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Studies on Tandem Transesterification and Intramolecular Cycloaddition of Nitrones. 1. Sequential Bicyclization of α-Methoxycarbonylnitrones with Allyl Alcohols

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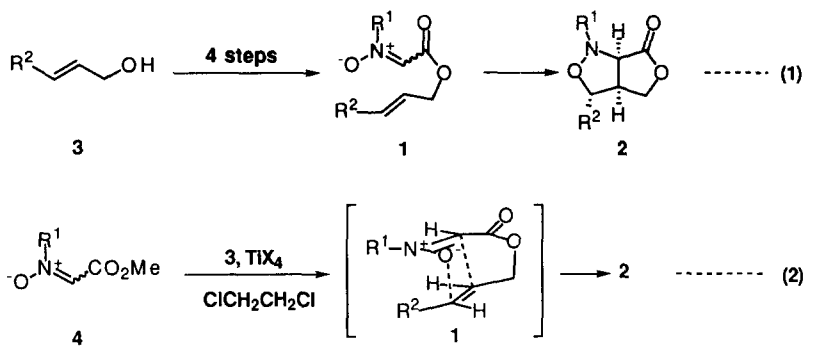
Abstract: Treatment of α-methoxycarbonylnitrones with 5 equiv. of allyl alcohols in the presence of 1 equiv. of titanium tetraisopropoxide causes tandem transesterification, *E,Z*-isomerization of the nitrone moieties, and intramolecular cycloaddition to afford bicyclized compounds in one step. To reduce amounts of allyl alcohol, combined use of a catalytic amount of titanium tetraisopropoxide and molecular sieves 4A was found to be a more improved catalytic system. It was also found that reactions of (*Z*)-allyl alcohols with α-methoxycarbonylnitrone are more facile than those of (*E*)-allyl alcohols. This aspect was extended to geometry differentiated cycloaddition.

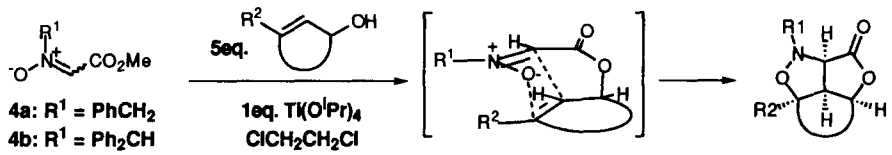
Intramolecular cycloaddition of nitrones bearing olefin moieties in the molecules has been widely recognized as a very useful method for stereoselective construction of nitrogen containing carbon frameworks.[1] The cycloaddition features high regioselectivity and stereospecificity which reflect geometry of the olefin moieties. In this category, cycloaddition of α-allyloxycarbonylnitrones (**1**) is also very attractive, since it gives relative stereochemically controlled cycloadducts (**2**) in one step.[2] However, synthesis of **1** requires at least four steps from starting allyl alcohols (**3**): α-bromoacetylation of **3**, substitution of the allyl bromoacetates with silver nitrate, treatment of the resulting nitrate esters with dimethylsulfoxide and sodium acetate and condensation of the



resulting glyoxylate with *N*-alkylhydroxylamine (eq. 1). This multi-step synthesis has been a significant drawback for use of the cycloaddition of **1**. On the other hand, efficient transesterification[3] might make possible tandem transformation[4] of **3** to **2**. Thus, transesterification of readily available α-methoxycarbonylnitrone (**4**) with **3** would provide **1**, which in turn could cycloadd intramolecularly to give **2** in the reaction system (eq. 2). Along this line, we recently reported that treatment of 4 with allyl alcohols (**3**) in the presence of titanium tetraisopropoxide causes tandem transesterification, *E,Z*-isomerization of the nitrone moieties, and intramolecular cycloaddition to give bicyclized products in one step.[5] We present here a full account of this work and additional studies on improvement of the reaction conditions and geometry differentiated cycloaddition.

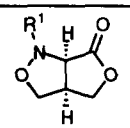
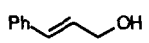
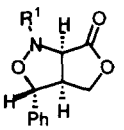
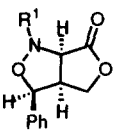
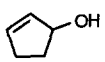
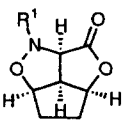
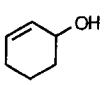
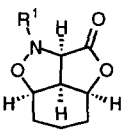
Results and Discussion

The starting nitrones (**4a,b**)[6a] were readily prepared from methyl glyoxylate and benzyl- or benzhydrylhydroxylamine by known method. As reported,[6a] the nitrones (**4a,b**) were equilibrating mixtures of (*E*)- and (*Z*)-forms in solution (**4a**, 1.6 : 1; **4b**, 1.1 : 1 *E, Z*-equilibrating mixture in $CDCl_3$, respectively).



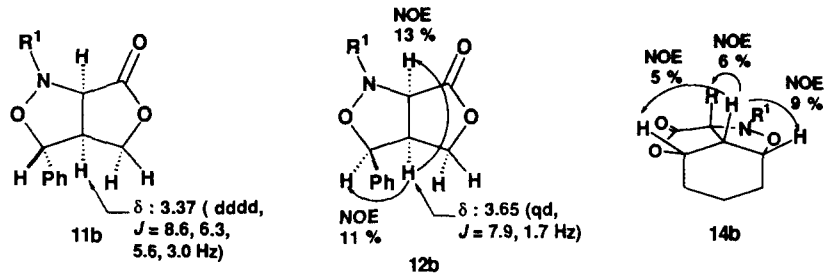
4a: $R^1 = PhCH_2$
4b: $R^1 = Ph_2CH$

Table 1 Reaction of **4** with **5-9** in the presence of titaninum tetraisopropoxide.

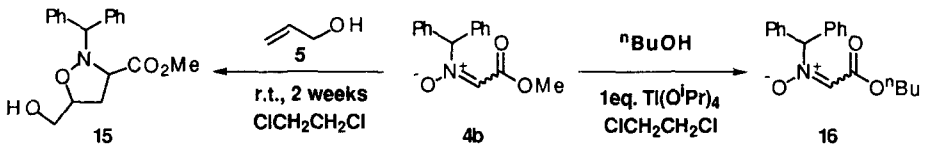
Entry	Nitrone	Allyl Alcohol	Conditions	Yield (%)	Product
1	4a	 5	r.t., 20 h	59	 10a
2	4b		r.t., 5 h	74	10b
3	4a	 6	50 °C, 5 h	75	 11a
4	4b		45 °C, 14h	78	11b
5	4a	 7	50 °C, 2 h	97	 12a
6	4b		55 °C, 2.5 h	89	12b
7	4a	 8	50 °C, 11 h	70	 13a
8	4b		45 °C, 14 h	99	13b
9	4a	 9	r.t, 9 h	45	 14a
10	4b		r.t., 34 h	77	14b

Treatment of the nitrones (**4a,b**) with 5 equiv. of allyl alcohols (**5-9**) in the presence of 1 equiv. of titanium tetraisopropoxide gave bicyclized compounds (**10a,b-14a,b**) in one step. The results are listed in **Table 1**. The reaction of **4a** with **5** smoothly proceeded at room temperature to afford **10a** in 59% yield (entry 1). The reaction of the nitrone (**4b**) having a more bulky substituent on the nitrogen atom gave **10b** in even better yield (entry 2). In the present cycloaddition, the geometry of allyl alcohols is reflected in the products. Thus, the use of (*E*)-cinnamyl alcohol (**6**) exclusively afforded 4,5-*trans*-stereochemistry on the isoxazolidine ring (entries 3,4) and the use of (*Z*)-cinnamyl alcohol (**7**) gave 4,5-*cis*-stereochemistry on the isoxazolidine ring of the products (entries 5,6). In the cases employing cyclic allyl alcohols (**8,9**), the reactions could control four relative stereogenic centers in one step (entries 7-10). The structures of cycloadducts (**10a,b-12a,b**) were confirmed by ^{1}H-NMR spectra including NOE experiments of **12b** and **14b** as shown in **Fig 1**.

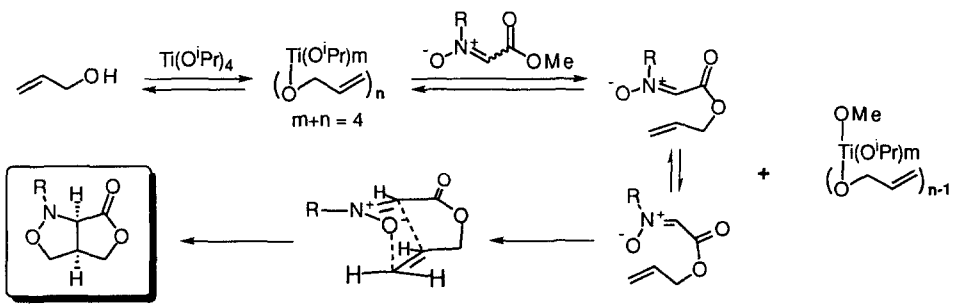
Fig 1.



In sharp contrast to the reactions shown in **Table 1**, the reaction **4b** with **5** in the absence of titanium tetraisopropoxide took place quite slowly (over at least two weeks) at room temperature to give cycloadduct (**15**) having the opposite regiochemistry as a 1:1 mixture of diastereomers in 70 % yield (compare with entry 2). Furthermore, treatment of **4b** with *n*-butanol in the presence of titanium tetraisopropoxide gave α-*n*-butyloxycarbonylnitrone (**16**). These facts clearly show that the cycloaddition in the presence of titanium tetraisopropoxide should occur by way of tandem transesterification, *E,Z*-isomerization of nitrone moiety, and



Scheme 1

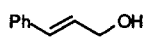
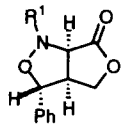
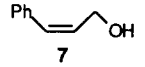
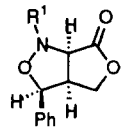
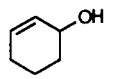
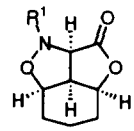


intramolecular cycloaddition instead of intermolecular cycloaddition and lactonization. Possibility of intramolecular cycloaddition from (*E*)-nitrone would be neglected due to the high strain in the transition state. The possible mechanism of the tandem process is shown in **Scheme 1**.[7]

Improvement of the reaction conditions

Although the desired tandem process of α-methoxycarbonylnitrones with allyl alcohols could be explored as mentioned above, the process required large excess of allyl alcohols. This may be a disadvantage when valuable allyl alcohols such as homochiral allyl alcohols were employed for the process. To solve this problem, more practical reaction conditions were sought. After experimentation, combined use of a catalytic amount of titanium tetrachloride and molecular sieves 4A (MS 4A) was found to be very effective for the tandem reaction as shown in **Table 2**. Thus, treatment of 1.0 equiv. of nitrone (**4a,b**) with 1.5 equiv. of allyl alcohols (**6,7,9**) in the presence of 0.1 equiv. of titanium tetrachloride gave the same products (**11b, 12b, 14a,b**) (entries 1-4). The reaction of (*Z*)-cinnamyl alcohol (**7**) was cleaner and gave higher yield than that of (*E*)-alcohol (**6**) (entry 1 vs. entry 2). In the cases of entries 2-4, the yields were excellent (compare with **Table 1**, entries 6,9,10). MS 4A seems to be essential for smooth reaction, since the reaction in the absence of MS 4A proceeded quite slowly (entry 5 vs. entry 6). Furthermore, the present condition is even better than that employing organotin catalyst which is known[3c] as an efficient catalyst for transesterification (entry 7 vs. entry 8).

Table 2 Tandem transesterification and intramolecular cycloaddition of **4** with 1.5 eq. of allyl alcohols.[a)]

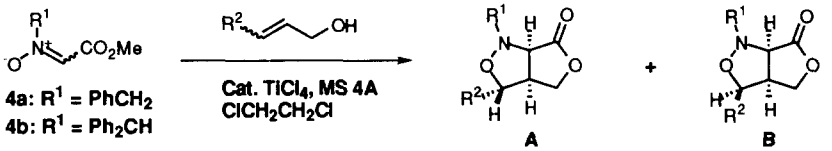
Entry	Nitrone	Allyl Alcohol	Conditions	Yield (%)	Product
1	4b	 **6**	50 °C, 11 h	65	 **11b**
2	4b	 **7**	50 °C, 1 h	99	 **12b**
3	4a	 **9**	r.t., 19 h	97	 **14a**
4	4b		50 °C, 2.5 h	96	**14b**
5	4b	9	r.t., 23 h	78	14b
6	4b	9	r.t., 79 h[b)]	21[c)]	14b
7	4b	9	toluene, r.t., 10 h	96	14b
8	4b	9	0.1eq. $(SCN^nBu_2Sn)_2O$ MS4A, toluene, r.t., 12 h	87	14b

a) Unless otherwise noted, all the reactions were carried out by employing 1.0 eq. of **4** and 1.5 eq. of **6,7,9** in the presence of 0.1 eq. of titanium tetrachloride and MS 4A in 1,2-dichloroethane. b) Without MS 4A. c) The yield was estimated by the ^{1}H-NMR spectrum of the reaction mixture after workup.

Efficiency of this catalytic system might be explained by the ease of formation of intermediate, titanium allyloxide.[8] MS 4A would serve for trapping methanol and hydrogen chloride generated as the reaction proceeds.[9]

Geometry differentiated cycloaddition

The fact that the reaction of **4** with (*Z*)-cinnamyl alcohol is much faster and cleaner than that with (*E*)-cinnamyl alcohol prompted us to develop a preparation method for cycloadducts of (*Z*)-allyl alcohols from a geometrical mixture of allyl alcohols, namely, geometry differentiated cycloaddition. As shown in **Table 3**, the geometry differentiated cycloaddition was investigated by employing a mixture of cinnamyl alcohol (entries 1,2) and crotyl alcohol (entries 3-5). Reaction of **4a** with 3 equiv. of cinnamyl alcohol (*E* : *Z* = 52 : 48) proceeded



4a: $R^1 = PhCH_2$
4b: $R^1 = Ph_2CH$

Table 3 Reactions of **4a,b** with geometrical mixtures of allyl alcohols in the presence of titanium catalyst.[a)]

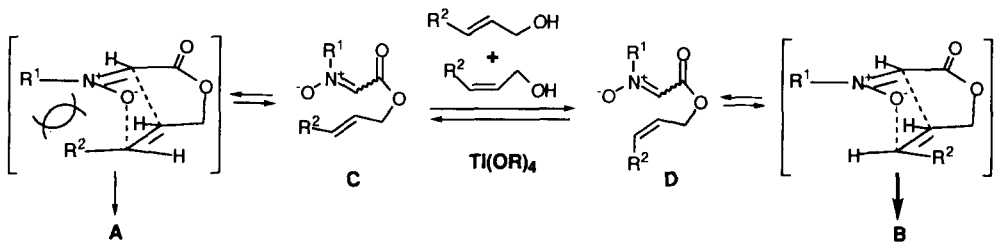
Entry	Nitrone	Allyl Alcohol	Conditions	Yield (%) Ratio (A : B)[b)]	Product	Recovered Allyl Alcohol (*E* : *Z*)[c)]
1	4a	R^2 = Ph *E* : *Z* = 52 : 48 [3 eq., (*Z*)-isomer, 1.44 eq.]	r. t., 22 h	55 (14 : 86)	11a and 12a	64 : 36
2	4b	R^2 = Ph *E* : *Z* = 52 : 48 [3 eq., (*Z*)-isomer, 1.44 eq.]	r. t., 20 h	86 (7 : 93)	11b and 12b	75 : 25
3	4a	R^2 = Me *E* : *Z* = 86 : 14 [8.3 eq., (*Z*)-isomer, 1.16 eq.]	$Ti(O^iPr)_4$, 1 eq. 50 °C, 4 h	77 (15 : 85)	17aA and 17aB (R^1 = $PhCH_2$, R^2 = Me)	------[d)]
4	4a	R^2 = Me *E* : *Z* = 86 : 14 [10 eq., (*Z*)-isomer, 1.4 eq.]	r. t., 45 h	82 (13 : 87)	17aA and 17aB	96 : 4
5	4b	R^2 = Me *E* : *Z* = 86 : 14 [10 eq., (*Z*)-isomer, 1.4 eq.]	r. t., 40 h	77 (7 : 93)	17bA and 17bB	------[d)]

a) Unless otherwise noted, all the reactions were carried out employing **4** (1 equiv.), titanium tetrachloride (0.1 equiv.), and MS 4A. b) The ratios were estimated based on the ^{1}H-NMR spectra of the crude mixtures. c) The ratios were obtained from the GLC analyses. d) Not determined.

cis-selectively to give a 14 : 86 mixture of **11a** (**A** type product) and **12a** (**B** type product) in moderate yield (entry 1). The *cis*-selectivity was increased by using nitrone (**4b**) bearing a more bulky substituent on the nitrogen atom (entry 2). In the cases employing a geometrical mixture of crotyl alcohol, this tendency appeared to be more clearer. Thus **4a** reacted with 8.3 equiv. of crotyl alcohol (*E* : *Z* = 86 : 14) in the presence of 1 equiv. of titanium tetraisopropoxide to give a 15 : 85 mixture of cycloadducts (**17aA** and **17aB**) (entry 3). The ratio of the products (**17aA** and **17aB**) is an apparently reversal of that of starting crotyl alcohol. Combined use of titanium tetrachloride and MS 4A gave slightly higher selectivity (entry 4). As observed in the cases employing cinnamyl alcohol, **4b** efficiently differentiated the geometry of crotyl alcohols to afford **17bA** and **17bB** in high selectivity (**17bA** : **17bB** = 7 : 93) (entry 5).

In these reactions, geometrical isomerization of allyl alcohol did not occur since independent reactions of **4** with (*E*)- or (*Z*)-allyl alcohol are absolutely stereospecific (**Table 1**, entries 3-6; **Table 2**, entries 1,2). In addition, the ratios of recovered allyl alcohols show a decrease of (*Z*)-isomers. These results clearly show that (*Z*)-allyl alcohol predominantly reacted with **4**. These phenomena may be rationalized by considering equilibrium on transesterification as shown in **Scheme 2**. Thus, nitrones (**4**) initially produce **C** and **D** by transesterification with (*E*)- and (*Z*)-allyl alcohols, and the **C** and **D** equilibrate each other *via* transesterification with (*Z*)- and (*E*)-allyl alcohol, respectively. In the intramolecular cycloaddition steps, **C** has a steric interaction between $\mathbf{R^1}$ and $\mathbf{R^2}$. As a result, the intramolecular cycloaddition mainly proceeds from **D** *via* the equilibrium, giving **B** type cycloadducts predominantly. Accordingly, **4b** having bulky $\mathbf{R^1}$ group more efficiently selects (*Z*)-allyl alcohol than **4a** due to the severe steric interaction.

Scheme 2



Conclusion

As stated above, we have developed tandem transesterification and intramolecular cycloaddition of α-methoxycarbonylnitrone with allyl alcohols. The tandem process was successfully extended to geometry differentiated cycloaddition of geometrical mixture of allyl alcohols. The process used in this study might facilitate access to various nitrogen containing natural products.

Experimental

General. All melting points were determined with a Yanagimoto MP-21 melting point apparatus and were uncorrected. Infrared (IR) spectra were recorded on a Hitachi 270-30, and a Shimadzu FTIR-8100 spectrometer. ^{1}H-NMR spectra were measured with a JEOL JNM-EX270 (270 MHz), and a JEOL JNM-EX400 (400 MHz) spectrometer. The chemical shifts are expressed in ppm downfield from tetramethylsilane, using tetramethylsilane (δ = 0) and/or residual chloroform (δ = 7.25) as an internal standard. Splitting patterns are indicated as s, singlet; d, doublet; t, triplet; q, quartet; m, multiplet; br, broad signal. Mass spectra were taken with a JEOL JMS-DX302 mass spectrometer. Unless otherwise noted, all experiments were carried out under an atmosphere of dry argon

using anhydrous solvents. GLC analyses were performed on a Shimadzu GC-14A using a capillary column (OV-1, 0.2 mm x 25 m). For thin layer chromatographic (TLC) analyses, Merck precoated TLC plates (silica gel 60 F254, 0.25 mm, Art 5715) were used. The following abbreviations were used for solvents: tetrahydrofuran (THF), diethyl ether (Et_2O), ethyl acetate (AcOEt), methanol (MeOH), and dichloromethane (CH_2Cl_2).

Methyl [(Phenylmethyl)imino]acetate *N*-Oxide (4a). This (218 mg, 81%) was prepared from *N*-benzylhydroxylamine[10] (171 mg, 1.4 mmol) and methyl glyoxylate[11] (157 mg, 1.8 mmol) in refluxing benzene (4 ml) employing Dean-Stark trap. mp: 89-92 °C (recrystallized from hexane-AcOEt). (*lit.*[6a], mp: 90-92 °C).

Methyl[(Diphenylmethyl)imino]acetate *N*-Oxide (4b) This (1.62 g, 78%) was prepared from *N*-diphenylmethylhydroxylamine[12] (1.53 g, 8.8 mmol) and methyl glyoxylate (0.778 g, 8.8 mmol) by the same procedure as that for **4a**. mp: 133.5-134 °C (recrystallized from hexane-AcOEt). (*lit.*[6a], mp: 131.5-132.5 °C).

General Procedure A: Reactions of the Nitrones (4a,b) with Allyl Alcohols (5-9) in the Presence of Titanium Tetraisopropoxide (Table 1). To a stirred solution of **4** (15 mg: **4a**, 0.078 mmol; **4b**, 0.056 mmol) in 1,2-dichloroethane (3 ml) was added successively titanium tetraisopropoxide (22 mg, 0.078 mmol for **4a**; 16 mg, 0.056 mmol for **4b**) and an allyl alcohol (0.39 mmol for **4a**, 0.28 mmol for **4b**) at room temperature. After stirring under the conditions indicated in Table 1, a small amount of water was added to the mixture, and the mixture was stirred for 1 h. The mixture was filtered through a pad of Celite, then the filtrate was diluted with water, extracted with dichloromethane, and dried over $MgSO_4$. After filtration, the filtrate was concentrated *in vacuo*. The residue was purified by column chromatography on silica gel to give a cyclized product.

General Procedure B: Reactions of the Nitrones (4a,b) with Allyl Alcohols (5-9) in the Presence of Titanium Tetrachloride and MS 4A (Table 2 and Table 3). To a stirred suspension of an allyl alcohol (0.39 mmol for **4a**, 0.28 mmol for **4b**) and MS 4A (100-150 mg) in 1,2-dichloroethane (3 ml) was added successively titanium tetrachloride (0.1 M solution in 1,2-dichloroethane, 78 μl, 0.078 mmol for **4a**; 56 μl, 0.056 mmol for **4b**) and a solution of **4** (15 mg: **4a**, 0.078 mmol; **4b**, 0.056 mmol) in 1,2-dichloroethane (0.5 ml) at room temperature. After stirring under the conditions indicated in Table 2 and Table 3, the same work up and purification as mentioned in General Procedure A gave a cyclized product.

(3a*S,6a*R**)-Tetrahydro-1-(phenylmethyl)-1*H*,6*H*-furo[3,4-*c*]isoxazol-6-one (10a) (Table 1, entry 1).** Following General Procedure A, this (11.0 mg, 59%) was obtained from **4a** (16.4 mg, 0.085 mmol), **5** (27 μl, 0.34 mmol), and titanium tetraisopropoxide (30 μl, 0.1 mmol) after purification by column chromatography on silica gel (CH_2Cl_2-ether, 10 : 1). mp: 163-164 °C (recrystallized from hexane-AcOEt). IR ($CHCl_3$) : 1782, 1221, 1210 cm^{-1}. ^{1}H-NMR ($CDCl_3$, 270 MHz) δ: 3.55 (1 H, ddddd, *J* = 10.2, 7.6, 8.4, 3.3, 3.0 Hz, C_{3a}-H), 3.92 (1 H, dd, *J* = 8.9, 3.0 Hz, C*H*H), 4.00 (1 H, dd, *J* = 10.2, 8.6 Hz, CH*H*), 4.05 (1 H, d, *J* = 13.2 Hz, PhC*H*H), 4.17 (1 H, d, *J* = 13.2 Hz, PhCH*H*), 4.27 (1 H, dd, *J* = 9.6, 3.3 Hz, C*H*H), 4.31 (1 H, d, *J* = 8.4 Hz, C_{6a}-H), 4.50 (1 H, dd, *J* = 9.6, 7.6 Hz, CH*H*), 7.26-7.44 (5 H, m, ArH). MS m/z: 219 (M^+, 19 %), 92 (10), 91 (100). HRMS m/z: Calcd for $C_{12}H_{13}NO_3$: 219.0896. Found: 219.0896.

(3a*R,6a*R**)-Tetrahydro-1-(diphenylmethyl)-1*H*,6*H*-furo[3,4-*c*]isoxazol-6-one (10b) (Table 1, entry 2).** Following General Procedure A, this (13.0 mg, 74%) was obtained from **4b** (16.0 mg, 0.059 mmol), **5** (22.5 mg, 0.39 mmol), and titanium tetraisopropoxide (0.087 mmol) after purification by column chromatography on silica gel (ether). mp: 214 °C (recrystallized from hexane-AcOEt). IR ($CHCl_3$): 3021, 1784, 1221 cm^{-1}. ^{1}H-NMR ($CDCl_3$, 270 MHz) δ: 3.52 (1 H, ddddd, *J* = 8.3, 7.5, 7.3, 2.6, 2.3 Hz, C_{3a}-H), 3.89 (1 H, dd, *J* = 9.2, 2.3 Hz, C*H*H), 4.13 (1 H, d, *J* = 8.3 Hz, C_{6a}-H), 4.26 (1 H, dd, *J* = 9.6, 2.6 Hz, CH*H*), 4.33 (1 H, dd, *J* = 9.0, 7.5 Hz, C*H*H), 4.43 (1 H, dd, *J* = 9.6, 7.3 Hz, CH*H*), 4.96 (1 H, br s, Ph_2CH), 7.17-7.37 (6 H, m, Ar-H), 7.5-7.58 (4 H, m, Ar-H). MS m/z: 295 (M^+, 2 %), 182 (10), 168 (16), 167 (100), 165 (20), 152 (11). HRMS m/z: Calcd for $C_{18}H_{17}NO_3$: 295.1209. Found: 295.1211.

(3*R,3a*R**,6a*R**)-Tetrahydro-3-phenyl-1-(phenylmethyl)-1*H*,6*H*-furo[3,4-*c*]isoxazol-6-one (11a) (Table 1, entry 3).** Following General Procedure A, this (19.9 mg, 85%) was obtained from **4a** (15.3 mg, 0.079 mmol), **6** (51 μl, 0.40 mmol), and titanium tetraisopropoxide (24 μl, 0.082 mmol) after purification by column chromatography on silica gel (CH_2Cl_2-ether, 20 : 1). mp: 91-92 °C (recrystallized from hexane-AcOEt). IR ($CHCl_3$): 1778, 1221, 1184 cm^{-1}. ^{1}H-NMR ($CDCl_3$, 270 MHz) δ: 3.43 (1 H, tdd, *J* = 9.2, 6.2, 5.6 Hz, C_{3a}-H), 3.96 (1 H, d, *J* = 9.2 Hz, C_{6a}-H), 4.21 (1 H, d, *J* = 14.2 Hz, PhC*H*H), 4.40 (1 H, d, *J* = 14.2 Hz, PhCH*H*), 4.45 (1 H, dd, *J* = 9.5, 5.6 Hz, C_4-H), 4.50 (1 H, dd, *J* = 9.5, 9.2 Hz, C_4-H), 4.91 (1 H, d, *J* = 6.3 Hz, C_3-H), 7.25-7.45 (10 H, m, Ar-H). MS m/z: 295 (M^+, 50 %), 189 (13), 160 (26), 143 (16), 115 (13), 106 (13), 105 (18), 92 (10), 91 (100), 77 (15). HRMS m/z: Calcd for $C_{18}H_{17}NO_3$: 295.1208. Found: 295.1208.

(3*R,3a*R**,6a*R**)-Tetrahydro-3-phenyl-1-(diphenylmethyl)-1*H*,6*H*-furo[3,4-*c*]isoxazol-6-one (11b) (Table 1, entry 4; Table 2, entry 1).** a) Table 1, entry 4: Following General Procedure A, this (17.4 mg, 78%) was obtained from **4b** (16.2 mg, 0.060 mmol), **6** (39 μl, 0.30 mmol), and titanium tetraisopropoxide (18 μl, 0.061 mmol) after purification by column chromatography on silica gel (CH_2Cl_2-ether, 20 : 1). mp: 160-160.5 °C (recrystallized from hexane-AcOEt). IR ($CHCl_3$): 1782, 1221, 1165 cm^{-1}. ^{1}H-NMR ($CDCl_3$, 270 MHz) δ: 3.37 (1 H, dddd, *J* = 8.6, 6.3, 5.6, 3.0 Hz, C_{3a}-H), 4.16 (1 H, d, *J* = 8.6 Hz, C_{6a}-H), 4.41 (1 H, dd, *J* = 9.9, 5.6 Hz, C_4-H), 4.45 (1 H, dd, *J* = 9.9, 3.0 Hz, C_4-H), 4.97 (1 H, d, *J* = 6.3 Hz, C_3-H), 5.29 (1 H, s, Ph_2CH), 7.15-7.38 (11 H, m, Ar-H), 7.42-7.60 (4 H, m, Ar-H). MS m/z: 371 (M^+, 3 %), 168 (16), 167 (100), 165 (15). HRMS m/z: Calcd for $C_{24}H_{21}NO_3$: 371.1521. Found : 371.1522.

b) Table 2, entry 1: Following General Procedure B, another lot of **11b** (13.5 mg, 65%) was obtained from **4b** (15.1 mg, 0.056mmol), **6** (11 μl, 0.086 mmol), titanium tetrachloride (0.1 M solution in 1,2-dichloroethane, 56 μl, 5.6 μmol), and MS 4A (131 mg). IR and ^{1}H-NMR spectra were identical with those in a).

(3*S,3a*R**,6a*R**)-Tetrahydro-3-phenyl-1-(phenylmethyl)-1*H*,6*H*-furo[3,4-*c*]isoxazol-6-one (12a) (Table 1, entry 5; Table 3, entry 1).** a) Table 1, entry 5: Following General Procedure A, this (23.1 mg, 97%) was obtained from **4a** (16.2 mg, 0.060 mmol), 7[13] (0.22 M solution in 1,2-dichloroethane, 1.83 ml, 0.40 mmol), and titanium tetraisopropoxide (24 μl, 0.082 mmol) after purification by column chromatography on silica gel (CH_2Cl_2-ether, 10 : 1). mp: 146-148 °C (recrystallized from hexane-AcOEt). IR ($CHCl_3$): 1784, 1225, 1210 cm^{-1}. ^{1}H-NMR ($CDCl_3$, 270 MHz) δ: 3.68 (1 H, qd, *J* = 7.6, 2.3 Hz, C_{3a}-H), 3.78 (1 H, dd, *J* = 10.2, 2.3 Hz, C_4-H), 4.08 (1 H, dd, *J* = 9.9, 7.3 Hz, C_4-H), 4.14 (1 H, d, *J* = 12.8 Hz, PhC*H*H), 4.23 (1 H, d, *J* = 8.3 Hz, C_{6a}-H), 4.42 (1 H, d, *J* = 12.8 Hz, PhCH*H*), 5.53 (1 H, d, *J* = 7.6 Hz, C3-H), 7.26-7.50 (10 H, m, Ar-H). MS m/z: 295 (M^+, 31 %), 160 (24), 115 (13), 106 (14), 105 (22), 92 (10), 91 (100), 85 (15), 77 (15). HRMS m/z: Calcd for $C_{18}H_{17}NO_3$: 295.1208. Found: 295.1206.

b) Table 3, entry 1: Following General Procedure B, a mixture of **11a** and **12a** (14 : 86, 25.2 mg, 55%) was obtained from **4a** (30 mg, 0.155 mmol), geometrical mixture of cinnamyl alcohol [(*E*) : (*Z*) = 52 : 48, 64 mg, 0.44 mmol], titanium tetrachloride (0.1 M solution in 1,2-dichloroethane, 0.15 ml, 15 μmol), and MS 4A (120 mg) after purification by column chromatography on silica gel (CH_2Cl_2-ether, 10 : 1). Further column chromatography on silica gel (CH_2Cl_2 : Et_2O = 40 : 1) gave pure **11a** and **12a**. Their spectral data were identical with those of authentic samples of **11a** and **12a**, respectively.

(3*S,3a*R**,6a*R**)-Tetrahydro-3-phenyl-1-(diphenylmethyl)-1*H*,6*H*-furo[3,4-*c*]isoxazol-6-one (12b) (Table 1, entry 6; Table 2, entry 2; Table 3, entry 2).** a) Table 1, entry 6: Following General Procedure A, this (18.8 mg, 89%) was obtained from **4b** (15.3 mg, 0.057 mmol), **7** (0.22 M solution in 1,2-dichloroethane, 1.3 ml, 0.29 mmol), and titanium tetraisopropoxide (17 μl, 0.058 mmol) after purification by column chromatography on silica gel (CH_2Cl_2-ether, 20 : 1). mp: 245 °C (recrystallized from hexane-AcOEt). IR ($CHCl_3$): 1784, 1456, 1217 cm^{-1}. ^{1}H-NMR ($CDCl_3$, 270 MHz) δ: 3.65 (1 H, qd, *J* = 7.9, 1.7 Hz, C_{3a}-H), 3.72 (1 H, dd, *J* = 10.2, 1.7 Hz, C_4-H), 4.02 (1 H, dd, *J* = 10.2, 7.9 Hz, spin saturation at 3.65→NOE; 7%, C_4-H), 4.31 (1 H, d, *J* = 7.9 Hz, spin saturation at 3.65→NOE; 13%, C_{6a}-H), 5.23 (1 H, br s, Ph_2CH), 5.55 (1 H, d, *J* = 7.6 Hz, spin saturation at 3.65→NOE; 11%, C_3-H), 7.15-7.37 (11 H, m, Ar-H), 7.58-7.61 (4 H, m, Ar-H). MS m/z: 371 (M^+, 1 %), 182 (12), 168 (12), 167 (100), 165 (17), 152 (10), 105 (11). HRMS m/z: Calcd for $C_{24}H_{21}NO_3$: 371.1521. Found: 371.1518.

b) Table 2, entry 2: Following General Procedure B, another lot of this compound (20.4 mg, 99%) was obtained from **4b** (15.1 mg, 0.056 mmol), **7** (0.42 M solution in dichloromethane, 0.2 ml, 0.83 mmol), titanium tetrachloride (0.1 M solution in 1,2-dichloroethane, 56 μl, 5.6 μmol), and MS 4A (107 mg).

c) Table 3, entry 2: Following General Procedure B, a mixture of **11b and 12b** (7 : 93, 41.4 mg, 86%) was prepared from **4b** (30 mg, 0.11 mmol), geometrical mixture of cinnamyl alcohol [(*E*) : (*Z*) = 52 : 44.8 mg, 0.33 mmol], titanium tetrachloride (0.1 M solution in 1,2-dichloroethane, 0.11 ml, 11 μmol), and MS 4A (125 mg) after purification by column chromatography on silica gel (CH_2Cl_2-ether, 20 : 1). Further purification by column chromatography on silica gel (CH_2Cl_2 : Et_2O = 40 : 1) gave pure **11b** and **12b**. Their spectral data were identical with those of authentic samples of **11b** and **12b**, respectively.

(3*R,3a*S**,4*S**,6a*R**)-Tetrahydro-3,4-ethano-1-(phenylmethyl)-1*H*,6*H*-furo[3,4-*c*]isoxazol-6-one (13a) (Table 1, entry 7).** Following General Procedure A, this (13.4 mg, 70%) was obtained from **4a** (15.1 mg, 0.078 mmol), **8** (32.9 mg, 0.39 mmol), and titanium tetraisopropoxide (23 μl, 0.079 mmol) after purification by column chromatography on silica gel (CH_2Cl_2-ether, 20 : 1). mp: 121-122 °C (recrystallized from hexane-AcOEt). IR ($CHCl_3$): 1781, 1183, 909 cm^{-1}. ^{1}H-NMR ($CDCl_3$, 270 MHz) δ: 1.89-2.35 (4 H, m, CH_2CH_2), 3.72 (1 H, dt, *J* = 8.6, 6.9 Hz, C_{3a}-H), 3.99 (1 H, d, *J* = 13.2 Hz, PhC*H*H), 4.02 (1 H, d, *J* = 8.6 Hz, C_{6a}-H), 4.19 (1 H, d, *J* = 13.2 Hz, PhCH*H*), 4.93 (1 H, br, C_3-H), 4.96 (1 H, ddd, *J* = 7.3, 5.6, 3.6 Hz, C4-H), 7.26-7.43 (5 H, m, ArH). MS m/z: 245 (M^+, 32 %), 92 (10), 91 (100). HRMS m/z: Calcd for $C_{14}H_{15}NO_3$: 245.1052. Found: 245.1052.

(3*R,3a*S**,4*S**,6a*R**)-Tetrahydro-3,4-ethano-1-(diphenylmethyl)-1*H*,6*H*-furo[3,4-*c*]isoxazol-6-one (13b) (Table 1, entry 8).** Following General Procedure A, this (17.6 mg, 99%) was obtained from **4b** (14.9 mg, 0.055 mmol), **8** (23.2 mg, 0.28 mmol), and titanium tetraisopropoxide (17 μl, 0.056 mmol) after purification by column chromatography on silica gel (CH_2Cl_2-ether, 20 : 1). mp: 236-237 °C (recrystallized from hexane-AcOEt). IR ($CHCl_3$): 3031, 1782, 1215 cm^{-1}. ^{1}H-NMR ($CDCl_3$, 270 MHz) δ: 1.84-2.07 (2 H, m, C*H*HC*H*H), 2.09-2.30 (2 H, m, CH*H*CH*H*), 3.70 (1 H, dt, *J* = 8.3, 6.9 Hz, C_{3a}-H), 4.12 (1 H, d, *J* = 8.3 Hz, C_{6a}-H), 4.90 (1 H, ddd, *J* = 6.9, 5.3, 3.6 Hz, C_3-H), 4.97 (2 H, br, Ph_2CH and C_4-H), 7.16-7.37 (6 H, m, Ar-H), 7.49-7.57 (4 H, m, Ar-H). MS m/z: 321 (M^+, 2 %), 152 (10), 168 (16), 167 (100), 165 (16). HRMS m/z: Calcd for $C_{20}H_{19}NO_3$: 321.1365. Found: 321.1369.

(3*R,3a*S**,4*S**,6a*R**)-Tetrahydro-1-(phenylmethyl)-3,4-propano-1*H*,6*H*-furo[3,4-*c*]isoxazol-6-one (14a) (Table 1, entry 9; Table 2, entry 3).** a) Table 1, entry 9: Following General Procedure A, this (10.2 mg, 45%) was obtained from **4a** (17.0 mg, 0.088 mmol), **9** (43 μl, 0.44 mmol), and titanium tetraisopropoxide (29 μl, 0.099 mmol) after purification by column chromatography on silica gel (CH_2Cl_2-ether, 20 : 1). mp: 116-116.5 °C (recrystallized from hexane-AcOEt). IR ($CHCl_3$): 1779, 1192, 982 cm^{-1}. ^{1}H-NMR ($CDCl_3$, 270 MHz) δ: 1.38-1.70 (4 H, m, C*H*HC*H*$_2$C*H*H), 2.00-2.16 (1 H, m, CH*H*CH$_2$CH$_2$), 2.18-2.32 (1 H, m, CH$_2$CH$_2$CH*H*), 3.26 (1 H, q, *J* = 7.6 Hz, C_{3a}-H), 4.00 (1 H, d, *J* = 13.2 Hz, PhC*H*H), 4.21 (1 H, d, *J* = 8.6 Hz, C_{6a}-H), 4.28 (1 H, d, *J* = 13.2 Hz, PhCH*H*), 4.39 (1 H, br, C_3-H), 4.68 (1 H, ddd, *J* = 7.3, 4.0, 2.6 Hz, C_4-H), 7.25-7.46 (5 H, m, Ar-H). MS m/z: 259 (M^+, 18 %), 106 (13), 92 (11), 91 (100). HRMS m/z: Calcd for $C_{15}H_{17}NO_3$: 259.1208. Found: 259.1211.

b) Table 2, entry 3: Following General Procedure B, another lot of **14a** (15.3 mg, 97%) was prepared from **4a** (11.7 mg, 0.061 mmol), **6** (8.9 μl, 0.091 mmol), titanium tetrachloride (0.5 M solution in 1,2-dichloroethane, 12 μl, 6.0 μmol), and MS 4A (144 mg). The IR and ^{1}H-NMR spectra were identical with those in a).

(3*R,3a*S**,4*S**,6a*R**)-Tetrahydro-1-(diphenylmethyl)-3,4-propano-1*H*,6*H*-furo[3,4-*c*]isoxazol-6-one (14b) (Table 1, entry 10; Table 2, entries 4 and 8).** a) Table 1, entry 10: Following General Procedure A, this (14.0 mg, 77%) was obtained from **4b** (14.6 mg, 0.054 mmol), **9** (27 μl, 0.27 mmol), and titanium tetraisopropoxide (18 μl, 0.060 mmol) after purification by column chromatography on silica gel (CH_2Cl_2-ether, 10 : 1). mp: 236 °C (recrystallized from hexane-AcOEt). IR ($CHCl_3$): 1782, 1221, 1192 cm^{-1}. ^{1}H-NMR ($CDCl_3$, 270 MHz) δ: 1.31-1.70 (4 H, m, C*H*HC*H*$_2$C*H*H), 1.90-2.05 (1 H, m, CH*H*CH$_2$CH$_2$), 2.15-2.27 (1 H, m, CH$_2$CH$_2$CH*H*), 3.25 (1 H, q, *J* = 7.6 Hz, C_{3a}-H), 4.28 (1 H, d, *J* = 8.6 Hz, spin saturation at 3.25→NOE; 6%, C_{6a}-H), 4.45 (1 H, br, spin saturation at 3.25→NOE; 9%, C_3-H), 4.62 (1 H, td, *J* = 6.9, 2.6 Hz, spin saturation

at 3.25→NOE; 5%, C_4-H), 5.05 (1 H, br s, Ph_2CH), 7.17-7.35 (6 H, m, Ar-H), 7.52-7.58 (4 H, m, Ar-H). MS m/z: 335 (M^+, 4 %), 168 (16), 167 (100), 165 (14). HRMS m/z: Calcd for $C_{21}H_{21}NO_3$: 335.1521. Found: 335.1520.

b) Table 2, entry 4: Following General Procedure B, another lot of **14b** (17.7 mg, 97%) was prepared from **4b** (14.8 mg, 0.055 mmol), **9** (8.2 µl, 0.084 mmol), titanium tetrachloride (0.1 M solution in 1,2-dichloroethane, 56 µl, 5.6 µmol), and MS 4A (129 mg). The IR and ^{1}H-NMR spectra were identical with those in a).

c) Table 2, entry 8: To a stirred suspension of **9** (11 µl, 0.11 mmol), 1,1,3,3-tetra-*n*-butyl-1,3-diisothiocyanate distanoxane[3c] (44.0 mg, 7.5 µmol), and MS 4A (92 mg) in dry toluene (0.8 ml) was added **4b** (20.0 mg, 0.074 mmol) at room temperature. After stirring for 12 h, the same workup and purification gave **14b** (21.6 mg, 87%). The IR and ^{1}H-NMR spectra were identical with those in a).

Methyl 5-(Hydroxymethyl)-2-(diphenylmethyl)isoxazolidine-3-carboxylate (15). To a stirred solution of **4b** (15.9 mg, 0.059 mmol) in 1,2-dichloroethane (3 ml) was added **5** (16.6 mg, 0.29 mmol) at room temperature. After stirring for 19 days under the same conditions, the mixture was concentrated in vacuo. The residue was purified by column chromatography on silica gel (ether) to afford **15** (13.6 mg, 70%) as a 1 : 1 mixture of diastereomers. Further column chromatography on silica gel (ether) gave less polar isomer (**15a**) and more polar isomer (**15b**). **15a**, mp: 93-95 °C (recrystallized from hexane-AcOEt). ^{1}H-NMR ($CDCl_3$, 270 MHz) δ: 2.17 (1 H, s, OH), 2.45-2.57 (2 H, m, C_4-H_2), 3.56 (3 H, s, CO_2Me), 3.50-3.60 (1 H, m, C*H*HOH), 3.69-3.82 (2 H, m, C_3-H and CH*H*OH), 4.36 (1 H, dddd, *J* = 11.2, 7.6, 4.0, 0.8 Hz, C_5-H), 5.02 (1 H, s, Ph_2CH), 7.16 - 7.53 (10 H, m, Ar-H). **15b**, mp: 118-120 °C (recrystallized from hexane-AcOEt). ^{1}H-NMR ($CDCl_3$, 270 MHz) δ: 1.94 (1 H, br s, OH), 2.33 - 2.68 (2 H, m, C_4-H_2), 3.51 (3 H, s, CO_2Me), 3.40-3.80 (3 H, m, C_3-H and CH_2OH), 4.32 (1 H, br s, C_5-H), 4.84 (1 H, s, Ph_2CH), 7.09-7.47 (10 H, m, Ar-H).

***n*-Butyl [(Diphenylmethyl)imino]acetate *N*-Oxide (16).** a) To a solution of **4b** (17.1 mg, 0.064 mmol), titanium tetraisopropoxide (20 µl, 0.068 mmol) in 1,2-dichloroethane (3 ml) was added *n*-butanol (30 µl, 0.33 mmol) at room temperature. After 15 min, TLC analysis showed formation of three compounds, probably **4b**, **16**, and isopropyl [(diphenylmethyl)imino]acetate *N*-oxide. Since these compounds were not separable, the reaction in b) was performed to confirm formation of **16**.

b) To a solution of **4b** (20.0 mg, 0.074 mmol), titanium tetraisopropoxide (33 µl, 0.1 mmol) in 1,2-dichloroethane (3 ml) was added *n*-butanol (0.1 ml, 1.1 mmol) at room temperature. After 30 min, TLC analysis showed that **4b** had disappeared. A small amount of water was added to the mixture, and the mixture was stirred for 1 h. The mixture was filtered through a pad of Celite, then the filtrate was diluted with water, extracted with dichloromethane, and dried over $MgSO_4$. After filtration, the filtrate was concentrated *in vacuo* to give a residue, which was purified by column chromatography on silica gel (hexane-AcOEt, 5 : 2) to furnish **16** (17.0 mg, 74%). The ^{1}H-NMR spectrum of **16** showed that **16** exists as a 1 : 1 mixture of two geometrical isomers in $CDCl_3$. mp: 97-99 °C (recrystallized from hexane-AcOEt). IR ($CHCl_3$): 1725, 1547, 1223 cm^{-1}. ^{1}H-NMR ($CDCl_3$, 270 MHz) δ: 0.92 (3 x 1/2 H, t, *J* = 6.9 Hz, CH_3), 0.94 (3 x 1/2 H, t, *J* = 6.9 Hz, CH_3), 1.38 (2 H, sextet, *J* = 6.9, CH_2CH_3), 1.52-1.73 (2 H, m, OCH_2CH_2), 4.19 (2 H, t, *J* = 6.9 Hz, OCH_2), 6.27 (1/2 H, s, Ph_2CH), 7.20-7.60 (10 H + 1/2 H + 1/2 H, m, Ar-H, Ph_2CH, $CHCO_2{}^nBu$), 8.36 (1/2 H, s, $CHCO_2{}^nBu$). Anal. Calcd for $C_{19}H_{21}NO_3$: C, 73.29; H, 6.80; N, 4.50. Found: C, 73.07; H, 6.84; N, 4.45. In order to confirm **16**, an authentic sample of it was prepared as described in c).

c) A solution of *N*-diphenylmethylhydroxylamine (52.5 mg, 0.40 mmol) and *n*-butyl glyoxylate (111 mg, 0.55 mmol) in benzene (5 ml) was refluxed using a Dean-Stark trap for 1.5h. The mixture was concentrated *in vacuo*, and the residue was purified by column chromatography on silica gel (hexane-AcOEt, 5 : 2) to afford **16** (106 mg, 84%). The IR and ^{1}H-NMR spectra of this sample were identical with those in b).

(3*S,3a*R**,6a*R**)-Tetrahydro-3-methyl-1-(phenylmethyl)-1*H*,6*H*-furo[3,4-*c*]isoxazol-6-one (17aA) and Its (3*R**,3a*R**,6a*R**)-Isomer (17aB) (Table 3, entries 3 and 4).**

a) Table 3, entry 3: Following General Procedure A, a 15 : 85 mixture of **17aA** and **17aB** (13.8 mg, 77%) was prepared from **4a** (14.9 mg, 0.077 mmol), crotyl alcohol [(*E*) : (*Z*) = 86 : 14, 54 µl, 0.64 mmol], and titanium tetraisopropoxide (21 µl, 0.077 mmol) after purification by column chromatography on silica gel (hexane-AcOEt, 3 : 2). **17aA**, ^{1}H-NMR ($CDCl_3$, 270 MHz): 1.34 (3 H, d, *J* = 6.3 Hz, Me), 3.03 (1 H, dddd, *J* = 9.2, 7.6, 6.3, 3.6 Hz, C_{3a}-H), 3.81 (1 H, d, *J* = 9.2 Hz, C_{6a}-H), 4.07 (1 H, quin, *J* = 6.3

Hz, C_3-H), 4.10 (1 H, d, J = 14.2 Hz, PhC*H*H), 4.29 (1 H, dd, J = 9.6, 3.6 Hz, C_4-H), 4.32 (1 H, d, J = 14.2 Hz, PhCH*H*), 4.45 (1 H, dd, J = 9.6, 7.6 Hz, C_4-H), 7.28 - 7.43 (5 H, m, Ar-H). MS m/z : 233 (M+, 26 %), 91 (100). HRMS m/z : Calcd for $C_{13}H_{15}NO_3$: 233.1052. Found : 233.1044. **17aB**, mp: 93 °C (recrystallized from hexane-AcOEt). IR ($CHCl_3$): 3020, 1783, 1224 cm^{-1}. ^{1}H-NMR ($CDCl_3$, 270 MHz): 1.31 (3 H, d, J = 6.3 Hz, Me), 3.41 (1 H, qd, J = 7.6, 2.3 Hz, C_{3a}-H), 3.99 (1 H, d, J = 13.2 Hz, PhC*H*H), 4.10 (1 H, d, J = 7.6 Hz, C_{6a}-H), 4.27 (1 H, d, J = 13.2 Hz, PhCH*H*), 4.28 (1 H, dd, J = 10.2, 7.6 Hz, C_4-H), 4.44 (1 H, dd, J = 10.2, 2.3 Hz, C_4-H), 4.53 (1 H, br quin, J = 6.6 Hz, C_3-H), 7.26 - 7.45 (5 H, m, Ar-H). MS m/z: 233 (M+, 32 %), 91 (100). HRMS m/z: Calcd for $C_{13}H_{15}NO_3$: 233.1052. Found: 233.1050.

b) Table 3, entry 4: Following General Procedure B, another 13 : 87 mixture of **17aA** and **17aB** (29.7 mg, 82%) was prepared from **4a** (30.0 mg, 0.156 mmol), crotyl alcohol [(*E*) : (*Z*) = 86 : 14, 0.132 ml, 1.56 mmol], and titanium tetrachloride (0.1 M solution in 1,2-dichloroethane, 0.15 ml, 0.015 mmol), and MS 4A (120 mg). Pure **17aA** and **17aB** were obtained by column chromatography on silica gel (hexane-AcOEt, 3 : 2). Their IR and ^{1}H-NMR spectra were identical with those in a).

(3*S,3a*R**,6a*R**)-Tetrahydro-3-methyl-1-(diphenylmethyl)-1*H*,6*H*-furo[3,4-*c*]isoxazol-6-one (17bA) and Its (3*R**,3a*R**,6a*R**)-Isomer (17bB) (Table 3, entry 5).** Following General Procedure B, a 7 : 93 mixture of **17bA** and **17bB** (23.2 mg, 67%) was prepared from **4b** (30.0 mg, 0.11 mmol), crotyl alcohol [(*E*) : (*Z*) = 86 : 14, 83.2 mg, 1.1 mmol], and titanium tetrachloride (0.1 M solution in 1,2-dichloroethane, 0.11 ml, 11 μmol), and MS 4A (122 mg) after column chromatography on silica gel (CH_2Cl_2-ether, 20 : 1). Further column chromatography on silica gel (CH_2Cl_2-ether, 40 : 1) gave pure **17bA** and **17bB**. **17bA**, mp: 185-187 °C (recrystallized from hexane-AcOEt). IR ($CHCl_3$): 1774, 1454, 1167 cm^{-1}. ^{1}H-NMR ($CDCl_3$, 270 MHz): 1.39 (3 H, d, J = 5.9 Hz, Me), 2.93 (1 H, ddddd, J = 9.6, 8.6, 6.3, 5.9, 2.0 Hz, C_{3a}-H), 4.10 (1 H, d, J = 8.6 Hz, C_{6a}-H), 4.11 (1 H, quin, J = 5.9 Hz, C_3-H), 4.27 (1 H, dd, J = 9.6, 2.0 Hz, C_4-H), 4.44 (1 H, dd, J = 9.6, 6.3 Hz, C_4-H), 5.33 (1 H, br s, Ph_2CH), 7.17 - 7.57 (10 H, m, Ar-H). MS m/z: 309 (M^+, 3%), 182 (10), 167 (100), 165 (16). HRMS m/z: Calcd for $C_{19}H_{19}NO_3$: 309.1364. Found: 309.1364. **17bB**, mp: 203-205 °C (recrystallized from hexane-AcOEt). IR ($CHCl_3$): 1786, 1495, 1454, 1361, 1221 cm^{-1}. ^{1}H-NMR ($CDCl_3$, 270 MHz): 1.16 (3 H, d, J = 6.9 Hz, Me), 3.31 (1 H, br qd, J = 7.3, 1.7 Hz, C_{3a}-H), 4.10 (1 H, d, J = 7.9 Hz, C_{6a}-H), 4.12 (1 H, dd, J = 10.2, 6.9 Hz, C_4-H), 4.43 (1 H, dd, J = 10.2, 1.7 Hz, C_4-H), 4.49 (1 H, br quin, J = 6.9 Hz, C_3-H), 4.97 (1 H, br s, Ph_2CH), 7.08 - 7.50 (10 H, m, Ar-H). MS m/z: 309 (M^+, 2%), 182 (18), 167 (100), 165 (19). HRMS m/z: Calcd for $C_{19}H_{19}NO_3$: 309.1364. Found: 309.1357.

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