Table 1.Reaction of propiophenone (Ia) with sulphur and morpholine (ratio 1:3:2)[x] [xx]

reaction temp. °C	reaction time,hr.	yield of (%) Ia	IIIa	IVa	IX	X
24	72	51	1.8	8.5	28	0.2
24	380	17	a	12	30	b
44	14	b	0.4	1.5	b	b
55	7	62	0.7	4.7	20	b
80	1.5	45	/	5.6	32	b
80	48	a	/	a	a	b
135	1/4	20	/	11	21	b
135	1/2	2	/	a	2	1
135	3	a	/	a	a	a

[a] very small amount; [b] not determined

of enaminoketone IVa with sulphur and morpholine is carried out in the presence of hydrogen sulphide,oxothioamide VI (yield 50 %) is formed even at 50°;[xxx] if reaction is carried out at 80°,oxothioamide VI is formed even without the addition of hydrogen sulphide (yield 24 %,beside the unchanged enaminoketone);at 135° thioamide V is mainly formed (yield 63 %).

All the evidence obtained in our investigation using propiophenone (Ia),ω-phenylpropiophenone (Ib)[1] and their derivatives II-IV indicates that,in agreement with the previously proposed formulation,[8] a course of the initial stages of the W-K reaction,when compounds having at least three carbon atoms in the alkyl chain are used,can be represented as follows :[xxxx]

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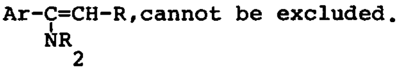
[x] Compounds Ia,IIIa-VI,IX-X were isolated by column chromatography and tlc and identified by comparison with authentic samples (u.v. and i.r. spectra).The amounts of the individual compounds were estimated by glc.Determination of Mannich base IIIa was carried out on an aliquot of a solution in benzene of the reaction products which was treated with dry HCl.The mixture of hydrochlorides of IIIa and IVa which separates was treated with a 10 % solution of Na_2CO_3;ethereal solution of IIIa and IVa was analysed by glc.The yield of IIIa was estimated from the amount of phenyl vinyl ketone (IIa) which is formed for decomposition of IIIa during gas-chromatographic analysis.

[xx] The yields of V and VI which account for residual reaction product are not determined at the moment.

[xxx] In acid medium some enaminoketones can be trasformed by H_2S into enaminothiones.[11]

[xxxx] Up to date,a competitive mechanism for thioamides $Ar-(CH_2)_n-CS-NR_2$ formation, e.g. via enamines  $Ar-\underset{NR_2}{C}=CH-R$,cannot be excluded.

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ISOLATION OF β-MORPHOLINOPROPIOPHENONE AND 1-BENZOYL-2-MORPHOLINOETHYLENE AMONG THE INTERMEDIATES OF THE REACTION OF PROPIOPHENONE WITH SULPHUR AND MORPHOLINE

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In the preceding paper[1] it was reported that ω-phenylpropiophenone (Ib) reacts with sulphur and morpholine (OC_4H_8NH) to give a mixture of compounds containing, besides Ib,the chalcone IIb,the β-aminoketone IIIb and the enaminoketone IVb.The same mixture is also obtained from each of the compounds IIb-IVb by reaction with sulphur and morpholine.These compounds,being sensitive to the action of the electrophilic or nucleophilic agents present in the system[1], can take part in the reversible and cyclical processes.

The peculiar behaviour of α,ω-bisarylsubstituted compounds in the conditions of the Willgerodt-Kindler (W-K) reaction can be ascribed to the fact that the thiocarbonyl compounds,e.g. C_6H_5-CO-CH_2-CS-C_6H_5,whose formation may be postulated on the analogy of the monoarylsubstituted compounds (see below) can easily undergo the attack of the nucleophilic species[1,2] since the thiocarbonyl group is not stabilized by the aryl group as it is by the basic residue contained in the thioamides,e.g. C_6H_5-CO-CH_2-CS-NC_4H_8O (VI).[3]

The reaction of propiophenone (Ia) and of some of its derivatives has now been carried out in various experimental conditions with the purpose of verifying if, also in the case of the monoarylsubstituted ketones (having,therefore,a terminal methyl group) compounds of type III and IV are produced as intermediates of the formation of thioamides V and oxothioamides VI (the possibility of isolating compound IIa was ruled out,since this compound readily reacts with amines).[x]

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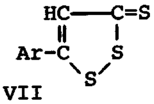
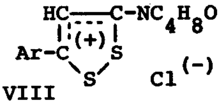
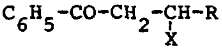
[x] The compounds obtained until now by reaction of aryl ethyl ketones with sulphur and morpholine are arylpropionthioamides,e.g.V,[4] and oxothioamides,e.g.VI.[5] In particular conditions 5-aryl-1,2-dithiolo-3-thiones (VII)[6,7] were obtained and also dithiolium salt VIII (Ar = p-$CH_3OC_6H_4$-).[7]

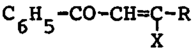

VII


VIII

Propiophenone (Ia) reacts with sulphur and morpholine even at room temperature;as expected not even in these conditions it was possible to isolate phenyl vinyl ketone (IIa) which,according to the postulated general mechanism,[8] is the first stable intermediate of the process.However,both at room temperature and higher temperature,besides the two thioamides V and VI,1-benzoyl-2-morpholinoethylene (IVa) was obtained.Compound IIIa was isolated only in small amount when the reaction was carried out in mild conditions.Moreover,benzyl methyl ketone (IX) is formed by an isomerization process.[x]



$C_6H_5\text{-CO-CH}_2\text{-}\underset{X}{\text{CH}}\text{-R}$



$C_6H_5\text{-CO-CH=}\underset{X}{\text{C}}\text{-R}$

Ia, R,X = H
Ib, R = C_6H_5-;X = H
IIIa,R = H;X = OC_4H_8N-
IIIb,R = C_6H_5-;X = OC_4H_8N-

IIa, R,X = H
IIb, R = C_6H_5-;X = H
IVa, R = H;X = OC_4H_8N-
IVb, R = C_6H_5-;X = OC_4H_8N-

$C_6H_5\text{-CH}_2\text{-CH}_2\text{-CS-NC}_4H_8O$
V

$C_6H_5\text{-CO-CH}_2\text{-CS-NC}_4H_8O$
VI

$C_6H_5\text{-CH}_2\text{-CO-CH}_3$
IX

β-aminoketone IIIa is very reactive in the conditions of the W-K reaction and at temperature below 65° it gives chiefly compounds Ia,IVa,VII and acetophenone (C_6H_5-CO-CH_3,X)[xx] besides the two thioamides V and VI.

Formation of compound Ia from IIIa point out that when monoarylsubstituted carbonyl compounds,as well as α,ω-bisarylsubstituted carbonyl compounds,[1] react with sulphur and morpholine,reductive processes (from sulphurated intermediates, i.e.,β-mercaptoketones)[10] yielding the parent ketone take place.

Enaminoketone IVa,like IVb,[1] in conditions of the W-K reaction,is stable towards electrophilic reagents and this accounts for its isolation when the reaction is carried out at lower temperature (that is,when only sulphur-containing electrophilic species are largely present in the reaction mixture).In agreement with this and with the expected reactivity towards the nucleophilic species,if the reaction

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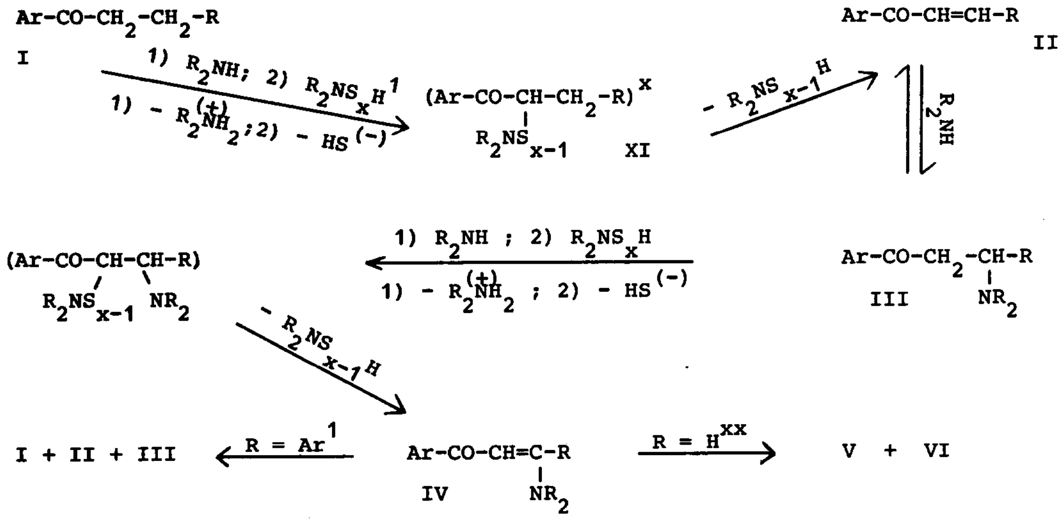
[x] In the literature[9] such isomerization process was reported to take place solely when a primary amine is used;in our experimental conditions,nevertheless, the isomerization process takes place also when a sec.amine,i.e.morpholine, is used.

[xx] At 60°,4hr.,ratio (IIIa:S:Morpholine) 1:1.5:1.5 yield (%) 9.6;15.3;10;13.8 for such compounds is obtained.



A more detailed discussion will be reported in the full paper.

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[x] The initial compound of thiolation[12] appears more correctly formulated as α-ketosulphenamide XI rather than α-mercaptoketone. The instability of this type of sulphenamide accounts, among other things, for the formation of unsaturated ketones also in mild conditions.

[xx] If R = CH$_3$ thiophene derivatives are obtained.[13]

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