HETEROCYCLES, Vol. 69, 2006, pp. 69 - 72. © The Japan Institute of Heterocyclic Chemistry
Received, 26th May, 2006, Accepted, 19th June, 2006, Published online, 20th June, 2006. COM-06-S(O)14

STEREOSELECTIVE SYNTHESIS OF *TRANS*-3a-ARYLOCTAHYDROINDOLES USING CYCLIZATION OF *N*-VINYLIC α-(METHYLTHIO)ACETAMIDES†

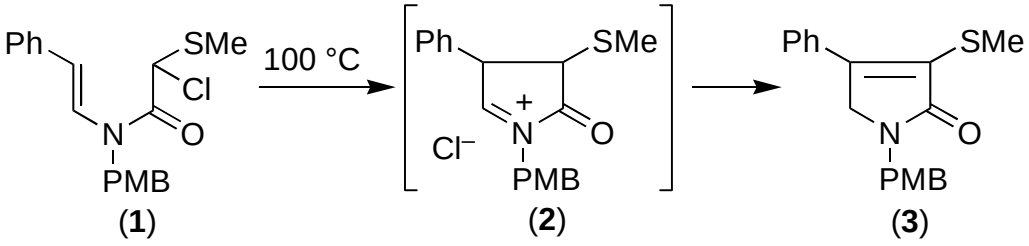
Miho Saito, Jun-ichi Matsuo, Masahiko Uchiyama, and Hiroyuki Ishibashi*

Division of Pharmaceutical Sciences, Graduate School of Natural Science and Technology, Kanazawa University, Kanazawa 920-1192, Japan. E-mail: isibasi@p.kanazawa-u.ac.jp

Abstract – Treatment of *N*-(2-arylcyclohex-1-enyl)-α-(methylthio)acetamide with NCS underwent cyclization to give 3a-arylhexahydroindol-2-one, which was stereoselectively converted into *trans*-3a-aryloctahydroindole.

Lewis acid promoted inter- and intramolecular carbon-carbon bond forming reactions of α-chlorosulfides with alkenic bonds have emerged as valuable tool in organic synthesis.[1] We previously reported that *N*-vinylic α-chloro-α-(methylthio)acetamide (**1**) underwent cyclization at 100 °C in the absence of Lewis acid to give product (**3**) in 30% yield (Scheme 1).[2] This cyclization can be explained in terms of a high nucleophilic nature of the C=C bond of enamide and a high electrophilic nature of α-chlorosulfide, giving the acyliminium ion intermediate (**2**).

Scheme 1



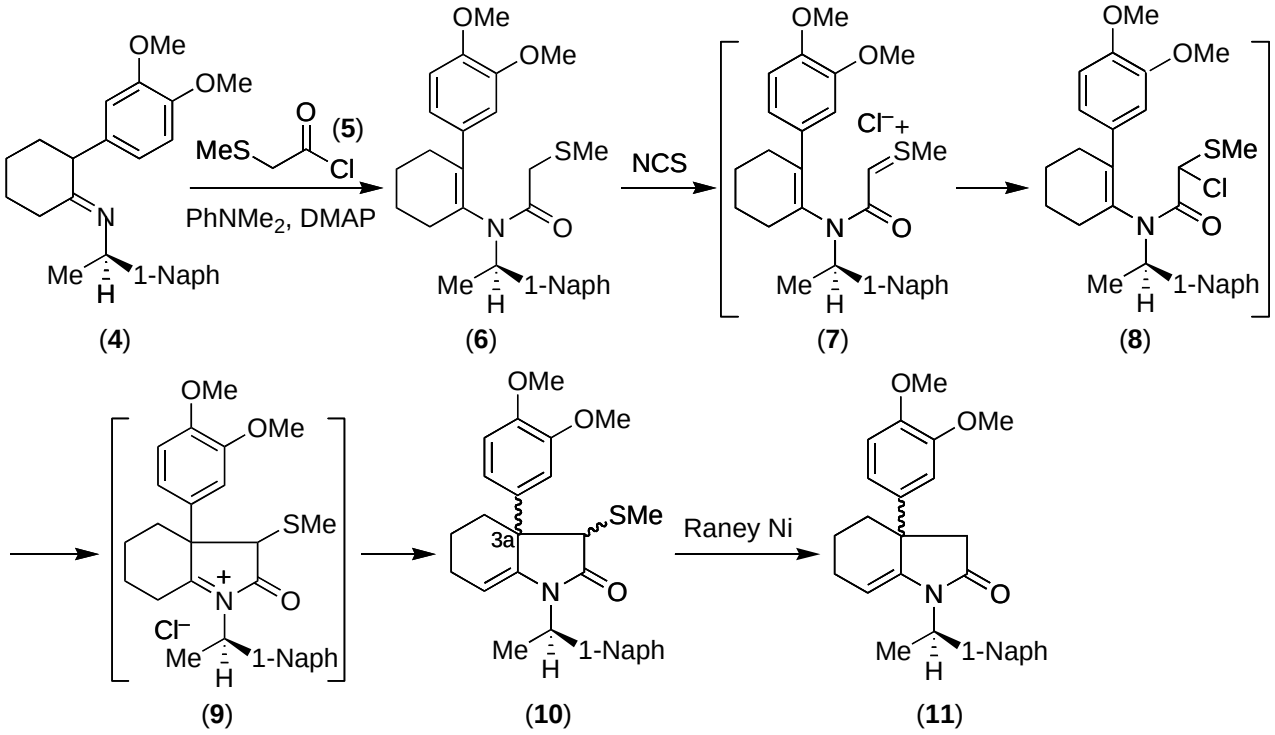
(**1**) (**2**) (**3**)

PMB = *p*-methoxybenzyl

† This paper is dedicated to Prof. Dr. Satoshi Ōmura (The Kitasato Institute) with respect and admiration on the occasion of his 70th birthday.

We have now found that treatment of *N*-(2-arylcyclohex-1-enyl)-α-(methylthio)acetamide (**6**) with NCS at room temperature gives no α-chlorosulfide (**8**) but affords cyclization product, 3a-aryhexahydroindol-2-one (**10**) in good yield (Scheme 2). Subsequent reductions of **10** give no mesembrane (**16**) but afford stereoselectively *trans*-mesembrane (**15**). Herein, we report the preliminary result of the works in this area.

Scheme 2



Condensation of 2-(3,4-dimethoxyphenyl)cyclohexanone and (*R*)-1-(1-naphyl)ethylamine followed by acylation of the resulting imine (**4**) with (methylthio)acetyl chloride (**5**)[3] at room temperature in the presence of *N*,*N*-dimethylaniline and 4-dimethylaminopyridine (DMAP) gave α-(methylthio)acetamide (**6**) having a chiral auxiliary on the nitrogen atom in 45% yield.

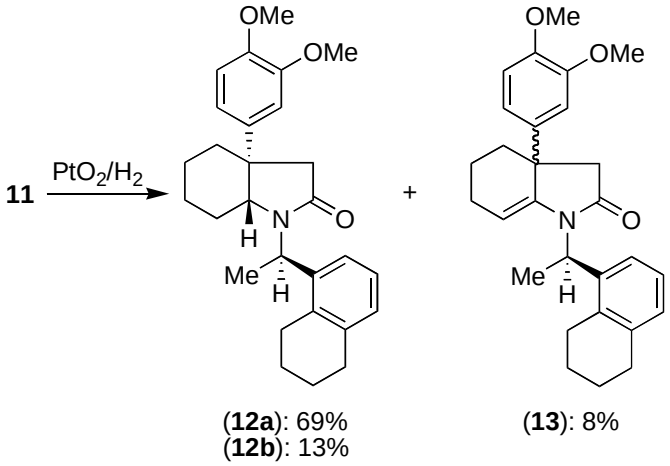
When compound (**6**) was treated with *N*-chlorosuccinimide (NCS) in CCl_4 at room temperature, cyclization occurred smoothly within 30 min to give two stereoisomers (**10**) over possible four diastereoisomers in a ratio of 74:26 (determined by NMR) and in 59% yield: no α-chlorosulfide (**8**) was obtained. Easy access of **10** from **6** without the formation of α-chlorosulfide can be explained by an attack of an electron rich olefinic bond of enamide (**7**) on its thionium ion, which is an intermediate for the formation of α-chlorosulfide (**8**) from **6** and NCS, followed by deprotonation of the resulting iminium ion (**9**). An alternative mechanism for the formation of **10** may involve an intramolecular S_N2 type nucleophilic substitution of α-chlorosulfide (**8**). Although the cyclization of **1** needed high reaction temperature (100 °C, see Scheme 1), the cyclization of **7** or **8** proceeded even at room temperature, probably due to a more electron rich tetrasubstituted olefinic bond of enamide (**7** or **8**) than the

disubsituted olefinic bond of enamide (**1**).

Desulfurization of compound (**10**) with Raney Ni gave an inseparable 73:27 diastereoisomeric mixture of compound (**11**) in 94% yield. This result indicated that the chiral induction by a 1-(1-naphtyl)ethyl group was estimated to be 73:27.

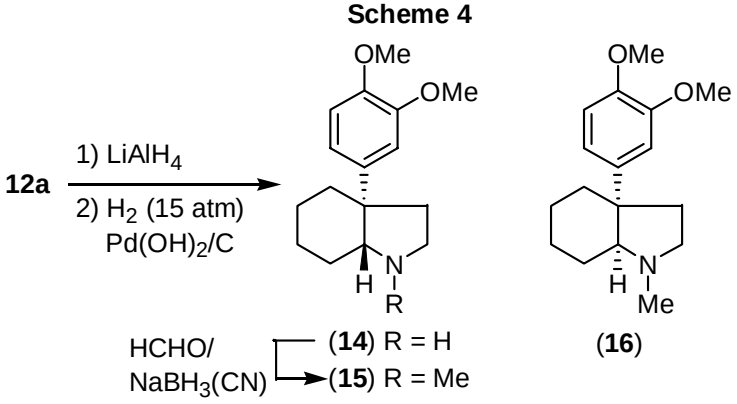
The catalytic hydrogenation of the mixture of two diastereomers (**11**) in the presence of PtO_2 in acetic acid gave two separable stereoisomers (**12a**) and (**12b**) bearing 1-(5,6,7,8-tetrahydro-1-naphtyl)ethyl group on the nitrogen atom in 69 and 13% isolated yields, respectively, together with compound (**13**) (8%) (Scheme 3). Stereochemistry of the ring juncture of **12a** was found to be *trans* by transforming **12a** into *trans*-mesembrane (**15**) (*vide infra*) (the relative *trans*-stereochemistry of the ring juncture of **12a** is depicted in Scheme 3).

Scheme 3



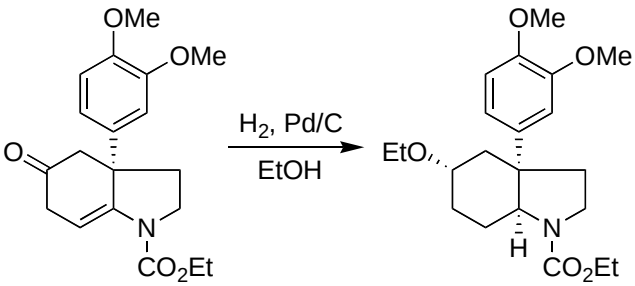
Reduction of the major stereoisomer (**12a**) with $LiAlH_4$ followed by hydrogenolysis of the resulting amine in the presence of $Pd(OH)_2/C$ gave compound (**14**) in 60% yield from **12a**. *N*-Methylation of amine (**14**) with $HCHO/NaBH_3(CN)$ gave *trans*-mesembrane (**15**)[4] in 88% yield (Scheme 4). Therefore, mesembrane (**16**) was not obtained by reduction of **11** with PtO_2/H_2, followed by hydrogenolysis and *N*-methylation.

Scheme 4



Hydrogenation of **11** to *trans*-fused compounds (**12**) was in sharp contrast to that of enamide (**17**) which gave exclusively *cis*-fused compound (**18**) (Scheme 5).[5]

Scheme 5



17 **18**

Elucidation of the absolute configuration of *trans*-mesembrane (**15**) and mechanistic problems for the stereochemistry of the hydrogenation of enamides of the type (**11**) are currently underway

ACKNOWLEDGEMENTS

The present work was supported by a Grant–in-Aid for Scientific Research from the Ministry of Education, Culture, Sports, Science and Technology of Japan.

REFERENCES

1. For reviews, see: (a) H. Ishibashi and M. Ikeda, *J. Synth. Org. Chem. Jpn.*, 1989, **47**, 330. (b) H. Ishibashi and M. Ikeda, *Rev. Heteroatom Chem.*, 1992, **7**, 191.
2. H. Ishibashi, T. Nakaharu, M. Nishimura, A. Nishikawa, C. Kameoka, and M. Ikeda, *Tetrahedron*, 1995, **51**, 2929.
3. A. Mooradian, C. J. Cavallito, A. J. Bergman, E. J. Lawson, and C. M. Suter, *J. Am. Chem. Soc.*, 1949, **71**, 3372.
4. W. H. Pearson, D. P. Szura, and M. J. Postich, *J. Am. Chem. Soc.*, 1992, **114**, 1329.
5. A. Padwa, M. A. Brodney, M. Dimitroff, B. Liu, and T. Wu, *J. Org. Chem.*, 2001, **66**, 3119.