Current literature 6-4-05
Graciela Mahler@ Wipf Group

Molybdenum Oxides as Highly Effective Dehydrative Cyclization Catalysts for the Synthesis of Oxazolines and Thiazolines

Org. Lett., **7** (10), 1971 -1974, 2005

Akira Sakakura, Rei Kondo, and Kazuaki Ishihara

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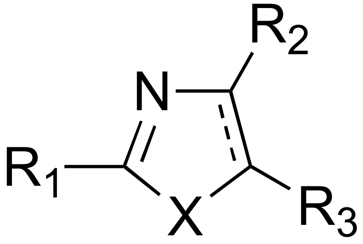
University, Chikusa, Nagoya, 464-8603
Japan



X = O, S

- 1,3-oxoaza and 1,3-tioaza 5 member rings are present in numerous bioactive natural products, pharmaceuticals and are important as chiral auxiliaries and ligands in asymmetric synthesis

- Stoichiometric reagents are known to be effective for the dehydrative cyclization of *N*-(-βhydroxyethyl)amides or *N*-(-mercaptoethyl)amides to oxazolines or thiazolines

Reported dehydrating catalysts:

* lanthanide chloride
* zeolite
* 3-nitrophenylboronic acid
* TsOH

The Direct Synthesis of 2-Oxazolines from Carboxylic Esters Using Lanthanide Chloride as Catalyst

Peiwen Zhou, Jason E. Blubaum, Christopher T. Burns, Nicholas R. Natale[1]

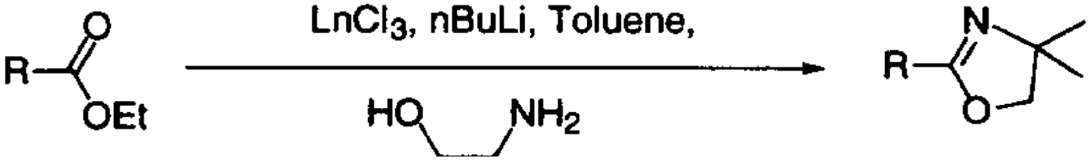
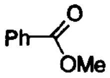
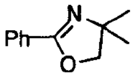
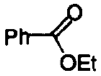
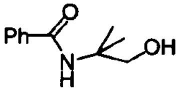
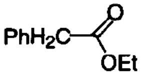
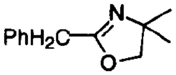
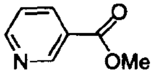
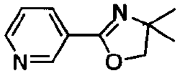
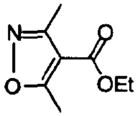
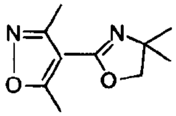
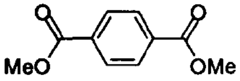
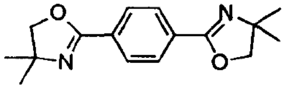
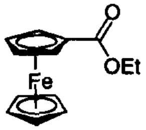
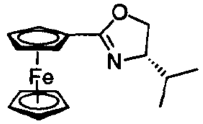
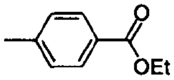
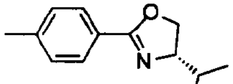


Table. Summary of Lanthanide Catalyzed Reactions of Esters with Amino Alkoxides

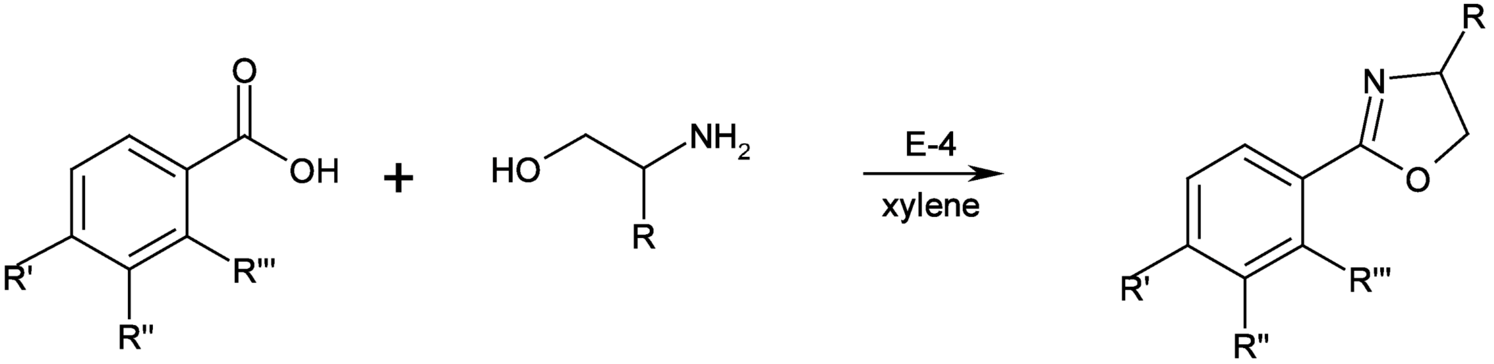
Entry	Substrate	$LnCl_3$ Equivalent	Product	Isolated yield, %
1		0.10 $LaCl_3$		81.8
2		0.050 $LaCl_3$		79.4
3		0.050 $LaTf_3$		0(100)*
4		0.050 $LaCl_3$		75.4
5		0.10 $LaCl_3$		64.1
6		0.10 $SmCl_3$		82
7		0.20 $LaCl_3$		44
8		0.10 $SmCl_3$		52
9		0.10 $SmCl_3$		54 (40)*

* Isolated yield of corresponding amide.

Tetrahedron Letters, Vol. 38, No. 40, pp. 7019-7020, 1997

A simple synthesis of 2-substituted oxazolines and oxazines

Agnieszka Cwik,[a] Zoltán Hell,[a,*] Adrienn Hegedüs,[a] Zoltán Finta[a] and Zoltán Horváth[b]



Ersorb-4 (E4) is a clinoptilolite-type zeolite material with high silicium content (Si:Al = 5:1). The original material is modified with ionic exchange and other water phase technologies followed by thermal treatment yielding a Ca-K mixed cation-based adsorbent with 4Å pore size.

Clinoptilolite : Hydrated Sodium Potassium Calcium Aluminum Silicate
$(Na, K, Ca)_2$ - $3Al_3(Al, Si)_2Si_{13}O_{36}$-$12H_2O$,

Tetrahedron Letters 43 (2002) 3985–3987

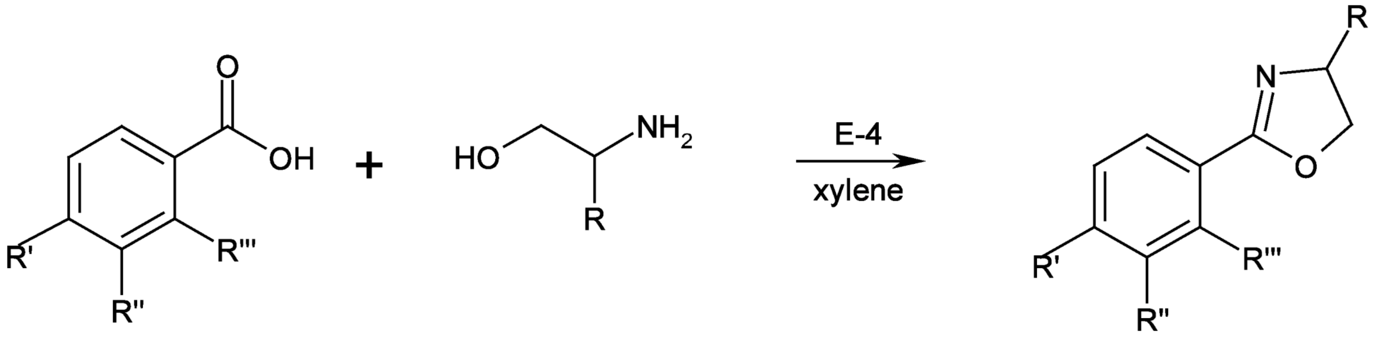
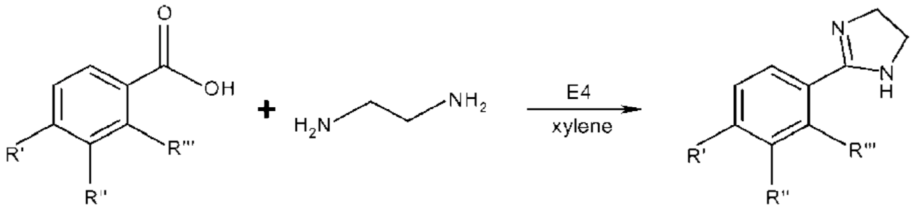
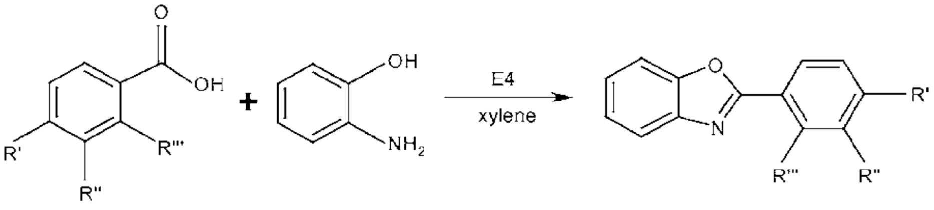


Table 1. Reaction of β-aminoalcohols with aromatic carboxylic acids

Entry	R	R′	R″	R‴	Yield[a] (%)
1	H	H	H	H	90
2	H	H	H	H	79[b]
3	H	H	H	H	52[c]
4	H	CH_3	H	H	35[d]
5	H	Cl	H	H	88
6	H	$(CH_3)_3C$	H	H	75
7	C_2H_5 (±)	H	H	H	73
8	C_2H_5 (±)	Cl	H	H	55[d]
9	C_2H_5 (*S*)	Cl	H	H	88
10	H	CH_3O	NO_2	H	78
11	H	H	H	OH	30[d]
12	H	H	H	$COOCH_3$	32
13	H	H	H	$OCOCH_3$	30
14	H	$COOCH_3$	H	H	85
15	H	CH_2Cl	H	OH	45



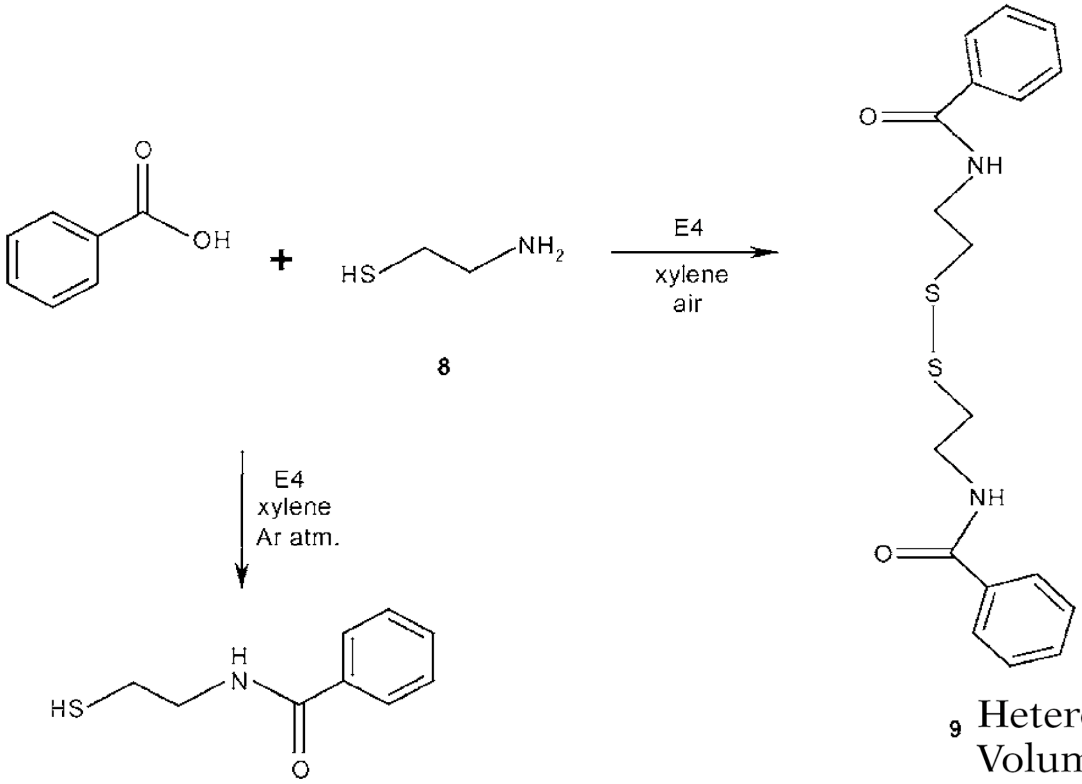
1 4 5



1 11 12

TABLE 1 Reaction of Ethylenediamine with Aromatic Carboxylic Acids **1**

	R′	*R″*	*R‴*	*Yield (%)*
5a	H	H	H	73
5b	Cl	H	H	43
5c	H	H	CH_3	71
5d	CH_3	H	H	73
5e	$(CH_3)_3C$	H	H	65
5f	CH_3O	NO_2	H	73
5g	H	H	$OCOCH_3$	59
5h	H	H	OH	62



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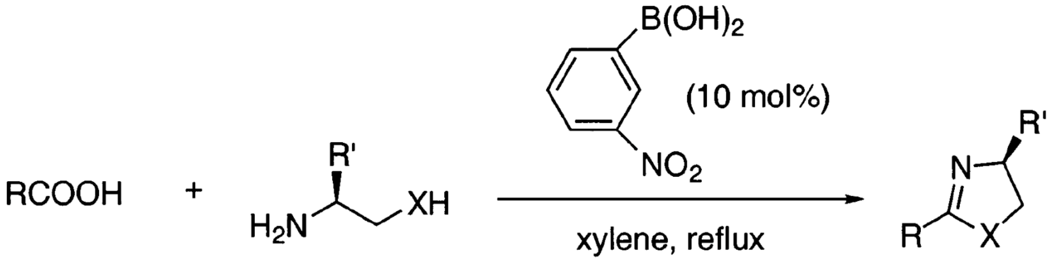
Heteroatom Chemistry
Volume 15, Number 6, 2004

Parallel Synthesis of Oxazolines and Thiazolines by Tandem Condensation−Cyclodehydration of Carboxylic Acids with Amino Alcohols and Aminothiols

Peter Wipf* and Xiaodong Wang



1, X = O
2. X = S

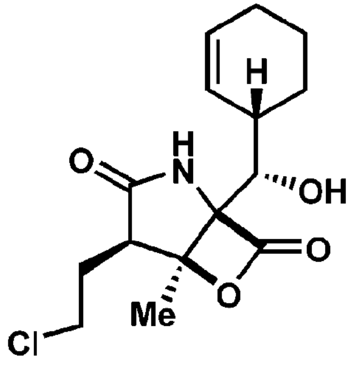
entry	carboxylic acid	amino alcohol or aminothiol	product	time [h]	yield[c] [%]
1	hydrocinnamic acid	(L)-*tert*-leucinol	**1b**	30	80
2	hydrocinnamic acid	(*S*)-phenylglycinol	**1c**	32	68
3[b]	hydrocinnamic acid	2-aminoethanethiol·HCl	**2a**	30	100
4	cinnamic acid	(L)-valinol	**1d**	49	46
5	cinnamic acid	(L)-*tert*-leucinol	**1e**	48	54
6[b]	cinnamic acid	2-aminoethanethiol·HCl	**2b**	30	15
7	benzoic acid	(L)-valinol	**1f**	28	33
8	*p*-*tert*-butylbenzoic acid	(L)-valinol	**1g**	45	41
9	3,5-dinitrobenzoic acid	(L)-valinol	**1h**	29	36
10	cyclohexanecarboxylic acid	(L)-valinol	**1s**	28	75
11	*N*-Cbz-L-glutamic acid 1-methyl ester	(L)-valinol	**1t**	28	62

[a] Carboxylic acid (0.30 mmol) and amino alcohol or aminothiol (0.60 mmol) were heated under reflux in a nitrogen atmosphere in the presence of 0.030 mmol of 3-nitrophenylboronic acid. [b] 2.0 equiv of (i-Pr)$_2$NEt was added. [c] Isolated yield after chromatographic separation.

J. Comb. Chem. **2002,** *4,* 656−660

A Simple Stereocontrolled Synthesis of Salinosporamide A

Leleti Rajender Reddy, P. Saravanan, and E. J. Corey*



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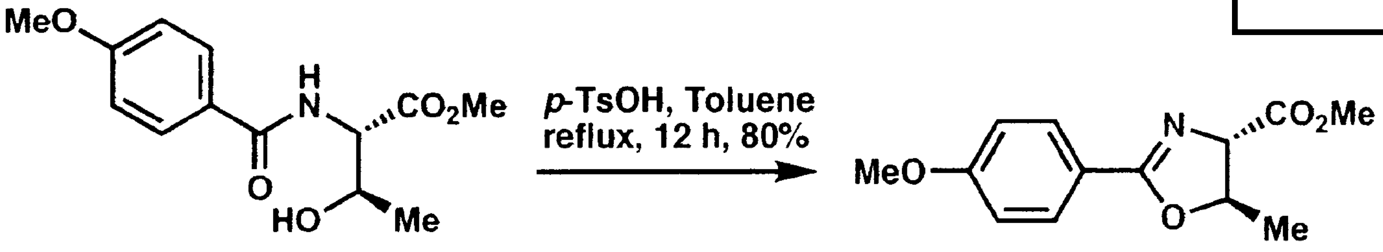


p-TsOH, Toluene
reflux, 12 h, 80%

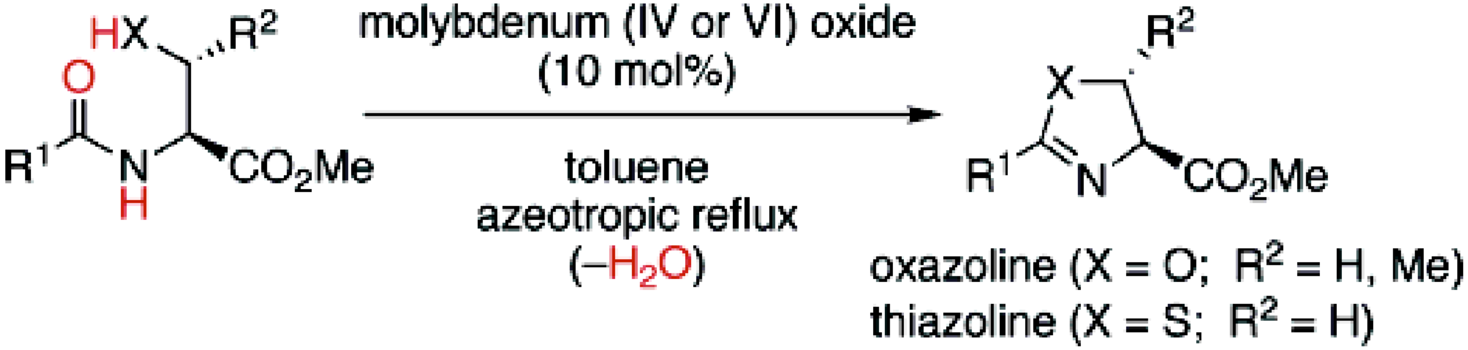
3

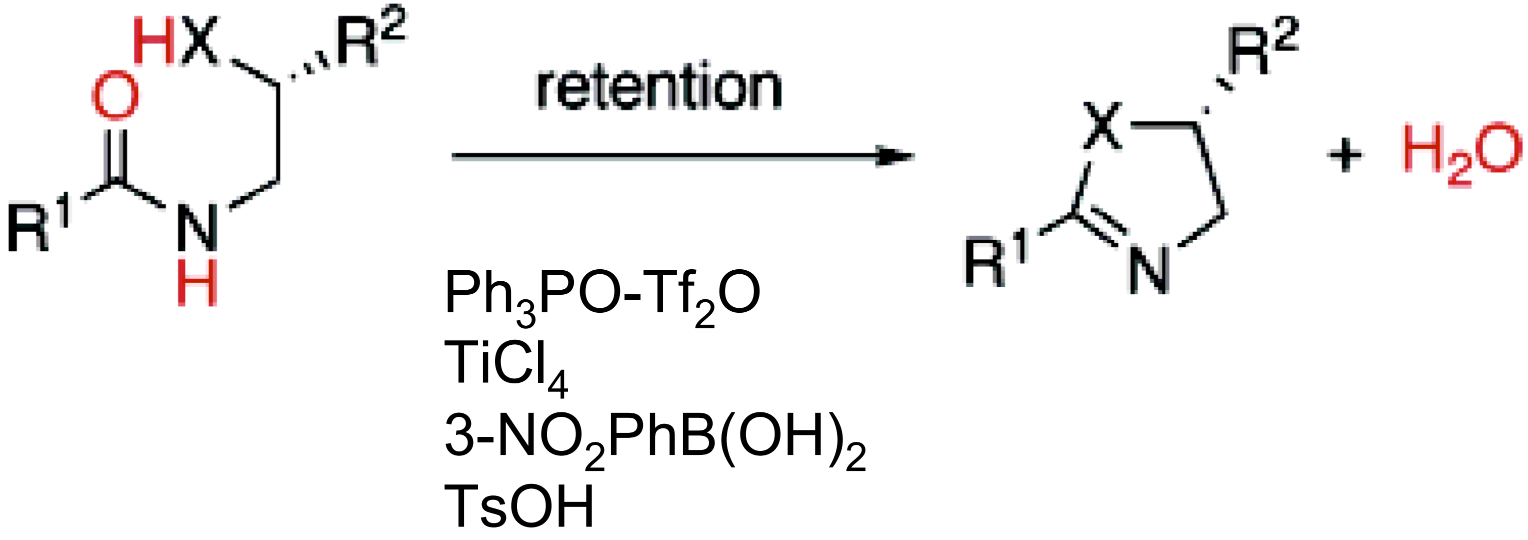
4

J. AM. CHEM. SOC. 2004, *126*, 6230−6231

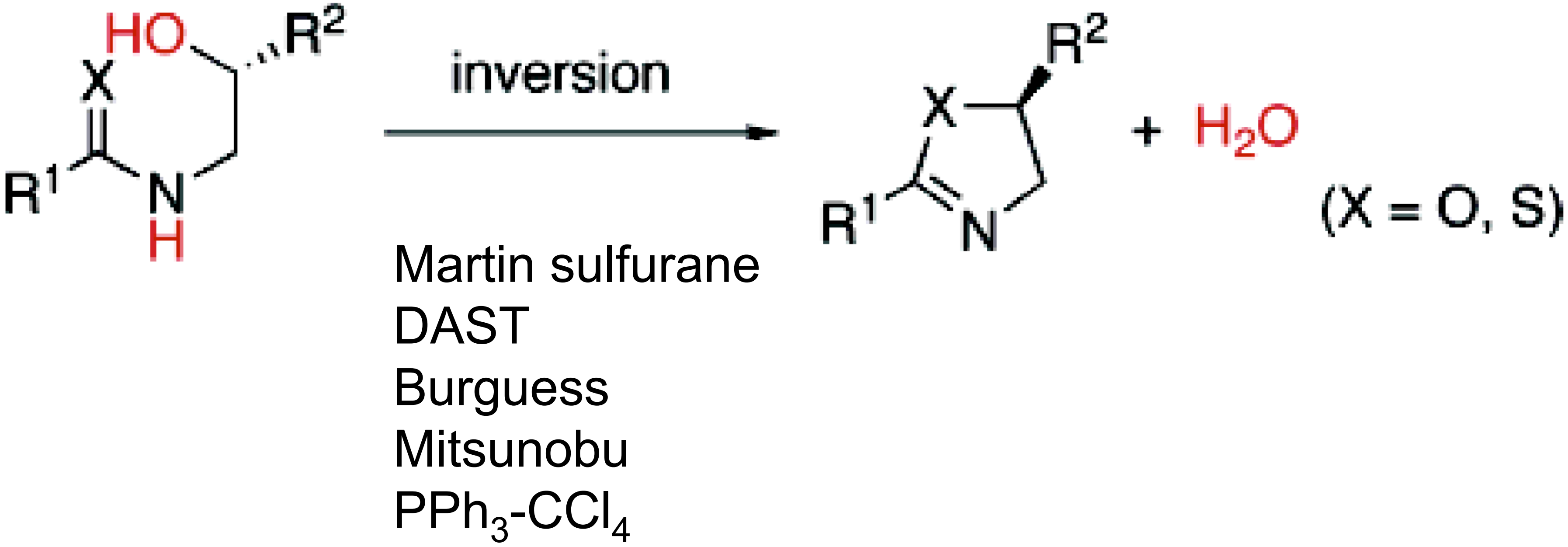
Low catalytic activities

The catalytic methods are limited to simple acid- or base-tolerant substrates that do not have any other functional groups.

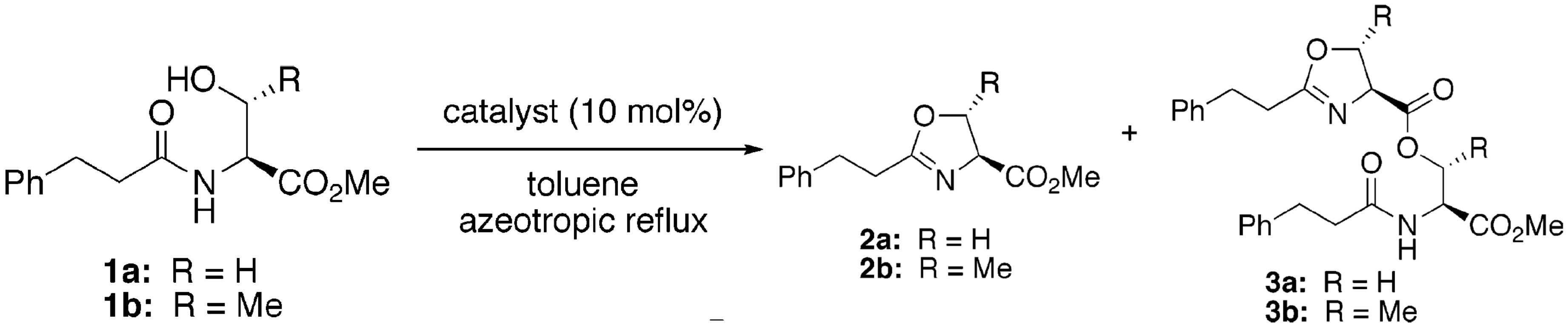




Ph_3PO-Tf_2O
$TiCl_4$
3-$NO_2PhB(OH)_2$
TsOH



Martin sulfurane
DAST
Burguess
Mitsunobu
PPh_3-CCl_4



1a: R = H
1b: R = Me

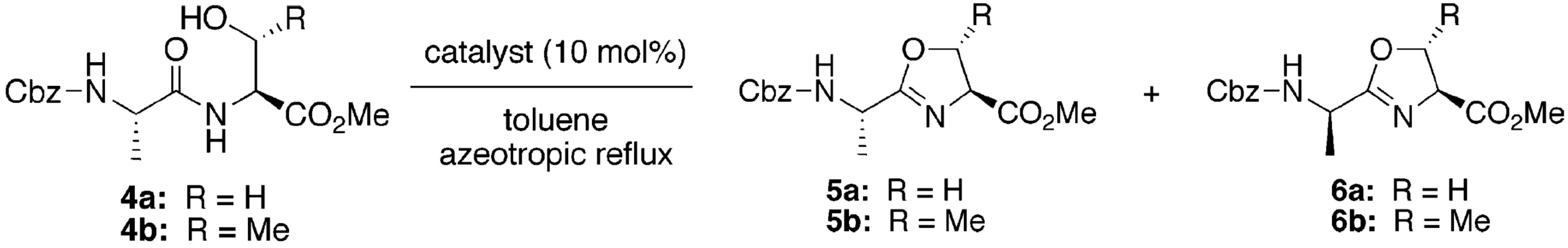
2a: R = H
2b: R = Me

3a: R = H
3b: R = Me

		1a → 2a		**1b → 2b**	
entry	catalyst	time (h)	yield (%)[b,c]	time (h)	yield (%)[b,c]
1	MoO_2	8	86 (10)	8	97 (0)
2	MoO_3	8	78 (5)	8	99 (0)
3	$(NH_4)_6Mo_7O_{24}\cdot 4H_2O$	4	87 (11)	2	97 (0)
4	$(NH_4)_2MoO_4$	4	89 (11)	2	95 (0)
5	$MoO_2(acac)_2$	1	87 (7)	1	90 (0)
6	$3\text{-}(NO_2)C_6H_4B(OH)_2$	8	3 (0)	8	4 (0)
7	no catalyst	8	0 (0)	8	0 (0)

[a] Reactions were carried out with 0.5 mmol of substrate and 10 mol % of catalyst in toluene (50 mL for serine derivatives and 10 mL for threonine derivatives) at azeotropic reflux with the removal of water. [b] Determined by HPLC analysis. [c] Yield of **3a** or **3b** in parentheses.

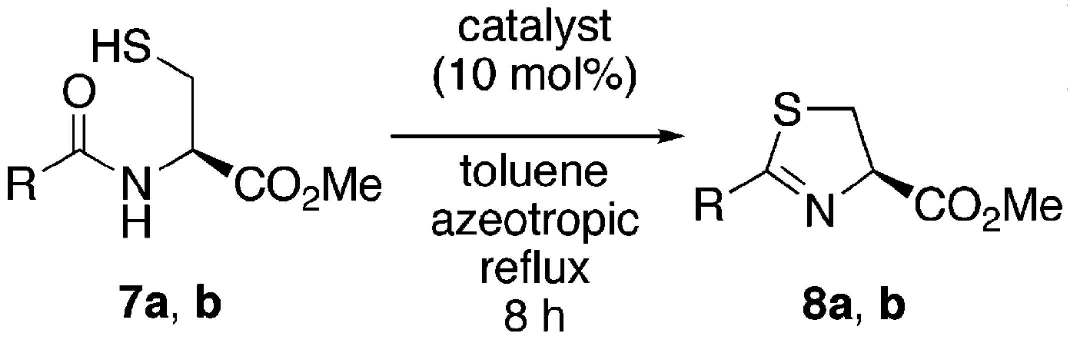
Table 2. Synthesis of Oxazolines **5**[a]



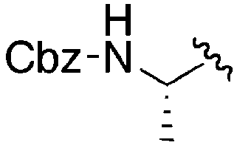
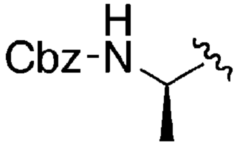
		4a → 5a		4b → 5b	
entry	catalyst	time (h)	yield (%)[b,c]	time (h)	yield (%)[b,c]
1	MoO_2	8	80 (4)	2.5	80 (5)
2	MoO_3	8	83 (2)	3	82 (6)
3	$(NH_4)_6Mo_7O_{24}\cdot 4H_2O$	2.5	90 (0)	2	86 (5)
4	$(NH_4)_2MoO_4$	1	93 (0)	1.5	84 (8)
5	$MoO_2(acac)_2$	1	68 (0)	1	82 (11)

[a] Reactions were carried out with 0.5 mmol of substrate and 10 mol % of catalyst in toluene (50 mL for serine derivatives and 10 mL for threonine derivatives) at azeotropic reflux with the removal of water. [b] Determined by HPLC analysis. [c] Yield of **6a** or **6b** in parentheses.

4b $\xrightarrow[\text{reflux}]{\text{TsOH}}$ **5b** 48% + **6b** 50%



7a, **b** → **8a**, **b**

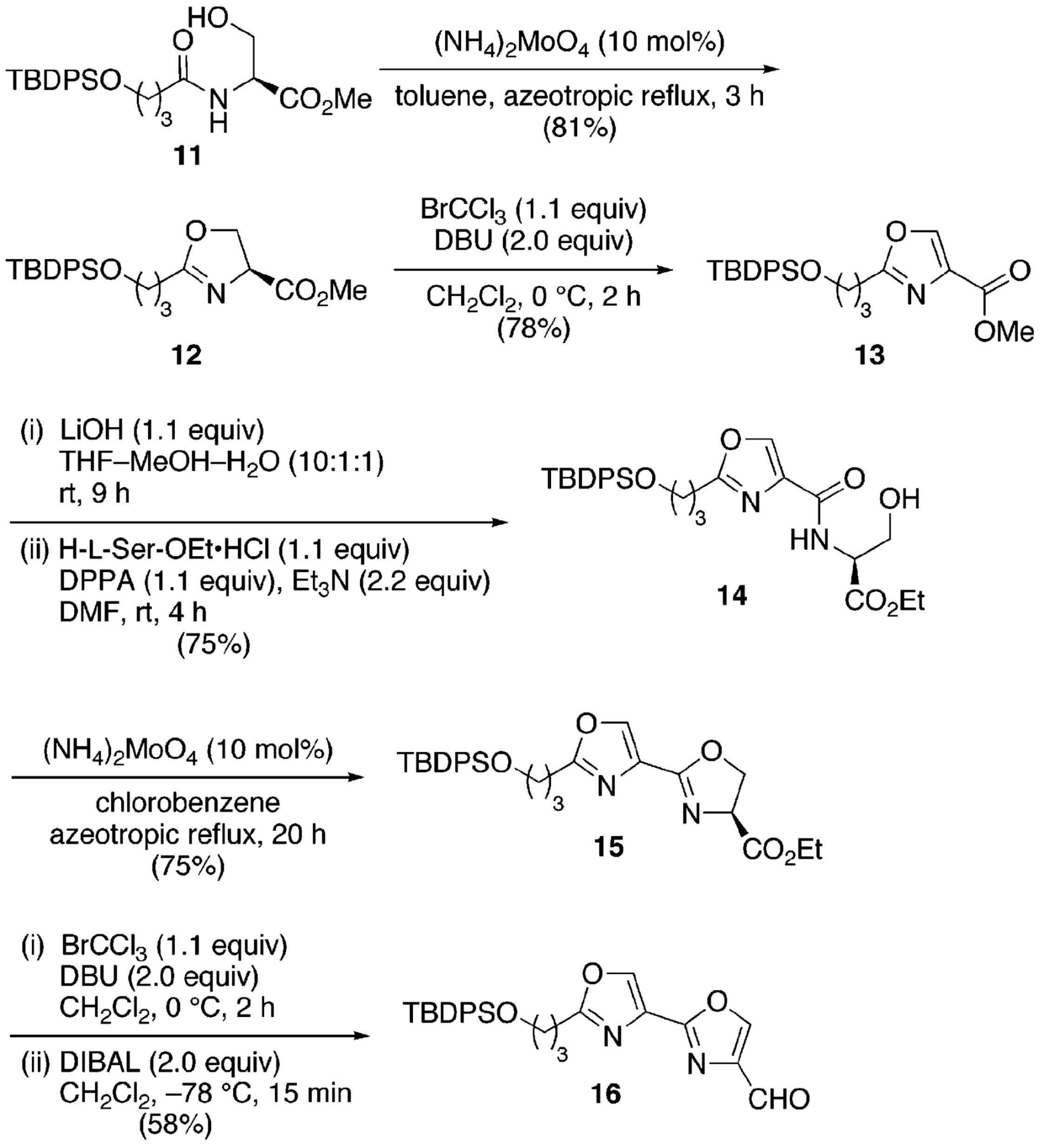
7, 8	R
a	Ph(CH$_2$)$_2$
b	
c	

entry	catalyst	**7a → 8a** yield (%)[b]	**7b → 8b** yield (%)[b]
1	MoO_2	29[c]	6[c]
2	MoO_3	18[c]	9[c]
3	$(NH_4)_6Mo_7O_{24}\cdot 4H_2O$	96[c]	16[c]
4	$(NH_4)_2MoO_4$	99[c]	26[c]
5	$MoO_2(acac)_2$	81 (98.7% ee)[d]	70 (15)[e,f]
6	no catalyst	9[c]	0[c]

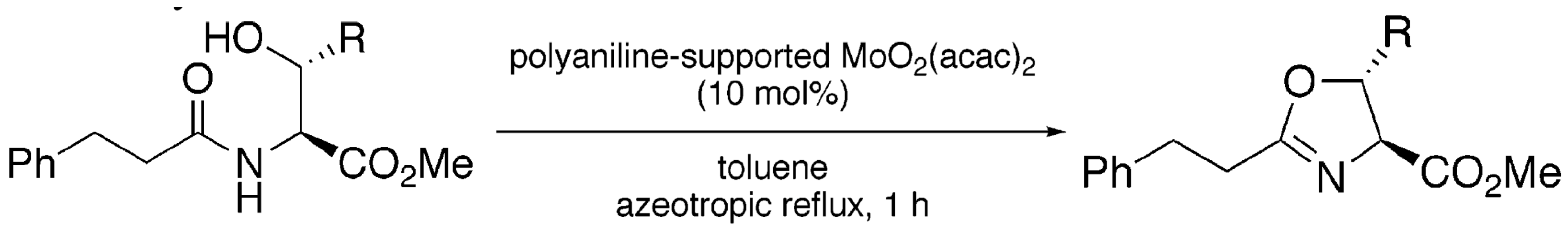
[a] Reactions were carried out with 0.5 mmol of substrate and 10 mol % of catalyst in toluene (50 mL) at azeotropic reflux with the removal of water for 8 h. [b] Determined by ^{1}H NMR analysis. [c] Enantiomeric exess or diastereomeric ratio of the product was not determined. [d] Determined by HPLC analysis on Chiralcel OD-H. [e] 5 h. [f] Yield of **8c** in parentheses. Determined by HPLC analysis on Develosil 30−5.

Using $TiCl_4$ Kelly reported 1:1diasteromeric mixture of the cyclodehydration comp. **7b**

Scheme 3. Synthesis of **16**, a Key Intermediate of Hennoxazole A



Scheme 4. Dehydrative Cyclization Using Polyaniline-Supported $MoO_2(acac)_2$ as a Recyclable Catalyst



run	1	2	3	4	5
yield (%)	99	95	91	92	87

Outline

- Neutral reagent
- MoO(acac)$_2$ more useful for cysteine derivatives and $(NH_4)_2MoO_4$ and $(NH_4)_6Mo_7O_{24}.4H_2O$ for serine and treonine derivatives.

Could be used in more complex substrates?