

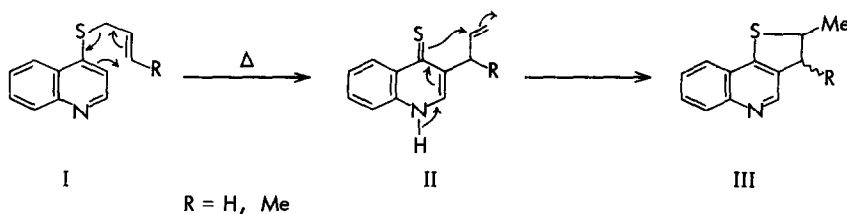
## THE THIO-CLAISEN REARRANGEMENTS OF ALLYL AND PROPARGYL 4-QUINOLYL SULFIDES

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(Received in Japan 10 April 1969; received in UK for publication 20 April 1969)

Earlier, we reported that the thio-Claisen rearrangement of allyl 4-quinolyl sulfides (I) to 2,3-dihydrothieno[3.2-c]quinolines (III) proceeded through the prototropic cyclization of the initially formed 3-allyl-4(1H)-quinolinethiones (II), on the basis of the quantitative transformation of II into III under mild conditions (1).



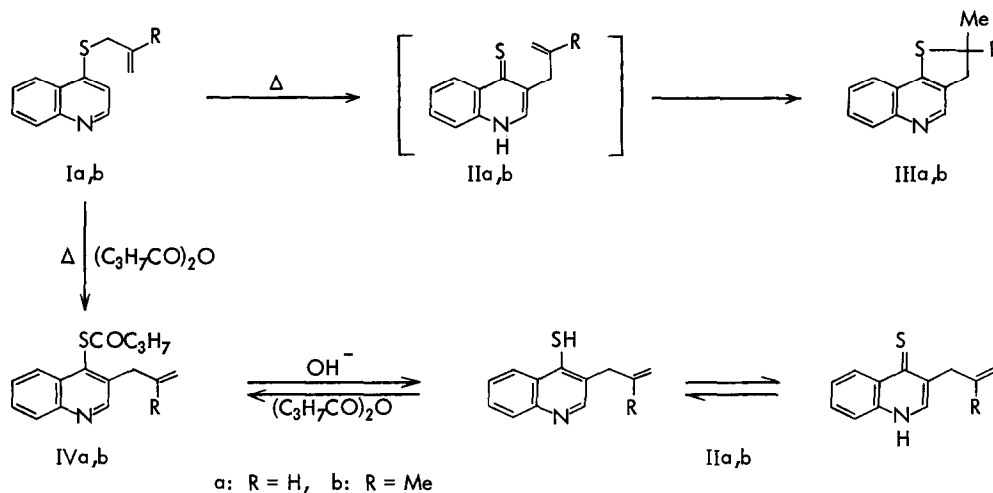
Recently, Kwart and Cohen (2) proposed a mechanism involving two possible intermediates, thiiran derivative and *o*-methallylthiophenol for the thio-Claisen rearrangement of methallyl phenyl sulfide. This report prompts us to report a definitive evidence for the intermediacy of II in the thio-Claisen rearrangement.

To trap an intermediate, 3-allyl-4(1H)-quinolinethione (IIa) during the rearrangement reaction, allyl 4-quinolyl sulfide (Ia) was heated at 200° for 2 hr in the presence of 1.5 moles of butyric anhydride. IIa was thus trapped as its butyric ester (IVa), oil;  $\nu_{\max}^{\text{CHCl}_3}$  1710 (C=O) (3), 1640, 995, and 920 ( $-\text{CH}=\text{CH}_2$ )  $\text{cm}^{-1}$ ; picrate, m.p. 149-150°, in 87% yield. The NMR spectrum showed the signals of three olefinic protons at  $\tau$  5.02, 4.93, and 4.10, two allylic protons at  $\tau$  6.34, and an aromatic C-2 proton at  $\tau$  1.16, besides those of propyl group at  $\tau$  9.0, 8.25, and 7.2. Hydrolysis product of IVa was identical with the authentic IIa (1) and butyric ester obtained by treatment of IIa with butyric anhydride, was also identical with IVa.

When methallyl 4-quinolyl sulfide (Ib), m.p. 47-48°, prepared by alkylation of sodium 4-quinolyl-

mercaptide with methallyl chloride at room temperature, was heated at 200° for 2 hr without solvent or in quinoline, 2,2-dimethyl-2,3-dihydrothieno[3.2-c]quinoline (IIIb), b.p.<sub>0.1</sub> 126°, was obtained in 85-90% yield. The NMR spectrum of IIIb showed the singlet signals of gem-dimethyl (6H) at  $\tau$  8.37, methylene (2H) at  $\tau$  6.71, and aromatic C-4 proton (1H) at  $\tau$  1.42. The rearrangement of Ib in the presence of 1.5 moles of butyric anhydride afforded butyric ester (IVb), oil;  $\nu_{\text{max}}^{\text{CHCl}_3}$  1709 (C=O) (3), 1652 and 900 ( $>\text{C}=\text{CH}_2$ )  $\text{cm}^{-1}$ ; picrate, m.p. 130-131°, in quantitative yield. Hydrolysis of IVb with alkali gave 3-methallyl-4(1H)-quinolinethione (IIb), m.p. 134-135°;  $\nu_{\text{max}}^{\text{Nujol}}$  3190 (NH), 1211 (C=S), 1650 and 907 ( $>\text{C}=\text{CH}_2$ )  $\text{cm}^{-1}$ , which was identical with IIb synthesized by reaction of 3-methallyl-4-chloroquinoline (4) with thiourea in boiling ethanol. On heating at 180° for 30 min, IIb cyclized to IIIb in quantitative yield.

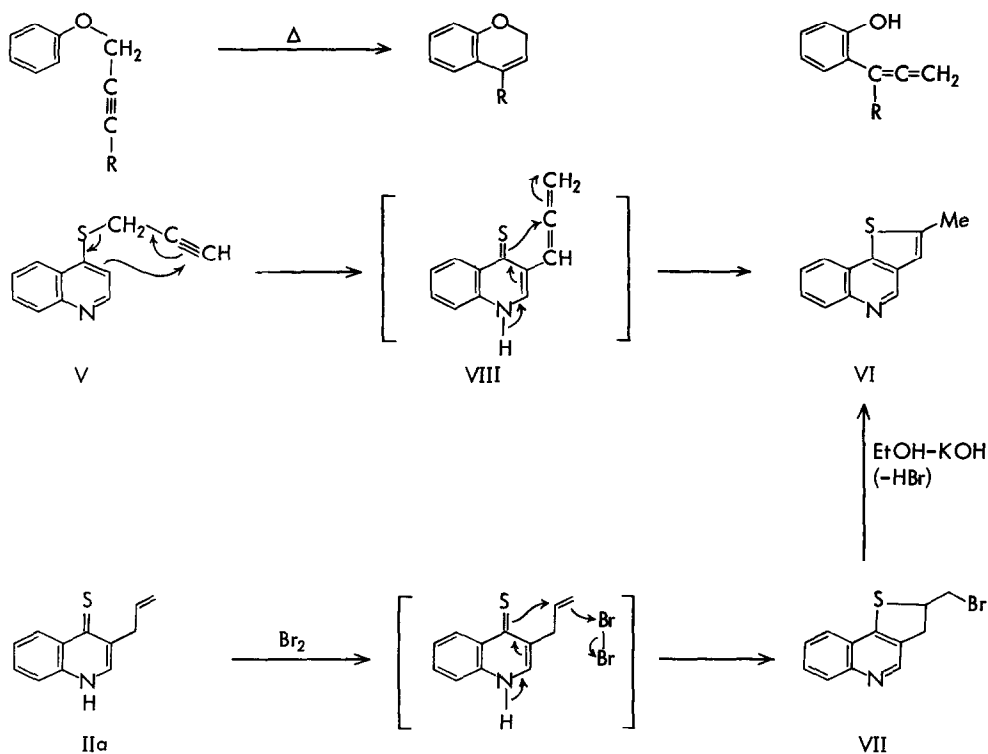
Thus, we conclude that 3-allyl-4(1H)-quinolinethiones (II) are sole intermediate in the thio-Claisen rearrangement of allyl 4-quinolyl sulfides (I).



It has been reported that the thermal rearrangement of aryl propargyl ethers is followed by direct cyclization to form pyran ring without prior Claisen rearrangement to allene derivatives (5,6,7). We have however found that propargyl 4-quinolyl sulfide (V) undergoes thio-Claisen rearrangement.

When the propargyl sulfide V, m.p. 105-106°;  $\nu_{\text{max}}^{\text{CHCl}_3}$  3308 ( $\equiv\text{CH}$ ) and 2120 ( $\text{C}\equiv\text{C}$ )  $\text{cm}^{-1}$ , prepared by alkylation of sodium 4-quinolylmercaptide with propargyl bromide at room temperature, was heated at 200° for 2 hr in dimethylaniline, 2-methylthieno[3.2-c]quinoline (VI), m.p. 66-67°, was obtained in 80%

yield. The NMR spectrum of VI showed proton signals at  $\tau$  7.43 (3H-doublet,  $J = 1.1$  Hz), 2.94 (1H-quartet,  $J = 1.1$  Hz), and 0.95 (1H-singlet), besides complex signals of four aromatic protons. This compound was identical with dehydrobromination product of 2-bromomethyl-2,3-dihydrothieno[3,2-c]quinoline (VII), m.p. 64.5-66°, prepared by the reaction of IIa with bromine.



The formation of VI in the thermal rearrangement of V is interpreted as a novel 3,3-sigmatropic rearrangement of aryl propargyl sulfide to give 3-allenyl-4(1H)-quinolinethione (VIII), followed by its prototropic cyclization.

The NMR spectra were observed in deuteriochloroform by using a Varian A-60 spectrometer. Satisfactory elemental analyses were obtained for the compounds.

## REFERENCES

1. Y. Makisumi, Tetrahedron Letters 1966, 6399.
2. H. Kwart and M. H. Cohen, J. Org. Chem. 32, 3135 (1967).
3. The carbonyl absorption of Ar-S-CO-R appears at about  $1710\text{ cm}^{-1}$ , R. A. Nyquist and W. J. Potts, Spectrochim. Acta 1959, 514.
4. Y. Makisumi, Chem. Pharm. Bull. (Tokyo) 12, 1424 (1964).
5. I. Iwai and J. Ide, Chem. Pharm. Bull. (Tokyo) 10, 926 (1962).
6. I. Iwai and J. Ide, Chem. Pharm. Bull. (Tokyo) 11, 1042 (1963).
7. B. S. Thyagarajan, K. K. Balasubramanian, and R. B. Rao, Tetrahedron 23, 1893 (1967).