# INVESTIGATIONS OF PYRANS AND RELATED COMPOUNDS

## XLV.* MECHANISM OF THE OPENING OF THE PYRONE RING OF CHROMONE UNDER THE INFLUENCE OF AMINES

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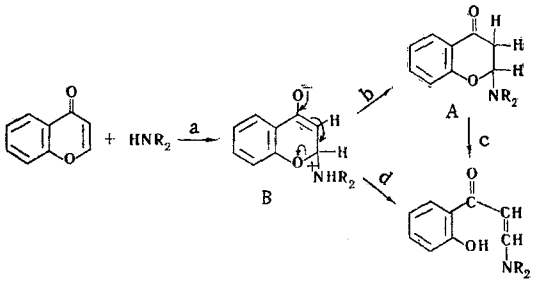
The mechanism of the opening of the heteroring of chromone under the influence of amines is discussed on the basis of the results of the reaction of chromone with 1-D-piperidine and of 3-D-chromone with piperidine.

The capacity of $\gamma$-pyrones, including chromones, for opening of the heterocyclic ring under the influence of various nucleophilic reagents of rather basic character (alkalis, amines, etc.) is widely known, but until now there has been no experimental proof of whether the cleavage of the pyrone ring by amines, for example, occurs via prior complete addition of the elements of the reagent to the double bond to form adduct A (path a-b-c) or directly from intermediate complex B, bypassing A (path a-d).




Path a-b-c is less likely but still cannot be excluded a priori, especially if the available data on the capacity of halogen in the 3 position of chromones for substitution without cleavage of the heteroring under the influence of amines or alkoxides (see, for example, [1-3]), as assumed in [2], through a step involving the complete addition of the reagent to the double bond of the pyrone ring, are taken into account.

We have established that 2-($\beta$-piperidinoacrylyl)phenol (Ia) [2], which does not contain deuterium in the $\alpha$ position [as monitored from the PMR spectrum (Fig. 1, curve 1)], is formed as a result of the reaction (at 20°C for about 5 min) of chromone with 2 mole of 1-D-piperidine (90% enriched in deuterium, as determined from the IR spectra).

On the other hand, the reaction of undeuterated piperidine with 3-D-chromone, no less than 95% enriched in deuterium, leads to 2-($\beta$-piperidino-$\alpha$-D-acrylyl)phenol (Ib), in which the deuterium label is completely retained (Fig. 1, curve 2).

Consequently, it can be stated with certainty that the opening of the chromone ring does not occur via the a-b-c path but most likely proceeds via the a-d path, i.e., only through intermediate B, which is similar to the complexes that, in accordance with generally accepted opinions, are formed in nucleophilic substitution reactions, for example, of halogen in halo-2,4-dinitrobenzenes or in $\beta$-chlorovinyl carbonyl compounds [4,5].

*See [10] for communication XLIV.

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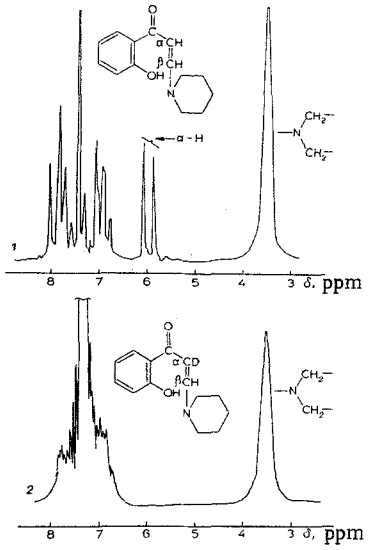



Fig. 1. PMR spectra: 1) 2-(β-piperidinoacrylyl)phenol (Ia) in deuterochloroform; 2) 2-(β-piperidino-α-D-acrylyl)phenol (Ib) in chloroform.

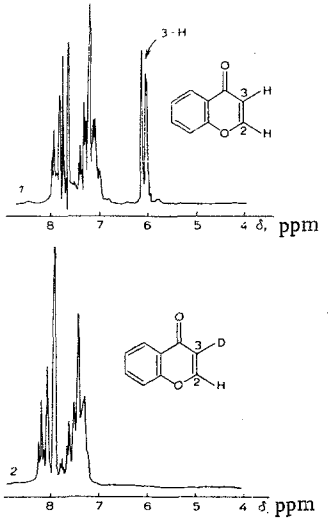
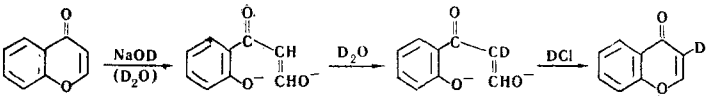



Fig. 2. PMR spectra in carbon tetrachloride: 1) chromone; 2) 3-D-chromone.

We synthesized the starting 3-D-chromone via the scheme [3]




The percentage of deuterium in the 3-D-chromone was determined from the PMR spectra (Fig. 2). We note that appreciable deuterium exchange in the benzene ring is not observed under these conditions (see Fig. 2 for a comparison of curves 1 and 2). A somewhat different path for the synthesis of 3-D-chromone by cyclization of 2-β-dimethylaminoacrylylphenol by heating in $D_2O + D_2SO_4$ was recently described [6]. We obtained negative results in attempts to synthesize 3-D-chromone by the reduction of 3-chlorochromone with zinc dust in $D_2O-C_2H_5OD$, although 3-chlorocoumarin and 4-chlorocoumarin were converted to the corresponding deuterocoumarins [7] by means of this method. Chromone cannot be deuterated by heating a solution of it in $D_2O$–dioxane. In this respect, chromone differs from 4-pyrone, in which about 70% deuterium exchange occurs in $D_2O$ in 26 h at 98° [8]. In chromone, the oxygen atoms of the heteroring and the carbonyl group are apparently exchanged with considerably more difficulty than in 4-pyrone: chromone cannot be labeled with $O^{18}$ (according to the mass spectrum) on heating with 60% $H_2O^{18}$ at 98-100° for 20 h. All of this can be explained by the fact that the heteroring in chromone is more resistant to cleavage under the influence of nucleophilic reagents than the 4-pyrone ring.

## EXPERIMENTAL*

The PMR spectra were recorded with an RS-60 spectrometer with an operating frequency of 60 MHz.

3-D-Chromone [3]. A total of 13.5 ml of 2 N NaOD was added to a solution of 2 g (13.7 mmole) of chromone in 8 ml of absolute dioxane. The mixture was allowed to stand at 20° for 1 h and was then acidified with DCl solution (from 3.6 ml of $SOCl_2$ and 3.2 ml of $D_2O$) and refluxed for 2 h. It was then evaporated to dryness, and the residue was treated rapidly with 2 N NaOH and extracted with ether to give 1 g (50%) of 3-D-chromone with mp 56-57° (from benzene–petroleum ether).

Reaction of Chromone with 1-D-Piperidine and of 3-D-Chromone with Piperidine. A 6.8-mmole sample of 1-D-piperidine was added to 3.4 mmole of chromone, and the mixture was allowed to stand for about 5 min. Petroleum ether was added, and Ia was separated and recrystallized from benzene–petroleum ether to give a product with mp 120-121° [2, 9]. Compound Ia did not contain deuterium in the α position (as monitored from the intensity of the α-H doublet with δ 5.9 ppm in comparison with the intensity of four proton units of the signal of the $-CH_2NCH_2-$ group at 2.8-3.5 ppm; the error in the determination was about 10%; one's attention should be directed to the form of the β-H doublet with δ 7.9 ppm).

The reaction of 3-D-chromone with piperidine was carried out similarly, and Ib was isolated. The PMR spectrum of Ib does not contain the signal of a proton in the α position (as evaluated by a comparison of the height of the α-H doublet with the spectrum of the undeuterated sample; the error in the determination was <5%).

*L. M. Meshcheryakova participated in the experimental work.

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