PHOTOCHEMICAL RING CONTRACTION REACTIONS OF QUINOLINE 1-OXIDES HAVING CARBOXYLIC ACID FUNCTION AT THE 4-POSITION TO INDOLE-3-CARBOXALDEHYDES *via* THE CORRESPONDING OXAZEPINES[1]

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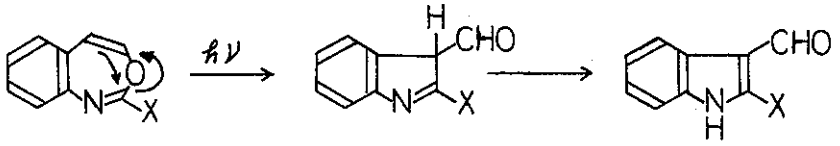
Irradiation of the N-oxide of 2-methyl- or 2-phenyl-quinoline 4-carboxylic acid with high-pressure mercury lamp with Pyrex filter in methanol was found to give 2-substituted indole-3-carboxaldehyde in an appreciable amount, together with carbostyril derivatives.

In order to account for the formation of these indoles a plausible mechanism including benz[d]-3,1-oxazepines and 3-formyl-3H-indole-3-carboxylic acids is proposed.

It was verified that the N-oxide of quinoline 4-carboxylic acid also gave indole-3-carboxaldehyde under these conditions.

In the previous paper of this series,[2] we reported the photochemical ring-contraction reaction of 5-unsubstituted benz[d]-3,1-oxazepines to indole-3-carboxaldehydes and proposed the mechanism shown in Scheme 1 including $\pi^2_s + \sigma^2_s$ pericyclic reaction as a key step as the most plausible one.



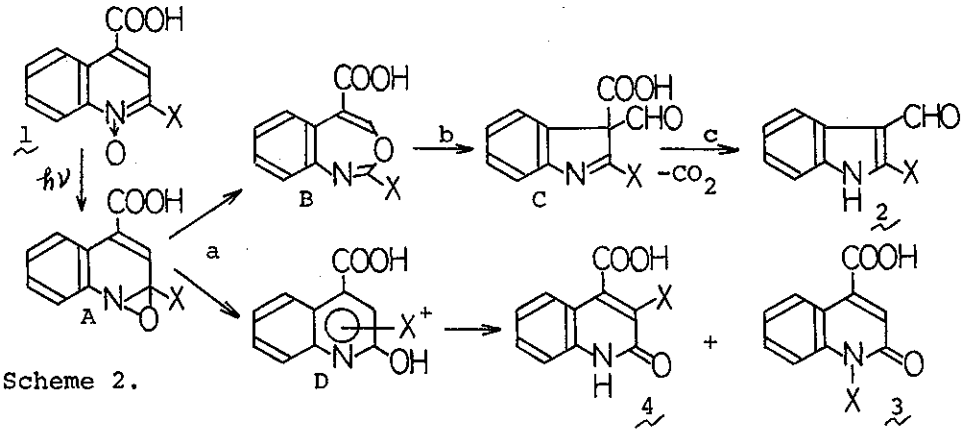
Scheme 1

In order to obtain further supporting evidences for the mechanism as well as to extend such novel ring-contraction reaction to the other benz[d]-3,1-oxazepines, we have irradiated a series of quinoline 1-oxide 4-carboxylic acids (1a-1c) in methanol.

Irradiation of 2-methylquinoline 1-oxide 4-carboxylic acid (1b) in methanol with high-pressure mercury lamp (Toshiba-400P) with Pyrex filter resulted in the formation of three major rearrangement products: 2b; $C_{10}H_9ON$, mp 198-200°, 3b; $C_{11}H_9O_3N$, mp 240-241° (dec.), and 4b; $C_{11}H_9O_3N$, mp >300°.

The structure of 2b was confirmed as 2-methylindole-3-carboxaldehyde by the mixture melting point determination with the authentic sample.[3] Both 3b[4] and 4b[5] showed typical carbostyril UV absorptions [$\lambda_{max}^{95\%\text{-EtOH}}$: nm (log ε): 3b; 229.5 (4.51), 275.5 (3.78), 283 (3.78) and 331 (3.76) and 4b; 221 (4.55), 272.5 (3.89) and 324 (3.88)] and the position of methyl group in each product was deduced from the NMR spectra [τ in DMSO-d_6: 3b; 6.37 (3H for CH_3) and 3.06 (1H for H-3), and 4b; 7.88 (3H for CH_3)].

Under the same irradiation conditions, 2-phenylquinoline 1-oxide 4-carboxylic acid (1a) afforded 2-phenylindole-3-carbox-



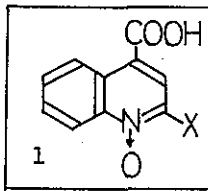
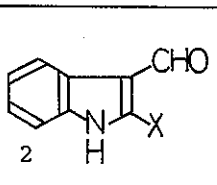
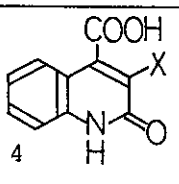
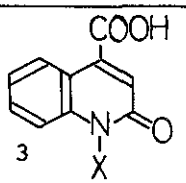
Scheme 2.

aldehyde[2] (2a; mp 250-252°) and 3-phenylcarbostyril 4-carboxylic acid[6], 4a, $C_{16}H_{11}O_3N$, mp 292-294° [λ_{max}^{MeOH}: nm (log ε): 225 (4.57), 286 (3.99) and 338 (3.95)] as the major rearrangement products, together with minor amounts of 2-phenylquinoline 4-carboxylic acid (ca. 5%) and the solvent addition product[7]; $C_{17}H_{15}O_4N$, mp 183-185° (ca. 7%).

Based on the previous results,[2] it seems reasonable to explain these ring-contraction reactions to include the sequential steps shown in Scheme 2. In step a, the N-oxide is transformed photochemically to the oxaziridine (A) which affords either carbostyrils or the oxazepine (B). The oxazepine (B) is then converted to the 3-formyl-3H-indole-3-carboxylic acid (C) in the next step (b). The indolenine (C) would then give the indole-3-carboxaldehyde (2) by elimination of carbon dioxide (step c). A facile decarboxylation of such indolenines to indoles has ample precedents.[8]

It seems to be note worthy that the presence of the carboxy-

Table I. The yields (theoretical yields) of 3-formylindoles (2) and carbostyrils (3 and 4) obtained from 1a-1c by irradiation with ≳300 nm rays in methanol.

 1	 2	 4	 3
1a: X=phenyl 1b: X=CH_3 1c: X=H	2a: 59.5% 2b: 37.0% 2c: 6.3%	4a: 26.3% 4b: 31.2% 4c (=3c): 79.0%	3a: ± 3b: 20.4%

lic function in these oxazepines would make the oxazepine-system susceptible to the further photochemical reaction (step b) by irradiation of the rays longer than 300 nm, because most of the oxazepines so far prepared are stable under these conditions.[9,10]

Compared to the fact that the photolysis of 2-methylquinoline 1-oxide in methanol affording almost exclusively the corresponding carbostyrils,[11] an appreciable amount of the formation of the oxazepine (as judged from the formation of 2b) from 1b in the present experiment seems to indicate that the presence of a carboxylic function in the oxaziridine (A) has prevented the formation of carbostyrils (3b and 4b) in some extent. This idea fits well with our previous proposal that the formation of carbostyrils from the oxaziridine (A) is a thermal process and its transition state is a π-complex (D),[12] which would be destabilized by the presence of electron-withdrawing group in the quinoline ring.

Finally, quinoline 1-oxide 4-carboxylic acid (1c) was irra-

diated in methanol by the same light source, whereby indole-3-carboxaldehyde (2c), mp 191-193°, was obtained, together with carbostyril (3c).

The results of photolyses of 1a-1c are summarized in Table 1. The amounts of carbostyrils are increased in the order of 1a < 1b < 1c, and this order runs parallel with the ease of carbonium ion rearrangement aptitude of the substituents (Ph < CH_3 < H) in the corresponding π-complex (D).[13]

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10 The possibility that the presence of a carboxylic acid function in these oxazepines facilitates their thermal conversion to the 3H-indolenines is not excluded, at present.

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Received, 15th November, 1976