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Investigations in the Retene Field

II. The Structure of 3-Hydroxy-9-nitroretene and some of its Derivatives

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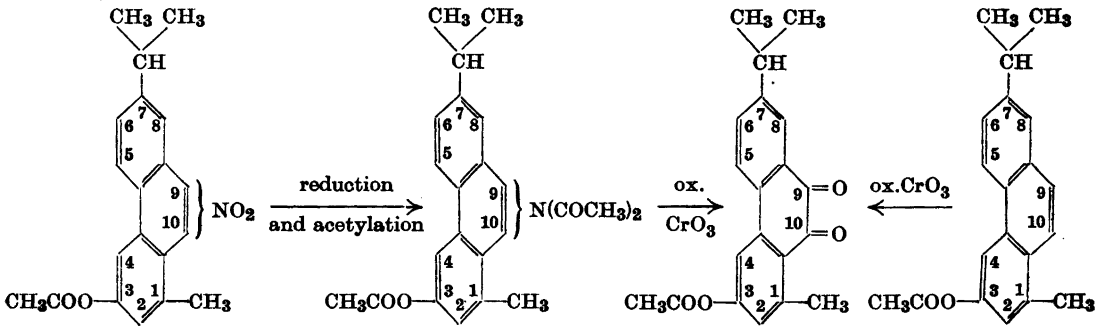
Earlier investigations carried out to throw some light on the reaction between retene and nitric acid, also included some nitrations of retene derivatives [1-3]. In this connection the mononitro-derivatives of the easily obtainable compounds 3-acetoxyretene, 3-hydroxyretene, 3-benzoyloxyretene and 3-ethoxyretene were prepared [2]. Since the structure of these compounds is of interest in the investigation of the nitration products of retene, a determination of their structure will be given here.

Previous investigations have shown that the nitration of 3-acetoxyretene yields, under suitable conditions, a mononitro-3-acetoxyretene. The acetyl-group of this compound is easily split off and the corresponding mononitro-3-hydroxyretene obtained. The latter forms, on benzoylating, the same mononitro-3-benzoyloxyretene which is obtained by nitration of 3-benzoyloxyretene. Thus, the nitro-group occupies the same position in all these derivatives, which are here called x-nitroderivatives. The mononitro-derivative, obtained on mild nitration of 3-ethoxyretene, is named 3-ethoxy-y-nitroretene.

On nitration of retene a few per cent of pure 9-nitroretene can be isolated [4]. Mild nitration of 3-acetaminoretene yields a mixture containing about 60 per cent of 3-acetamino-9-nitroretene and 40 per cent of 3-acetamino-4-nitroretene [5]. Thus, there was some reason to investigate whether the nitro-group might not probably occupy the 9-position in the x- and y-compounds. Oxidation of the derivatives to quinone is a simple method of deciding whether this is the case. A nitro-group in the 9 or 10-position should be eliminated by this reaction. According to experiments reported in the literature, oxidation of the compounds in question does not yield quinones [2]. In the present work,

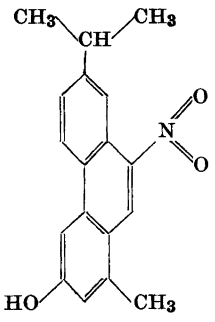
however, it has been found that if the nitro-group is first reduced to an amino-group, a quinone is easily formed on oxidation. The following reactions prove that the nitro-group of 3-acetoxy-x-nitroretene may possibly occupy the 9- or 10-position, since the resulting compound is identical with 3-acetoxyretene-quinone [6]. — To protect the amino-group (if situated in another position than 9 or 10) during the oxidation, the acetylated amine was used. Since the N-diacetyl-compound is easily prepared, it was used in the oxidation experiment.



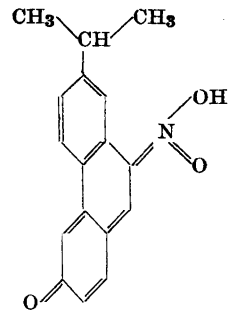
In order to judge between these two possible positions 9 and 10 for the nitro-group, 3-hydroxy-9-nitroretene was prepared from 3-amino-9-nitroretene [3]. This hydroxy-nitroretene is identical with the 3-hydroxy-x-nitroretene, mentioned above, and consequently the nitro-group occupies the 9-position in the latter compound. The benzoyl- and acetyl-derivatives of the two hydroxy-nitroretenes were found to be identical which was only to be expected as the hydroxy-nitroretenes are identical.

On ethylation, 3-hydroxy-9-nitroretene yields an ether which is shown to be identical with the 3-ethoxy-y-nitroretene, obtained on mild nitration of 3-ethoxyretene. Consequently, in this case also the nitro-group occupies the 9-position.

On ethylation — which was carried out in alkaline ethanolic solution — it was observed that the yellow 3-hydroxy-9-nitroretene dissolves in alkalis giving a red colour. The reaction is reversible, for, on acidification, the yellow modification is again obtained. The change of colour may probably be schematically explained in the same way as in other analogous cases by the following structural changes in the molecule.



Neutral and acid solution



Alkaline solution

The reddish-yellow colour of 3-amino-9-nitroretene and 3-amino-4-nitroretene [5] may possibly be explained in a similar way.

It is reported in the literature [7] that reduction of 3-acetoxy-9-nitroretene yields an unstable amine which was isolated as its N-acetyl-derivative. As seen from the description of the synthesis (see the experimental part of the present work), this amine can be prepared by reducing the nitro-compound with $Na_2S_2O_4$ in ethanolic solution. It is obtained as white scales showing no tendency to decompose.

Since there is a possibility that the reduction of 3-acetoxy-9-nitroretene, reported in the literature, yields 3-hydroxy-9-aminoretene (assuming that the acetyl-group was split off during the reduction which was carried out with $SnCl_2$ in a solution containing hydrogen chloride), it was of interest to prepare this hydroxy-aminoretene and investigate its stability. On reducing 3-hydroxy-9-nitroretene with $Na_2S_2O_4$ in ethanolic solution, a white product was obtained which crystallized beautifully as long needles. Analysis of the compound and of its acetyl-derivative showed that 3-hydroxy-9-aminoretene was formed. No decomposition of the compound was observed.

The reported instability of 3-acetoxy-9-aminoretene was therefore probably due to impurities.

The compounds discussed in this paper are listed in Table 1 (p. 147).

EXPERIMENTAL

3-Acetoxy-9-aminoretene

To a boiling solution of 2.0 g of 3-acetoxy-9-nitroretene in 500 ml of ethanol was added in portions over a period of 5 minutes, a solution of 8 g of $Na_2S_2O_4$ in 100 ml of water. The pale yellow solution gradually faded and was at last completely colourless. Inorganic salts are precipitated during the reduction. To the hot reaction mixture 800 ml of water was added. The salts dissolved, and from the clear solution small, white scales

Table 1. Compounds the structure of which are determined in the present work.

(Hydrochlorides and picrates not included).

Name	Formula	M.p. °C *
3-Ethoxy-9-nitroretene	$C_2H_5OC_{18}H_{16}NO_2$	114—114.5
3-Benzoyloxy-9-nitroretene	$C_6H_5COOC_{18}H_{16}NO_2$	145.5—146.5
3-Acetoxy-9-nitroretene	$CH_3COOC_{18}H_{16}NO_2$	197—198
3-Hydroxy-9-nitroretene	$HOC_{18}H_{16}NO_2$	178.5—179
3-Hydroxy-9-aminoretene **	$HOC_{18}H_{16}NH_2$	ca. 230 (decomp.)
3-Acetoxy-9-aminoretene **	$CH_3COOC_{18}H_{16}NH_2$	172—173
3-Acetoxy-9-acetaminoretene	$CH_3COOC_{18}H_{16}NHCOCH_3$	205.5—206.5
3-Acetoxy-9-diacetylaminoretene **	$CH_3COOC_{18}H_{16}N(COCH_3)_2$	186—186.5

began to crystallize. At 0 °C the crystals were filtered off, washed with water and dried. Yield 1.2 g. Recrystallization from ethanol yielded a pure product melting at 172—173 °C.

$C_{20}H_{21}O_2N$	Calc.	C 78.1	H 6.88	N 4.56
	Found	» 78.4	» 6.90	» 4.48

The *hydrochloride* crystallizes as small, white needles when a hot ethanol solution of the amine is diluted with dilute hydrochloric acid and allowed to cool. After washing with ether and drying, the hydrochloride was titrated with 0.1 N sodium hydroxide. Approximate m.p. 235—240 °C (decomp.).

$C_{20}H_{22}O_2NCl$ Calc. HCl 10.6 Found HCl 10.5

The *picrate* was obtained from ethanol as yellow needle-shaped crystals melting at approximately 221 °C (decomp.). The picrate is slightly soluble in ethanol.

$C_{26}H_{24}O_9N_4$	Calc.	C 58.2	H 4.51
	Found	» 58.3	» 4.42

The *N-monoacetyl-derivative* is formed on mild acetylation. The amine was boiled in acetic anhydride for one minute and after decomposition of the anhydride with water, the white reaction product was crystallized from ethanol. 3-Acetoxy-9-acetaminoretene forms small, white, needle-shaped crystals with m.p. 205.5—206.5 °C.

$C_{22}H_{23}O_3N$	Calc.	C 75.6	H 6.65
	Found	» 76.0	» 6.53

* The melting points are approximately corrected.
** Compound not published before.

The *N-diacetyl-derivative* is obtained when the amine is boiled in acetic anhydride for 30 minutes. It crystallizes from propanol as short, white prisms. M.p. 186—186.5 °C.

$C_{24}H_{25}O_4N$	Calc.	C 73.6	H 6.44	N 3.58
	Found	» 73.6	» 6.50	» 3.64

This derivative can also be prepared by boiling 3-hydroxy-9-aminoretene in acetic anhydride for 30 minutes.

3-Acetoxyretenequinone

This compound is usually prepared by oxidation of 3-acetoxyretene [6]. Here it is shown that it can be prepared from N-diacetyl-3-acetoxyretylamine-(9). 0.6 g of the latter compound was suspended in 10 ml of glacial acetic acid, and to this suspension 1.2 g of CrO_3 was added. At the beginning of the reaction the temperature was 40 °C but the heat of the reaction caused it to rise. However it was kept below 70 °C. When the reaction was finished, 5 ml of water was added and the solution allowed to cool. The crystallized quinone, thus obtained, was filtered off and recrystallized from glacial acetic acid. It forms flat, orange-coloured, needle-shaped crystals with m. p. 200—201 °C. Yield 0.2 g. Admixture of 3-acetoxyretenequinone, prepared from 3-acetoxyretene, does not cause any change in the melting point.

$C_{20}H_{18}O_4$	Calc.	C 74.5	H 5.63
	Found	» 74.3	» 5.70

3-Hydroxy-9-nitroretene

2.0 g of 9-nitro-3-retylamine hydrochloride were suspended in a mixture of 180 ml of glacial acetic acid, 30 ml of water and 2 ml of conc. sulphuric acid. The amine was diazotized at 20 °C with a solution of 1 g of $NaNO_2$ in 10 ml of water. To the pale yellow diazonium salt solution 60 ml of dilute sulphuric acid (1 volume of water and 1 volume of conc. sulphuric acid) were added, followed by an excess of urea. The solution was slowly heated to 60 °C and kept at this temperature for three or four hours. After the addition of 100 ml of water, the solution was allowed to cool. The precipitated hydroxy-compound was filtered off washed with water and dried. Yield crude product 1.6 g. Two recrystallizations from glacial acetic acid yielded pure product. M.p. 178.5—179 °C. If the compound is mixed with the nitroretenol which is obtained by splitting off the acetyl-group from nitrated 3-acetoxyretene, no change in the melting point can be observed.

$C_{18}H_{17}O_3N$	Calc.	C 73.2	H 5.80
	Found	» 73.0	» 5.72

3-Acetoxy-9-nitroretene was prepared by boiling the hydroxy-compound in acetic anhydride for 45 minutes. The 3-acetoxy-9-nitroretene thus obtained crystallizes as pale yellow scales with m.p. 197—198 °C.

$C_{20}H_{19}O_4N$	Calc.	C 71.2	H 5.67
	Found	» 70.7	» 5.59

On nitration, 3-acetoxyretene yields a mononitro-derivative with the same melting point 197—198 °C. A mixture of this compound with the 3-acetoxy-9-nitroretene described above melts at 197—198 °C.

3-Benzoyloxy-9-nitroretene was prepared by treating 3-hydroxy-9-nitroretene with benzoyl chloride in pyridine solution. From ethanol, it crystallizes as long, yellow needles with m.p. 145.5—146.5 °C.

$C_{25}H_{21}O_4N$	Calc.	C 75.2	H 5.30
	Found	» 75.0	» 5.30

On nitration, 3-benzoyloxyretene yields a mononitro-3-benzoyloxyretene which after some recrystallizations from ethanol (boiling the ethanol solution with some charcoal is recommended) is quite pure and has the same melting point as 3-benzoyloxy-9-nitroretene. A mixture of the two compounds also melts at 145.5—146.5 °C.

3-Ethoxy-9-nitroretene was prepared in the following way. 0.5 g of 3-hydroxy-9-nitroretene was dissolved in 8 ml of ethanol and a solution of 1 g of KOH in 5 ml of water was added. An intensely red-coloured solution was formed. At 5 °C, 1.5 ml of diethyl sulphate was added and the mixture was stirred at this temperature for ten hours. Gradually the ethyl ether precipitated as a yellow crystalline product and the red colour became weaker. Two recrystallizations from propanol yielded a pure substance, crystallizing as long, thin, yellow needles with m.p. 114—114.5 °C.

$C_{20}H_{21}O_3N$	Calc.	C 74.3	H 6.55
	Found	» 74.3	» 6.56

On mild nitration of 3-ethoxyretene, a mononitro-3-ethoxyretene is formed. Its melting point is the same as that of 3-ethoxy-9-nitroretene. A mixture of these two compounds also gave the melting point 114—114.5 °C.

3-Hydroxy-9-aminoretene

A solution of 15 g of $Na_2S_2O_4$ in 75 ml of water was slowly added with stirring to a solution of 7.5 g of 3-hydroxy-9-nitroretene in 200 ml of dilute ethanol (75 per cent). As the reduction progressed, 3-hydroxy-9-aminoretene precipitated and the reaction mixture was practically decolourized. After the addition of 200 ml of water and cooling to 20 °C, the reaction product was filtered off, washed with water and dried. Yield crude product 6.0 g. After recrystallization from ethanol, 3-hydroxy-9-aminoretene was obtained as long, white, needle-shaped crystals. The compound melts within an interval of some degrees at approximately 230 °C (decomp.).

$C_{18}H_{19}ON$	Calc.	C 81.5	H 7.23	N 5.28
	Found	» 81.6	» 7.18	» 5.24

The *hydrochloride*. To a hot solution of 3-hydroxy-9-aminoretene in ethanol, dilute hydrochloric acid was added. On cooling the hydrochloride was obtained as white needles. It was filtered off, washed with ether and dried at 100 °C for 15 minutes. The amount of HCl was determined by titration with 0.1 N sodium hydroxide.

$C_{18}H_{20}ONCl$ Calc. HCl 12.1 Found HCl 12.2

On heating, the hydrochloride decomposes and shows no definite melting point. The decomposition product melts within an interval of some degrees at approximately 275—280 °C.

The *picrate* crystallized from ethanol solution as yellow scales. Like the hydrochloride it decomposes on heating. When the temperature exceeds 200 °C the picrate turns dark, but does not melt.

$C_{24}H_{22}O_8N_4$	Calc.	C 58.3	H 4.49
	Found	» 58.1	» 4.62

The combustion must be carried out carefully, otherwise the picrate decomposes very rapidly.

SUMMARY

Previously prepared mononitro-derivatives of 3-ethoxyretene, 3-benzoyloxyretene, 3-acetoxyretene and 3-hydroxyretene are shown to have the nitro-group in the 9-position. 3-Hydroxy-9-aminoretene and its acetyl-derivatives have been prepared. 3-Acetoxy-9-aminoretene, reported in the literature as an unstable amine, has been isolated and shows no tendency to decompose.

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