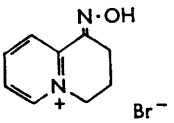
530. *Quinolizines. Part VII.*[1] *Rearrangement Products from 1,2,3,4-Tetrahydro-1-hydroxyiminoquinolizinium Bromides.*

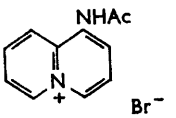
By A. Fozard and Gurnos Jones.

The cyclic amides (III) and (IV) have been synthesised and their hydrolysis products studied in an attempt to identify a Beckmann rearrangement product [2] from the oxime (I). On treatment of the oxime (I) with sulphuric acid at 130° a 1-amino-2-hydroxyquinolizinium salt (XIX) was obtained; its properties and its conversion into 2-hydroxyquinolizinium bromide [1] (XXII) are described.

In a previous publication [2] we reported the Wolff aromatisation of the oxime (I) to give 1-acetamidoquinolizinium salts (II). In one experiment, in which the oxime (I) was boiled with acetic anhydride containing a trace of sulphuric acid, a small quantity of an isomer of



(I)



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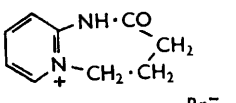

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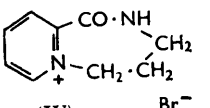


(IV)

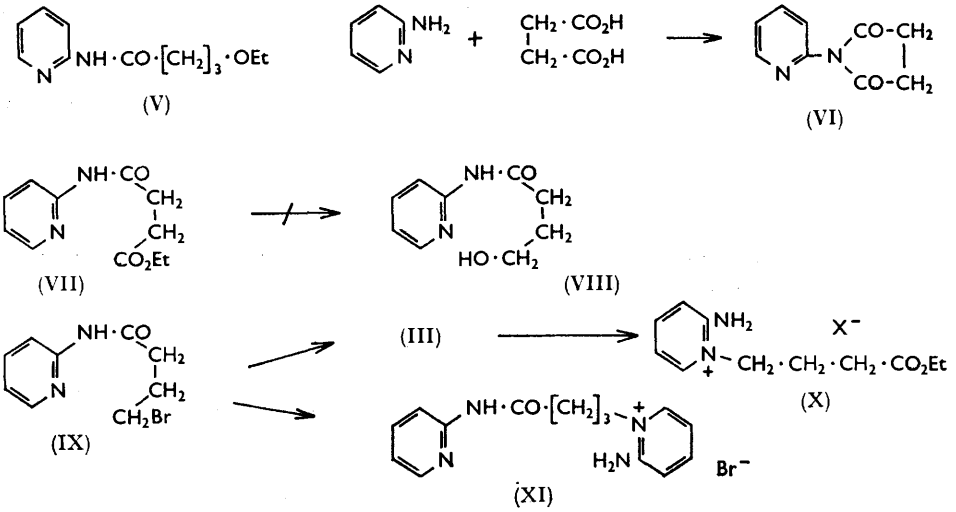
the oxime was obtained, and formulated as the cyclic amide (III) or (IV), formed by Beckmann rearrangement of the oxime. We have been unable to repeat this preparation, all subsequent experiments giving acetamidoquinolizinium salts, such as compound (II), but we record below the synthesis of the amides (III) and (IV).

An earlier attempt to synthesise the amide (III) by cyclisation of the monocyclic amide (V) failed because of the ease of hydrolysis of the amide link under acid conditions.[2] Attempts to obtain the alcohol (VIII) and subsequently convert this into the bromide (IX) were unsuccessful. When 2-aminopyridine was heated with succinic acid the main product was the substituted succinimide (VI); from 2-aminopyridine and ethyl hydrogen succinate the amido-ester (VII) was obtained, but attempts to reduce the ester group with lithium aluminium hydride were unsuccessful, 2-aminopyridine being the main isolated product.

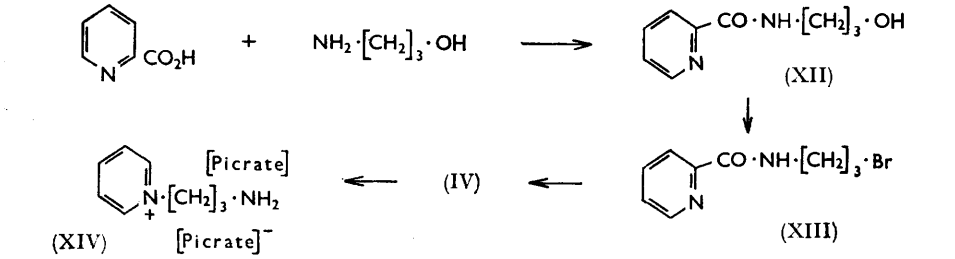
The amide (III) was finally synthesised by treatment of 2-aminopyridine with γ-bromobutyryl bromide, the crude bromo-amide (IX) being cyclised in chloroform. The amide (III) had a similar ultraviolet (u.v.) absorption to that reported [2] for the Beckmann rearrangement product but was higher melting. Hydrolysis of the cyclic amide (III) with ethanolic hydrobromic acid gave the 2-aminopyridinium ester (X), which was synthesised

[1] Part VI, Fozard and Jones, preceding Paper.
[2] Collicut and Jones, *J.*, 1960, 4101.

from 2-aminopyridine and ethyl γ-bromobutyrate. In the reaction between 2-aminopyridine and γ-bromobutyryl bromide the use of an excess of 2-aminopyridine led to the isolation of another quaternary salt; analysis and the infrared (i.r.) absorption spectrum indicated the structure (XI).



Picolinic acid and 3-aminopropan-1-ol gave a good yield of the amido-alcohol (XII). Treatment of the alcohol (XII) with phosphorus tribromide in dry benzene gave the crude bromide (XIII). Cyclisation of this bromide under anhydrous conditions gave the cyclic

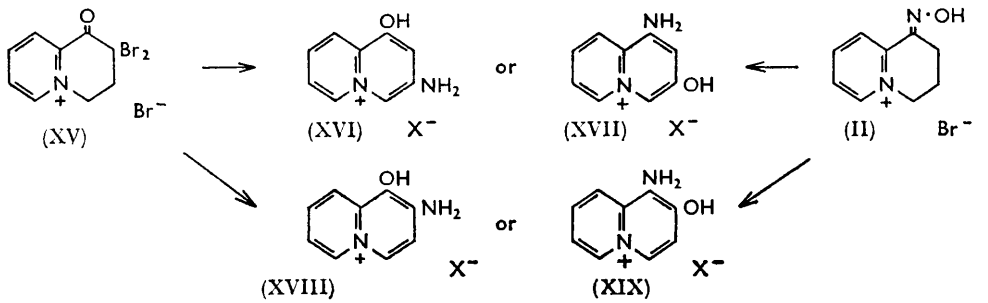


amide (IV), hydrolysed to the decarboxylated 3-aminopropylpyridinium salt, isolated as a dipicrate (XIV). The ultraviolet (u.v.) absorption of the amide (IV) differed considerably from that of the Beckmann rearrangement product of the oxime (I) and though a positive identification was impossible the rearrangement product resembled (III) rather than (IV).[3]

Since the Beckmann rearrangement of the oxime (I) could not be repeated under the conditions previously reported,[2] a number of alternative procedures were tried. Treatment of the oxime (I) with thionyl chloride in liquid sulphur dioxide [4] was unsuccessful, as was sulphuric acid in boiling acetic acid, the oxime being recovered in both cases. When the oxime (I) was heated with polyphosphoric acid at 130° a low yield of an aminoquinolizinium hydrobromide was obtained, shown to be 1-amino-4-hydroxyquinolizinium bromide by comparison with a specimen obtained by a different route. The major product could not be isolated pure but is probably the 1-amino-2-hydroxyquinolizinium salt obtained also in the sulphuric acid rearrangement described below. After treatment

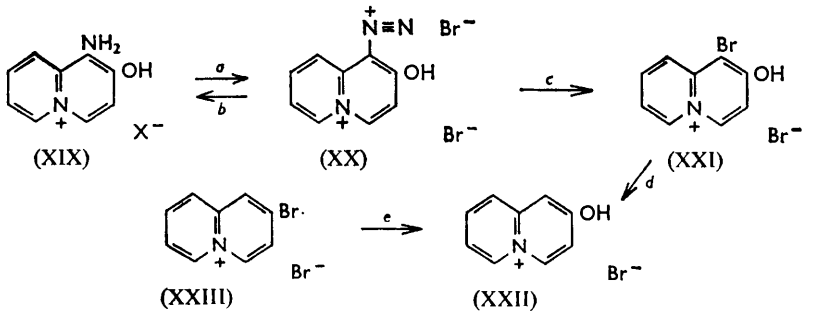
[3] Bauer and Hewitson, *J. Org. Chem.*, 1962, **27**, 3982.
[4] Striegler, *J. prakt. Chem.*, 1961, **15**, 1.

with concentrated sulphuric acid at 80° the oxime was recovered, but at 130° a high yield of an aminohydroxyquinolizinium salt was obtained. Comparison showed the picrate to be identical with that of the aminohydroxyquinolizinium compound previously prepared [5] from the dibromo-ketone (XV). This aminohydroxyquinolizinium salt has been ten-



tatively formulated as (XVI) but the three other structures (XVII), (XVIII), and (XIX) must also be considered. The formation of the aminohydroxy-compound from the oxime (I), presumably by Wolff aromatisation, indicates that the amino-group must be in position 1, thus eliminating structures (XVI) and (XVIII). Further, compound (XVIII) has been prepared by an alternative route and shown to be different from the aminohydroxyquinolizinium salt described here.[6] Although it appeared unlikely that the amine and hydroxyl groups could be adjacent, as there was no evidence of formation of a copper complex when the salt was treated with copper acetate [such as that formed by 1-hydroxy-2-aminoquinolizinium salts (XVIII) [6]] it is shown below that the aminohydroxyquinolizinium salt is correctly represented by structure (XIX).

The aminohydroxyquinolizinium bromide (XIX; X = Br) was readily diazotised in aqueous solution at −8° (unlike 1-aminoquinolizinium salts [2]) giving an insoluble diazonium salt (XX) of unusual stability. The salt showed a strong absorption maximum at 2179 cm.$^{-1}$ (N≡N stretching) and coupled with alkaline 2-naphthol to give a purple azo-compound. No sign of decomposition was observed when the solid diazonium salt was heated at temperatures up to 130°, and little up to 200°. The salt (XX) could be recrystallised from methanol or from water with only slight change in the i.r. spectrum, but was decomposed by 20—30 minutes' boiling in aqueous solution, giving a mixture containing a bromo-



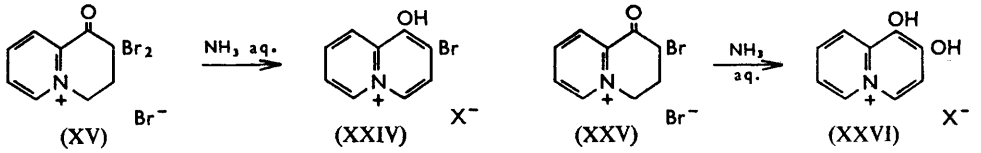
(*a*) $NaNO_2$, aqueous HBr; (*b*) aqueous HI; (*c*) $H{\cdot}CONMe_2$, heat; (*d*) Pd–C, H_2; (*e*) AgOAc,AcOH.

hydroxyquinolizinium salt. Under Gattermann conditions with hydrobromic acid the diazonium salt (XX) reacted exothermically, but gave a similar mixture. When the diazonium salt (XX) was boiled with hydriodic acid a salt of the aminohydroxyquinolizinium compound (XIX) was obtained, presumably by reduction to the hydrazine and

[5] Fozard and Jones, *J.*, 1963, 2203.
[6] Fozard and Jones, unpublished work.

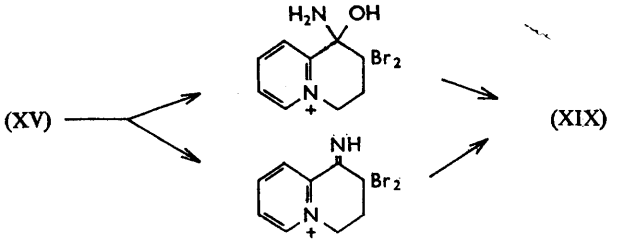
subsequent cleavage of this. When the diazonium salt was heated in dimethylformamide until nitrogen was evolved, the product was an almost pure bromohydroxyquinolizinium bromide, reduced with difficulty to 2-hydroxyquinolizinium bromide (XXII), identical with that obtained after acetolysis of 2-bromoquinolizinium bromide [1] (XXIII). Hence, the bromohydroxyquinolizinium salt can be formulated as (XXI), the diazonium salt must be (XX), and the aminohydroxyquinolizinium salt (XIX). It is noteworthy that when heated in dimethylformamide the diazonium salt undergoes nucleophilic replacement by bromide and not reduction as previously reported.[7]

The mode of formation of 1-amino-2-hydroxyquinolizinium salts (XIX) from the oxime (I) and from the dibromo-ketone (XV) has been investigated to a limited extent. The original suggestion [5] that the dibromo-ketone (XV) was first converted into the 2-bromo-1-hydroxyquinolizinium salt (XXIV) has been proved incorrect since when the bromohydroxy-bromide (XXIV; X = Br) was heated with concentrated ammonia solution the sole isolated product was the bromohydroxyquinolizinium hydroxide (XXIV; X = OH). Another possible intermediate is the 1,2-dihydroxyquinolinium salt (XXV), as dihydroxynaphthalenes are known [8] to be converted into aminohydroxynaphthalenes by the action of concentrated ammonia solution.* However, the monobromo-ketone (XXV), on treatment with hot concentrated ammonia solution gives a 1,2-dihydroxyquinolizinium salt (XXVI) and not an aminohydroxyquinolizinium salt (XIX) so that it appears unlikely that the 1,2-dihydroxyquinolizinium salt is intermediate in the conversion of compound (XV) into the aminohydroxyquinolizinium salt (XIX).



(XV) (XXIV) (XXV) (XXVI)

The most likely route appears to involve previous reaction of the carbonyl group with ammonia to give the hydroxy-amine or derived imine, with subsequent hydrolysis and elimination of the *gem*-dibromo-system.



The second route to 1-amino-2-hydroxyquinolizinium salts from the oxime (I) must involve an initial Wolff aromatisation to give the 1-aminoquinolizinium salt (XXVI) with subsequent insertion in the 2-position of some substituent which is readily converted (for example in the working up process when the crude product is dissolved in water) into a hydroxyl group. When the solution, obtained by treatment with sulphuric acid, from the oxime (I) after being heated at 130° was mixed with dry ether, a hygroscopic solid was obtained; the i.r. absorption of this compound showed maxima at 1155 (SO_4^-) and at

* A small yield of 1,2-dihydroxynaphthalene has been obtained by heating 2,2-dibromo-1-tetralone with aqueous ethanolic ammonia.

[7] Ger. Pat. 901,175 and 905,014 (*Chem. Abs.*, 1955, **49**, 10365; 1956, **50**, 12111).

[8] Friedlander and Rüdt, *Ber.*, **29**, 1609; Kozlov and Veselovskaia, *Zhur. obshchei. Khim.*, 1961, **31**, 3030.

1055 cm.$^{-1}$ (SO_3H?) but analyses could not be obtained, because of the extremely hygroscopic nature of the compound, and its ease of hydrolysis.

Experimental

Melting points were determined on a Kofler block apparatus. Ultraviolet (u.v.) absorption spectra were determined in aqueous solution, unless otherwise stated. Infrared (i.r.) absorption spectra were determined in Nujol mulls.

N-2-*Pyridylsuccinimide* (VI).—A mixture of 2-aminopyridine (4·7 g.) and succinic acid (6·4 g.) was heated under reflux at 200° (oil bath) for 40 min. The mixture was then distilled at 15 mm. to 220° and the residue was crystallised from methanol, giving needles of N-2-pyridylsuccinimide (VI), m. p. 138° (6·45 g., 73%) (lit.,[9] m. p. 137°) (Found: C, 60·85; H, 4·65; N, 15·8. Calc. for $C_9H_8N_2O_2$: C, 61·35; H, 4·55; N, 15·8%); $\lambda_{max.}$ 2580 Å ($\log_{10}\varepsilon$ 3·51); $\nu_{max.}$ 1700 cm.$^{-1}$ (imide CO).

Ethyl N-2-*Pyridylsuccinamate* (VII).—2-Aminopyridine (4·7 g.) and ethyl hydrogen succinate (11·0 g.) were heated at 130° (oil-bath) for 5 hr., cooled, and distilled under reduced pressure. *Ethyl* N-2-*pyridylsuccinamate* had b. p. 95—105°/0·1 mm.; crystallisation from ethanol–ethyl acetate gave needles, m. p. 71·5—72° (8·8 g., 73%) (Found: C, 55·1; H, 6·6; N, 11·8. $C_{11}H_{14}N_2O_3,H_2O$ requires C, 55·0; H, 6·7; N, 11·7%); $\lambda_{max.}$ (95% EtOH) 2330 and 2940 Å ($\log_{10}\varepsilon$ 3·98 and 3·50); $\nu_{max.}$ 1740 (ester CO) and 1685 cm.$^{-1}$ (amide CO).

On heating 2-aminopyridine and ethyl hydrogen succinate above 130°, the main product of reaction was the succinimide (VI).

Attempted Reduction of Ethyl N-2-*Pyridylsuccinamate.*—To a stirred solution of the ester (VII) (5·5 g.) in ether (300 ml.) was added a slurry of lithium aluminium hydride (0·55 g.) in ether (100 ml.) at a rate sufficient to maintain gentle boiling. After the addition the mixture was stirred for 0·5 hr., and then water (30 ml.) was added slowly. The mixture was filtered, and the ether layer dried (Na_2SO_4) and evaporated. The residue was distilled under nitrogen and had b. p. 72°/2·5 mm. The i.r. spectrum and m. p. showed it to be 2-aminopyridine.

γ-Bromobutyryl Bromide.—γ-Bromobutyric acid (10·0 g.) and phosphorus tribromide (10·0 g.) were heated at 130° for 4 hr. After cooling, the liquid was decanted and distilled, giving *γ-bromobutyryl bromide* (10·2 g., 74%), b. p. 104—105°/15 mm.

2-*Oxo*-2,3,4,5-*tetrahydro*-1-H-*pyrido*[1,2-a][1,3]-*diazepinium Bromide* (III).—γ-Bromobutyryl bromide (13·8 g.) was added to 2-aminopyridine (2·8 g.) in an exothermic reaction with copious evolution of hydrogen bromide. After the initial reaction, the mixture was heated on a water-bath for 1 hr., cooled, and basified with saturated aqueous sodium carbonate solution. The alkaline mixture was extracted with chloroform, the extract dried (Na_2SO_4), and the solvent evaporated. The residue (A) was heated at 140° (oil-bath) for 30 min., cooled, and triturated with alcohol, giving the cyclic *amide bromide* (III) (0·48 g., 7·3%) (m. p. 225—228°), recrystallised from ethanol as prisms, m. p. 232—233° (Found: C, 45·05; H, 4·85; N, 11·2. $C_9H_{11}BrN_2O$ requires C, 44·65; H, 4·55; N, 11·55%); $\lambda_{max.}$ 2310 and 2900 Å ($\log_{10}\varepsilon$ 4·02 and 4·04); $\lambda_{max.}$ (95% ethanol) 2360 and 2950 Å ($\log_{10}\varepsilon$ 3·98 and 4·0); $\nu_{max.}$ 1690 cm.$^{-1}$ (lactam CO).

2-*Amino*-1-3′-*ethoxycarbonylpropylpyridinium Picrate* (X).—(*a*) The cyclic amide (III) (0·25 g.) in 50% hydrobromic acid (15 ml.) was boiled for 2 hr., the solution becoming bright red. The solution was evaporated to dryness under reduced pressure, and the residue dissolved in water and again evaporated. Several repetitions of this process with ethanol gave a yellow hygroscopic solid, which was suspended in ethyl acetate and filtered (0·224 g.). A *picrate* (X) was prepared by adding an aqueous solution of the crude solid to saturated sodium picrate solution and crystallised from ethanol as yellow needles, m. p. 147—151° (Found: C, 46·65; H, 4·4. $C_{17}H_{19}N_5O_9$ requires C, 46·65; H, 4·35%); $\lambda_{max.}$ 2320, 3140infl., and 3540 Å ($\log_{10}\varepsilon$ 4·36, 4·03, and 4·20); $\nu_{max.}$ 3450 (NH) and 1715 cm.$^{-1}$ (ester CO).

(*b*) A solution of 2-aminopyridine (1·94 g.) and ethyl γ-bromobutyrate (4·0 g.) in tetramethylene sulphone (5 ml.) was kept at 40° for 5 days. The viscous oil was triturated with ether (50 ml.) and twice with ethyl acetate (50 ml.). The oil was dissolved in water and converted into the picrate (X; X = picrate) (6·79 g., 75%). A sample crystallised from ethanol showed no depression in a mixed m. p. determination with that obtained by method (*a*), and the i.r. absorption spectra were identical.

2-*Amino*-1-(3-2′-*pyridylcarbamoylpropyl*)*pyridinium Bromide* (XI).—2-Aminopyridine (6·0 g.)

[9] Hoey and Lester, *J. Amer. Chem. Soc.*, 1951, **73**, 4473.

and γ-bromobutyryl bromide (9·2 g.) were heated as described in the preparation of the cyclic amide (III). The residue (A) in 95% ethanol was boiled for 15 hr., the ethanol distilled off, and the residue dissolved in the minimum quantity of methanol. After cooling and filtration, crystallisation from ethanol gave rhombs of the *pyridinium bromide* (XI) (1·0 g., 10%), m. p. 216—217° (Found: C, 50·3; H, 5·15; N, 16·3. $C_{14}H_{17}BrN_4O$ requires C, 49·9; H, 5·05; N, 16·6%); $\lambda_{max.}$ 2300, 2750, and 2970 Å ($\log_{10}\varepsilon$ 4·15, 3·93, and 3·86); $\nu_{max.}$ 3300 (NH) and 1660 cm.$^{-1}$ (amide CO).

N-3-*Hydroxypropylpicolinamide* (XII).—3-Aminopropan-1-ol (10·0 g.) and picolinic acid (8 g.) were boiled for 1 hr. Distillation gave the *picolinamide* (XII) (11 g., 92%), b. p. 147—153°/0·1 mm. (Found: C, 60·3; H, 6·75. $C_9H_{12}N_2O_2$ requires C, 60·0; H, 6·7%); $\lambda_{max.}$ 2170 and 2630 Å ($\log_{10}\varepsilon$ 3·99 and 3·73); $\nu_{max.}$ 3390 (H bonded OH), 1665 (amide I), 1527 (amide II), and 1055 cm.$^{-1}$ (CO stretch, primary acyclic alcohol). The *picrate* had m. p. 179° (Found: C, 44·2; H, 3·5; N, 17·35. $C_{15}H_{15}N_5O_9$ requires C, 44·0; H, 3·7; N, 17·1%). The *hydrobromide* crystallised from 95% ethanol as needles, m. p. 187—188° (Found: C, 41·55; H, 5·1; N, 10·9. $C_9H_{13}BrN_2O_2$ requires C, 41·4; H, 5·0; N, 10·7%); $\lambda_{max.}$ 2655 ($\log_{10}\varepsilon$ 3·56) in 95% EtOH; $\nu_{max.}$ 2050 ($^+$NH) * and 1740 cm.$^{-1}$ (CO stretching).

1-*Oxo*-2,3,4,5-*tetrahydro*-1H-*pyrido*[1,2-a][1,4]-*diazepinium Bromide* (IV).—Phosphorus tribromide (2·1 g.) was added to the hydroxy-amide (XII) (3·5 g.) in benzene (30 ml.) with stirring. The mixture was boiled for 4 hr. and cooled, and the benzene evaporated. The residue was treated with a saturated aqueous solution of sodium carbonate, and extracted several times with chloroform. The chloroform extracts were dried (Na_2SO_4) and the chloroform removed. The residue was heated at 130—140° (oil-bath) for 1 hr. and then cooled; a solution in the minimum quantity of ethanol was kept at −5° overnight, giving the *cyclic amide bromide* (IV) as rhombs (from ethanol) (1·03 g., 22%), m. p. 218—219° (Found: C, 41·6; H, 4·85; N, 10·3. $C_9H_{11}BrN_2O,H_2O$ requires C, 41·4; H, 5·0; N, 10·7%); $\lambda_{max.}$ 2780 Å ($\log_{10}\varepsilon$ 3·56) in 95% EtOH; $\nu_{max.}$ 1680 cm.$^{-1}$ (lactam CO). The *picrate* was crystallised from acetone–ethanol, forming micro-needles, m. p. 206·5—209° (Found: C, 45·85; H, 3·5; N, 17·6. $C_{15}H_{13}N_5O_8$ requires C, 46·05; H, 3·35; N, 17·9%).

1-3′-*Aminopropylpyridinium Dipicrate* (XIV).—The amide (IV) (0·45 g.) in 95% ethanol (25 ml.) and 50% aqueous sodium hydroxide (5 drops) was boiled overnight, the solution turning dark red. The mixture was cooled, neutralised with 50% aqueous hydrobromic acid, and evaporated to dryness under reduced pressure. A solution of the residue in alcohol (charcoal) was again evaporated, and the residue dissolved in water; addition of aqueous sodium picrate precipitated a *picrate* (0·230 g.) which formed yellow rhombs, m. p. 206—209°, from acetone (Found: C, 40·8; H, 3·15; N, 19·0. $C_{20}H_{18}N_8O_{14}$ requires: C, 40·4; H, 3·05; N, 18·85%); $\lambda_{max.}$ 2100, 2480, and 3530 Å ($\log_{10}\varepsilon$ 4·47, 4·32, and 4·41).

Attempted Beckmann Rearrangement of 1,2,3,4-*Tetrahydro*-1-*hydroxyiminoquinolizinium Salts*.—(*a*) To the oxime chloride (I; X = Cl) (1·0 g.) in liquid sulphur dioxide (100 ml.) thionyl chloride (3 g.) was added. The sulphur dioxide was allowed to evaporate; the residue was unchanged oxime chloride (I; X = Cl).

(*b*) The oxime bromide (I; X = Br) (1·0 g.) was dissolved in hot glacial acetic acid, 5 drops of concentrated sulphuric acid were added, and the solution was boiled for 4 hr. After evaporation of the acetic acid under reduced pressure, the residue was dissolved in ethanol and percolated through Amberlite IRA 400 (Br), to give the unchanged oxime bromide (I; X = Br).

(*c*) The oxime bromide (1 g.) was heated with polyphosphoric acid (6 g.) for 15 min. at 120—130° (oil-bath). The mixture was cooled and 95% ethanol (100 ml.) was added. An insoluble oil was dissolved in water and percolated through an Amberlite IRA 400 (Br) column. The aqueous eluate was evaporated under reduced pressure and the residue purified from ethyl acetate–ethanol, giving a yellow amorphous powder, m. p. >340° (decomp.) (Found: C, 33·9; H, 3·9; N, 9·05. $C_9H_{10}Br_2N_2O$ requires C, 33·6; H, 3·15; N, 8·65%); $\nu_{max.}$ 1970 ($^+$NH) and 1650 cm.$^{-1}$ (lactam CO?); identical with a specimen of 1-*amino*-4-*hydroxyquinolizinium bromide hydrobromide* obtained by another route.[6]

1-*Amino*-2-*hydroxyquinolizinium Salts* (XIX).—A solution of the oxime bromide (I; X =

* A band in the region around 2000 cm.$^{-1}$ is mentioned,[10] as present in amino-acid hydrochlorides We have found a band of medium intensity in this region in all hydrochlorides and hydrobromides prepared in this and other work.

[10] Randall, Fowler, Fuson, and Dangl, "Infrared Determination of Organic Structures," Van Nostrand, New York, 1949, p. 15 and Table, p. 20.

Br) (2·0 g.) in concentrated sulphuric acid (25 ml.) was heated at 130—140° (oil-bath) for 30 min., cooled, and carefully poured into dry ether (300 ml.) at −10°. The precipitate was dissolved in water, and the solution percolated through Amberlite IRA 400 (Br). Evaporation under reduced pressure gave a yellow solid, a suspension of which in ethanol was filtered (1·46 g., 55%). Recrystallisation from ethanol–ethyl acetate containing a drop of hydrobromic acid gave pale yellow plates of the *hydroxy-amine bromide hydrobromide* (XIX; X = Br, as hydrobromide), m. p. 205—215° (decomp.) (Found: C, 34·35; H, 3·05; N, 9·2. $C_9H_{10}Br_2N_2O$ requires C, 33·6; H, 3·15; N, 8·7%); $\lambda_{max.}$ 3320 and 3610 Å ($\log_{10}\varepsilon$ 3·90 and 3·93); $\nu_{max.}$ 2000 cm.$^{-1}$ ($^+$NH). An aqueous solution of the hydrobromide gave a dark green colour with neutral aqueous ferric chloride. The hydroxy-amine picrate (XIX; X = picrate) crystallised from ethanol as yellow needles, m. p. 215° (Found: C, 45·7; H, 2·35. Calc. for $C_{15}H_{11}N_5O_8$: C, 46·25; H, 2·85%). A mixed m. p. with a sample prepared from the dibromoketone (XV) [5] showed no depression.

2-*Hydroxyquinolizinium*-1-*diazonium Dibromide* (XX).—(*a*) The hydrobromide (XIX; X = Br, as hydrobromide) (1·25 g.) in 25% hydrobromic acid (17 ml.) was cooled to −8°. Excess of aqueous sodium nitrite was added; the mixture was left for 1 hr. and then filtered. The *diazonium salt* (XX) (1·07 g., 83%) showed signs of decomposition above 130°, but melted at 270—272° (Found: N, 12·2. $C_9H_7Br_2N_3O$ requires N, 12·6%); $\nu_{max.}$ 2150, 2179 (N≡N), and 1653 cm.$^{-1}$ (lactam CO); $\lambda_{max.}$ (95% EtOH) 2310, 2480infl., 2780, and 3600 Å ($\log_{10}\varepsilon$ 4·16, 3·99, 3·70, and 3·75).

(*b*) 1-Amino-2-hydroxyquinolizinium hydroxide (XX; X = OH) (0·13 g.), prepared from the dibromo-ketone (XV),[5] was dissolved in 25% hydrobromic acid and treated as above. The diazonium salt (0·173 g., 71%) was identical in spectra and in m. p. with that prepared as in (*a*).

Action of Hydriodic Acid on the Diazonium Salt (XX).—The diazonium salt (XX) (0·62 g.) was dissolved in 55% hydriodic acid (20 ml.), and the solution boiled for 1·5 hr. Evaporation to dryness and treatment of the residue with ethanol–ethyl acetate gave an orange solid (0·1 g.). This solid had a spectrum identical with that of 1-amino-2-hydroxyquinolizinium bromide hydrobromide (XIX; X = Br, as hydrobromide) but differed in m. p., and is assumed to be the hydriodide.

1-*Bromo*-2-*hydroxyquinolizinium Bromide* (XXI).—The diazonium compound (XX) (0·775 g.) was dissolved in dry redistilled dimethylformamide (10 ml.) and heated to 130° (oil-bath), nitrogen being evolved. When this was complete the solution was cooled and evaporated under reduced pressure. The residue was suspended in a small amount of ethanol and filtered (0·40 g., 56%). Crystallisation from ethanol gave the bromohydroxy-bromide (XXI), m. p. 266—272°, identical in i.r. absorption spectrum with the compound obtained from 1-amino-2-hydroxyquinolizinium hydroxide [5] and from 2-hydroxyquinolizinium bromide.[1]

Reduction of 1-*Bromo*-2-*hydroxyquinolizinium Bromide* (XXI).—The bromide (XXI) (0·47 g.) in 95% ethanol (100 ml.) was hydrogenated at atmospheric pressure with 10% palladium–charcoal (0·25 g.). Uptake of hydrogen was slow, but approximately 1 mole of hydrogen was absorbed. The mixture was filtered and the filtrate evaporated. The residue was separated by fractional crystallisation from ethanol, the less-soluble fraction being unchanged bromohydroxy-bromide (XXI). The more-soluble product was 2-hydroxyquinolizinium bromide (XXII), showing no depression in a mixed m. p. determination with a sample prepared from 2-bromoquinolizinium bromide.[1] The i.r. and u.v. spectra of the two samples were identical (Found: C, 44·35; H, 3·8; N, 5·2. Calc. for C_9H_8BrNO,H_2O: C, 44·3; H, 4·15; N, 5·75%).

Reaction of 2-*Bromo*-1-*hydroxyquinolizinium Bromide* (XXIV; X = Br) *with Ammonia*.—Ammonia solution (5 ml.; s.g. 0·88) was added to a solution of the bromohydroxy-bromide (XXIV; X = Br) (0·75 g.) in water (2 ml.). The mixture was heated on a water-bath for 30 min. and cooled. The yellow solid was crystallised from acetone to give yellow needles of 2-*bromo*-1-*hydroxyquinolizinium hydroxide* (XXIV; X = OH) (0·49 g., 83%), m. p. 220·5—221° (Found: C, 45·1; H, 3·3; N, 5·75. $C_9H_8BrNO_2$ requires C, 44·65; H, 3·3; N, 5·8%); $\lambda_{max.}$ 2160 and 3800 Å ($\log_{10}\varepsilon$ 4·47 and 4·06).

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