Novel Thermal Rearrangements of Tetrahydro-azirinocyclobutabenzofuran Derivatives

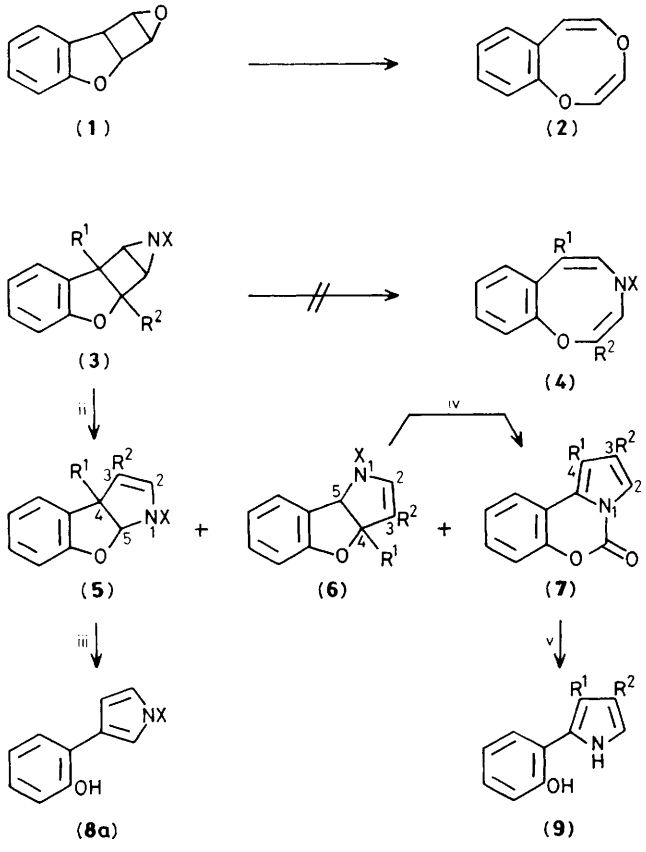
Jyoji Kurita, Hiroichi Sakai, Sachiko Yamada, and Takashi Tsuchiya*

School of Pharmacy, Hokuriku University, Kanagawa-machi, Kanazawa 920-11, Japan

Thermolysis of the 1a,1b,6b,6c-tetrahydro-azirino[2',3': 3,4]cyclobuta[1,2-*b*][1]benzofurans (**3**) results in ring transformations to form the benzofuro[2,3-*b*]pyrroles (**5**) and their [3,2-*b*]-isomers (**6**).

There is a growing interest in the ring-opening reactions of highly strained bicyclopentane ring systems[1] and their hetero-analogues.[2] Recently, we reported[3] that the flash vacuum pyrolysis of the dioxatricyclo-octane derivatives (**1**) at 550 °C resulted in ring expansion to give the novel 1,4-benzodioxocines (**2**), although even when the compounds (**1**) were heated in solvents at 250 °C, no reaction occurred. These results prompted us to examine the thermal behaviour of aza-analogues of (**1**), and we report here that the title compounds (**3**) gave interesting rearrangement products, although the expected 1,4-benzoxazocines (**4**) could not be obtained.

The tetrahydro-azirinocyclobutabenzofurans (**3a—c**) were prepared from 1-benzoxepines[4] by photocyclization followed by treatment with ethoxycarbonylnitrene generated from *N*-ethoxycarbonyl-*O*-(*p*-nitrophenylsulphonyl)hydroxylamine.[5]

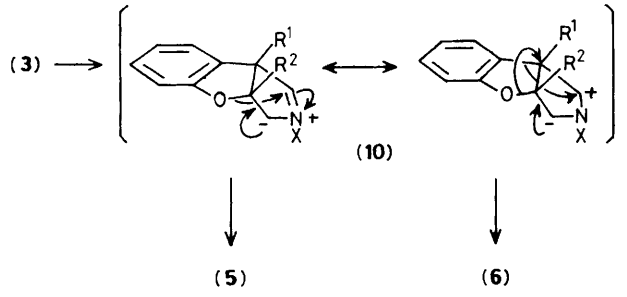


a; $R^1 = R^2 = H$
b; R^1 = Me, $R^2 = H$
c; $R^1 = R^1$ = Me
X = CO_2Et

Scheme 1. *Reagents and conditions:* i, flash vacuum pyrolysis, ii, toluene or xylene, 160 °C, 8—12 h; iii, 10% HCl, ethanol, room temp.; iv, heat; v, 10% NaOH, ethanol.

Heating the compounds (**3**) (Scheme 1) in toluene or xylene at 160 °C for 8—12 h in a sealed tube resulted in ring transformations to give the benzofuro[2,3-*b*]pyrroles (**5**) (40—70%), their [3,2-*b*]-isomers (**6**) (5—20%), and the 1,3-oxazin-2-ones (**7**) (20—30%).† Flash vacuum pyrolysis of (**3**) at 380 °C also gave the same products (**5**)—(**7**), but in lower yields. In neither case was the formation of 1,4-benzoxazocine (**4**) observed. The products were characterized by their spectral data and the results of the following chemical reactions. Treatment of (**5a**) (R^1 = H) with 10% HCl in ethanol at room temperature gave the *o*-(3-pyrrolyl)phenol (**8a**) in 86% yield, but the compounds (**5b,c**) (R^1 = Me) did not react under similar conditions. Compounds (**6**) were readily converted into (**7**) by further heating; this result clearly indicates that the oxazinones (**7**) are derived from (**6**) presumably *via* *N*-ethoxycarbonyl-*o*-(2-pyrrolyl)phenols. Treatment of (**7**) with 10% NaOH in ethanol afforded the *N*-unsubstituted *o*-(2-pyrrolyl)phenols (**9**) in high yields.

A possible mechanism for the thermolysis is shown in Scheme 2. The ring conversion of (**3**) into (**5**) and (**6**) may proceed *via* initial C–C bond fission in the aziridine ring to the ionic intermediates (**10**), which may undergo migration of the phenoxy group to give (**5**). On the other hand, the products (**6**) might be formed from (**10**) by a Wagner–Meerwein type phenyl group migration followed by the shift of the phenoxy group. We assume that the difference in thermolysis between (**1**) and (**3**) may depend on the different mode of the initial



Scheme 2

† Satisfactory elemental analyses and spectral data were obtained for all products. (**5b**) (oil): i.r. ν ($CHCl_3$) 1705 (C=O) cm^{-1}; ^1H n.m.r. δ ($CDCl_3$) 1.59 (3H, s, 4-Me), 5.23 (1H, d, *J* 4 Hz, 3-H), 6.32 (1H, s, 5-H), 6.70 (1H, d, *J* 4 Hz, 2-H), 6.9—7.4 (4H, m, Ph-H), 1.37 and 4.36 (3H, t, and 2H, q, CO_2Et). The ^1H n.m.r. spectra of (**6a—c**) measured at room temperature showed complex broad split signals presumably owing to the temperature dependent inversion of the rings. The split signals of (**6a**) coalesced completely at 110 °C to give a simple spectrum: δ, [$^2H_8$]toluene, 5.12 (1H, dd, 3-H), 5.55 (1H, d, 5-H), 5.73 (1H, dd, 4-H), and 6.79 (1H, d, 2-H), 1.23 and 4.23 (3H, t, and 2H, q, CO_2Et), 6.8—8.1 (4H, m, Ar-H); $J_{2,3}$ 4.5, $J_{3,4}$ 2.5, and $J_{4,5}$ 9 Hz. However, (**6b**) was converted into (**7b**) at 100—110 °C, and thus the structure of (**6b**) including the position of the methyl group was inferred from that of (**7b**): m.p. 106—107 °C; i.r. ν (KBr) 1750 (C=O) cm^{-1}; ^1H n.m.r. δ ($CDCl_3$) 2.48 (3H, s, 4-Me), 6.57 (1H, d, *J* 4 Hz, 3-H), 7.65 (1H, d, *J* 4 Hz, 2-H), and 7.4—8.0 (4H, m, Ar-H).

bond fission in the three-membered ring. The thermolysis of the oxiranes (**1**) may proceed *via* homolytic bond fission only at a high temperature to give the ring expansion products (**2**), while the aziridines (**3**) might undergo ionic bond cleavage at a lower temperature to afford the rearrangement products reported.

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References

1 For a review, see K. U. Ingold and J. C. Walton, *Acc. Chem. Res.*, 1986, **19**, 72.
2 R. A. Aitken, J. I. G. Cadogan, I. Gosney, B. J. Hamill, and L. M. McLaughlin, *J. Chem. Soc., Chem. Commun.*, 1982, 1164; H.-D. Martin, H. Höchstetter, and A. Steigel, *Tetrahedron Lett.*, 1984, **25**, 297; J. Kurita, K. Iwata, M. Hasebe, and T. Tsuchiya, *J. Chem. Soc., Chem. Commun.*, 1983, 941; J. Kurita, K. Iwata, H. Sakai, and T. Tsuchiya, *Chem. Pharm. Bull.*, 1985, **33**, 4572; J. Kurita, H. Sakai, and T. Tsuchiya, *J. Chem. Soc., Chem. Commun.*, 1985, 1769.
3 J. Kurita, S. Yamada, H. Sakai, and T. Tsuchiya, *J. Chem. Soc., Chem. Commun.*, 1985, 1254.
4 H. Igeta, H. Arai, H. Hasegawa, and T. Tsuchiya, *Chem. Pharm. Bull.*, 1975, **23**, 2791.
5 W. Lwowski and T. J. Maricich, *J. Am. Chem. Soc.*, 1965, **87**, 3630; M. Seno, T. Namba, and H. Kise, *J. Org. Chem.*, 1978, **43**, 3345.