

SIMPLE SYNTHESSES OF MARINE ALKALOID, ( $\pm$ )-CHELONIN A,  
AND ITS ANALOGS<sup>1</sup>

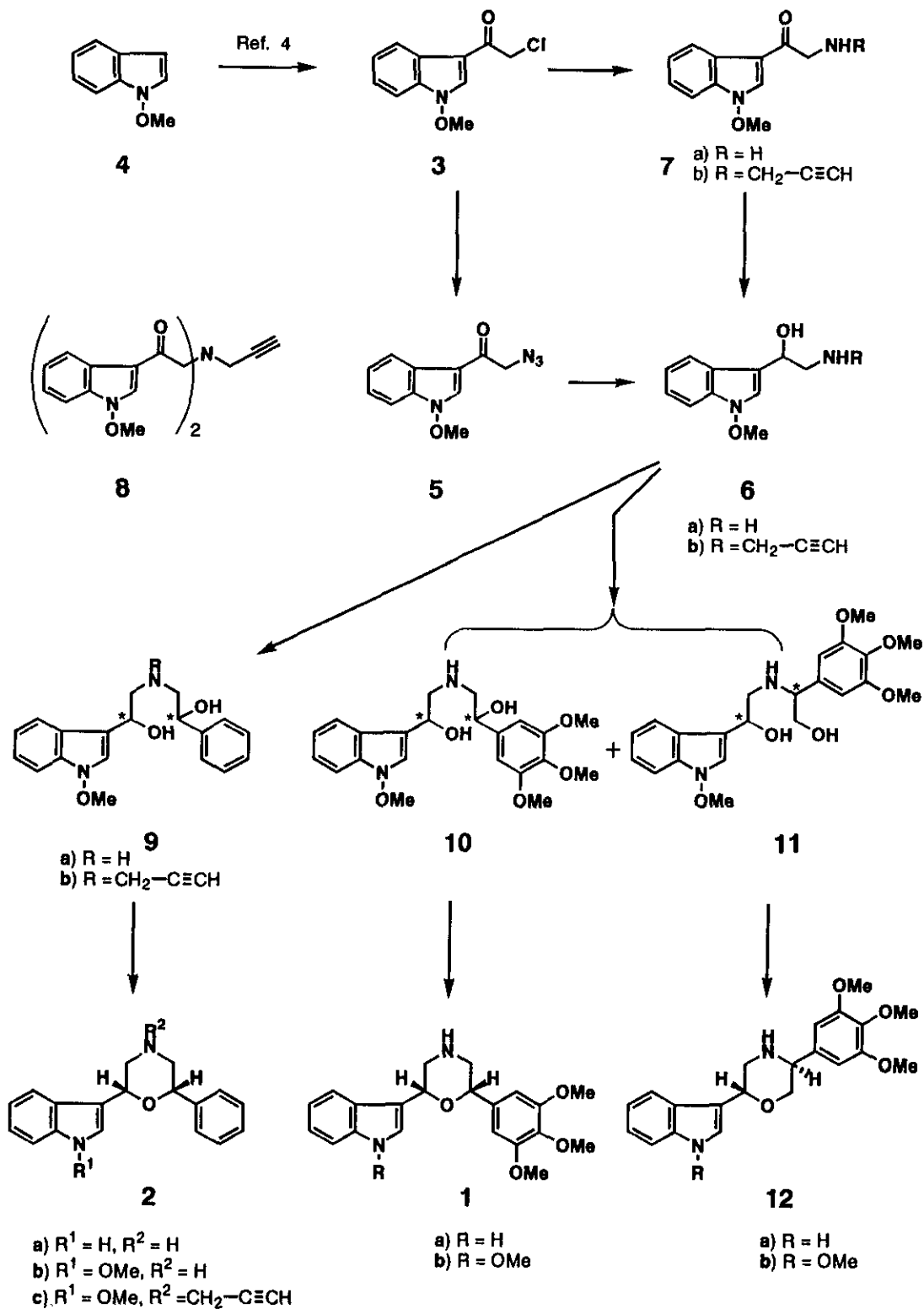
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*Abstract*----The first total synthesis of ( $\pm$ )-chelonin  
A and syntheses of its analogs are achieved based on  
1-hydroxyindole chemistry.

Chelonin A (**1a**, Scheme 1), was isolated from marine sponge *Chelonaplysilla* sp. and determined by D. J. Faulkner and co-workers.<sup>2</sup> They also reported its potent antimicrobial and antiinflammatory activities.<sup>2</sup> In this communication, we wish to report the first and simple total synthesis of ( $\pm$ )-**1a** and syntheses of its analogs based on 1-hydroxyindole chemistry.<sup>3</sup> First, we tried the synthesis of model compounds, 2,6-*cis*-2-(indol-3-yl)-6-phenylmorpholine (**2a**) and 2,6-*cis*-2-(1-methoxyindol-3-yl)-6-phenyl-*N*-propargylmorpholine (**2c**). 3-(2-Chloroacetyl)-1-methoxyindole<sup>4</sup> (**3**), available from 1-methoxyindole (**4**), was converted to 3-(2-azidoacetyl)-1-methoxyindole (**5**) in 87% yield by treatment with NaN<sub>3</sub> in CH<sub>3</sub>CN-H<sub>2</sub>O for 2 h under reflux. Reduction of **5** with LiAlH<sub>4</sub> in THF for 1 h at room temperature afforded **6a** in 48% yield. The compound (**6a**) was alternatively produced in 72% yield by the reduction of 3-(2-aminoacetyl)-1-methoxyindole<sup>4</sup> (**7a**) with NaBH<sub>4</sub> in MeOH for 1 h at room temperature. When **3** was reacted with propargyl amine (excess) in MeOH for 1 h under reflux, monomer (**7b**) and dimer (**8**) were produced in 53% and 32% yields, respectively. Reduction of **7b** with NaBH<sub>4</sub> in MeOH for 8 h at room temperature afforded 57% yield of

## Scheme 1



**6b**. Subsequent reaction of **6a** with styrene oxide in  $\text{CH}_3\text{CN}$  for 24 h under reflux produced **9a** as a 1:1 mixture of diastereoisomers in 57% yield. Similar reaction of **6b** with styrene oxide afforded **9b** as a 1:1 mixture of diastereoisomers in 80% yields.

Treatments of **9a** and **9b** with 2N HCl in MeOH for 1 h or 20 min at room temperature smoothly underwent cyclization to give the desired **2b** and **2c** as a single isomer in both cases, in 74 or 70% yields, respectively. The  $^1\text{H}$ -nmr spectrum of **2b** shows the presence of two sets of  $\text{H}_{\text{axial}}\text{-H}_{\text{axial}}$  coupling ( $J=10.6$  Hz), which clearly proves that phenyl and 1-methoxyindol-3-yl substituents are *cis* and equatorial. Similarly, the stereochemistry of **2c** are proved to be *cis* and both substituents are equatorial. Catalytic hydrogenation of **2b** over 10% Pd/C at room temperature and 1 atm for 4 h produced **2a** in 51% yield.

Based on the successful model experiments, **6a** was next treated with 3,4,5-trimethoxystyrene oxide<sup>5</sup> under the similar reaction conditions as described above to give the regioisomers, **10** and **11**, in 19 and 21% yields, respectively. Acid cyclizations of **10** and **11** formed the corresponding **1b** and **12b** in 89 and 81% yields, respectively. One pot preparations of **1b** and **12b** from **6a** were realized in 16 and 15% overall yields, respectively, when the reactions of **6a** with the epoxide and acid cyclization were carried out successively. Catalytic hydrogenation of **1b** over 10% Pd/C at room temperature and 1 atm for 4 h produced **1a** in 59% yield, while the same reaction of **12b** afforded **12a** in 57% yield.

Spectral data of natural product<sup>2</sup> (**1a**) are identical with those of ( $\pm$ )-**1a** and not with those of ( $\pm$ )-**12a**. Thus, the structure of chelonin A was alternatively proved by chemical synthesis. 3,4,5-Trimethoxyphenyl and indol-3-yl substituents of **12a** are proved to be *trans* and equatorial, based on its  $^1\text{H}$ -nmr spectrum showing two sets of  $\text{H}_{\text{axial}}\text{-H}_{\text{axial}}$  coupling ( $J=10.3$  and 11.4 Hz).

In summary, we have developed a simple method which can produce various

chelonin analogs only by changing epoxide components. Since optically active epoxides are available, syntheses of chiral chelonin analogs are currently in progress.

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All new compounds gave satisfactory spectral and elemental analysis for crystals or high resolution mass spectral data for oil. **1a**) mp 161-162°C (decomp.); **1b**) oil; **2a**) hard oil; **2b**) hard oil; **2c**) oil; **5**) mp 69-70°C; **6a**) mp 126-127°C (decomp.); **6b**) mp 95-96°C; **7b**) mp 76-77°C; **8**) mp 173-174°C; **10**) oil; **11**) oil; **12a**) mp 155-159°C; **12b**) mp 124-126°C.
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5. 3,4,5-Trimethoxystyrene oxide was prepared from 3,4,5-trimethoxybenzaldehyde in 56% yield by the reaction with dimethylsulfoxonium methylide.

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