160. Aplysinopsin-Type Alkaloids from *Dendrophyllia* sp., a Scleractinian Coral of the Family Dendrophylliidae of the Philippines. Facile Photochemical (*Z*/*E*) Photoisomerization and Thermal Reversal

by **Graziano Guella**[a]), **Ines Mancini**[a]), **Helmut Zibrowius**[b]), and **Francesco Pietra**[a])*

[a]) Istituto di Chimica, Università di Trento, I-38050 Povo-Trento
[b]) Station Marine d'Endoume, F-13007 Marseille

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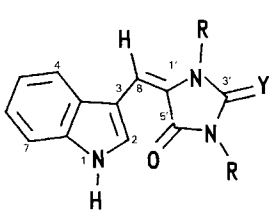
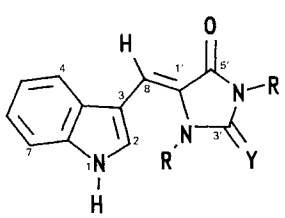
The dendrophylliid *Dendrophyllia* sp. of Palawan contains the indole alkaloids 2′-demethylaplysinopsin (**4**) and 2′-demethyl-3′-*N*-methylaplysinopsin (**6**) and their 6-bromo analogues in a (*Z*/*E*) ratio larger than 95:5; these mixtures undergo facile photoisomerization to give mixtures richer in the (*E*) stereoisomer which undergo thermal isomerization to give back the original mixtures.

1. Introduction. – Since aplysinopsin (**1**) was first isolated from the sponge *Aplysinopsis reticulata* (Dictyoceratida) of the Great Barrier Reef [1], a number of related indole alkaloids have been found in other marine organisms. Such compounds can be classified into four structural types, represented by aplysinopsin itself (**1**) [1], 3′-deimino-3′-oxoaplysinopsin (**2**), isolated from the dendrophylliid coral *Tubastraea* sp. collected at Palawan, Philippines [2], 3′-deimino-2′,4′-didemethyl-3′-oxoaplysinopsin (**3**), isolated from the Mediterranean dendrophylliid *Leptopsammia pruvoti* [2], and finally, 2′-demethylaplysinopsin (**4**), and the 6-bromo analogue **5**, isolated from the sponge *Dercitus* sp. (Choristida) collected in Belize waters [3].

We have recently reported that the (*E*/*Z*) configuration of compounds of the structural type **1**–**3** can be assigned on the basis of a larger *H*–C(8),C(5′) $^1H,^{13}C$ heteronuclear



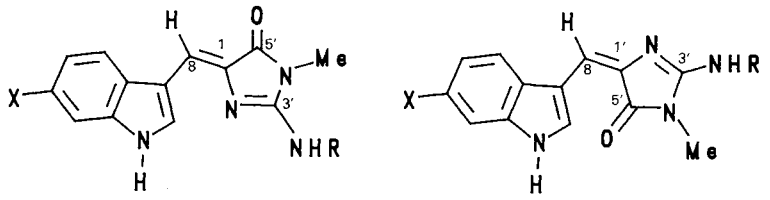
(*E*)[a])



(*Z*)[a])

1 R = Me, Y = NH, (*E*/*Z*) > 95:5[b])
2 R = Me, Y = O, (*E*/*Z*) > 95:5[b])
3 R = H, Y = O, (*Z*/*E*) > 95:5[b])

[a]) Arbitrary numbering.
[b]) Natural isomer ratio.



(*Z*)[a]) (*E*)[a])

4 X = R = H, (*Z*/*E*) > 95:5[b])
5 X = Br, R = H, (*Z*/*E*) > 95:5[b])
6 X = H, R = Me, (*Z*/*E*) > 95:5[a])
7 X = Br, R = Me, (*Z*/*E*) > 95:5[b])

[a]) Arbitrary numbering.
[b]) Natural isomer ratio.

coupling constant [4] in the (*E*) than in the (*Z*) stereoisomer and that these compounds undergo (*E*/*Z*) photoisomerization [2]. Thus, compounds of type **1** and **2**, which have predominantly the (*E*) configuration, on irradiation with 350-nm light or under daylight, were found to afford slowly mixtures richer in the (*Z*) isomer [2]. Compound **3** showed the opposite behavior: under irradiation, the (*Z*/*E*) ratio of stereoisomers decreased [2].

We report on compounds **4** and **5** isolated together with **6**, **7**, **9a**, and **9b** from the dendrophylliid coral *Dendrophyllia* sp., collected at Palawan, Philippines; this is one of the many brightly colored but poorly known dendrophylliids of the Indo-Pacific reefs.

2. Results and Discussion. – 2.1. *Configurational Assignment.* The isolation of compounds **4** and **5** from *Dendrophyllia* sp., after they had been isolated from the sponge *Dercitus* sp. [3], has a wider scope than a mere indication of the distribution of marine natural products in marine species. In fact, with enough compound **5** at hand, it can be now determined that the *H*–C(8),C(5′) $^1H,^{13}C$ coupling constant has such a small magnitude, 3.8 Hz, to be only compatible with the (*Z*) configuration. Should the (*E*) configuration, as originally drawn for **5** [3], be correct, a higher *J* value, *ca.* 10 Hz, would have been expected [2]. This is further supported by the fact that the product of photoisomerization of **5** shows a *H*–C(8),C(5′) $^1H,^{13}C$ coupling constant of 9.0 Hz, implying configuration (*E*).

Natural **4** is not available in sufficient amount to carry out heteronuclear NMR experiments. However, configuration (*Z*) can be assigned to synthetic **4** (obtained as shown below) from a small *H*–C(8),C(5′) $^1H,^{13}C$ coupling constant (4.1 Hz).

One of the two Me groups of compounds **6** and **7**, being revealed as a br. *d* (*Table 2*), has to be located at the external NH group. The problem remains of assigning the other Me group at either N(2′) or N(4′). That the latter is the proper choice is indicated by the near identity of the Me–N(4′) chemical shifts ($\delta(H)$ 3.05, $\delta(C) \approx 25$ ppm) in compounds **1** and **2** [2], and **6** and **7** (*Table 2* and *1*). The MS data (*Exper. Part*), showing fragmentation at both N(2′)–C(3′) and C(1′)–C(5′) as expected for aplysinopsin-type compounds [3] [4], are in accordance with such conclusions. Further structural support comes from NMR and MS data (*Exper. Part*) for the unnatural isomer **11** (*Scheme*) with the Me group at N(2′).

Table 1. *^{13}C-NMR Data for Compounds* **4**, **5**, *and* **7** *in* $(CD_3)_2SO$[a])

	(*E*)-**4**	(*Z*)-**4**	(*E*)-**5**	(*Z*)-**5**	(*E*)-**7**	(*Z*)-**7**
C(2)	128.5 (*d*)	128.9	129.0	129.6	129.0	129.9
C(3)	109.5 (*s*)	111.6	110.7	111.9	110.8	112.0
C(3a)	127.7 (*s*)	126.9	126.7	125.7	126.8	125.7
C(4)	117.9 (*d*)	118.7	119.9	121.0	120.0	121.1
C(5)	119.8 (*d*)	119.7	122.5	122.4	122.5	122.4
C(6)	121.7 (*d*)	121.8	114.4	114.5	114.5	114.5
C(7)	111.8 (*d*)	111.8	114.4	114.3	114.4	114.3
C(7a)	135.8 (*s*)	135.9	136.5	136.7	136.5	136.5
C(8)	114.4 (*d*)	106.9	113.3	106.1	113.9	106.5
C(1′)	135.7 (*s*)	136.3	134.9	136.9	136.6	136.9
C(3′)	154.9 (*s*)	157.5	155.0	157.7	154.7	157.1
C(5′)	167.1 (*s*)	169.2	167.0	169.0	167.1	169.0
R	–	–	–	–	27.8	27.8
Me–N	25.7 (*q*)	25.6	25.6	25.6	25.4	25.5

[a]) ^3J(C(5′),*H*–C(8)) = 4.1, 9.0, 3.8, 9.0, 4.1, and 9.0 for (*Z*)-**4**, (*E*)-**5**, (*Z*)-**5**, (*E*)-**7**, (*Z*)-**7**, and (*E*)-**11**, respectively.

Table 2. *^{1}H-NMR Data for Compounds* **4**–**7** *in* $(CD_3)_2SO$

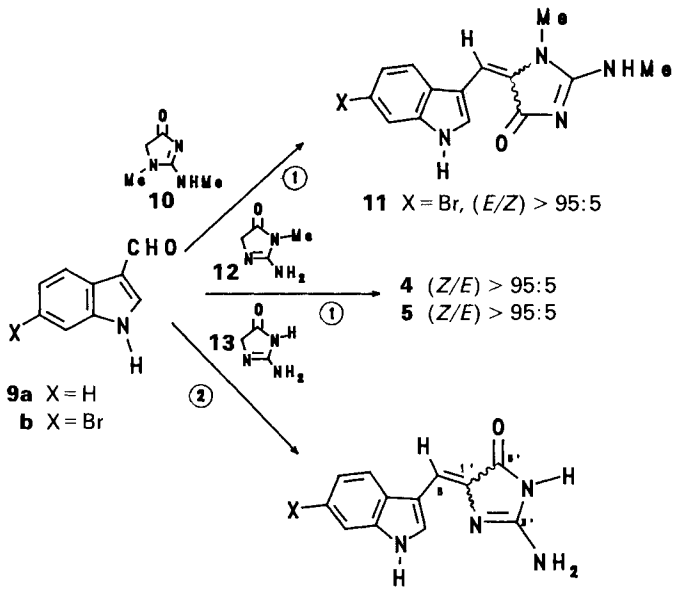
	(*E*)-**4**[a])	(*E*)-**5**[a])	(*E*)-**6**	(*Z*)-**6**	(*E*)-**7**	(*Z*)-**7**
H–C(2)	8.78 (br. *s*)	8.85 (br. *s*)	8.70 (br. *s*)	8.29 (br. *s*)	8.89 (br. *s*)	8.26 (br. *s*)
H–C(4)	7.62 (*d*, J = 8.2)	7.74 (*d*, J = 8.5)	7.62 (*d*, J = 8.2)	7.80 (*d*, J = 8.2)	7.79 (*d*, J = 8.5)	8.01 (*d*, J = 8.5)
H–C(5)	7.10 (*t*, J = 8.2)	7.18 (*dd*, J = 8.5, 1.8)	7.10 (*t*, J = 8.2)	7.10 (*t*, J = 8.2)	7.20 (*dd*, J = 8.5, 1.8)	7.18 (*dd*, J = 8.5, 1.8)
H–C(6)	7.16 (*t*, J = 8.2)		7.18 (*t*, J = 8.2)	7.18 (*t*, J = 8.2)	–	
H–C(7)	7.42 (*d*, J = 8.2)	7.60 (*d*, J = 1.8)	7.42 (*d*, J = 8.2)	7.44 (*d*, J = 8.2)	7.59 (*d*, J = 1.8)	7.59 (*d*, J = 1.8)
H–C(8)	6.94 (*s*)	6.89 (*s*)	7.04 (*s*)	6.77 (*s*)	7.00 (*s*)	6.73 (*s*)
N–Me	3.06 (*s*)	3.06 (*s*)	3.04 (*s*)	3.03 (*s*)	3.05 (*s*)	3.02 (*s*)
R	–	–	2.86 (br. *s*)	2.96 (br. *s*)	2.85 (br. *s*)	2.98 (br. *d*, J = 4.8)
H–N(1)	11.10 (br. *s*)	11.53 (br. *s*)	11.40 (*m*)	11.40 (*m*)	11.55 (br. *s*)	11.60 (br. *s*)
H–N(3′)	not det.	not det.	7.40 (*m*)	7.40 (*m*)	7.40 (*m*)	7.40 (br. *q*, J = 4.8)

[a]) As to data for (*Z*)-**4** and (*Z*)-**5**, see [3].

Configuration (*Z*)-**7** is assigned on the basis of a small value of the *H*–C(8),C(5′) ^{1}H,^{13}C coupling constant (4.1 Hz) as well as on the characteristic δ values 8.26 and 6.73 for H–C(2) and H–C(8), respectively. In accordance, the product obtained by photoisomerization of (*Z*)-**7** shows a higher value, 9.1 Hz, for ^3J(C(5′),*H*–C(8)), as expected for the (*E*)-**7** configuration. The (*Z*) configuration for natural **6** is assigned on similar grounds.

2.2. *Stereospecific Synthesis.* Condensation of 1*H*-indole-3-carbaldehyde (**9a**) or of its 6-bromo analogue **9b** with either dihydro-imidazolone **13** or the methylated analogues **10** and **12** leads in each case to a nearly pure stereoisomer *(Scheme)*. In the case of **11**, the

Scheme



① In piperidine at reflux.
② By heating on the *Bunsen* flame.

(*E*/*Z*) ratio is larger than 95:5, whereas in the cases of **4**, **5**, and **14**, the reverse occurs ((*Z*/*E*) > 95:5). Thus, in accordance with our previous observations [2], aplysinopsin-type compounds without substituents at N(2′) are formed by far predominantly in (*Z*) configuration, whereas the converse is true with the compounds bearing a Me group at N(2′). The same situation occurs with naturally occurring aplysinopsin-type compounds, and deviations from the above stereoisomeric ratios only depend on specific workup conditions.

In conclusion, the results described in the *Scheme* show that the stereochemical outcome of the condensations is determined by the thermodynamic stability of the products[1]).

2.3. *Photochemical and Thermal Isomerizations.* Following our initial observation that both aplysinopsin (**1**) and 3′-deimino-3′-oxoaplysinopsin (**2**) undergo photoisomerization in solution, either under UV irradiation (350 nm) or under daylight, to give mixtures appreciably richer in the (*Z*) isomer [2], we examine now the photochemical behavior of the novel compounds reported here.

Compound **7** with the natural composition (*Z*/*E*) > 95:5 undergoes a much more facile photoisomerization than either **1** or **2** [2] to give mixtures richer in the (*E*) isomer ((*Z*/*E*) = 1:3). Interestingly, the latter revert to mixtures of natural composition in a few days at room temperature in the dark. This thermal isomerization occurs much faster on raising the temperature, being complete in 2 h at 60°.

[1]) On the basis of previous limited data concerning formation of compounds **1**–**3**, kinetic control of the product distribution was assumed [2]; it is now clear that this is not the case.

These facts can be interpreted in terms of compound (*Z*)-**7** being thermodynamically more stable but photochemically more labile than its stereoisomer (*E*)-**7**. To shed light on such behavior, the mixture of photoisomerization of **7** was separated into the pure stereoisomers by HPLC with AcOEt/MeOH 9:1 (t_R 5.5 and 8.1 min for (*Z*)- and (*E*)-**7**, resp.), allowing the evaluation of the ratio of their extinction coefficients at the irradiation wavelength (*ca.* 350 nm); $\varepsilon_Z/\varepsilon_E \approx 2.5$. This ratio is approximately the same as that found for the isomers in the photoequilibrated mixture, the isomer with stronger light absorption having undergone a more extensive change than the stereoisomer with weaker light absorption. This represents a rather common case where the ratio of the concentrations of the two isomers at equilibrium is given by the inverse of the ratio of the respective extinction coefficients, provided that quantum yields are the same for the two isomers. In agreement with these observations, irradiation with 350-nm light of neat (*E*)-**7** for 2 h at r.t. led to the same mixture as above ((*Z*/*E*) = 1:3), whereas on heating neat (*E*)-**7** at 60° for 2 h in the dark, neat (*Z*)-**7** was formed.

The same conclusions can be drawn for 3′-deimino-3′-oxoaplysinopsin (**2**). The two (*Z*/*E*) isomers were obtained in pure form by HPLC with hexane/AcOEt 1:1 (t_R 8.5 and 13.0 min for (*E*)- and (*Z*)-**2**, resp.) which allowed us to evaluate that the ratio of the extinction coefficients is $\varepsilon_Z/\varepsilon_E \approx 4$. On irradiation of either isomer with 350-nm light, a mixture of composition (*E*/*Z*) = 3:1 was obtained, as expected for a more extensive transformation of the isomer with stronger light absorption. When the mixture of composition (*E*/*Z*) = 3:1 was heated in piperidine at reflux, the (*E*/*Z*) ratio changed until it reached the value 95:5 observed for synthetic **2** [2]. This means that the stereospecificity of the condensation leading to **2** has thermodynamic and not kinetic origin [2].

We have extended these observations to compounds **1** and **3**–**5**. Though pure stereoisomers could not be obtained, NMR monitoring of the irradiated (or heated) solutions clearly indicates, in agreement with all observations above, that **1** has the same behavior as **2**, whereas **3**–**5** behave like **7**. Thus, (*E*)-**1** is thermodynamically and photochemically more stable than (*Z*)-**1** and with **3**–**5**, the (*Z*) isomer is thermodynamically more stable and photochemically more labile.

3. Conclusions. – Summarizing the observations of the present and the previous work [2], the far-reaching conclusions below are warranted.

i) The quickest and firm basis for the configurational assignment of aplysinopsin-type compounds are long-range heteronuclear coupling values (larger *H*–C(8),C(5′) $^1H,^{13}C$ NMR coupling in the (*E*) than in the (*Z*) isomer). When too small amounts of compounds prevent these data to be collected, reasonable conclusions can be reached from an accurate examination of H–C(2) and H–C(8) ^1H-NMR shift values.

ii) The stereochemical course of the synthesis of aplysinopsin-type compounds *via* condensation of 1*H*-indole-3-carbaldehydes and dihydroimidazolones is determined by the thermodynamic stability of the products. If N(2′) is Me-substituted, the (*E*) isomer is thermodynamically more stable and if N(2′) bears a H-atom or a lone pair in place of the Me group, the (*Z*) isomer is thermodynamically more stable.

iii) The aplysinopsin-type compounds so far investigated belong to a general class of compounds where photoequilibration is attained on predominant transformation of the stereoisomer with stronger light absorption. For natural or synthetic aplysinopsin-type compounds being predominantly in the (*Z*) form, photochemical equilibration represents

a useful approach to the (*E*) isomer, provided that chromatographic methods are available to separate the stereoisomeric mixtures.

iv) Mixtures of aplysinopsin-type compounds with either a H-atom or a lone pair at N(2′) and which have been photochemically enriched in the (*E*) isomer undergo a facile thermal reversion to a mixture of the original (*Z*/*E*) > 95:5 composition; *i.e.* aplysinopsins of this type are labile both photochemically and thermally.

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Experimental Part

1. *General.* See [2] for general methods and equipments.

2. *Collection and Isolation.* The *Dendrophyllia* sp. was collected in May 1985 under small reef overhangs (depth 3–5 m) at a small island ('Manu-Manou') south of Capsalon Island, off Danlig village in Dumaran Passage, NE of Palawan, Philippines (*ca.* 10°33′N–119°42.5′E). The rather cryptic coral has orange-pink live tissues, a prominent columella and septa arranged in the Pourtales plan, typically in four cycles. Corallites are up to 35 mm high and 10 mm wide. Colonies vary from phaceloid on an encrusting base to low dendroid with lateral buds on a higher main corallite and tend to produce flat stolons that spread over the substrate or older parts of colonies. The extracted material comprises 154 corallites, ranging from isolated broken corallites to small colonies with up to 12 corallites. Reference specimens of the extracted coral are deposited in the National Museum of Natural History, Washington (USNM 85221), and the British Museum (Natural History), London (BMNH 1989.4.25.1–4). After collection, the live corals were immersed in 95% EtOH, transported in the dark at r.t. and stored at –20° in December 1985. In May 1987, the liquid was decanted and evaporated[2]), and the aq. residue was extracted first with petroleum ether and then with AcOEt. Evaporation of the two extracts gave 0.17 and 0.15 g of dark, oily residues, resp. The latter was subjected to FC with $CHCl_3$/MeOH gradient elution, collecting 13 fractions of 50 ml each. The 3rd fraction was evaporated and then subjected to *RP-8* reverse-phase chromatography with MeCN/H_2O 42:58 to give *1*H-*indole-3-carboxaldehyde* (**9a**; t_R 4.9 min; < 1 mg) and *6-bromo-1*H-*indole-3-carbaldehyde* (**9b**; t_R 9.1 min; 12 mg). The 8th fraction was evaporated and the residue subjected to *RP-18* reverse-phase chromatography with MeCN/H_2O 2:3 to give **6** (t_R 12 min, *ca.* 1 mg) and **7** (t_R 10 min, 10 mg). According to HPLC, NMR, and MS analysis, the 10th fraction was composed of **1** and the 6-bromo analogue in a 9:1 ratio (*RP-18* with MeCN/H_2O 4:1, t_R 8 and 10 min, resp.). More polar fractions 11–13th were evaporated and subjected to *RP-18* reverse-phase chromatography with MeCN/H_2O 2:3 to give **4** and **5** (t_R 4.6 (12 mg) and 8 min (3 mg), resp.).

3. *Data for the Natural Aplysinopsin-Type Compounds.* ^{13}C-NMR data for **4**, **5**, and **7**: *Table 1.* ^{1}H-NMR data for (*E*)-**4**, (*E*)-**5**, **6**, and **7**: *Table 2;* the data for (*Z*)-**4** and (*Z*)-**5** are practically identical to those given for the compounds isolated from the sponge *Dercitus* sp. [3].

*(Z)-3,5-Dihydro-5-[(1*H*-indol-3-yl)methylidene]-3-methyl-2-(methylamino)-4*H*-imidazol-4-one* ((*Z*)-**6**): Yellow solid. M.p. > 250° (dec.). MS: 254 (100, $M^{+\cdot}$), 155 (21), 130 (17).

*(Z)-5-[(6-Bromo-1*H*-indol-3-yl)methylidene]-3,5-dihydro-3-methyl-2-(methylamino)-4*H*-imidazol-4-one* ((*Z*)-**7**): Yellow solid. M.p. > 280° (dec.). UV (MeOH): 385 (10700), 286 (5200), 238 (8500). IR (KBr): 3450*m*, 1660*s*, 1600*s*. MS: 332/334 (100, $M^{+\cdot}$), 233/235 (5), 208/210 (10), 155 (10).

(*E*)-**7**: Yellow solid. M.p. > 280° (dec.). UV (MeOH): 392 (4200), 285 (2100), 241 (4500). IR (KBr): 3450*m*, 1660*s*, 1600*s*. MS: superimposable to that of (*Z*)-**7**.

4. *Synthesis of Aplysinopsin-Type Compounds.* Equimolar amounts (*ca.* 0.2 mmol) of the appropriate aldehyde and dihydroimidazolone, according to the *Scheme*, were heated at reflux for 4 h in piperidine. On piperidine evaporation, the products were obtained in practically quantitative yield.

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[2]) When cleaning with NaOCl the residues from extraction, it became clear that a small colony (3 corallites) of another dendrophylliid (belonging to the genus *Tubastraea*) was present. However, we can rule out that present compounds are derived from the *Tubastraea* on the basis that *a)* we report here the major aplysinopsin-type compounds from the above collection, *b)* the concentration of aplysinopsin-type compounds is comparable in corals of the general *Tubastraea* [2] and *Dendrophyllia*.

2'-Demethylaplysinopsin (= *2-Amino-3,5-dihydro-5-[(1H-indol-3-yl)methylidene]-3-methyl-4H-imidazol-4-one*; **4**). The 2-amino-3,5-dihydro-3-methyl-4*H*-imidazol-4-one (**12**) was obtained by methylation of **13** [5]. Reaction with 1*H*-indol-3-carboxaldehyde (**9a**) (*Fluka*) gave **4** with (*Z*/*E*) > 95:5, identical under all respects to the natural product (*Tables 1* and *2*).

6-Bromo-2'-demethylaplysinopsin (= *2-Amino-5-[(6-bromo-1H-indol-3-yl)methylidene]-3,5-dihydro-3-methyl-4H-imidazol-4-one*; **5**). The 6-bromo-1*H*-indole-3-carbaldehyde (**9b**) [5] was reacted with **12** to give **5** with (*Z*/*E*) > 95:5, identical under all respects to the natural product (*Tables 1* and *2*).

4'-Demethyl-3'-N-methylaplysinopsin (= *1,5-Dihydro-5-[(6-bromo-1H-indol-3-yl)methylidene]-1-methyl-2-(methylamino)-4H-imidazol-4-one*; **11**). Compound **9b** [6] was reacted with 1,5-dihydro-1-methyl-2-(methylamino)-4*H*-imidazol-4-one (**10**; obtained on heating 1,3-dimethyl-2-iminoimidazolidin-4-one at reflux in MeOH [5]) to give **11** with (*E*/*Z*) > 95:5. This process has already been reported without indication of the stereochemical outcome, but stating that the product is not identical with natural aplysinopsin (**1**) [1a]. ^{1}H-NMR ($(CD_3)_2SO$; (*E*)-**11**): 9.08 (br. *s*, H–C(2)); 7.88 (*d*, *J* = 8.4, H–C(4)); 7.73 (*dd*, *J* = 8.4, 1.5, H–C(5)); 7.62 (*d*, *J* = 1.8, H–C(7)); 6.52 (*s*, H–C(8)); 11.58 (br. *s*, H–N(1)); 3.26 (*s*, MeN); 7.80 (br. *s*, NHMe); 2.92 (br. *s*, NH*Me*; irradiation at 7.80→sharper). ^{13}C-NMR ($(CD_3)_2SO$; (*E*)-**11**): 129.2 (*d*, C(2)); 109.3 (*s*, C(3)); 126.8 (*s*, C(3a)); 112.0 (*d*, C(4)); 122.2 (*d*, C(5)); 114.4 (*s*, C(6)); 114.3 (*d*, C(7)); 136.4 (*s*, C(7a)); 103.6 (C(8)); 131.7 (*s*, C(1')); 164.5 (*s*, C(3')); 175.1 (*s*, C(5')); 27.7 (*q*, Me–N(2')); 24.9 (*q*, Me–NH). MS: 332/334 (100, M^+), 254 (16), 233/235 (44), 208/210 (10), 169 (8), 155 (10), 154 (15).

2',4'-Didemethylaplysinopsin (= *2-Amino-3,5-dihydro-5-[(1H-indol-3-yl)methylidene]-4H-imidazol-4-one*; **14**). An equimolar mixture of **9a** (*Fluka*) and 2-amino-3,5-dihydro-4*H*-imidazol-4-one (**13**; obtained by cyclization of guanidinacetic acid [5]) was heated over the *Bunsen* flame to give **14** with (*Z*/*E*) > 95:5. ^{1}H-NMR ($(CD_3)_2SO$; (*E*)-**14**; within brackets, (*Z*)-**14**): 8.99 [8.09] (br. *s*, H–C(2)); 7.90 [7.80] (*d*, *J* = 7.5, H–C(4)); 7.09 [7.08] (*t*, *J* = 7.5, H–C(5)); 7.15 [7.15] (*t*, *J* = 7.5, H–C(6)); 7.55 [7.41] (*d*, *J* = 7.5, H–C(7)); 7.03 [6.73] (*s*, H–C(8)); 12.35 [11.70] (*s*, H–N(1)). ^{13}C-NMR ($(CD_3)_2SO$; (*Z*)-**14**; within brackets, (*E*)-**14**): 126.2 [127.0] (*d*, C(2)); 110.4 [109.3] (*s*, C(3)); 127.0 [127.6] (*s*, C(3a)); 118.4 [117.6] (*d*, C(4)); 119.9 [119.9] (*d*, C(5)); 122.2 [120.2] (*d*, C(6)); 112.6 [112.2] (*d*, C(7)); 135.8 [135.6] (*s*, C(7a)); 103.7 [109.8] (*d*, C(8)); 124.2 [118.2] (*s*, C(1')); 161.8 [159.6] (*s*, C(3')); 173.9 [168.3] (*s*, C(5')). MS ((*Z*)-**14**): 226 (100, M^+), 156 (38), 155 (38).

5. *Photoisomerizations of Aplysinopsin-Type Compounds.* *Ca.* 0.2M (D_6)DMSO solns. of aplysinopsin-type compounds were irradiated for 2 h in a 5-mm NMR sample tube under air cooling (^{1}H- and ^{13}C-NMR monitoring); no by-products were observed. Thus, with **4**, **5**, and **14**, the initial ratio (*Z*/*E*) > 95:5 dropped to *ca.* 3:1. Compound (*Z*)-**6** gave a 1:3 mixture of (*Z*)- and (*E*)-**6**. The same behavior was found with (*Z*)-**7** which gave a 1:3 mixture of (*Z*)- and (*E*)-**7**. In this case, pure (*E*)-7 was obtained by HPLC. In contrast, with **11**, the initial ratio (*E*/*Z*) > 95:5 was unaffected even after prolonged irradiation (5 h).

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