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Chemical Reactions of β-Aminoketones

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The advances in the field of the chemical reactions of β-aminoketones during the period 1970-1980 are described and arranged systematically. The question of the deamination and deaminomethylation of β-aminoketones is discussed; the possibility of alkylating various nucleophiles by β-aminoketones is demonstrated and the mechanism of the alkylation reaction is discussed. In addition, data are presented on the cyclisation, reduction, and photochemistry of β-aminoketones and the applications of the latter are described.
The bibliography includes 158 references.

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I. INTRODUCTION

The literature for 1970–1980 on the synthesis of β-aminoketones were surveyed in a previous review.[1] During the period 1960–1970, another review article was devoted to the same topic.[2] Data on the aminoacid analogues of β-aminoketones were first surveyed in another communication by the present authors.[3]

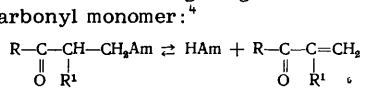
The high reactivity and also the ready availability of β-aminoketones have long attracted the attention of chemists throughout the world. Various aminoalcohols, heterocycles, αβ-unsaturated ketones, and other compounds are synthesised from them.

This paper presents a systematic account of the advances during the last decade in the field of the chemical reactions of β-aminoketones. The question of the deamination and deaminomethylation of β-aminoketones is examined. In addition, the possibility of alkylating various nucleophiles by β-aminoketones is demonstrated and the mechanism of the alkylation reaction is discussed. Data on the synthesis of secondary and tertiary γ-aminoalcohols from the corresponding β-aminoketones either by the reduction of the latter or by their interaction with organometallic compounds are surveyed. The photochemical reactions of β-aminoketones and other reactions are described.

Extensive experimental data concerning the chemical reactions of β-aminoketones have accumulated during the last decade. The β-aminoketone molecule contains two functional groups: the carbonyl and amino-groups, and the chemical reactions described below are mainly associated with these groups.

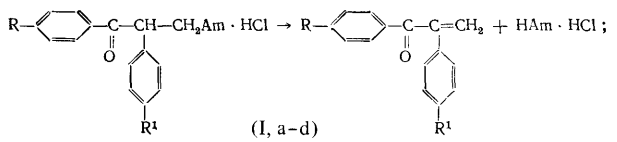
II. DEAMINATION

One of the characteristic properties of β-aminoketones is their αβ-deamination reaction, giving an amine and an unsaturated carbonyl monomer:[4]



The synthesis of carbonyl monomers from Mannich bases is based on the fact that the latter contain a mobile hydrogen atom in the α-position and tend to eliminate the amine residue. The elimination reaction has been discussed previously in a number of communications.[5-7]

The problem of the stability of β-aminoketones is particularly important for the search for new medicinal drugs. In view of this, a number of workers[8-12] investigated the kinetics of the elimination reactions of the hydrochlorides of substituted propiophenones (I, a-d) as a function of the size of the alkoxy-group, the character of the amino-group, the pH of the medium, and temperature.



(I, a-d)

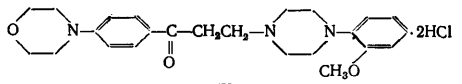
(a) Am=NC_5H_{10}, NC_4H_8, R=H, HO, CH_3O, ..., $C_7H_{15}O$, iso-C_9H_7O, iso-$C_5H_{11}O$, R^1=H;
(b) Am=NC_4H_8O, R=H, HO, CH_3O, ..., $C_5H_{11}O$, iso-$C_6H_{11}O$, R^1=H;
(c) Am=NC_4H_8, R=H, R^1=CH_3O, ..., $C_5H_{11}O$, iso-C_9H_7O, iso-C_4H_9O, iso-$C_5H_{11}O$;
(d) Am=NC_5H_{10}, NC_4H_8O, R=H, R^1=CH_3O.

On the basis of the results, Gevorgyan et al.[9] concluded that the replacement of the hydrogen atom in the *p*-position in the benzene ring by the methoxy-group, as in compound (Ia, Am = NC_4H_8; R = CH_3O; R^1 = H), reduces the rate of elimination. However, it has been noted that, on further increase in the length of the alkyl group, as in compounds (Ia, Am = NC_4H_8; R = CH_3O, ..., $C_7H_{15}O$; R^1 = H), the influence of the latter diminishes, which entails an increase of the rate of elimination. An analogous behaviour has been observed also after the introduction of the propoxy-group in the *p*-position in the benzene ring at the α-carbon atom, as in compound (Ic, R = H, R^1 = C_3H_7O).[11]

It has been established that[8,9] the rate of elimination increases with increase of temperature and the pH of the medium. The rate of elimination is appreciably influenced also by the basicity of the amino-group.[8] Thus it has been shown in relation to the hydrochlorides of β-amino-α-phenyl-4-butoxypropiophenones (I, a and b) that derivatives of

piperidine (with the basicity constant $K_b = 1.6 \times 10^{-3}$) are much more stable than those of morpholine ($K_b = 2.44 \times 10^{-6}$). The pyrrolidine derivatives occupy an intermediate position in terms of their stability ($K_b = 1.3 \times 10^{-3}$).

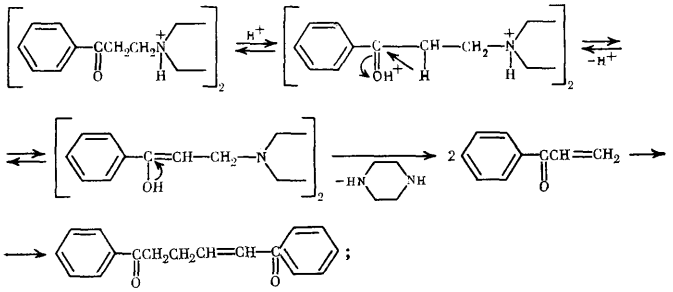
The kinetics of the elimination reaction of the dihydrochloride of 3-(4-*o*-methoxyphenyl-1-piperazinyl)-4-morpholinopropiophenone (II) have been investigated in the pH range 1–10.[13]



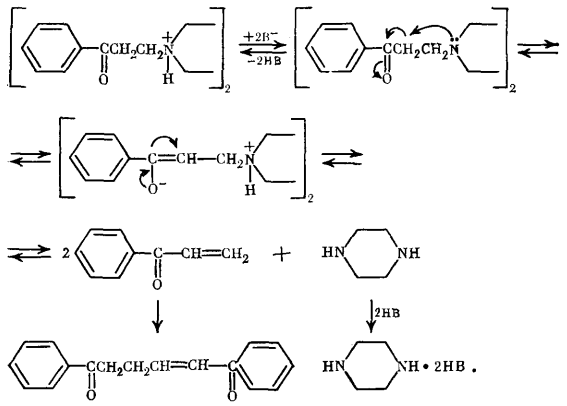
(II)

It was established that the elimination is reversible and that the degree of reaction depends on the pH. The reaction does not lead to equilibrium, since it is accompanied by a series of consecutive-parallel stages such as deaminomethylation, hydration, and dimerisation. In highly acid media the elimination reaction of the protonated form of the Mannich base (II) is an acid-catalysed process. A study has also been made[14–16] of the kinetics of the elimination reaction of the dihydrochloride of 1,4-bis(β-benzoylethyl)piperazine (III) as a function of the nature of the solvent, the pH, the ionic strength of the medium, and the buffer concentration. It has been established that compound (III) exhibits the highest stability at pH 4.5, while at pH 5.1 the main process is the elimination of the amine; at pH 6.0 a cleavage-addition process takes place. Two mechanisms have been proposed for the elimination reaction at pH < 3.5 and pH > 3.5:

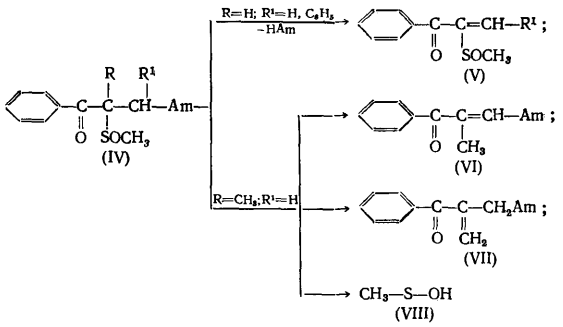
(1) at pH < 3.5:



(2) at pH > 3.5:



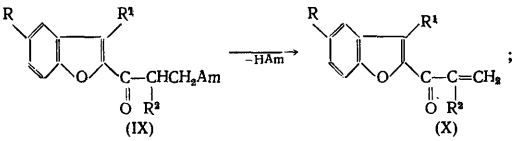
Depending on whether there are substituents in the α- and β-positions, the β-amino-α-methanesulphinylpropiophenones (IV) undergo the elimination reaction in different ways: compounds (IV) with R = R^1 = H decompose at room temperature, while those with R = H and $R^1 = C_6H_5$ distil at t = 180 °C under a pressure of 10^{-2} mmHg with formation of the vinyl ketone (V) and an amine. On the other hand, distillation of the aminoketone (IV, R = CH_3; R^1 = H) gives rise to a mixture of the products (VI), (VII), and (VIII)[17,18] whose structures have been established by physicochemical methods of analysis.



(a) R=H, CH_3; R^1=H; Am=N(CH_3)$_2$, N(C_2H_5)$_2$, NC_4H_8, NC_5H_{10}; (b) R=H; R^1=C_6H_5; Am=N(CH_3)$_2$, NC_4H_8, NC_5H_{10}.

Other studies on the synthesis of vinyl ketones from β-aminoketones have also been carried out.[19–23]

According to the data of Faure and Mattioda,[24] the deamination of 3-amino-1-(substituted 2'-benzofuryl)-1-propanones (IX) by one of four methods (pyrolysis, heating in an aqueous alkaline medium, steam distillation, and treatment of the quaternary ammonium slats in an aqueous alkaline medium) leads to the vinyl ketones (X).

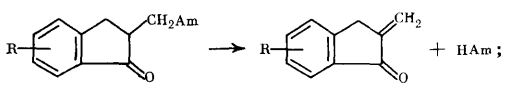


(IX) (X)

R=R^1=R^2=H, Am=N(CH_3)$_2$, NC_5H_{10};
R=Cl, Br, CH_3O, R^1=R^2=H,
Am=N(CH_3)$_2$, N(C_2H_5)$_2$, NC_5H_{10};
R=H, R^1=R^2=CH_3, Am=N(CH_3)$_2$;
R=H, CH_3O, R^1=CH_3, R^2=C_2H_5, Am=N(CH_3)$_2$.

Owing to their instability, the latter can be isolated in a pure form only when there are alkyl substituents in the 3-position at the α-carbon atom relative to the carbonyl group.

The possibility of the polarographic monitoring of the decomposition reaction of the β-aminoketone has been demonstrated in relation to 2-piperidinomethyl-5-propyl- and 6-ethyl-2-morpholinomethyl-1-indanones (XI). The elimination reaction was carried out in aqueous solution at pH 7 and 37 °C.[25]

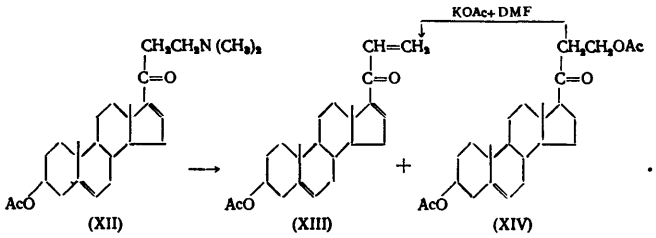


(XI)

Am=N(CH_3)$_2$, NC_4H_9, NC_5H_{10}; R=CH_3, ..., C_3H_7, iso-C_3H_7, CH_3O; Am=NC_4H_8O; R=CH_3, ..., C_3H_7, iso-C_3H_7, CH_3O, Cl, Br.

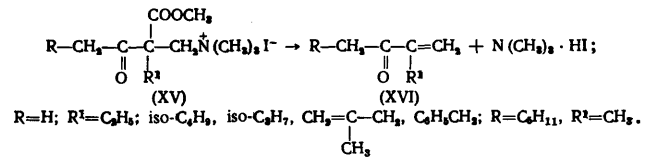
A mixture of acetic acid and acetic anhydride was used to elininate dimethylamine from 3β-hydroxy-21-dimethylaminomethylpregna-5,6-dien-20-one (XII).[26] However, the main reaction product was not the required 3-acetate of 3β-hydroxy-21-homopregna-5,16,21-trien-20-one (XIII) but

the 3,21-diacetate of 3β,21a-dihydroxy-21-homopregna-5,16-dien-20-one (XIV):

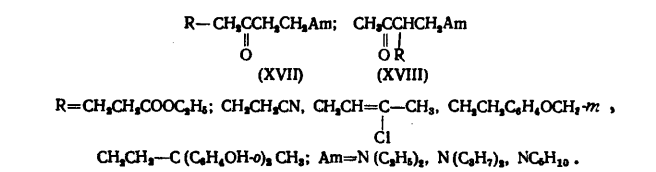


The attempts to eliminate the amine from compound (XII) by treatment with toluenesulphonic acid or phlorizil [phlorizin? (Ed. of Trans.)] were unsuccessful and led merely to an insignificant yield of compound (XIII). A solution to the problem was found by employing potassium acetate and dimethylformamide (DMF). The yield of compound (XIII) was then 65% of theoretical.

Aliphatic aminoketones also undergo the elimination reaction.[27-31] Thus a convenient method of synthesis of the vinyl ketones (XVI) in DMF at 75 °C in the course of 48 h was developed on the basis of the quaternary salts of the β-aminoketones (XV):[27]

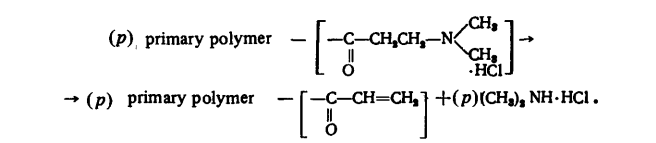


When a mixture of the isomeric aminoketones (XVII) and (XVIII) is heated at 60–120 °C, only compound (XVIII) undergoes the elimination reaction, while compound (XVII) is entirely stable under these conditions:[28]

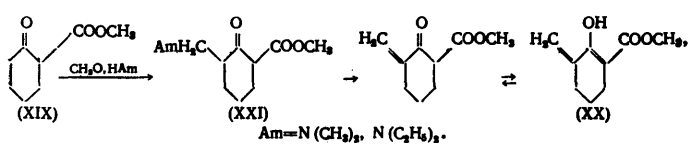


A method has been proposed for the determination of 1-diethylamino-3-butanone in the synthesis of methyl vinyl ketone.[29]

An example of the formation of a vinyl ketone also from a β-aminoketone containing a polymeric fragment has been described:[30]

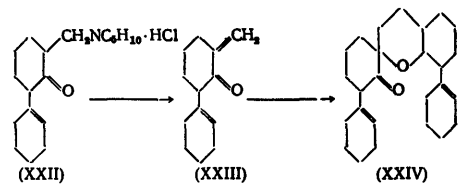


The aminomethylation of 2-methoxycarbonyl-1-cyclohexanone (XIX) by reaction with paraformaldehyde and dialkylamines in dioxan at 80 °C in the course of 8 h leads to the enolic form of 2-methoxycarbonyl-6-methylene-1-cyclohexanone (XX) with a yield of 37%:[32]



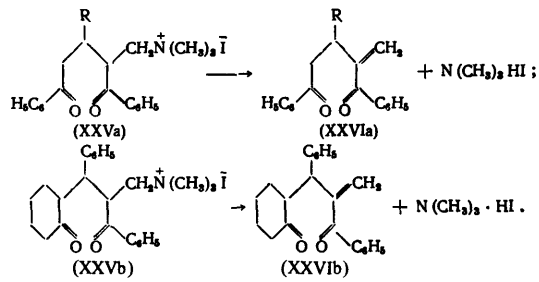
The authors explained the formation of compound (XX) by the initial appearance of 2-dialkylaminomethyl-2-methoxycarbonyl-1-cyclohexanone (XXI) followed by the elimination of the amine.

The pyrolysis of the hydrochloride of 6-cyclohex-1^1-enyl-2-piperidinomethyl-1-cyclohexanone (XXIII) at 230–250 °C for 30 min leads to a 52.6% yield of 6-cyclohex-1^1-enyl-2-methylene-1-cyclohexanone (XXIII), which subsequently dimerises to spiro-[(3-cyclohexenyl-2-oxocyclohexano)-1,2^1-(8^1-cyclohexenyl-3^1,4^1,5^1,6^1,7^1,8^1-hexahydrochroman)] (XXIV):[33]

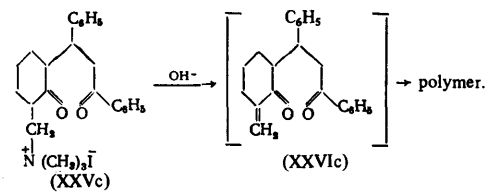


The elimination reaction involving β-aminoketones has also been described in other communications.[34-36]

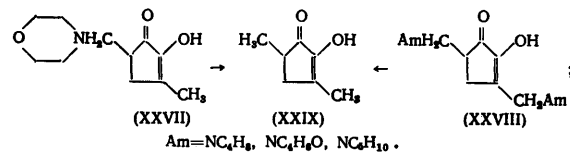
It has been shown[37-42] that the aminomethyl derivatives of diketones also tend to eliminate the amine. Thus the methiodides of dimethylaminomethyldiketones (XXV, a–c) give rise to quantitative yields of the substituted vinyldiketones (XXVI, a–c) in the presence of sodium carbonate either at room temperature or on heating (to 60–70 °C) in DMF:



In the case of the aminodiketone (XXVc) the deamination should have produced the vinyldiketone (XXVIc), but the latter readily polymerises even at room temperature to give a hardening gelatin-like product:[39]



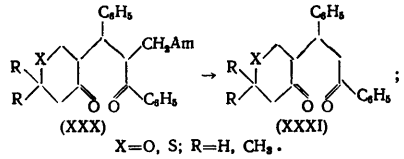
When 2-hydroxy-3-methyl-5-morpholinomethylcyclopent-2-en-1-one (XXVII) or 3,5-bisaminomethyl-2-hydroxycyclopent-2-en-1-one (XXVIII) is heated in acetic acid in the presence of zinc at 70–80 °C, 2-hydroxy-3,5-dimethylcyclopent-2-en-1-one (XXIX) is formed:[43,44]



III. DEAMINOMETHYLATION

It is of interest to note that, when the hydrochlorides of the aminomethyl derivatives of the diketone (XXX) are refluxed in water or ethanol, deaminomethylation and not

deamination is observed, i.e. the initial diketones (XXXI) are obtained in quantitative yields:[40,42]

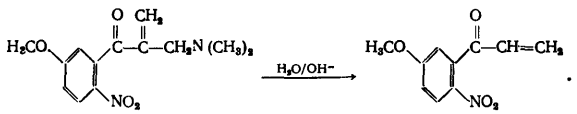


(XXX) (XXXI)

X=O, S; R=H, CH_3.

This fact accounts for the finding that the aminomethylation of the diketones (XXX) in ethanol hardly occurs.

An instance of deaminomethylation in a system where deamination is impossible for structural reasons has been described:[45]



As can be seen from the foregoing, the thermal stabilities of β-aminoketones are various: some of them undergo the elimination reaction at room temperature[17,18,36,37] but the majority undergo this reaction at an elevated temperature.[21,24,26,28,29,31,32,35-41] In a series of cases the elimination reaction is promoted by an acid medium[13-16,26] whereas in others an alkaline medium favours the reaction.[13,26,37]

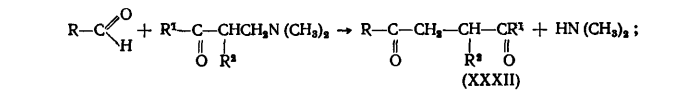
IV. ALKYLATION BY β-AMINOKETONES

Various nucleophiles ($-\rangle$ CH, $\rangle$ NH, -SH, $\rangle$ PH, -OH)

are readily alkylated by β-aminoketones. The reaction can proceed in two directions and in their treatment of the mechanism of the alkylation reaction all investigators start with the hypothesis of the initial elimination of the amine and the formation of the corresponding vinyl derivative. The subsequent interaction is regarded as one with the activated double bond formed.

(a) C-Alkylation

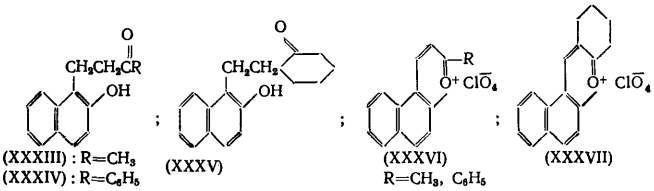
Aromatic and heterocyclic aldehydes interact with β-aminoketones in the presence of sodium cyanide or 3-ethyl-5-(2-hydroxyethyl)-4-methylthiazolidinium bromide as the catalyst with formation of the corresponding 1,4-diketones (XXXII):[46]



(XXXII)

R=CH_3, C_6H_5, 2-thienyl, 3-pyridyl, $CH_3(CH_3)_2C$—, $(CH_3)_2C{=}CH$—; R^1=CH_3, C_6H_5, $(CH_3)_3C$—, —$CH{=}C(CH_3)_2$, —$C(CH_3){=}CH$—CH_3, 1-cyclopent-1-enyl, or 1-cyclohex-1-enyl; R^2=H, CH_3, C_6H_5.

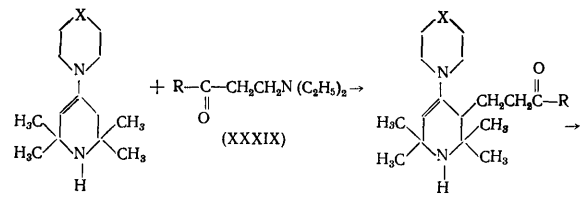
The alkylation of 2-naphthol by the β-aminoketones synthesised from acetone, acetophenone, or cyclohexanone yielded the alkyl(aryl) β-(2-hydroxy-1-naphthyl)ethyl ketones (XXXIII)–(XXXV), which were subsequently converted into the pyrylium salts (XXXVI) and (XXXVII).[47]



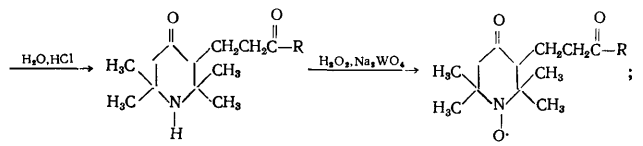
(XXXIII): R=CH_3
(XXXIV): R=C_6H_5
(XXXV)
(XXXVI)
R=CH_3, C_6H_5
(XXXVII)

The authors were able to alkylate only the 2-naphthol. Resorcinol does not react with β-diethylaminopropiophenone, while the interaction with 4-diethylamine-2-butanone gives rise to high-molecular-weight compounds. Phenol cannot be alkylated by β-aminoketones even in the presence of sodium hydroxide and sodium ethoxide.

Alkylation of the enamines (XXXVIII) by the β-aminoketones (XXXIX) afforded 3-(2-acylethyl-2,2,6,6-tetramethyl-4-oxopiperidines (XL), which were converted into the corresponding nitroxy-radicals (XLI) by oxidation with the H_2O_2–Na_2WO_4 mixture in accordance with the scheme[48]



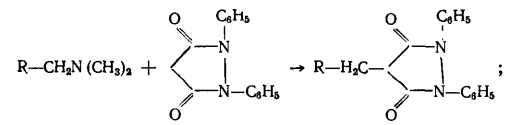
(XXXVIII) (XXXIX)



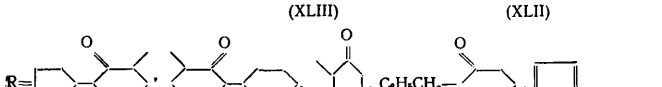
(XL) (XLI)

X=O, CH_2, R=C_6H_5, p-$CH_3OC_6H_4$, $C_6H_5CH{=}CH_2$.

New 4-substituted pyrazolidines (XLII) have been obtained by alkylating the sodium salt of 3,4-dihydroxy-1,2-diphenylpyrazolidine (XLIII) with β-aminoketones:[49]

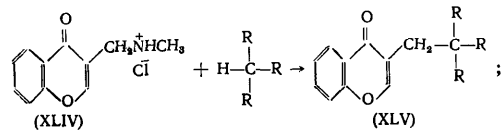


(XLIII) (XLII)

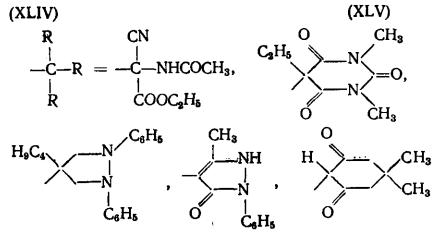


$C_2H_5OCO(CH_2)_2COCH_2$—, $HOOC(CH_2)_2COCH_2$—.

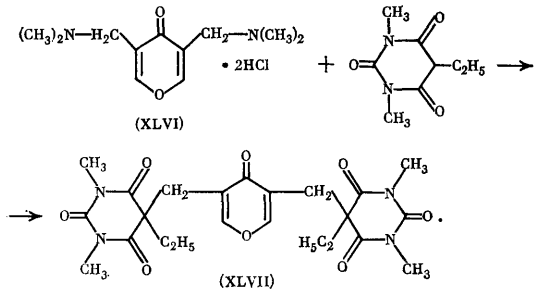
3-Substituted chromones (XLV) have been obtained by the alkylation of various CH-acid components with 3-dimethylaminomethylchromone (XLIV):[50]



(XLIV) (XLV)



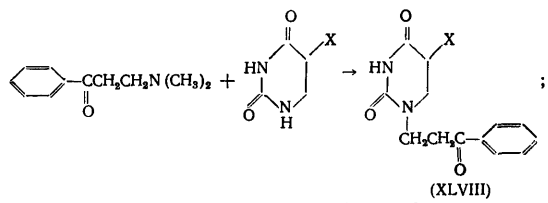
The bisaminomethyl derivatives of ketones have also been used as alkylating agents. Thus the reaction of bis-*NN'*-dimethylaminomethylpyrone (XLVI) with 5-ethyl-1,5-dimethylbarbituric acid gives rise to 3,5-bis(5-ethyl-1,3-dimethyl-2,4,6-trioxotetrahydropyrimidinomethyl)-4-pyrone (XLVII):[51]



(XLVI) (XLVII)

(b) *N*-Alkylation

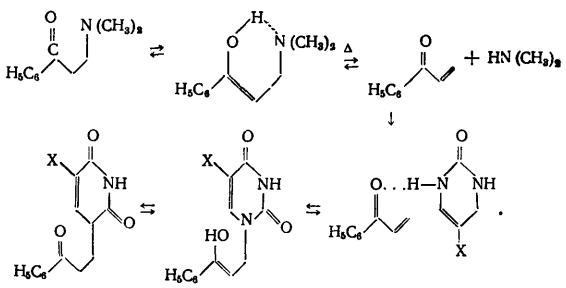
β-Aminoketones interact with 5-alkyl- and 5-halogenouracils to form the corresponding *N*-1-substituted uracils (XLVIII):[19,52]



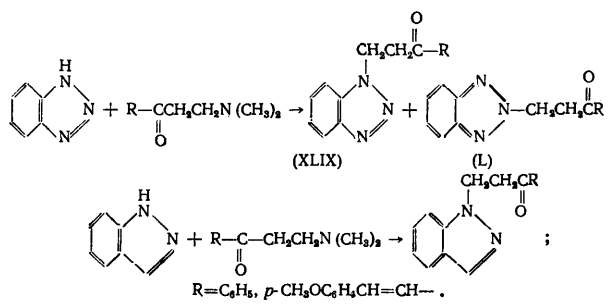
(XLVIII)

X=H, CH_3, C_2H_5, C_3H_7, Br, F.

The possible mechanisms of the alkylation of uracils have been discussed:



Tertiary β-aminoketones have been used as alkylating agents for benzotriazole and indazole:[53,54]

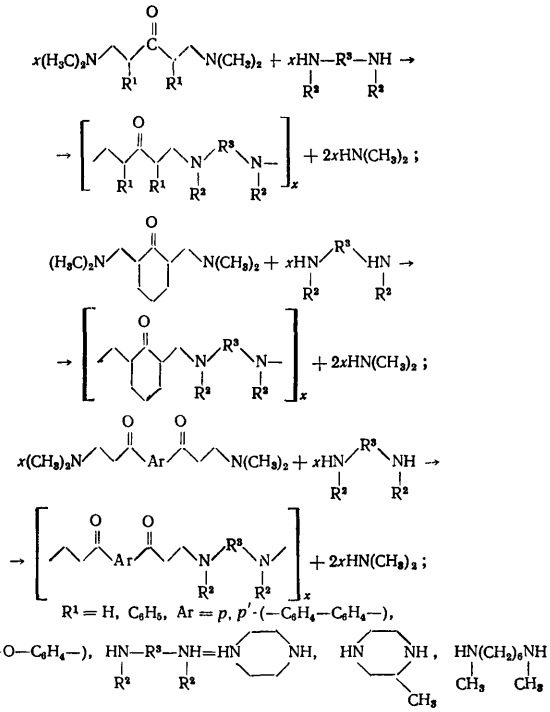


(XLIX) (L)

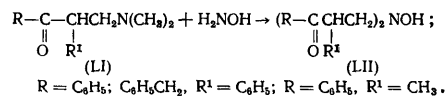
R=C_6H_5, *p*-$CH_3OC_6H_4CH{=}CH{-}$.

The alkylation of benzotriazole yields both the 1- and 2-substituted derivatives (XLIX) and (L).[53]

The polycondensation reaction of bisdialkylaminoketones and their methiodides with bis(secondary amines) has been described:[55,56]



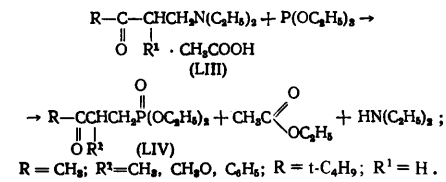
The stereochemistry of the resulting polymers has been investigated and a stereochemical comparison of the initial monomers has been carried out.[55,56] A number of studies have been made of the alkylation of morpholine, piperazine, dibenzylamine, and *p*-chloroaniline.[57-59] Treatment of the Mannich bases (LI) with hydroxylamine leads to the formation of compound (LII):



When R^1 = H or CH_3 and R = CH_3, the usual oximes are formed.[60]

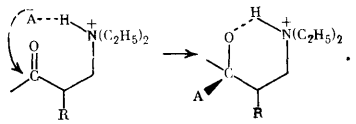
(c) *P*- and *As*-Alkylation

The ability of β-aminoketones to interact with nucleophiles extends also to phosphorous esters.[61,62] In their study of the kinetics of the condensation of trialkyl phosphites with the β-aminoketones (LIII), Ivanov and co-workers[63,64] concluded that a necessary condition for the interaction is the conversion of the nitrogen into the ammonium form. They selected alkyl halides, hydrochloric acid, acetic acid, water, phenol, etc. as the salt forming agents:

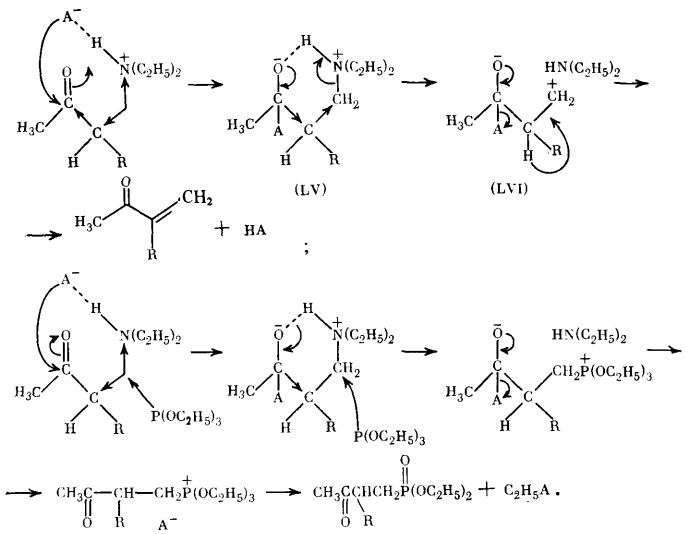


R = CH_3; R^2=CH_3, CH_3O, C_6H_5; R = t-C_4H_9; R^1 = H.

As stated above, the amino-group is substituted via an elimination-addition mechanism, but the experimental data obtained in the above studies[63,64] conflict with this scheme. In all cases, on interaction with trialkyl phosphites, the β-aminoketones give rise solely to esters of ketophosphonic acids (LIV). Analysis of the results enabled the authors to conclude that the nature of the activating influence of the carbonyl group is as follows:[64]

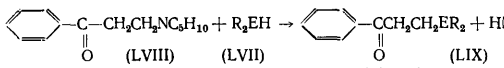


β-Aminoketones are typical ambident electrophiles and have two reaction centres with a reduced electron density: the α-carbon atom and the carbonyl carbon atom. In addition, two nucleophiles are involved in the reaction: the acid anion and triethyl phosphite. The nucleophilicity of the anion is greater than that of the phosphite and one can therefore postulate that the first reaction step is the addition of the acid anion to the carbonyl group with formation of the intermediate (LV) via the mechanism



Subsequent refinement of the reaction mechanism showed that the elimination proceeds via the intermediate (VLI) and that the stage involving the transition from compound (LV) to (LVI) should proceed at a lower rate than the stage in which compound (LV) is formed. The substitution reaction takes place via the solvation of the C(1) carbon atom by triethyl phosphite. The latter gives up its unshared electron pair in the course of the dissociation of the C–N bond to be used to form the C–P bond. The authors concluded that solvation plays a major role in accelerating the decomposition of Mannich bases.

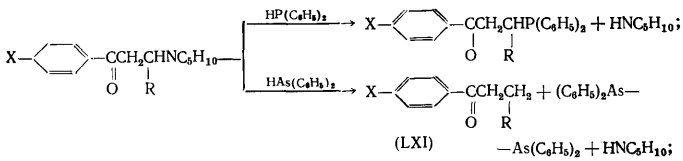
The reactions of β-aminoketones with secondary arsines and phosphines have also been investigated.[65,66] When secondary phosphines and arsines (LVII) interact with β-piperidinopropiophenone (LVIII) the corresponding phosphines and arsines (LIX) are formed smoothly in 80% yield:



E = P, As, R = C_6H_5, cyclohexyl.

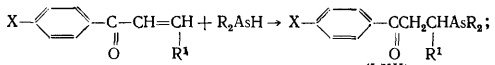
A quantitative comparison of the rates of formation of different phosphines and arsines has shown that phosphines react in ethanol faster than arsines and that the nucleophilicity of the compounds and steric factors and not the acidity of the compounds evidently play a decisive role.

The interaction of the *p*- and α-substituted β-aminoketones (LX) with diphenylphosphine and diphenylarsine leads to the formation of various products. In the latter case the hydride transfer reaction takes place, as shown by the formation of the ketone (LXI) and tetraphenyldiarsine:



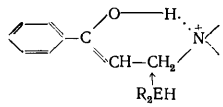
X=Br, Cl, CH_3O, R=H; X=H, R=CH_3, C_6H_5.

The ketoarsines (LXII) can be obtained by the addition of secondary arsines to unsaturated ketones:[65,66]



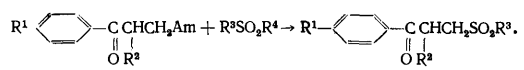
X=H, Br, CH_3O; R = C_4H_9, C_6H_5; R^1=C_6H_5, CH_3.

On this basis, the authors conclude that the alkylation evidently proceeds via a nucleophilic substitution reaction and not via vinyl ketones. They believe that a cyclic transition state of the Mannich base is formed, in which a positive charge is located at the α-carbon atom, which facilitates nucleophilic substitution.



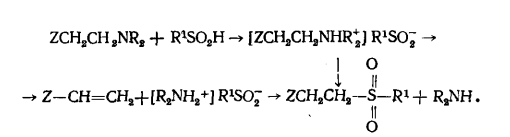
(d) *S*-Alkylation

The β-aminoketones (LXIII) react with sulphinic acids or their sodium salts to form the sulphoketones (LXIV)[67–72] (Table 1):

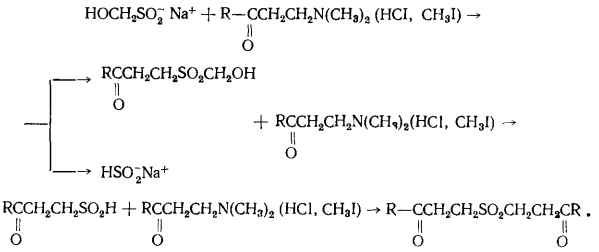


(LXIII) (LXIV)

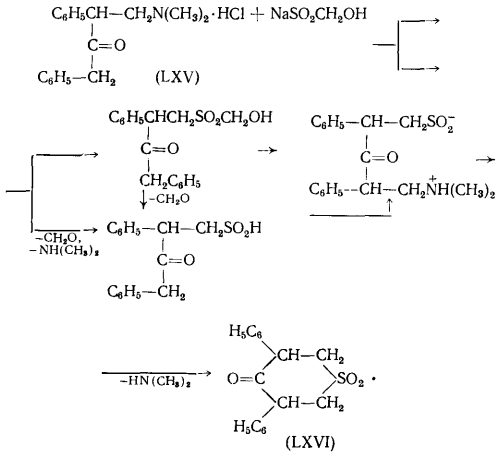
It is believed[67] that the reaction mechanism is as follows:



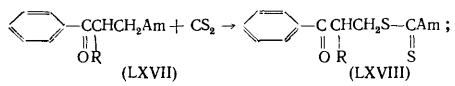
Symmetrical dialkyl sulphones have been obtained in accordance with the following scheme:[68]



The β-aminoketone (LXV) has been converted into 3,5-diphenyltetrahydrothiopyran-4-one 1,1-dioxide (LXVI):[70]

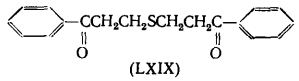


The reaction of the β-aminoketones (LXVII) with carbon disulphide leads to the formation of the substituted dithiourethanes (LXVIII):[73]



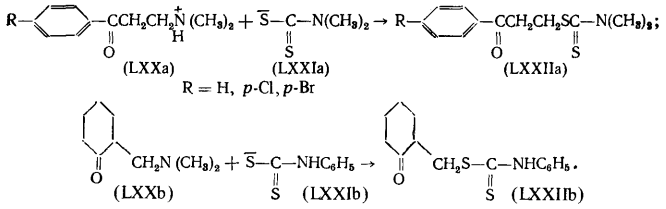
R=H, C_6H_5; Am=NC_4H_8O, NC_6H_{10}.

The same β-aminopropiophenones react with carbon disulphide in aqueous ammonia to form di(2-benzoylethyl) sulphide (LXIX):[74]



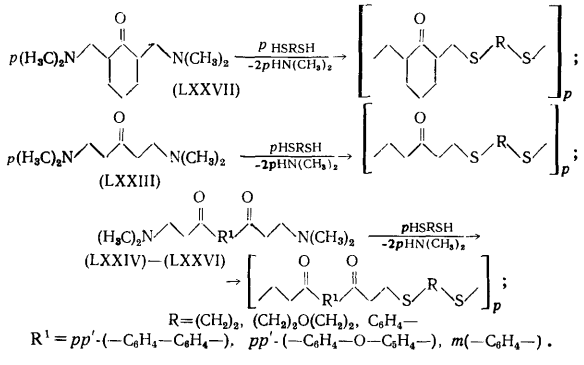
(LXIX)

The interaction of the Mannich bases (LXX, a and b) with the dithiocarbamates (LXXI, a and b) results in the elimination of the amine from the aminoketone molecule and the formation of *S*-(2-acetyl)dithiocarbamates (LXXIII, a and b):[74]



R = H, *p*-Cl, *p*-Br

The bis-Mannich bases (LXXIII)–(LXXVII), obtained from acetone, 4,4-diacetylbiphenyl, di(4-acetylphenyl) ether, 1,3-diacetylbenzene, and cyclohexanone, have been introduced into the polycondensation reaction with ethane-1,2-dithiol, oxydiethanedithiol, and 1,3-dimercaptobenzene. The reaction products are the corresponding poly(β-ketothioethers) (LXXVIII, a–d):[75,76]

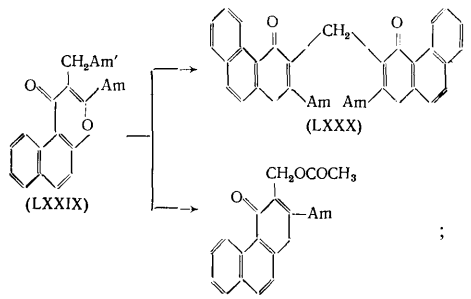


R=$(CH_2)_2$, $(CH_2)_2O(CH_2)_2$, C_6H_4—

R^1 = *pp'*-(—C_6H_4—C_6H_4—), *pp'*-(—C_6H_4—O—C_6H_4—), *m*(—C_6H_4—).

(e) *O*-Alkylation

On heating in acetic anhydride at 95°–100 °C for 3–6 h, 3-dialkylamino-2-dialkylaminomethyl-1-oxo-1*H*-naphtho-[2,1-*c*]pyrans (LXXIX) are converted into 2,2'-methylenebis-{3-dialkylamino-1-oxo-1*H*-naphtho[2,1-*c*]pyrans} (LXXX) in satisfactory yields:[77]



(LXXIX) (LXXX) (LXXXI)

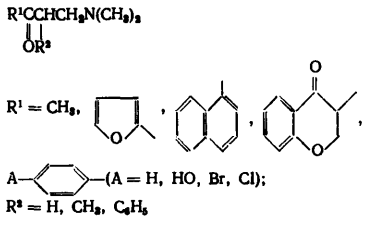
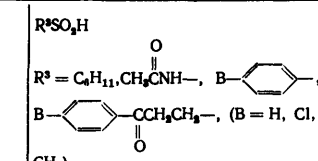
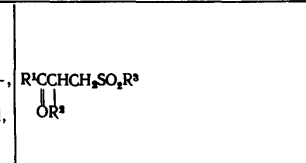
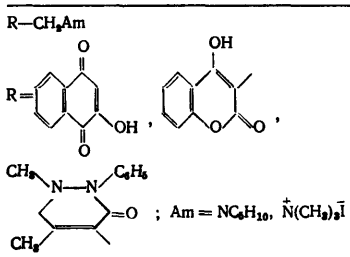
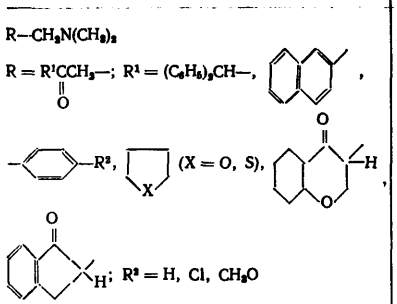
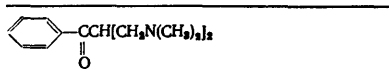
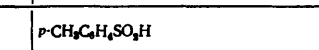
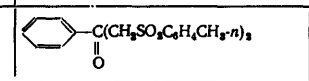
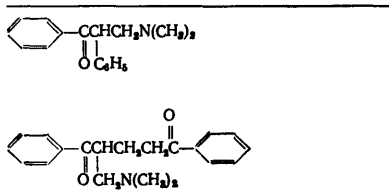
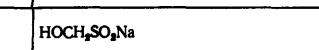
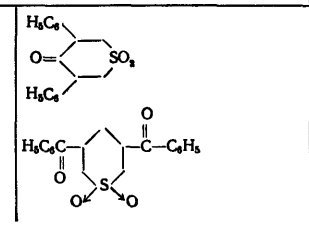
Am=$N(CH_3)_2$, $N(C_2H_5)_2$, NC_4H_8, NC_5H_{10}, $N(CH_3)(CH_2C_6H_5)$, $N(iso\text{-}C_3H_7)_2$, $N(CH_2—CH=CH_2)_2$; Am'=NC_4H_8O, NC_5H_{10}.

When Am = Am' = NC_5H_{10}, the *O*-alkylation product, namely 2-acetoxymethyl-1-oxo-3-(*N*-piperidyl)-1*H*-naphtho-[1,2-*c*]pyran (LXXXI), is obtained in 34% yield together with compound (LXXX).

V. CYCLISATION

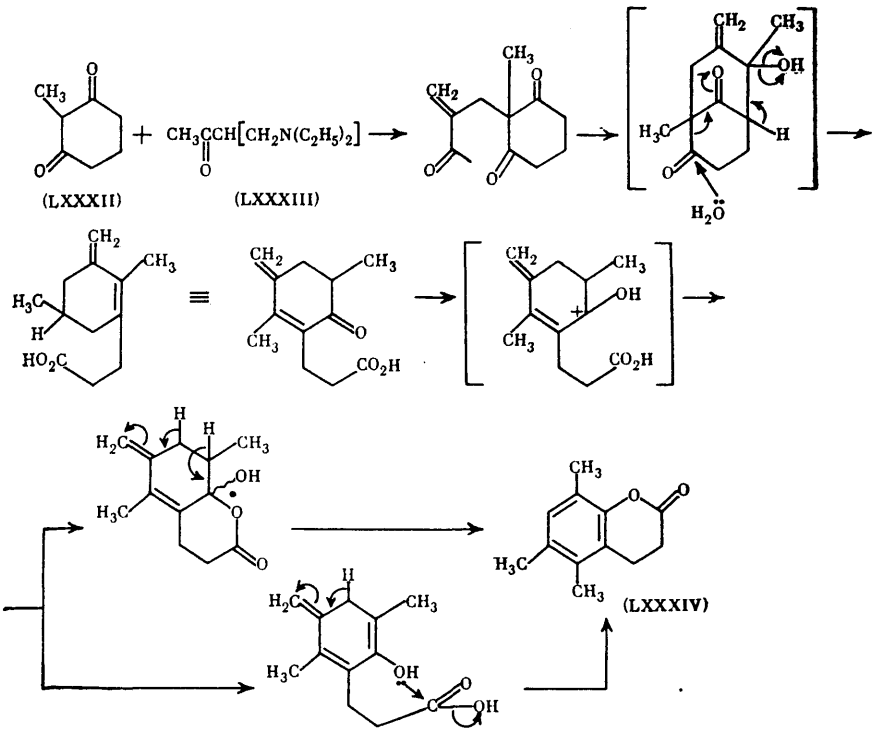
It is known that Mannich bases (β-aminoketones) can serve as intermediates in the synthesis of various heterocyclic compounds via cyclisation reactions. The latter can be

Table 1. *S*-Alkylation.

Alkylating compound (Mannich base)	Alkylated compound	Reaction product	Yield, %	Refs.
			16—83	[67, 71, 72]
			57—79	[67]
			19—57	[69]
			53.0	[68]
			14.0 32.0	[70]

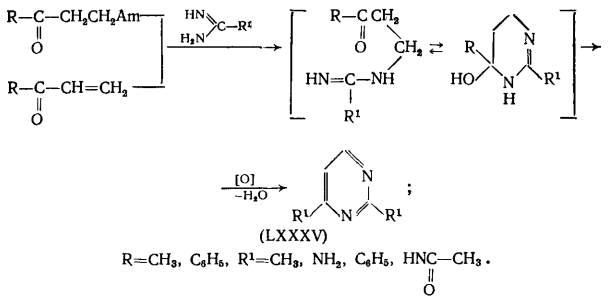
divided into two types: (1) reactions occurring with elimination of the amino-group; (2) reactions occurring without the elimination of the amino-group.

In most cases cyclisation with participation of β-amino-ketones is of the first type. In particular, when equimolar amounts of 2-methylcyclohexane-1,3-dione (LXXXII), *N*-bis-diethylaminomethylacetone (LXXXIII), and pyridine are refluxed in benzene, the dihydrocoumarin (LXXXIV) is obtained in 60% yield.[78] The ethyl analogue of compound (LXXXII) reacts analogously to the latter:



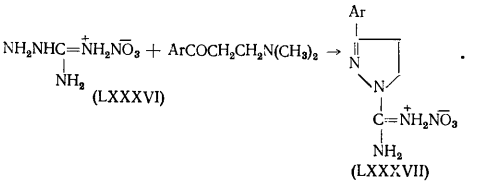
It is of interest to note that a bicyclic ketone is formed under the same conditions from 2-methylcyclopentane-1,3-dione, but its structure has not been stated.[78]

The interaction of the keto-derivatives of Mannich bases with amidines and guanidine leads to the pyrimidines (LXXXV).[79] The yield of the latter is then significantly higher than in the analogous condensation using the corresponding vinyl ketones:



The quaternary slats of β-aminoketones have also been used in this reaction, but this does not increase the yield of the corresponding pyrimidines.

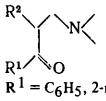
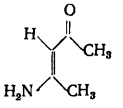
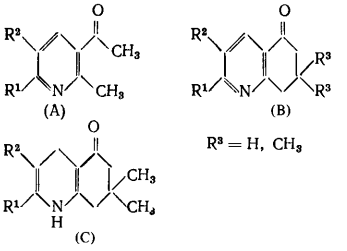
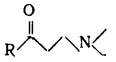
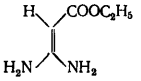
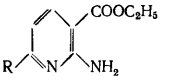
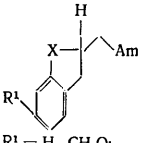
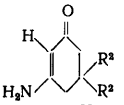
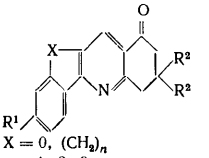
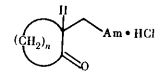
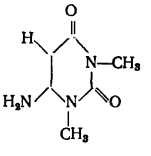
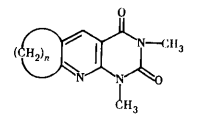
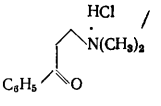
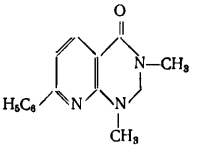
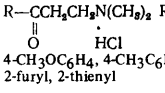
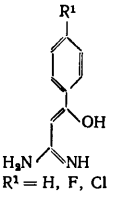
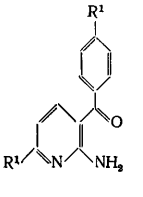
Aminoguanidinium nitrate (LXXXVI) reacts with arylaminoketones in alcoholic solutions at pH 10 to form 1-amidino-Δ^2-pyrazolines (LXXXVII):[80]



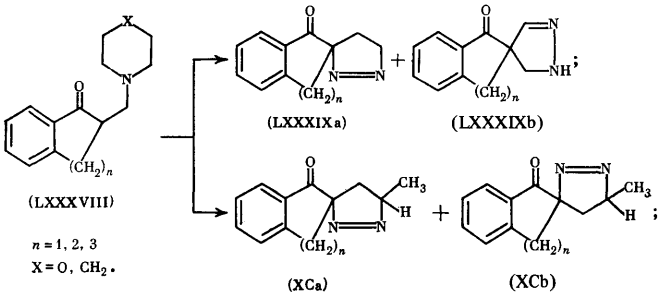
The mechanism of the formation of the pyrazoline (LXXXVII) proposed by the authors includes the conversion of the aminoketone into the vinyl ketone and its subsequent conversion into a hydrazone, which cyclises to the pyrazoline. The authors demonstrated that, depending on the pH of the medium, the reaction products can also be di-β-ketohydrazines and the dinitrates of amidinohydrazones.

2-(*N*-Aminomethyl)cycloalkanones (LXXXVIII) have been converted into the diastereoisomeric spiro-pyrazolines (LXXXIX, a and b) and (XC, a and b) with the aid of an ethereal solution of diazomethane or diazoethane.[81] The

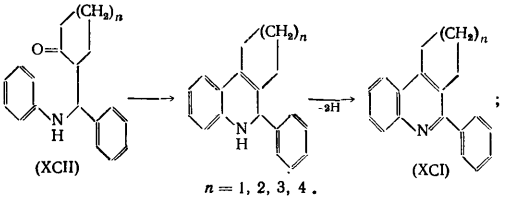
Table 2. The synthesis of heterocycles from β-aminoketones.

Initial compound		Reaction product	Yield, %	Refs.
 $R^1 = C_6H_5$, 2-naphthyl, $R^2 = H, CH_3, C_6H_5$		 (A) (B) (C) $R^3 = H, CH_3$	42—57 (A), 21—54 (B), 43—62 (C)	[83]
 $R = CH_3, C_6H_5, 4\text{-}ClC_6H_4, 4\text{-}CH_3OC_6H_4$, 2-furyl, 2-thienyl			43—56	[85]
 $R^1 = H, CH_3O$; $Am = N(CH_3)_2, NC_5H_{10}$	 $R^2 = H, CH_2$	 $X = O, (CH_2)_n$ $n = 1, 2, 3$	29—47	[84]
 $Am = N(CH_3)_2, NC_5H_{10}$			32—53	[86]
	ditto		36—57	[87]
 4-$CH_3OC_6H_4$, 4-$CH_3C_6H_4$, 2-naphthyl, 2-furyl, 2-thienyl	 $R^1 = H, F, Cl$		23—69	[88]

authors proposed a probable reaction mechanism:

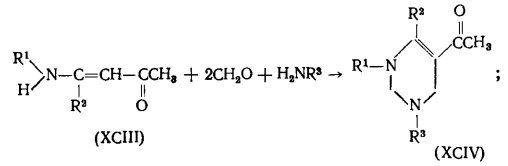


Substituted quinolines (XCI) have been obtained by the cyclisation of 2-(1-anilinomethyl-1-phenyl)cycloalkanones (XCII) by refluxing the latter with a 9 : 1 mixture of acetic and sulphuric acids:[82]



The synthesis of certain heterocyclic systems from various β-aminoketones has been described[83-88] (Table 2).

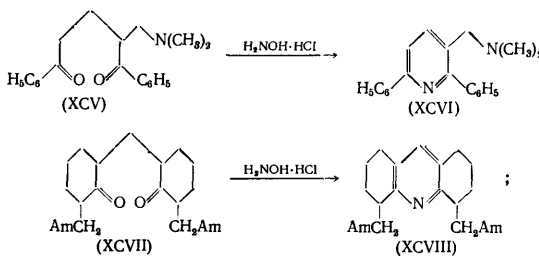
Under the conditions of the Mannich reaction with one mole of a primary amine and two moles of formaldehyde, the enaminoketones (XCIII) cyclise to the tetrahydropyrimidino-derivatives (XCIV):[89,90]



(XCIII) (XCIV)

R^1=CH_3, C_6H_5, $CH_2C_6H_5$, R^2 = H, CH_3, R^3=CH_3, $C(CH_3)_3$.

The interactions of β-aminoketones with hydroxylamine hydrochloride, formaldehyde, and other compounds are reactions of the second type.[91-95] Thus 1,3-dibenzoyl-3-dimethylaminomethylpropane (XCV) has been converted into 3-dimethylaminomethyl-2,6-diphenylpyridine (XCVI) with the aid of hydroxylamine hydrochloride, while bis(3-diamino-methyl-2-oxo-1-cyclohexyl)methane (XCVII) has been converted into 4,5-bis(aminomethyl)-*sym*-octahydroacridine (XCVIII):[91-93]

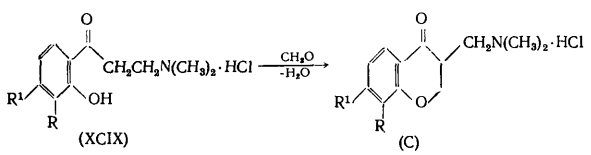


(XCV) (XCVI)

(XCVII) (XCVIII)

Am=$N(CH_3)_2$, $N(C_2H_5)_2$.

Substituted chromanones (C) have been obtained by cyclising the β-aminoketones (XCIX) with formaldehyde:[94]

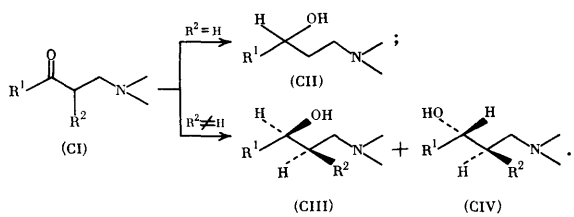


(XCIX) (C)

R, R^1 = H, CH_3O,

VI. REDUCTION

The carbonyl group of β-aminoketones can be readily converted into the hydroxy-group by reducing agents such as complex metal hydrides (lithium tetrahydroaluminate and sodium tetrahydroborate)[53,54,96-117] (Table 3), sodium amalgam,[118] and others.[106-111,119] The reduction products (γ-aminoalcohols) are of interest as biologically active substances:[97,100-102,120]

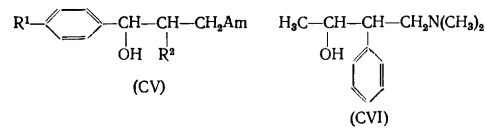


(CI) (CII) (CIII) (CIV)

It can be seen from the above scheme that the reduction of the aminoketones (CI, R^2 = H) leads to the formation of only one aminoalcohol (CII),† while the reduction of the amino-ketones (CII, $R^2 \neq$ H) having an α-asymmetric centre gives rise to two diastereoisomeric aminoalcohols (CIII) and CIV).#

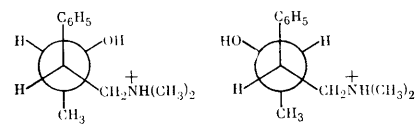
The absolute and relative configurations as well as the predominant conformations of the diastereoisomeric amino-alcohols have been determined by infrared and NMR spectroscopy and by mass-spectrometry.[98,100,105-114]

The aminoalcohols (CV) and (CVI) have been resolved into the diastereoisomers by fractional crystallisation.[98,100,112]



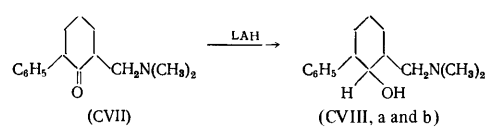
(CV) (CVI)

It has been shown[98] that the conformers (CVIa) and (CVIb) of compound (CVI) predominate.



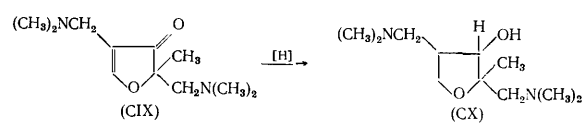
(CVIa) (*threo*) (CVIb) (*erythro*)

The reduction of the β-aminoketone (CVII), which is a derivative of phenylcyclohexanone, leads to a mixture of the stereoisomeric aminoalcohols (CVIIIa) and (CVIIIb), which has been resolved[114] into its components on a chromatographic column to give (CVIa) : (CVIb) = 3 : 1:



(CVII) (CVIII, a and b)

Whereas the reduction of 2,4-bisdimethylaminomethyl-2-methylfuran-3(2*H*)-one (CIX) with the aid of palladium on charcoal involves only the double bond, when rhodium on charcoal or sodium tetrahydroborate is used, the aminoalcohol (CX) is formed:[119]

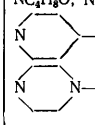
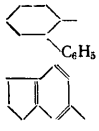
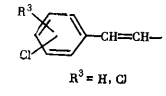


(CIX) (CX)

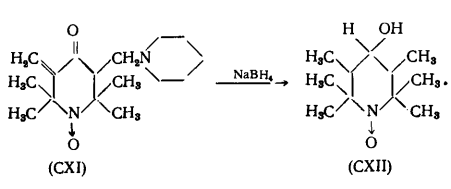
†A case is known in which achiral β-dialkylaminopropio-phenones were reduced to the optically active aminoalcohols by treatment with lithium tetrahydroaluminate/(−)-menthol.[121]

#The stereochemistry of the reduction of the β-asymmetric β-aminoketones has been described.[122,123] In particular, the reaction between lithium tetrahydroaluminate and a series of β-asymmetric β-aminoketones has been investigated.[123] It has been shown that the stereoselectivity of the reduction of *NN*-dialkylamino-derivatives is greater than that of the reduction of *N*-monoalkylamino-derivatives.

Table 3. Products of the reduction of β-aminoketones.

R^1	R^2	Am	Reducing agent	Yield, %	Biological activity	Refs.
		$p\text{-}R^1\text{—}C_6H_4CH(OH)\text{—}CH(R^2)\text{—}CH_2Am$				
H, F, CH_3	n-C_3H_7 n-C_4H_9	NC_4H_8O, NC_6H_{10}, NC_6H_{12}, 	LAH $NaBH_4$	52—77	spasmolytic, neurotropic, analgesic	[100, 102]
H, CH_3O——CH=CH—	H		$NaBH_4$	80—98	—	[53, 54]
$C_6H_5CH_2O$	CH_3		ditto	58	anticough, analgesic	[101]
F, CH_3, iso-C_3H_7, CH_3O, C_2H_5O, 2,4-$(CH_3)_2$, CH_3SO_2, 3,4-$(CH_3O)_2$, CH_3SO	H, CH_3	$N(CH_3)_2$, $N(C_2H_5)_2$, NC_4H_8, NC_5H_{10}, NC_6H_8O, NC_6H_{12}, 	LAH, $NaBH_4$	71—95	bacteriacidal, fungicidal	[96, 104]
—A A = H, CH_3O, Cl OH, NO_2	H, CH_3 C_6H_5	$N(CH_3)_2$, $N(C_2H_5)_2$, NC_5H_{10}, NC_4H_8O $N(CH_3)CH_2C_6H_5$	LAH	71—93	analgesic	[112]
		$R^1\text{—}CH(OH)\text{—}CH(R^2)\text{—}CH_2Am$				
	CH_3		$NaBH_4$	50	anticough, analgesic	[101]
CH_3	C_6H_5	$(NCH_3)_2$	LAH			[98]
$(C_6H_5)_2C\text{—}R^3$ R^3 = H, OH, CH_3O	CH_3	$HNCH_3$, HNC_2H_5, $N(CH_3)_2$, NC_6H_{10}	LAH $NaBH_4$	30—78	anticonvulsant, effect on CNS	[97]
 C_6H_5, $C_6H_5CH_2CH_2$,	H	$N(CH_3)_2$, NC_6H_{10}, HN—;  $R^3 = CH_3$, $CH_2C_6H_5$, CH_2CH_2OH,  A = H, CH_3, F, Cl, CH_3O	LAH $NaBH_4$	32—99	sedative	[103, 117]
 R^3 = H, Cl	$(CH_2)_4CH_3$	$N(CH_3)_2$	$NaBH_4$	32—38	—	[105]

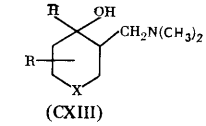
The αβ-unsaturated ketone (CXI) has been reduced to the 2,2,3,5,6,6-hexamethyl-4-hydroxypiperidin-1-yloxy-radical (CXII) with sodium tetrahydroborate:[124]



(CXI) (CXII)

Deamination takes place simultaneously.

A number of studies have been devoted to the stereochemical characteristics of the reduction of the aminomethyl derivatives of tetrahydropyran-4-ones and tetrahydrothiopyran-4-ones to the aminoalcohols (CXIII).[106-111]

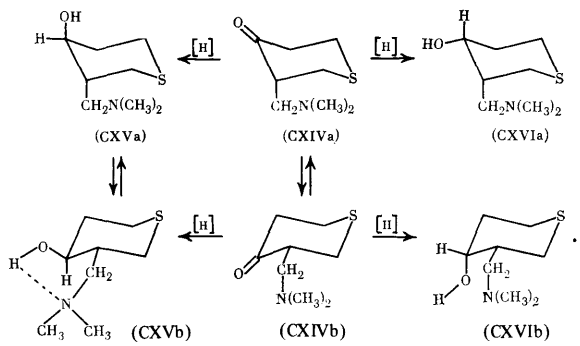


(CXIII)

R = CH_3, $(CH_3)_2$, $(CH_3)_3$, $CH_2N(CH_3)_2$, X = O, S.

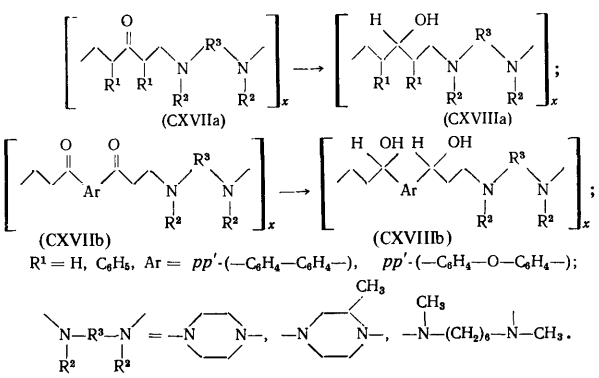
The quantitative ratios, the steric configurations, and the predominant conformations of the stereoisomeric aminoalcohols have been established by gas-liquid chromatography (GLC) and infrared and ^1H NMR spectroscopy and the steric specificity of the test reactions has been elucidated. It has been shown in a number of instances[107,110,111] that the quantitative ratio of the stereoisomeric aminoalcohols depends on the character of the reducing agent and the reaction conditions.

It has been noted that the equatorial isomers of the corresponding alcohols predominate in the reduction of the unhindered and conformationally stable 4-oxotetrahydro-1-thiopyrans (CXIV) with lithium tetrahydroaluminate, while in the reduction with aluminium isopropoxide the axial isomers are the dominant ones,[107] which agrees with the available data.[125] The individual isomers (CXV) and (CXVI) have been isolated by crystallising the mixture:

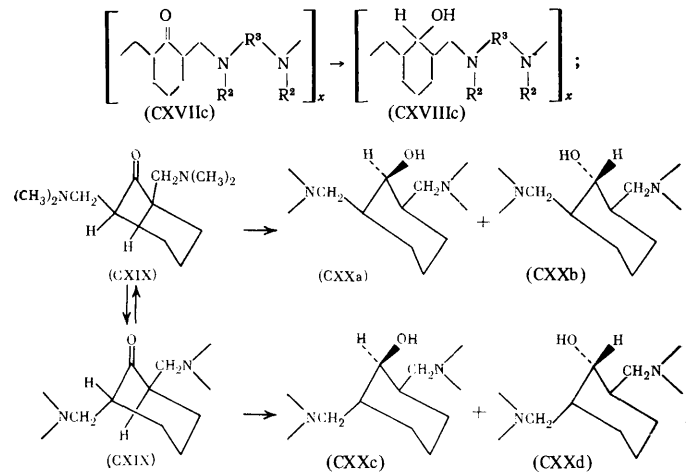


The authors[107] concluded that the aminoketone (CXIV) is reduced preferentially in the conformation (CXIVb), which should be promoted by the formation of a cyclic complex of the chelate type with participation of the metal hydride and the carbonyl amino-groups.[125] The reduction with participation of the conformation (CXIVa) followed by the conversion of the aminoalcohol conformers (CXVa) and (CXVIa) formed initially into compounds (CXVb) and (CXVIb) respectively is less likely, since this involves breaking the stereochemical rules governing the reduction of six-membered cyclic ketones.[126]

Data concerning the reduction of poly-β-dialkylaminoketones (CXVII) to the corresponding poly-γ-aminoalcohols (CXVIII) have been published:[127]



For comparison, a study has also been made of the reduction of the corresponding monomeric aminoketones. The stereochemistry of the reduction products (both polymeric and monomeric) has been investigated. The reduction has been carried out both with lithium tetrahydroaluminate and catalytically:[127]



The reduction of the bis-Mannich base (CXIX) with lithium tetrahydroaluminate leads to the formation of all the possible stereoisomeric aminoalcohols (CXX, a–d). It has been established[127] that fragments having three configurations alternate in the polymeric γ-aminoalcohols:

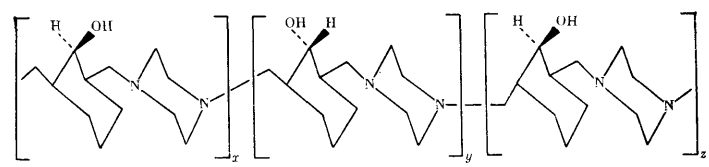
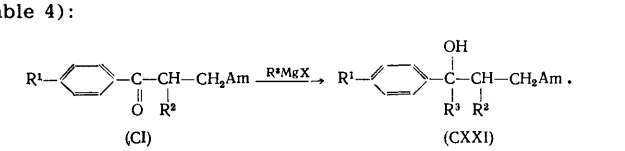


Table 4. Products of the interaction of β-aminoketones with a Grignard reagent.

R¹	R²	R³	Am	Biological activity	Refs.
H, CH_3, F	CH_3, C_2H_5, $C_6H_5CH_2$, C_6H_{11}	CH_3, C_2H_5, n-C_3H_7	$N(CH_3)_2$, NC_6H_{12}, N—CH_3	—	[100, 102]
H	C_2H_5	H	NC_5H_{10}, NC_4H_8O	—	[99]
C_6H_5	C_2H_5, C_3H_7	H	NC_5H_{10}	morphine-like	[112]
CH_3, CH_3O, iso-C_3H_7	$C_6H_5CH_2$	H	$N(CH_3)_2$, $N(C_2H_5)_2$, NC_4H_8, NC_4H_8O, NC_5H_{10}	bacteri-cidal	[104]

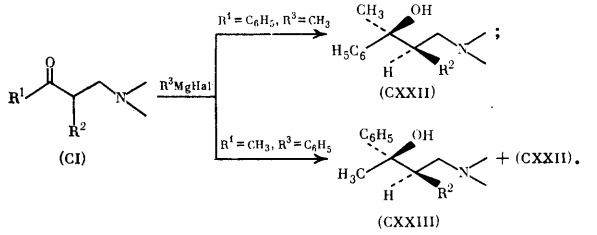
VII. REACTIONS WITH ORGANOMETALLIC COMPOUNDS

The tertiary γ-aminoalcohols (CXXI) have been obtained by the reaction of the β-aminoketones (CI) with a Grignard reagent or organolithium compounds[99–104,108,109,112,128–130] (Table 4):

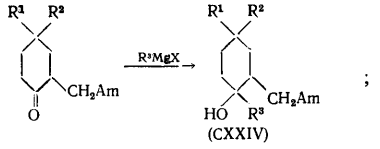


The stereochemistry of the reactions of aryl and methyl 2-aminoalkyl ketones substituted in the α-position, with Grignard reagents has been studied in detail.§ The configurations and the ratios of the diastereoisomers have been determined.[131,132]

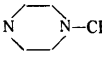
The reaction with the phenyl-substituted aminoketones (CI, $R^1 = C_6H_5$) is 100% stereospecific and leads to the amino-alcohol (CXXII), while the reaction of the methyl-substituted ketobases (CI, $R^1 = CH_3$) takes place with the preferential formation of the diastereoisomer (CXXIII) (the optical yields are 86–100%).[133]



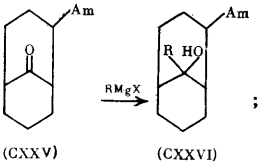
A large series of 4-substituted 2-aminomethyl-1-phenyl-(benzyl)cyclohexanols (CXXIV) have been synthesised by the interaction of cyclic Mannich bases with a Grignard reagent;[129] depending on the structure of the reactants, the yields are 30–80%. In particular, a relation is observed between the yields and the character of the amino-group: the best results have been obtained for the pyrrolidino- and morpholino-derivatives:

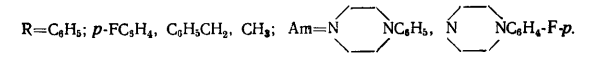


R^1=H, CH_3, R^2=H, CH_3, $CHCl_2$, CCl_3, R^3=C_6H_5, $C_6H_4CH_2$;

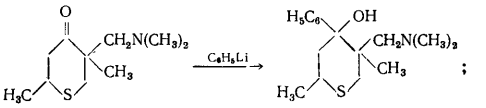
Am=NC_4H_8, NC_4H_8O, NC_6H_{10}, .

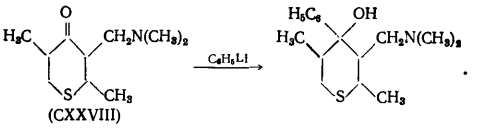
The reactions of the bicyclic Mannich bases (CXXV) with a Grignard reagent lead to the formation of the aminoalcohol (CXXVI); for R = C_6H_5, only one isomer of the aminoalcohol was isolated and its configuration established:[128]



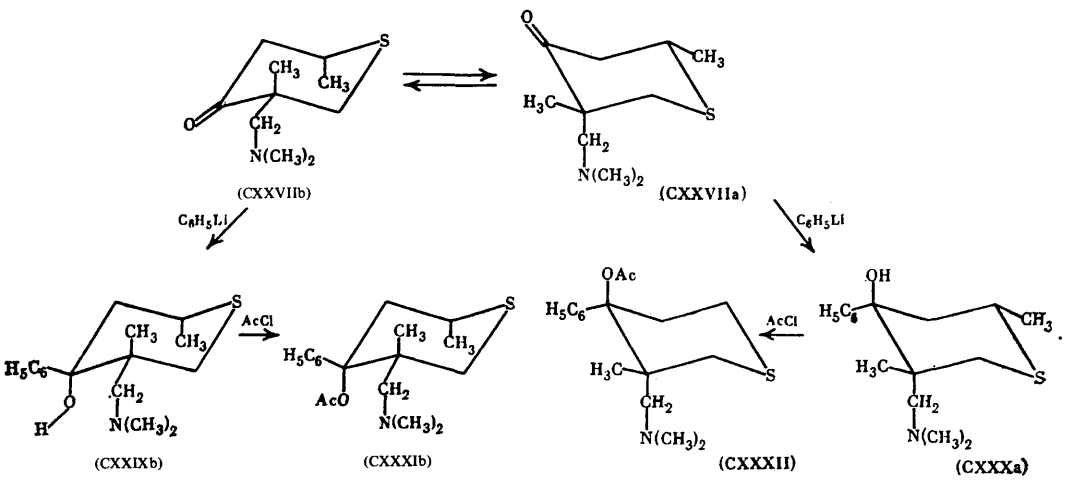
R=C_6H_5; *p*-FC_6H_4, $C_6H_5CH_2$, CH_3; Am=.

A strong predominance of one of two conformers has been observed in the synthesis of tertiary aminoalcohols from the aminomethyl derivatives of γ-ketones, in particular compounds (CXXVII) and (CXXVIII):[108,109,111,130]

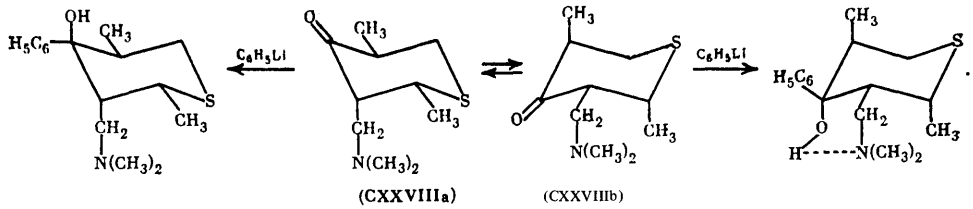




The aminoalcohols (CXXIX) and (CXXX), which are formed as the dominant components from the aminoketone (CXXVII), have respectively the *cis*- and *trans*-configurations relative to the hydroxy- and aminomethyl group, but in solutions the conformational equilibrium is displaced towards the conformers (CXXIXb) and (CXXXa):



§ The interaction of a Grignard reagent with β-aminoketones having an asymmetric carbon atom in the β-position or in the alkylamino-group also proceeds with a high degree of stereospecificity.[122,133,134]

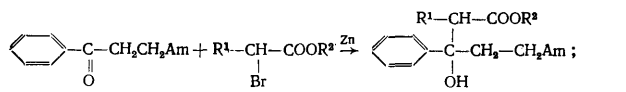


(CXXVIIIa) (CXXVIIIb)

The steric orientation of the hydroxy-groups of the amino-alcohols (CXXIX) and (CXXX) has also been confirmed by the character of the bands of the acetoxy-groups in the infrared spectra of solutions of the corresponding acetates (CXXXI) and (CXXXII).

The authors[109] concluded that the aminoketones (CXXVII) and (CXXVIII) interact with phenyl-lithium in the form of the conformers (CXXVIIb) and (CXXVIIIb) via a cyclic chelate complex with subsequent attack on the carbonyl group by the organometallic compound from the equatorial region leading to the *cis*-alcohols (CXXIXb) and (CXXXb), as shown above.

A number of studies[135-138] have been devoted to the reaction of β-aminopropiophenones (CXXXIII) with Reformatskii's reagent:



(CXXXIII)

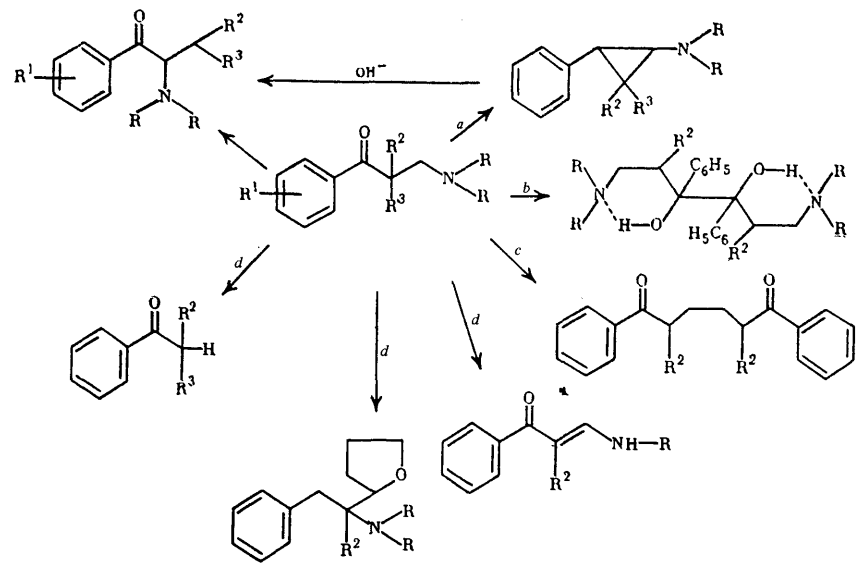
R^1=CH_3, C_2H_5, iso-C_3H_7, t-C_4H_9, R^2=CH_3, C_2H_5, Am=$N(CH_3)_2$, NC_4H_8O, NC_5H_{10}.

The yields for all R^1, except t-C_4H_9, amount to 81%. The steric hindrance in the case of the t-butyl derivative results in a considerable decrease of the yield (not above 10%).

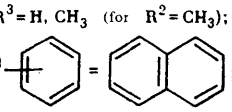
A stereochemical study of the course of the reaction[136-138] showed that compound (CXXXIV) is a mixture of the *erythro*- and *threo*-forms.[133-135] The relative configurations of the diastereoisomers have been established.[137] The authors suggest that the reaction proceeds via a bicyclic transition state in which the nitrogen atom participates and that this is the reason for the observed asymmetric induction.[138] The question of the stability of the transition state is discussed.

VIII. PHOTOCHEMICAL REACTIONS

The authors of a large number of communications[139-153] investigated the photochemistry of β-aminoketones (Mannich bases). The reactions undergone by the latter on irradiation can be divided into the following groups: cyclisations (a), dimerisations (b), isomerisations (c), and other reactions (d). The reactions are shown in the scheme below:



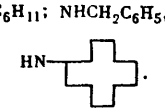
(a) R^1 = H, CH_3, iso-C_3H_7, R^2 = CH_3, C_2H_5, C_6H_5, R^3 = H, CH_3 (for R^2 = CH_3);

(b) R^1 = R^3 = H, R^2 = H, C_6H_5, R^3 = 4-CH_3O, for R^1 ;

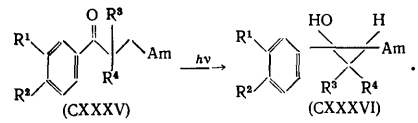
(c) R^1 = R^3 = H, R^2 = H, C_6H_5;

(d) R^1 = H, CH_3, R^2 = R^3 = CH_3;

R^1 = H, R^2 = R^3 = CH_3; $N\begin{smallmatrix}R\\R\end{smallmatrix}$ = $HN(C_3H_7$-iso), $HN(C_4H_9$-t), HNC_6H_{11}; $NHCH_2C_6H_5$,

$NHCH_2CH_2C_6H_5$, NC_4H_8O, NC_5H_{10}, HN—Ad (Ad = adamantyl), .

The photochemical cyclisation of β-aminopropiophenones (CXXXV) has been reported;[140,142] cyclopropanols were obtained for the first time by this procedure. The cyclisation products (CXXXVI) are indicated in Table 5.

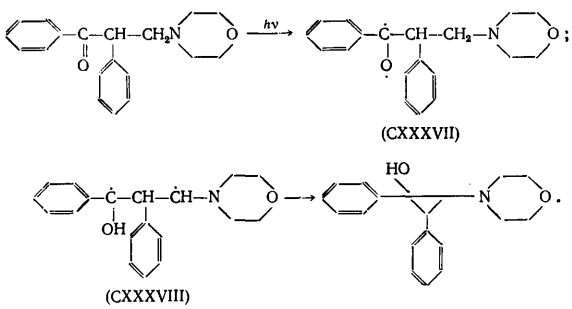


(CXXXV) (CXXXVI)

Table 5. Products of the cyclisation of β-aminopropiophenones (CXXXVI).

R^1	R^2	R^3	R^4	Am	Yield, %	Refs.
H H, CH_3	H H, CH_3, $CH(CH_3)_2$	H CH_3	CH_3, C_6H_5 CH_3	NC_4H_9O $NHCH_3$, NHC_6H_5, $NHCH_2C_6H_5$ $NHCH_2CH_2C_6H_5$	85—98 25—72	[115] [117]

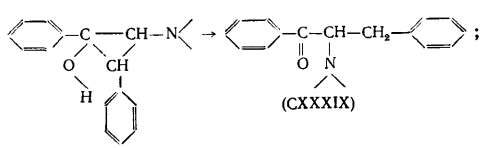
It has been suggested that the excitation of the C = O group results in the initial formation of the C—O biradicals (CXXXVII) which abstract a hydrogen atom from the β-position with the simultaneous formation of the OH group and the C—C biradical (CXXXVIII), which is converted, by intermolecular recombination, into the cyclopropane ring in accordance with the scheme[140]



(CXXXVII)

(CXXXVIII)

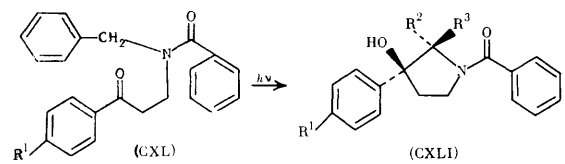
It is of interest that the cyclopropanols (CXXXVI) isomerise to 2-amino-1,3-diphenylpropanones on treatment with alkali or pyridine (CXXXIX):[140,142,143]



(CXXXVI) (CXXXIX)

$N\langle$ = NC_5H_{10}, NC_4H_9O.

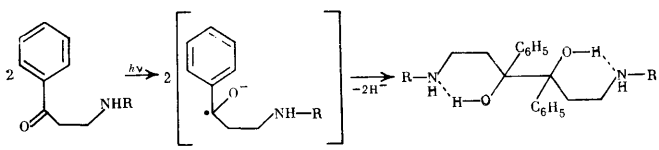
Irradiation of the aminoketones (CXL) in ether gives rise to 1-benzoyl-2-phenyl-3-(4-R-phenyl)pyrrolidin-3-ols (CXLI), which have been resolved into the stereoisomers (2*R*, 3*S*) and (2*S*, 3*R*) by preparative thin-layer chromatography:[144]



(CXL) (CXLI)

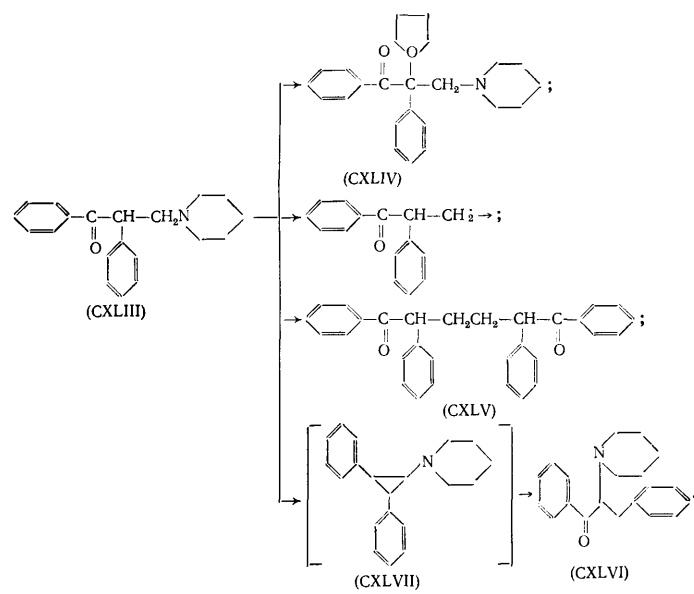
R^1 = H, R^2 = H, R^3 = C_6H_5; R^1 = Cl, R^2 = H, R^3 = C_6H_5;
R^1 = Cl, R^2 = C_6H_5, R^3 = H; R^1 = Br, R^2 = H, R^3 = C_6H_5;
R^1 = Br, R^2 = C_6H_5, R^3 = H R^1 = CH_3O, R^2 = H, R^3 = C_6H_5.

It is believed[146,147] that photodimerisation with formation of pinacols (the so-called "pinacolisation" reaction) proceeds via the radical-anion(CXLII):



(CXLII)

On irradiation, 2-phenyl-3-piperidinopropiophenone (CXLIII) undergoes different photochemical reactions depending on the solvent:[149]

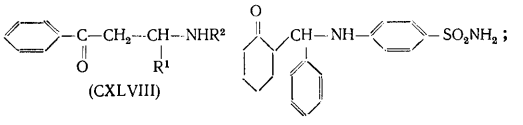


(CXLIII) (CXLIV) (CXLV) (CXLVII) (CXLVI)

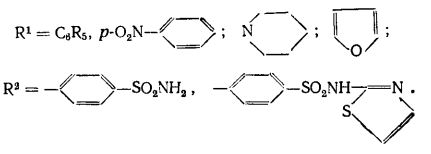
Thus 1,2-diphenyl-3-piperidino-2-(2-tetrahydrofuryl)1-propanone (CXLIV) is formed in tetrahydrofuran (THF). In dioxan, tetrahydropyran, and their mixtures with benzene or in a THF—benzene mixture, compound (CXLIII) gives rise to 1,2,5,6-tetraphenyl-1,6-hexanedione (CXLV) and 1,3-diphenyl-2-piperidino-1-propanone (CXLVI).

The symmetrical diketone (CXLV) is the product of the dimerisation of the radical formed on protolytic elimination of the amine from the initial compound. It is believed[149] that the isomerisation with formation of the α-aminoketone (CXLVI) proceeds via the intermediate cyclopropanol (CXLVII).

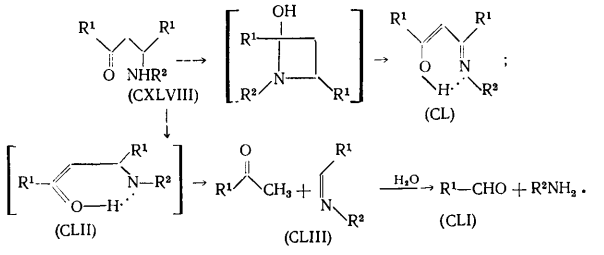
The photochemistry of the sulphamide Mannich bases of the type of compounds (CXLVIII) and (CXLIX) has been investigated:[150]



(CXLVIII) (CXLIX)



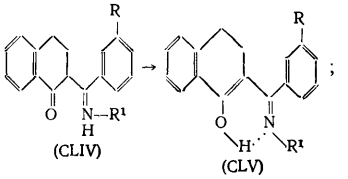
Ultraviolet irradiation of compounds (CXLVIII) in methanol results in the occurrence of two reactions: dehydrogenation to the corresponding β-iminoketones (CL), which exist in the enolic form, and cleavage to the amine, acetophenone, and the aldehyde (CLI):



(CXLVIII) (CL) (CLII) (CLIII) (CLI)

The cyclic intermediate state (CLII), from which acetophenone and the corresponding azomethines (CLIII) are formed, has been proposed for the photolytic cleavage of the aminoketone (CXLVIII).

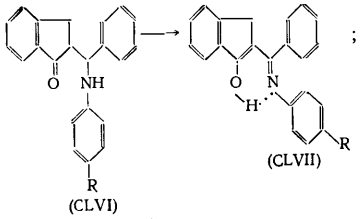
Irradiation of the Mannich bases (CLIV) with ultraviolet light leads to 2-[(*N*-R^1-imino)(4′-R-phenyl)]methyl-3,4-dihydro-1-naphthols (CLV):[152]



(CLIV) (CLV)

R=H, NO_2, R^1=C_6H_5, *p*-$CH_3OC_6H_4$, α-naphthyl.

2-[(4′-R-Phenylimino)phenyl]methyl-1-indenols have been obtained from compounds (CLVI) under analogous conditions:



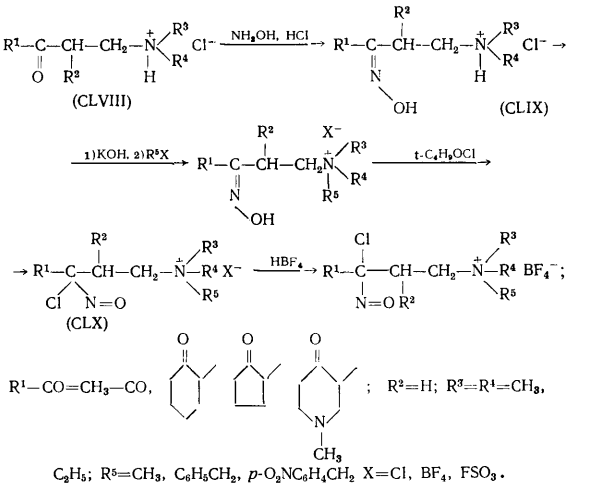
(CLVI) (CLVII)

R=H, CH_3O.

IX. OTHER REACTIONS

It has been shown[154] that the β-aminoketones obtained by the aminomethylation of 1-tetralone, 3,3,6,7-tetramethyl-1-tetralone, acetophenone, 1-chromanone, and *N*-methyl-4-piperidinone with piperidine are capable of producing on acetolysis unsaturated ketones, which are slowly converted into dimers.

The Mannich bases (CLVIII) have been converted into the oximes (CLIX), which were then oxidised to the *gem*-chloro-nitroso-derivatives (CLX) by the chloronium ion:[155]



(CLVIII) (CLIX) (CLX)

C_2H_5; R^5=CH_3, $C_6H_5CH_2$, *p*-$O_2NC_6H_4CH_2$ X=Cl, BF_4, FSO_3.

Complexes with lanthanide metal ions have been obtained from β(α)-naphthylamino-2,4,6-dihydroxypropiophenones;[156] a "metal–metal" bond has not been observed in these complexes, which indicates their monomeric nature.

The influence of 5-substituted 2-hydroxy-β-morpholinopropiophenones and *NN*-bis[β-(2-hydroxy-5R-benzoyl)ethyl]-piperazines on the resistance of polyethylene to the action of the atmosphere under the conditions of accelerated ageing has been investigated.[157] Despite their low effectiveness as thermal stabilisers, they are good light stabilisers of polyethylene.

Aminoketones have been finding applications also in the preparation of various polymers.[3c,55,56,75,76,127,158]

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