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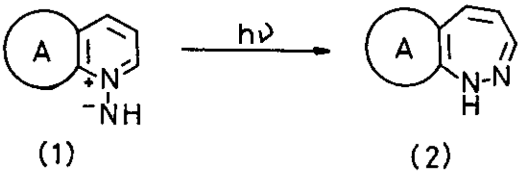
PHOTOLYSIS OF THIENO[2,3-c]PYRIDINE N-IMIDES: FORMATION OF NOVEL 1,3- AND 2,3-THIENODIAZEPINES

Takashi Tsuchiya,* Michiko Enkaku, and Hiroyuki Sawanishi

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

Abstract —— Photolysis of the 7-methyl-thieno[2,3-c]pyridine N-imides (3) resulted in rearrangements with ring-expansion to give 1H-1,3- (4) and 3H-2,3- (5) thieno[2,3-d]diazepines, which are previously unknown heterocyclic ring systems.

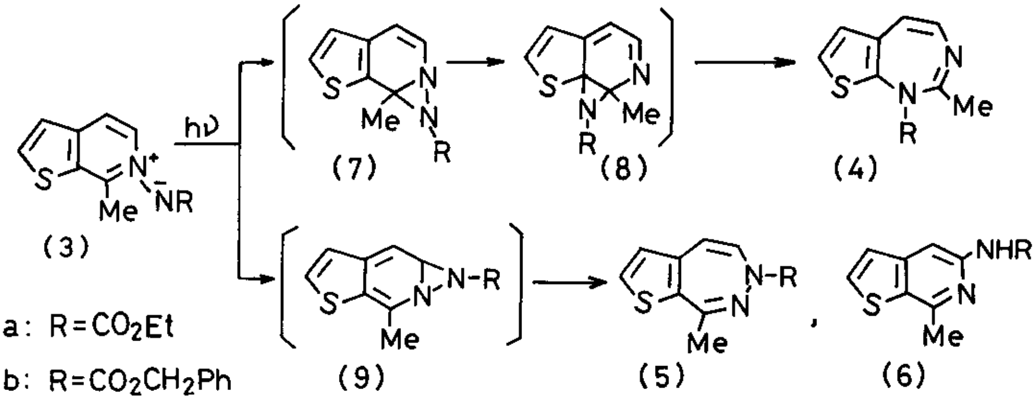
In connection with the photochemistry of monocyclic pyridine N-imides,[1] we were interested in examining the photochemical behaviour of condensed pyridine N-imides and have reported that quinoline[2] and their related fused pyridine[3] N-imides (1) undergo the photochemical rearrangement with ring-expansion to give the corresponding new fused 1H-1,2-diazepines (2). Very recently, we have shown[4] that the photolysis of 1-substituted isoquinoline N-imides gave 1H-1,3-benzodiazepines by a two-step rearrangement. Whereas this type of rearrangement has been reported in the photolysis of aromatic amine N-oxides such as quinoline,[5] isoquinoline,[6] and quinazoline[7] N-oxides, which give the corresponding oxazepines and oxadiazepines, the above result of the isoquinoline N-imides had been the first example for amine N-imides. Therefore, we examined the photochemical behaviour of the title N-imides.



A: Benzene, pyridine,
Thiophene, Furan,
Pyrrole, etc.

Scheme 1

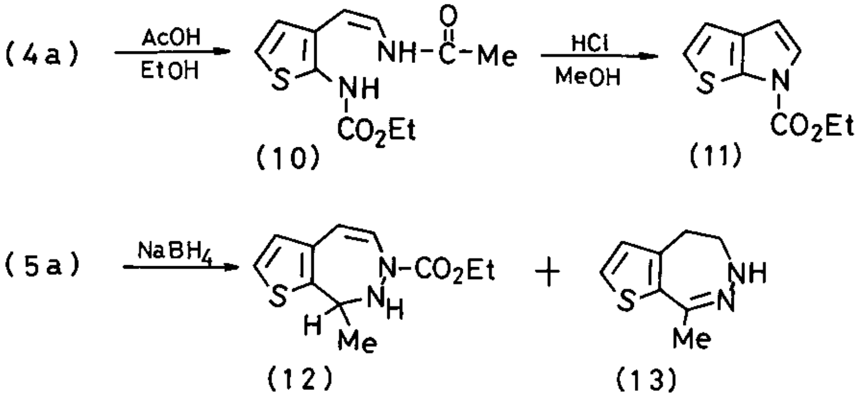
Irradiation (400 W, high-pressure Hg lamp; Pyrex filter) of the 7-methylthieno[2,3-c]pyridine N-imides (3a,b)[8] for ca. 3 hr in methylene chloride and chromatography on silica gel gave the 1H-1,3-thienodiazepines (4a: 7-8%, 4b: 10%), the 3H-2,3-thienodiazepines (5a: 30%, 5b: 55%), and the 5-aminothienopyridines (6a,b: 3-5%).[9] However, similar irradiation of 7-unsubstituted thieno[2,3-c]pyridine N-imides gave only 7-aminothieno[2,3-c]pyridines and no diazepines.



Scheme 2

The spectral data of the new diazepines and the results of the following chemical studies are consistent with the proposed structures. Treatment of the 1,3-diazepine (4a) with ethanol or methanol in the presence of acetic acid gave the ring-opened product (10: 65%),[10] which was then treated with hydrogen chloride to give 1-ethoxycarbonyl-thieno[2,3-b]pyrrole (11: 60%).[11] These results are analogous to those observed for 1,3-benzodiazepines[4] and 1,3-benzoxazepines.[6] However, similar treatment of the 2,3-diazepine (5a) resulted in recovery of the starting material unchanged. Reduction of 5a with sodium borohydride in ethanol afforded the 1,2-dihydro compound (12: 27%) and the 4,5-dihydro compound (13: 34%).

The present photolysis may involve the initial formation of two kinds of diaziridine intermediates, (7) and (9), as shown in Scheme 2. The former (7) may then rearrange into the aziridines (8) by a [1,5] sigmatropic shift, followed by ring-expansion to give the 1,3-diazepines (4), by analogy with the case of 1-unsubstituted quinoline N-imides.[4] The latter intermediates (9) may give the ring-expanded 2,3-diazepines (5) and the 5-aminothienopyridines (6), similar to



Scheme 3

the cases of monocyclic pyridine N-imides.[1]

The photolysis of N-imides of monocyclic pyridines, even though 2,6-disubstituted pyridines, give only 1,2-diazepines and no other diazepines.[1] Whereas 2-substituted quinolines and related fused pyridines give no diazepines,[2,3] 1-substituted isoquinolines give 1,3-diazepines and no 1,2- or 2,3-diazepines.[4] However, the present photolysis affords two kinds of diazepines. It should be noted that the photochemical behaviour of the thienopyridines is different from those of monocyclic pyridines, quinolines, and isoquinolines. Further work is needed to clarify these differences and related works are in progress.

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References and Footnotes

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8) The N-amides (**3a**: mp 188-189°, **3b**: 153-154°) were prepared from 7-methylthieno[2,3-c]pyridine (M.L. Dressler and M.M. Joullie, *J. Heterocyclic Chem.*, 1970, **7**, 1257) by successive N-amination with O-mesitylenesulfonylhydroxylamine, acylation, and base treatment.

9) Satisfactory elemental analyses and spectral data (mass, n.m.r., and i.r.) were obtained for all new compounds reported. For examples, **4a**: oil, ν(liq.) 1720 cm^{-1}, δ ($CDCl_3$) 1.22 and 4.14 (3H, t, and 2H, q, CO_2Et), 2.66 (3H, s, 2-Me), 6.22 (1H, d, J=8 Hz, 5-H), 6.78 (1H, d J=8 Hz, 4-H), 6.68 and 7.58 (each 1H, d J=5 Hz, thiophene-H). **5a**: mp 88-89°, ν (KBr) 1700 cm^{-1} (C=O), δ ($CDCl_3$) 1.31 and 4.27 (3H, t, and 2H, q, CO_2Et), 2.37 (3H, s, 1-Me), 6.20 (1H, d J=7 Hz, 5-H), 6.34 (1H, d, J=7 Hz, 4-H), 6.90 and 7.40 (each 1H, d J=5 Hz, thiophene-H). **6a**: mp 87-88°, ν (KBr) 1730 cm^{-1} (C=O), δ ($CDCl_3$) 1.23 and 4.23 (3H, t, and 2H, q, CO_2Et), 2.62 (3H, s, 7-Me), 7.24 and 7.56 (each, d J=5 Hz, thiophene-H), 8.14 (1H, s, 4-H), 8.10 (1H, br, NH). **4b**: oil. **5b**: mp 114-115°. **6b**: mp 179-180°.

10) Compound (**10**): mp 153-154°, ν (KBr) cm^{-1} 3250 and 3300 (NH), 1710 and 1670 (C=O), δ ($CDCl_3$) 1.28 and 4.20 (3H, t, and 2H, q, CO_2Et), 2.00 (3H, s, COMe), 5.24 (1H, d J=9 Hz, $-C\underline{H}=CH-N$), 6.98 (1H, d J=9 Hz, $-CH=C\underline{H}-N$), 6.70 and 6.90 (each 1H, d J=5 Hz, thiophene-H).

11) Compound (**11**): oil, ν (liq.) 1740 cm^{-1}, δ ($CDCl_3$) 1.44 and 4.50 (3H, t, and 2H, q, CO_2Et), 6.56 (1H, d J=5 Hz, 3-H), 7.00 (1H, d, J=5 Hz, 4-H), 7.06 (1H, d J=5 Hz, 5-H), 7.44 (1H, d J=5 Hz, 2-H).

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