PREPARATION OF ETHYL 1-ARYL-2-(2-PYRIDYL)ETHENYLCARBAMATES AND THEIR BIOLOGICAL ACTIVITIES

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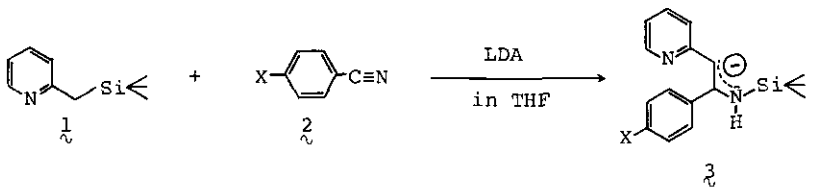
Abstract —— Anions of *N*-silylenamines, generated from 2-(trimethylsilylmethyl)pyridine and *p*-substituted benzonitriles in the presenc of LDA, reacted with ethyl chloroformate to give a mixture of ethyl (*E*)- and (*Z*)-1-aryl-2-(2-pyridyl)ethenylcarbamates. Their insecticidal or fungicidal properties were evaluated.

In the course of our investigations on the reactions of α-silylcarbanions with carbonyl compounds or their analogs, we have reported three results. Lithiated 2-(trimethylsilylmethyl)pyridine (1) reacts with imines to give (*E*)-2-alkenylpyridines stereospecifically;[1] it reacts with benzonitrile (2a) to give (*E*)-1-phenyl-2-(2-pyridyl)-1-(trimethylsilylamino)ethene, (*E*)-3a, under kinetically controlled conditions; but (*Z*)-3a was predominantly obtained under thermodinamically controlled conditions.[2] These *N*-silylenamines are ambident nucleophiles possessing N and C atoms as reaction centers, and are expected to become a useful material for synthetic organic chemists. We have found that these *N*-silylenamines reacts with ethyl chloroformate to afford ethyl carbamate derivatives, which are expected to show strong biological activities.[3] Here we report this reaction of *N*-silylenamines with etyl chloroformate and biological properties of the products as an insecticide or a fungicide.

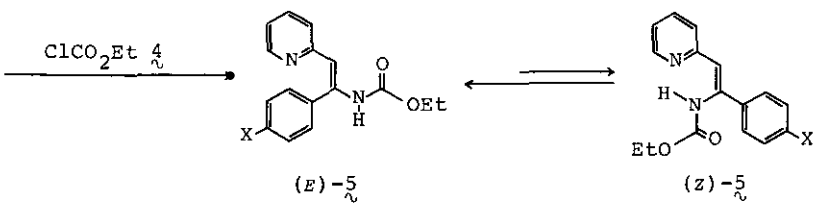
The *N*-silylenamines, 1-aryl-2-(2-pyridyl)-1-(trimethylsilylamino)ethenes (3a) ∿ (3d), were generated from 1 and *p*-substituted benzonitriles, (2a) ∿ (2d), according to the procedure reported previously.[2] The resulting reaction mixtures without further purification were allowed to react with ethyl chloroformate (4) to afford the final products: ethyl 1-aryl-2-(2-pyridyl)ethenylcarbamates (5a) ∿ (5d) in moderate yields (Eq. 1). Generally, a 8 : 2 mixture of (*E*)- and (*Z*)-5 was obtain-

ed. The results are summarized in Table 1. In this one-pot reaction, a considerable amount of 3 was formed together with 5. This low reactivity of 3 was in agreement with the fact that 3a, purified by distillation,[2] also gave a small amount of 5a (16%) together with a large amount of phenacylpyridine (42%), which was formed from the unreacted 3a by hydrolysis[2,4] during a column chromatography on silica gel.



1 2 3

(Eq. 1)



(E)-5 (Z)-5

Table 1. Yields and physical properties of 5

	X	Yield[a] (%)	Mp (°C)	(from)	E : Z [b]
a	H	38	138.5 - 139.3	(benzene)	80 : 20
b	Cl	13	149.3 - 150.5	(ligloin)	75 : 25
c	CH_3	21	133.4 - 134.4	(ligloin)	81 : 19
d	OCH_3	33	155.3 - 156.3	(ligloin)	80 : 20

a) Determined by hplc (SiO_2). b) Determined by ^{1}H-nmr.

The structure of 5 was spectrometrically determined.[5,6,7,8] For example, the ms of 5a shows a molecular ion (M^+) peak at m/z 268 (molecular weight 268), and the ^{1}H-nmr spectrum of 5a consists of two kinds of ethyl groups (δ 0.7, 0.6H and 3.7, 0.4H for the z-isomer; δ 1.1, 2.4H and 4.1, 1.6H for the E-isomer)[9] and singlet-like phenyl protons of the E-isomer, complicated with two ABCX systems for the 2-pyridyl protons, alkenyl protons, N-H protons, and multiplet phenyl protons of the z-isomer. By adding deuterium oxide, the N-H protons disappeared. Furthermore,

neither a methylene group nor a methine group was observed in either ^{1}H-nmr or ^{13}C-nmr. The ir spectrum of 5a, measured in KBr disk, suggested the presence of the enamine system (ν_{NH} 3350 cm^{-1} and $\nu_{C=C}$ 1620 cm^{-1}) together with the ester group ($\nu_{C=O}$ 1645 cm^{-1}). No absorption due to a C=N bond was observed. These facts suggest that ethoxycarbonylation did not occur on the C atom, but rather on the N-atom of the enamine system. That is, this reaction is a kind of an aminolysis of 4 by the *N*-silylenamine 3. This differs from a result reported for a reaction of 3a with phenacyl bromide.[10]

Biological activities[11] of 5b and 5d as a herbicide, an insecticide, or a fungicide were evaluated. The *p*-chloro derivaive, 5b, showed a strong insecticidal activity against adult small brown planthoppers, *Laodelphax steriatellus* Fallen on rice plant seedlings, which were dipped in the sample solution (1000 ppm) and dried in air (mortality after 48 h, 70%); while that of the *p*-methoxyl derivative (5d) was lower (50%). Neither 5b nor 5d showed any insecticidal activity at all against other insects employed (house flies, *Musca domestica* (L.); azuki been weevil, *Callosobruchus* chinensis Linne; larvae of common cutworms, *Spodoptera litura* Fabricius; two-spotted spider mites, *Tetranychus urticae* Koch; southern root-knot nematodes, *Meolidogyne incognita* Kofoid et White). In addition, 5b showed a fungicidal activity, *in vivo*, against stem rot of beans by *Sclerotinia sclerotiorum* (disease-control rate was 50% using a 500 ppm solution of 5b). The other, 5d, however, showed no activity as a fungicide, and no herbicidal activity was found in 5b or 5d.

In a typical run, 20 mmol of 1 was lithiated with 20 mmol of LDA in THF at -75 °C and the resultant solution was treated with 20 mmol of 2 at -75 °C. The resultant mixture was stirred for 1 h at -75 °C and for 2 h at room temperature,[2] followed by treatment with 20 mmol of 4 at -75 °C (exothermic). After stirring for 1 h at -75 °C and for 2 h at room temperature, the reaction mixture was quenched with 50 ml of water at 0 °C, and then completely extracted with ether. The extract was dried over Na_2SO_4, and evaporated *in vacuo*. The residue was recrystallized from an appropriate solvent to give a pure product.

REFERENCES AND NOTES

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4. T. Konakahara and Y. Takagi, *Heterocycles*, 1980, 14, 393.

5. All new compounds gave satisfactory results for C, H, N analyses. 5a: ir(KBr) 3350(ν_{NH}), 1645($\nu_{C=O}$), 1620 cm^{-1} ($\nu_{C=C}$); ^{1}H-nmr(60 MHz, $CDCl_3$) δ 0.7(0.6H, t, $-CH_3$ of the *Z*-isomer), 1.1(2.4H, t, $-CH_3$ of the *E*-isomer), 3.7(0.4H, q, $-CH_2-$ of the *Z*-isomer), 4.1(1.6H, q, $-CH_2-$ of the *E*-isomer), 6.3 ∿ 8.4(11H, singlet-like Ph-H of the *E*-isomer, multiplet Ph-H of the *Z*-isomer, and two ABCX systems for 2-Py-H complicated with =CH and NH); ms(70 eV) m/z(rel intensity) 268(M^+, 44), 267(76), 222(18), 221(100), 119(61).

6. 5b: ir(KBr) 3310(ν_{NH}), 1660($\nu_{C=O}$), 1630 cm^{-1} ($\nu_{C=C}$); ^{1}H-nmr(60 MHz, $CDCl_3$) δ 0.6[0.8H, t, $-CH_3$(*Z*)], 1.1[2.2H, t, $-CH_3$(*E*)], 3.5[0.5H, q, $-CH_2-$(*Z*)], 4.0 [2.5H, q, $-CH_2-$(*E*)], 6.4 ∿ 8.3(10H, m, Py-H, ph-H, =CH, and NH); ms(70 ev) m/z(rel intensity) 302(M^+, 47), 301(72), 255(100), 119(54).

7. 5c: ir(KBr) 3370(ν_{NH}), 1650($\nu_{C=O}$), 1610 cm^{-1} ($\nu_{C=C}$); ^{1}H-nmr(60 MHz, $CDCl_3$) δ 0.7[0.6H, t, $-CH_3$(*Z*)], 1.1[2.4H, t, $-CH_3$(*E*)], 2.1[2.4H, s, Ph-CH_3(*E*)], 2.3[0.6H, s, Ph-CH_3(*Z*)], 3.7[0.4H, q, $-CH_2-$(*Z*)], 4.0[1.6H, q, $-CH_2-$(*E*)], 6.0 ∿ 8.4(10H, m, Py-H, Ph-H, =CH, and NH); ms(70 eV) m/z(rel intensity) 282(M^+, 48), 281(65), 235(100), 119(59).

8. 5d: ir(KBr) 3350(ν_{NH}), 1645($\nu_{C=O}$), 1620 cm^{-1} ($\nu_{C=C}$); ^{1}H-nmr(60 MHz, $CDCl_3$) δ 0.8[0.6H, t, $-CH_3$(*Z*)], 1.2[2.4H, t, $-CH_3$(*E*)], 3.4 ∿ 5.4(5H, m, $-CH_2-$ and $-OCH_3$), 6.0 ∿ 8.6(10H, m, Py-H, Ph-H, =CH, and NH); ms(70 eV) m/z(rel intensity) 298(M^+, 66), 297(71), 251(100), 119(47).

9. The configuration of 5 was determined by a comparison of the spectral data of (*E*)- and (*Z*)-3a reported in ref. 2. in addition, the ir spectra of 5a in cyclohexane suggested the presence of two isomers(ν_{NH} 3500, 3300 cm^{-1}), which were analyzed by hplc using a column of silver nitrate on silica gel support (*E* : *Z* = 8 : 2).

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11. Evaluation of biological activities of these compounds was performed at SDS Biotech K.K. Tokyo Research Laboratory.

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