# Ecdysteroids from a *Zoanthus* sp.

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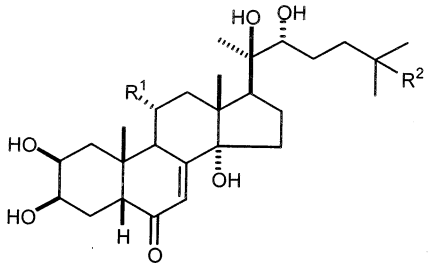
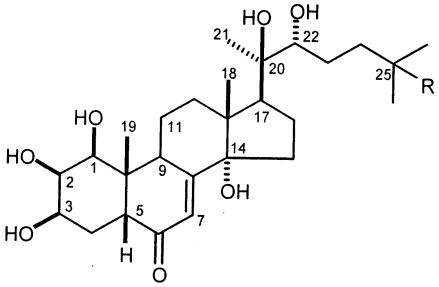
A new ecdysteroid, zoanthusterone, has been isolated from a marine zoanthid, *Zoanthus* sp. Ten known ecdysteroids, ponasterone A, 20-hydroxyecdysone 2-acetate, viticosterone E, integristerone A 25-acetate, 2-deoxy-20-hydroxyecdysone, ecdysone, ajugasterone C, dacryhainansterone, inokosterone, and 20-hydroxyecdysone, have also been isolated. This is the first report of ecdysteroids in a *Zoanthus* species.

Chemical investigations on constituents of some marine zoanthids have been reported.[1,2] Ecdysteroids, the arthropod moulting hormone, are among the constituents of these animals. The zoanthid *Gerardia savaglia* has been reported to contain 20-hydroxyecdysone (**1**),[3] ecdysone, ajugasterone C (**2**),[4] and the new ecdysteroid gerardiasterone.[5] Compound **1** and a new ecdysteroid, 4-dehydroecdysterone, have been isolated from an Australian *Parazoanthus* species.[6] Another zoanthid, *Palythoa australae*, has recently been investigated, and two new ecdysteroids, palythoalones A and B, including the known ecdysteroids, makisterone B and inokosterone, have been isolated.[7] In this paper we report on the isolation of a new ecdysteroid, zoanthusterone (**3**), and 10 known ecdysteroids, including the rare ecdysteroid integristerone A 25-acetate (**4**),[8] from a *Zoanthus* species (Zoanthidae).

The zoanthid *Zoanthus* sp., collected off Samae-sarn, Sattahip District, Chonburi Province, was subjected to extraction, and 10 known ecdysteroids were isolated and identified from the BuOH extract. These included ponasterone A (**5**),[9] 20-hydroxyecdysone 2-acetate,[10] viticosterone E,[10,11] integristerone A 25-acetate (**4**),[8] 2-deoxy-20-hydroxyecdysone,[12] ecdysone,[13] ajugasterone C (**2**),[14] dacryhainansterone (5-deoxykaladasterone),[15] inokosterone,[16] and 20-hydroxyecdysone (**1**).[17] These ecdysteroids were identified by comparisons of spectroscopic data with those of reported compounds and, in some cases, TLC comparisons with authentic ecdysteroids (see Experimental Section). Along with these compounds, a new ecdysteroid, **3**, was also isolated and characterized using spectroscopic techniques, especially 1D and 2D NMR.




**1:** $R^1$ = H, $R^2$ = OH
**2:** $R^1$ = OH, $R^2$ = H
**5:** $R^1$ = $R^2$ = H




**3:** R = H
**4:** R = OAc
**6:** R = OH
**7:** C-1 epimer of **6**

Compound **3**, zoanthusterone, was obtained as an amorphous solid, and the molecular formula was established as $C_{27}H_{44}O_7$ by HRFABMS (negative ion mode, *m/z* 479.3007 $[M - H]^-$). The IR absorption bands at 3422 and 1654 $cm^{-1}$ indicated the presence of hydroxyl and unsaturated keto groups, respectively. $^1H$ NMR features in $C_5D_5N$ as well as the color reaction on TLC with anisaldehyde reagent suggested this compound to be an ecdysteroid. The methyl resonances in the $^1H$ NMR spectrum at $\delta$ 1.22, 1.40, and 1.55 were assignable to those of 18-Me, 19-Me, and 21-Me, respectively. The singlet nature and relatively downfield resonance of the latter signal revealed the presence of a hydroxyl group at the 20-position. The absence of singlet signal(s) of 26- and 27-Me groups at ca. $\delta$ 1.3 and the presence of two doublets ($J$ = 6.2 Hz) at $\delta$ 0.79 and 0.80 indicated that this compound is a 25-deoxyecdysteroid.

As the molecular weights of this ecdysteroid and 20-hydroxyecdysone (**1**) were the same, the 25-hydroxyl group should be located at another position in **3**. Placement of this last hydroxyl group at the 24-position was not possible, since a considerable downfield shift of H-22 and H-25 signals should result. In fact, such expected compounds would be pterosterone and its C-24 epimer, 24-*epi*-pterosterone,[18] the $^1H$ NMR data of which were different from those of compound **3**. Placement of the hydroxyl group at C-23 was not possible on the basis of chemical shift value and splitting pattern of H-22. The presence of a hydroxyl group at C-11 seemed logical. However, the resulting structure would be ajugasterone C (**2**), which was also isolated from this animal and exhibited different $^1H$ NMR spectra. The argument that the expected compound could

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**Table 1.** $^1$H NMR Data of Compounds **1**, **3**, **4**, **5**, and **7**

| H | **1** ($C_5D_5N$) | **3** ($C_5D_5N$) | **3** ($CD_3OD$) | **4** ($C_5D_5N$) | **5** ($C_5D_5N$) | **7**[a] ($C_5D_5N$) | **7**[a] ($CD_3OD$) |
|---|---|---|---|---|---|---|---|
| 1 | | 4.30 (br s) | 3.81 (br s, $W_{1/2} = 7$) | 4.31 (br s) | | 4.31 (br s) | 3.82 (br s, $W_{1/2} = 6.8$) |
| 2 | 4.18 (m) | 4.24 (br s) | 3.87 (br t, 2.8) | 4.24 (br s) | 4.16 (m) | 4.29 (m) | 3.87 (br t) |
| 3 | 4.21 (br s) | 4.30 (br s) | 4.04 (br s, $W_{1/2} = 12$) | 4.31 (br s) | 4.23 (br s) | 4.30 (m) | 4.03 (m) |
| 5 | 2.99 (dd, 12.5, 3.3) | 3.29 (br d, ca. 2) | 2.60 (dd, 12.3, 4.7) | 3.30 (m) | 3.02 (dd, 13.2, 3.8) | 3.30 | 2.60 (dd, 13, 4) |
| 7 | 6.23 (d, 2.1) | 6.27 (br s) | 5.82 (d, 1.9) | 6.27 (br s) | 6.26 (d, 2.4) | 6.30 (d, 2.5) | 5.82 (d, 2.3) |
| 9 | 3.57 (m) | 3.56 (m) | 3.07 (m) | 3.58 (m) | 3.60 (m) | 3.60 (m) | 3.07 (m) |
| 17 | 2.98 (t, 8.5) | 2.90 (t, 8.7) | 2.36 (t, 8.3) | 2.96 (t, 9) | 2.93 (t, 9.1) | 3.01 (t, 8) | 2.38 (t, 8) |
| 22 | 3.86 (dd, 8.5, 1.2) | 3.79 (br d, 9.7) | 3.32[b] | 3.83 (br d, 9.8) | 3.80 (br d, 10.4) | 3.87 (m) | 3.33 |
| 18-Me | 1.20 (s) | 1.22 (s) | 0.89 (s) | 1.22 (s) | 1.23 (s) | 1.25 (s) | 0.90 (s) |
| 19-Me | 1.05 (s) | 1.40 (s) | 1.06 (s) | 1.41 (s) | 1.07 (s) | 1.44 (s) | 1.08 (s) |
| 21-Me | 1.57 (s) | 1.55 (s) | 1.15 (s) | 1.59 (s) | 1.57 (s) | 1.59 (s) | 1.19 (s) |
| 26-Me | 1.36 (s) | 0.79 (d, 6.2) | 0.90 (d, 6.8) | 1.41 (s) | 0.81 (d, 6.1) | 1.38 (s) | 1.20 (s) |
| 27-Me | 1.36 (s) | 0.80 (d, 6.2) | 0.91 (d, 6.8) | 1.47 (s) | 0.83 (d, 6.1) | 1.38 (s) | 1.20 (s) |
| AcO | | | | 1.93 | | | |

[a] Data taken from ref 23. [b] Partially superimposed by solvent signal.

possibly be the C-11 epimer of **2** was also unlikely, since the H-9 signal should be resolved to a relatively simple splitting pattern, instead of a multiplet signal at $\delta$ 3.56. Moreover, the presence of an 11-hydroxyl group should give rise to a downfield shift of the H-9 resonance.[19]

The presence of the H-5 signal as well as its multiplicity (br d, $J \approx 12$ Hz in $C_5D_5N$ and dd, $J = 12.3$ and 4.7 Hz in $CD_3OD$) did not permit the placement of an additional hydroxyl group at either the 5- or 4-positions. The last possibility was to locate the hydroxyl group at the 1-position. Structure **3** seemed to fit the spectroscopic data by the following observations. From comparisons of $^1$H NMR data of compound **3** in $C_5D_5N$ with those of compounds **4** and **5** (Table 1) it was concluded that the A-ring and the side chain of **3** were respectively the same as those of **4** and **5**. It should be noted that the unusual downfield 19-Me signal ($\delta$ 1.40), as compared with that of compound **5** ($\delta$ 1.07), was due to the presence of an oxygen function at the 1-position.[20] Assignment of the 19-Me $^1$H NMR resonance was confirmed by HMBC correlations of this methyl signal with C-1 ($\delta$ 77.7), C-5 ($\delta$ 48.0), C-9 ($\delta$ 36.4), and C-10 ($\delta$ 45.0). A large downfield shift (0.27 ppm) of H-5 on going from **5** to **3** was due to interaction between the axial 1-hydroxyl function and the H-5$\beta$.[20] To confirm that the 1-hydroxyl group was $\beta$-oriented, analysis of the $W_{1/2}$ (bandwidth at half-height) value of H-1 was made. The H-1 to H-3 signals in $C_5D_5N$ were, unfortunately, not well separated; it was therefore not possible to accurately measure $W_{1/2}$ values in this solvent. However, the $^1$H NMR spectrum of **3** in $CD_3OD$ provided individual H-1 ($\delta$ 3.81, br s, $W_{1/2} = 7$ Hz), H-2 ($\delta$ 3.87, br t, $J = 2.8$ Hz), and H-3 ($\delta$ 4.04, br s, $W_{1/2} = 12$ Hz) resonances. The relatively small $W_{1/2}$ value of H-1 suggested its equatorial orientation. In other words, the 1-hydroxyl group was in axial orientation as indicated in structure **3**. It followed that the coupling constant and $W_{1/2}$ value of H-2 and H-3 fixed the configuration at C-2 and C-3 as shown. The magnitude of $W_{1/2}$ values of H-1 and H-3 and the coupling constant of H-2 were approximately the same as those of integristerone A (**6**), the $W_{1/2}$ of H-1 and H-3 in $D_2O$ of which were 7 and 8 Hz, and the coupling constant of H-2 was 3.2 Hz.[20] It was noteworthy that the above argument was based on the assumption that H-5 was in the $\beta$-orientation. If H-5 was on the $\alpha$-face, while those of the 1-, 2-, and 3-hydroxyl groups were on the same $\beta$-face as those of the structure **3**, a large $W_{1/2}$ value (18−25 Hz) of the H-3 signal should result. Alternatively, if H-5 was in the $\alpha$-orientation and if all the A-ring hydroxyl groups were in the $\alpha$-orientation, the $W_{1/2}$ values and coupling constants of H-1, H-2, and H-3 would still be similar to those of structure **3**. H-5 could be in relatively close proximity to the 1$\alpha$- and 3$\alpha$-hydroxyl groups and could possibly result in a downfield shift of the H-5 resonance.

To establish the stereochemistry at C-5, NOE measurements were employed. Thus, irradiation of 19-Me of **3** resulted in NOE enhancement of the H-5 signal. The $\alpha$-orientation nature of H-2 was further confirmed by NOE correlation between this proton and H-9. It was therefore concluded that the A/B-ring fusion was *cis*[21,22] and the structure of the new ecdysteroid is **3**, i.e., 1$\beta$-hydroxyponasterone A.

It should be noted that 1$\alpha$,20*R*-dihydroxyecdysone (**7**), the C-1 epimer of integristerone A (**6**), has been isolated recently from the plant *Axyris amaranthoides*, and the stereochemistry at C-1 was established on the basis of NOE experiments, especially the NOE correlation between 19-Me and H-1 and the absence of NOEs between H-1 and H-2 and H-11.[23] Despite a different stereochemistry at C-1, compounds **3** and **7** gave very similar $^1$H NMR and $^{13}$C NMR data (Tables 1 and 2), except for those of the 25- to 27-positions. The $W_{1/2}$ value of H-1 (6.8 Hz) of **7** was surprisingly almost the same as that of compound **3** and was unusually small for coupling of two axial protons (H-1 and H-2). It is noteworthy that a NOE correlation between 19-Me and H-1 was also observed in our case. A molecular model indicated that NOE interactions between 19-Me and H-1$\alpha$, and 19-Me and H-1$\beta$, could possibly occur. In practice, the absence of an NOE should be used only as supporting evidence for assigning a particular stereochemistry. In our experience, the $W_{1/2}$ value is more reliable in

**Table 2.** $^{13}C$ NMR Data of Compounds **1**, **3**, **4**, and **7** in $C_5D_5N$

| C | **1**[a] | **3** | **4** | **7**[b] |
|---|---|---|---|---|
| 1 | 38.0 | 77.7 | 77.7 | 76.2 |
| 2 | 68.3 | 69.9 | 70.0 | 68.1 |
| 3 | 68.2 | 72.1 | 72.2 | 70.5 |
| 4 | 32.5 | 33.3 | 33.3 | 33.0 |
| 5 | 51.4 | 48.0 | 48.1 | 46.4 |
| 6 | 203.5 | 204.8 | 205.5 | |
| 7 | 121.7 | 123.3 | 123.3 | 121.6 |
| 8 | 166.1 | 167.2 | 166.9 | |
| 9 | 34.6 | 36.4 | 36.6 | 35.0 |
| 10 | 38.8 | 45.0 | 45.0 | 42.0 |
| 11 | 21.2 | *c* | 23.0 | 21.4 |
| 12 | 32.1 | 33.6 | 33.6 | 32.0 |
| 13 | 48.2 | 49.3 | 47.7 | 47.0 |
| 14 | 84.4 | 85.7 | 85.7 | 84.2 |
| 15 | 31.8 | 31.4 | 31.2 | 31.5 |
| 16 | 21.6 | *c* | *c* | 21.5 |
| 17 | 50.2 | 51.7 | 51.8 | 50.1 |
| 18 | 17.9 | 19.5 | 19.5 | 17.8 |
| 19 | 24.5 | 22.9 | 22.0 | 20.3 |
| 20 | 77.0 | 78.4 | 78.5 | 76.8 |
| 21 | 21.7 | 23.0 | 23.2 | 21.6 |
| 22 | 77.7 | 78.4 | 79.1 | 77.5 |
| 23 | 27.5 | 29.8 | 31.6 | 27.5 |
| 24 | 42.6 | 38.7 | 40.9 | 42.6 |
| 25 | 69.8 | 31.4 | 84.0 | 69.5 |
| 26 | 30.1 | 24.0 | 27.7 | 30.0 |
| 27 | 30.1 | 24.9 | 27.9 | 30.1 |
| Me*C*$O_2$ | | | 172.0 | |
| *Me*$CO_2$ | | | 23.9 | |

[a] Data taken from ref 1. [b] Data taken from ref 23. [c] Obscured signal.

the assignment of stereochemistry of hydrogens in a molecule than the NOE experiment, at least in the ecdysteroid field.[22,24]

In conclusion, the *Zoanthus* sp. investigated contained a complex mixture of ecdysteroids, including the two rare 1,2,3-trihydroxyecdysteroids (**3** and **4**) reported here. To our knowledge, this is the first report of ecdysteroids in a *Zoanthus* species.[1,2]

## Experimental Section

**General Experimental Procedures.** Melting points were determined on an Electrothermal apparatus and are uncorrected. $^1H$ and $^{13}C$ NMR spectra were measured with a JEOL JNM-A 500 and a Bruker AVANCE 400 spectrometers operating at 500, 400, and 125 and 100 MHz, respectively. The chemical shifts ($\delta$) are reported in ppm, and coupling constants ($J$) are given in Hz. For the spectra taken in $C_5D_5N$ and $CD_3OD$, the residual nondeuterated solvent signals at $\delta$ 8.71 and 3.30 and the solvent signals at $\delta$ 149.90 and 49.00 were used as references for $^1H$ and $^{13}C$ NMR spectra, respectively. Mass spectra were measured on a Finnigan MAT 90 instrument. Unless indicated otherwise, Merck Si gel 60 (finer than 0.063 mm) was used for column chromatography. TLC was conducted on plates precoated with Merck Si gel 60 $F_{254}$. The eluting solvent system for column chromatography used throughout the experiments was $CHCl_3$−MeOH, with increasing percentage of the more polar solvent. Reversed-phase column chromatography was conducted using Merck Si gel 60 RP-18 (40−63 $\mu$m). Spots on TLC were visualized under UV light and by spraying with anisaldehyde−$H_2SO_4$ reagent, followed by heating. Reversed-phase HPLC was performed on a Spherisorb S10ODS2 column (5 $\mu$m, 250 × 10 mm) with MeOH−$H_2O$ as a mobile phase at a flow rate of 2 mL $min^{-1}$, using a UV detector at 254 nm.

**Animal Material.** The zoanthids *Zoanthus* sp. were collected off Samae-sarn, Sattahip District, Chonburi Province. The voucher specimen (AS-RU-MA2) is deposited at the Faculty of Science, Ramkhamhaeng University.

**Extraction and Isolation.** Fresh zoanthids (3 kg) were milled and extracted exhaustively with MeOH, and most of the solvent was evaporated in vacuo. Water (600 mL) was added and the mixture extracted successively with *n*-hexane, $CHCl_3$, and *n*-butanol to yield 30, 46, and 130 g of the hexane, $CHCl_3$, and BuOH extracts, respectively. A portion (30 g) of the BuOH extract was subjected to column chromatography (Merck Si gel, 0.063−0.200 mm), eluting with $CHCl_3$ and $CHCl_3$−MeOH with increasing MeOH content. The eluate was examined by TLC, and 13 combined fractions were obtained. Fraction 6 was chromatographed with the same adsorbent and eluting solvent system to give 13 subfractions. Subfraction 9 (16 mg) yielded colorless needles (from MeOH−EtOAc), mp 256−258 °C (lit. 259−260 °C),[9] which was identified to be ponasterone A (**5**) from spectroscopic ($^1H$ NMR and FABMS) data. Subfraction 11 (16 mg) was a mixture that was identified as 20-hydroxyecdysone 2-acetate and viticosterone E by TLC and $^1H$ NMR comparisons with authentic samples.[10,11] Subfraction 13 was subjected to column chromatography, followed by two repeated reversed-phase column chromatographies eluting with $H_2O$ and $H_2O$−MeOH with increasing MeOH content to afford compound **4** (1 mg) and compound **3** (2 mg). Compound **4** was identified to be integristerone A 25-acetate by spectroscopic (IR, $^1H$ NMR, and mass spectral) comparisons with those published previously[8] and was confirmed by 2D NMR experiments.

Fraction 7 was subjected to repeated column chromatography to give 2-deoxy-20-hydroxyecdysone (4 mg), the spectroscopic (IR, $^1H$ NMR, and FAB mass spectral) data of which was consistent with those reported previously.[12,21]

Fraction 9 was chromatographed and subfraction 6 was subjected to column chromatography to yield ecdysone (3 mg) and ajugasterone C (**2**, 2 mg). The spectroscopic ($^1H$ NMR and FAB mass spectral) data of the two compounds were consistent with those reported previously.[1,13,14] Subfraction 7 was similarly subjected to further separations using normal-phase and reversed-phase column chromatography to yield dacryhainansterone (5-deoxykaladasterone, 2 mg) and inokosterone (2 mg). The identity of the former ecdysteroid was established by spectroscopic ($^1H$ and $^{13}C$ NMR and FAB mass spectral) data.[15] The latter ecdysteroid was identical to that reported previously by spectral comparisons.[25] Subfraction 10 was chromatographed, and the ecdysteroid thus obtained (14 mg) was crystallized from MeOH−EtOAc to give 20-hydroxyecdysone (**1**), mp 240−241 °C (lit. 240−242 °C).[17] TLC and $^1H$ NMR spectral comparisons of **1** with those of an authentic sample revealed the identity of this compound.

**Compound 3**: colorless amorphous solid; IR (KBr) $\nu_{max}$ 3422, 2926, 1654, 1458, 1375, 1120, 1063 $cm^{-1}$; $^1H$ and $^{13}C$ NMR (Tables 1 and 2, respectively); HMBC correlations ($C_5D_5N$): H-7 (C-5, C-9, C-14), H-17 (C-18, C-20, C-21), 18-Me (C-12, C-13, C-14, C-17), 19-Me (C-1, C-5, C-9, C-10), 21-Me (C-17, C-20, C-22), H-22 (C-20, C-21), 26-Me (C-24, C-25, C-27), 27-Me (C-24, C-25, C-26); HRFABMS (negative ion mode) $m/z$ 479.3007 $[M - H]^-$ (calcd for $C_{27}H_{44}O_7 - H$, 479.3008).

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## References and Notes

(1) Lafont, R.; Wilson, I. *The Ecdysone Handbook*, 2nd ed.; The Chromatographic Society: Nottingham, 1996.
(2) Faulkner, D. J. *Nat. Prod. Rep.* **2001**, *18*, 1−49, and previous reports in this series.
(3) Sturaro, A.; Guerriero, A.; De Clauser, R.; Pietra, F. *Experientia* **1982**, *38*, 1184−1185.
(4) Guerriero, A.; Pietra, F. *Comp. Biochem. Physiol. B* **1985**, *80*, 277−278.
(5) Guerriero, A.; Traldi, P.; Pietra, F. *J. Chem. Soc., Chem. Commun.* **1986**, 40−41.
(6) Searle, P. A.; Molinski, T. F. *J. Nat. Prod.* **1995**, *58*, 264−268.

(7) Shigemori, H.; Sato, Y.; Kagata, T.; Kobayashi, J. *J. Nat. Prod.* **1999**, *62*, 372−374.
(8) Sadikov, Z. T.; Saatov, Z. *Chem. Nat. Compd.* **1999**, *35*, 440−441; *Khim. Prir. Soedin.* **1999**, 492−493.
(9) Nakanishi, K.; Koreeda, M.; Sasaki, S.; Chang, M. L.; Hsu, H. Y. *Chem. Commun.* **1966**, 915−917.
(10) Suksamrarn, A.; Pattanaprateep, P. *Tetrahedron* **1995**, *51*, 10633−10650.
(11) Rimpler, H. *Tetrahedron Lett.* **1969**, 329−333.
(12) Galbraith, M. N.; Horn, D. H. S.; Middleton, E. J.; Hackney, R. J. *Chem. Commun.* **1968**, 83−85.
(13) Girault, J.-P.; Lafont, R. *J. Insect Physiol.* **1988**, *34*, 701−706.
(14) Imai, S.; Murata, E.; Fujioka, S. *Chem. Commun.* **1969**, 456−457.
(15) Szendrei, K.; Varga, E.; Hajdu, Zs.; Herke, I.; Lafont, R.; Girault, J.-P. *J. Nat. Prod.* **1988**, *51*, 993−995.
(16) Hikino, H.; Mohri, K.; Hikino, Y.; Arihara, S.; Takemoto, T.; Mori, H.; Shibata, K. *Tetrahedron* **1976**, *32*, 3015−3021.
(17) Werawattanametin, K.; Podimuang, V.; Suksamrarn, A. *J. Nat. Prod.* **1986**, *49*, 365−366.
(18) Suksamrarn, A.; Yingyongnarongkul, B.; Charoensuk, S. *Tetrahedron* **1999**, *55*, 255−260.
(19) Suksamrarn, A.; Promrangsan, N.; Jintasirikul, A. *Phytochemistry* **2000**, *53*, 921−924.
(20) Girault, J.-P.; Bathori, M.; Varga, E.; Szendrei, K.; Lafont, R. *J. Nat. Prod.* **1990**, *53*, 279−293.
(21) Suksamrarn, A.; Yingyongnarongkul, B. *Tetrahedron* **1996**, *52*, 12623−12630.
(22) Suksamrarn, A.; Yingyongnarongkul, B. *Tetrahedron* **1997**, *53*, 3145−3154.
(23) Sarker, S. D.; Sik, V.; Rees, H. H.; Dinan, L. *Phytochemistry* **1998**, *49*, 2305−2310.
(24) Suksamrarn, A.; Charoensuk, S.; Yingyongnarongkul, B. *Tetrahedron* **1996**, *52*, 10673−10684.
(25) Yingyongnarongkul, B.; Suksamrarn, A. *ScienceAsia* **2000**, *26*, 15−20.