Semicarbazone,

4.0 Grams of the ketone (chloroform additive product), dissolved in 20 c.c. of pyridine, were mixed with 5.0 grams of semicarbazide hydrochloride dissolved in 15 c.c. of water, and 15 c.c. of alcohol were added in order to form a homogenous solution. After the mixture had been kept for two days, the flocculent, slightly red precipitate of the semicarbazide-semicarbazone was filtered off, and recrystallised from a mixture of aniline and amyl alcohol. It forms an almost colourless powder, melting at 218° , which is very sparingly soluble in most organic solvents, but is somewhat soluble in aqueous pyridine and readily soluble in warm aniline. This substance has also been prepared by the usual method with semicarbazide acetate (Found: C = 59.0; H = 6.9; N = 22.8. $C_{21}H_{27}O_3N_4$ requires C = 59.3; H = 6.4; N = 23.1 per cent.).

Semicarbazone of 4'-Dimethylamino-2-methoxydistyryl Ketone.

Three grams of an alcoholic solution of the methyl ether were mixed with an excess of semicarbazide acetate. After standing for two days, the precipitated semicarbazone was filtered off, and freed from unchanged methyl ether by washing with boiling alcohol. The semicarbazone, after recrystallisation from chloroform, forms brilliant yellow leaves melting at 213° (Found: N = 15.3. $C_{21}H_{24}O_2N_4$ requires N = 15.4 per cent.).

Pyridine Additive Product of 4'-Dimethylamino-2-hydroxydistyryl Ketone Phenylhydrazone.

16.4 Grams of the chloroform additive product of the ketone were dissolved in 50 c.c. of pyridine, and 17 grams (3 mols.) of

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phenylhydrazine hydrochloride added. The mixture was heated for thirty minutes on the water-bath, after which it was kept at the ordinary temperature. On cooling, the whole solidified to a yellow mass, which was redissolved in a small quantity of pyridine. Addition of ethyl acetate caused the separation of a small amount of a yellow substance readily soluble in water, but this was not further investigated. The ethyl acetate was driven off and the residue allowed to crystallise after the addition of alcohol. Ten grams of the hydrazone were thus obtained as a yellow, crystalline mass melting at 141° . On repeated crystallisation from benzene, the melting point gradually rises, which effect must be due to the gradual removal of the pyridine, as the substance melting at 141° can again be obtained by one recrystallisation from alcoholic pyridine. No accurate analytical results could be obtained for the compound of higher m. p., but it was indicated that the pyridine addendum was being partly replaced by benzene. None of the compounds gave the Knorr pyrazoline reaction (Found: C = 78.0; H = 6.8; N = 12.1. $C_{25}H_{25}ON_3$ requires C = 77.9; H = 6.5; N = 12.2 per cent.).

Phenylhydrazone of 4'-Dimethylamino-2-methoxydistyryl Ketone.

3.1 Grams of the methyl ether were dissolved in 15 c.c. of pyridine and treated with 4.3 grams (3 mols.) of phenylhydrazine hydrochloride. After heating for one hour on the water-bath, a pale yellow oil, which rapidly solidified on standing, separated out, and was recrystallised from alcohol-pyridine mixture. The phenylhydrazone forms pale yellow clusters, melting at 127° , readily soluble in pyridine, but only slightly soluble in alcohol. The results of analysis show this compound to be a pyridine additive product (Found: C = 78.0; H = 7.0. $C_{26}H_{27}ON_3 \cdot C_5H_5N$ requires C = 78.1; H = 6.7 per cent.). On recrystallising this compound from absolute alcohol, the pyridine is removed. The free phenylhydrazone consists of lemon-yellow prisms melting at 154° . This compound, as well as that obtained from the hydroxy-ketone itself, exhibits an intense greenish-yellow fluorescence in dilute solution (Found: N = 10.7. $C_{26}H_{27}ON_3$ requires N = 10.6 per cent.).

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