

THIO-CLAISEN REARRANGEMENT OF CYCLIC S-ALLYLTHIOIMIDATES¹

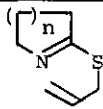
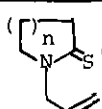
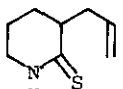

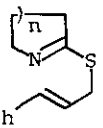
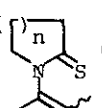

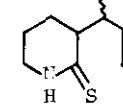
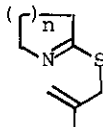
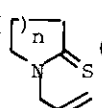
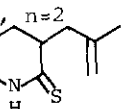


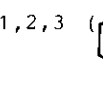
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Abstract - Palladium(II)-catalyzed or non-catalyzed thio-Claisen rearrangement of cyclic S-allylthioimidates is described.

The [3,3]-sigmatropic rearrangement is of considerable synthetic utility.² There have been many reports on the attempts to improve the usefulness of aliphatic Claisen rearrangement as a tool for organic synthesis by lowering the activation energy using transition metal-catalyzed reaction.³ In connection with our research on the heterocyclic chemistry using thiolactams,⁴ we required a variety of N-allylthiolactams. Yoshida *et al.* have reported the highly selective S→N allylic rearrangement of S-allylthioimidates using palladium(II) salt as a catalyst.⁵ We carried out the thio-Claisen rearrangement of cyclic S-allylthioimidates (**1a-c**) in the presence of 1 mol% of bis(benzonitrile)palladium(II) chloride by refluxing in tetrahydrofuran (THF). Although **1a** and **1c** underwent the S→N allylic to yield N-allyl products (**2a** and **2c**), respectively (Entries 1 and 4), **1b** did the S→C rearrangement to form 3-allylpiperidine-2-thione (**3**) (Entry 2). No trace of N-allyl product (**2b**, n=2) was detected. In addition, Yoshida *et al.* have reported that the use of harder Pd(OAc)₂ instead of PdCl₂ resulted in a spectacle change in the ratio of S→C/S→N rearrangement from 81:19 to 4:96 in an acyclic thioimide.^{6,7} Even though Pd(OAc)₂ as a catalyst was used, the rearrangement of **1b** furnished only **3**, and **2b** was not isolated (Entry 3). These results prompted us to study the rearrangement of other cyclic S-allylthioimidates.⁸

The S→N rearrangement of S-*trans*-cinnamylthioimidates (**4a** and **4c**) followed by the isomerization afforded N-vinyl thiolactams (**5a** and **5c**), respectively (Entries 5 and 7). On the other hand, **4b** underwent the S→C rearrangement to produce 3-allylthiolactam (**6**) (Entry 6). In accordance with the previous observations that

Table. Palladium(II)-Catalyzed Rearrangement of Cyclic S-Allylthioimidates^{a,b}

Entry	Cyclic S-Allyl-thioimidates	Reaction Times [h]	Products ^c	Yield [%]	mp or bp/ ¹ H NMR [δ]
1	1a, n=1 	24	2a, n=1 	28 (45) ^d	124 °C/9 mmHg
2	1b, n=2	43	3 	74	74-77 °C 9.60 (1H, br s, NH)
3	1b, n=2	40	3 	66	
4	1c, n=3	15	2c, n=3	94	83 °C/0.3 mmHg
5	4a, n=1 	40	5a, n=1 	23	oil (32) ^d 1.76 (3H, d, J=7.5 Hz, Me) 6.25 (1H, q, J=7.5 Hz, vinyl H)
6	4b, n=2 	15	6e 	58 ^e (3) ^d	129-132 °C 9.22 (1H, br s, NH)
7	4c, n=3	15	5c, n=3	45	oil (3) ^d 1.79 (3H, d, J=7 Hz, Me)
8	7a, n=1 	40	8a, n=1 	0 (64) ^d	
9	7b, n=2	15	9b, n=2 	25 (25) ^d	71-78 °C 1.74 (3H, s, Me) 8.94 (1H, br s, NH)
10	7c, n=3	15	8c, n=3 	8	65 °C/0.4 mmHg
			9c, n=3 	8 (13) ^d	105-107 °C 1.73 (3H, s, Me) 9.07 (1H, br s, NH)
11	10a-c, n=1,2,3 	48		0 ^f	

a All reactions were carried out in the presence of 1 mol% PdCl₂(PhCN)₂ by refluxing THF except for Entry 3. In Entry 3, Pd(OAc)₂ (5 mol%) as a catalyst was used.

b Although reactions of compounds (1a-c, 4b,c, and 7b,c) without Pd(II) were carried out under reflux in THF, the rearrangement did not take place.

c All new compounds were fully characterized spectroscopically (IR, ¹H NMR, and MS spectra) and combustion or high resolution MS spectra.

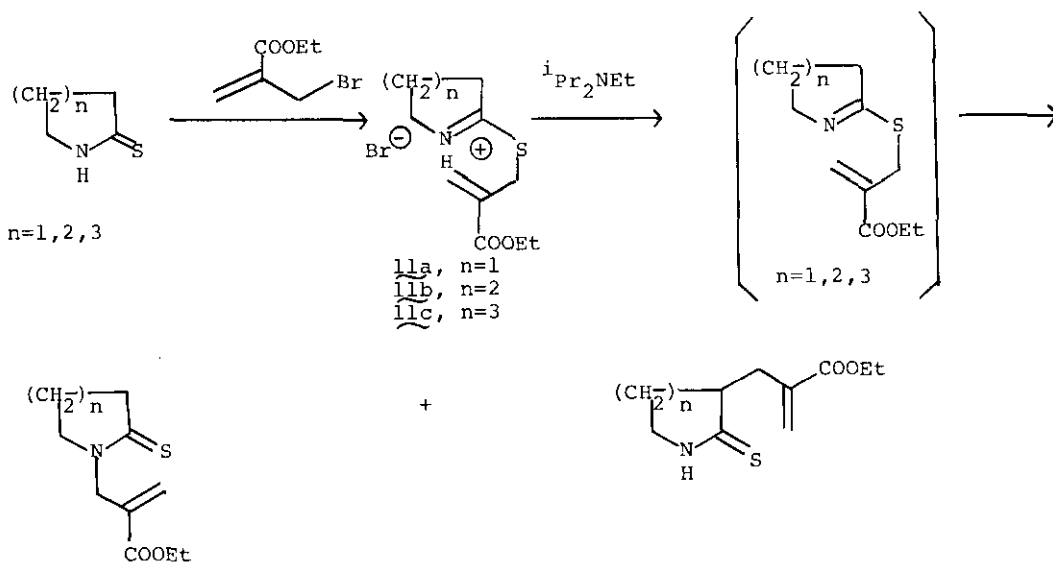
d Yields of the recovery of the starting materials.

e The ratio of erythro:threo is about 1:10 on the basis of ¹H NMR spectrum.

f The rearranged products were not detected in ¹H NMR spectra.

the rearrangement is related by a substituent (CH_3 , Ph, or Cl) at 2-position of the allyl group, S-(2-methyl)allylthioimidates (**7a-c**) were either unreactive (**7a**) or (**7b** and **7c**) rearranged very slowly. The rearrangement of **7b** and **7c** afforded the $\text{S} \rightarrow \text{C}$ product (**9b**) and the $\text{S} \rightarrow \text{N}$ product (**8c**) together with the $\text{S} \rightarrow \text{C}$ product (**9c**), respectively (Entries 9 and 10) in rather low yields. S-(1,1-Dimethyl)-allylthioimidates (**10a-c**) underwent no rearrangement to result in the recovery of the starting materials.

Gompper has reported that the introduction of an electron withdrawing group at the 2-position of the allyl group facilitated the $\text{S} \rightarrow \text{N}$ rearrangement via dipolar intermediate.⁹ According to the method described, S-allylation of thiolactams with ethyl (α -bromomethyl)acrylate followed by dehydrobromination with Hunig's base at room temperature gave the $\text{S} \rightarrow \text{N}$ rearrangement products (**12a-c**) via S-allylthioimidates, respectively. Interestingly, the $\text{S} \rightarrow \text{C}$ rearrangement product (**13b**) from **11b** was not isolated. On the other hand, the $\text{S} \rightarrow \text{C}$ rearrangement product (**12c**), not obtained by Gompper, was isolated from **11c**.¹⁰



	Yield	mp or bp		Yield	mp
12a , n=1	59%	38-40 °C	13a , n=1	0%	
12b , n=2	70%	62-65 °C	13b , n=2	0%	
12c , n=3	49%	150-153 °C/0.23 mmHg	13c , n=3	23%	107-109 °C

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