Chem. Pharm. Bull.
30(4)1210—1214(1982)

The Alkaloid AM-6201 from *Streptomyces xanthochromogenus*

Masayuki Onda,* Yaeko Konda, Kiyoizumi Hinotozawa, and Satoshi Ōmura

School of Pharmaceutical Sciences, Kitasato University and The Kitasato Institute, Minato-ku, Tokyo 108, Japan

(Received September 3, 1981)

The alkaloid AM-6201 (1) has been isolated from culture broths of *Streptomyces xanthochromogenus* strain AM-6201, and its structure elucidation is described.

Keywords——alkaloid; enolic 1,3-cyclopentanedione; furan; ozonolysis; nuclear magnetic resonance (^1H and ^{13}C)

In the course of our studies on alkaloids from microorganisms, the alkaloid AM-6201 (**1**) was isolated from culture broths of *Streptomyces xanthochromogenus* strain AM-6201, and we have preliminarily reported its structure.[1] The alkaloid AM-6201 (**1**) exhibited antitumor activity against Ehrlich ascites carcinoma in mice and had inhibitory activity *in vitro* against KB cells derived from a human-mouth epidermoid carcinoma. In this paper we report in detail the results obtained by further investigations.

The mass spectrum (MS) and elementary analysis data provided the formula $C_{14}H_{15}NO_6$ for **1**. The infrared (IR) spectrum showed characteristic bands for an enolic 1,3-cyclopentanedione[2] at 1690, 1650 (sh) and 1600 cm^{-1} in addition to two carbonyl bands for an ester (1750 cm^{-1}) group and an amide group (1630 cm^{-1}). The presence of the enol function was proved by the fact that treatment of **1** with diazomethane gave the compound (**2**), $C_{15}H_{17}NO_6$, which showed a three-proton singlet for a methoxy group at δ 4.06 in the proton magnetic resonance (^1H NMR) spectrum. The ^1H NMR spectrum of **1** showed two one-proton doublets for an (*E*)-vinylene group conjugated with an electron-withdrawing group at δ 7.48 (*J* 15 Hz) and 5.86 (*J* 15 Hz), and a three-proton singlet for an acetoxy group at δ 2.10. Decoupling experiments revealed the presence of a system (**3**) consisting of a methylene group coupled with a proton vicinally and a proton in the long range mode. One methyl, three methylene, four methine and six quaternary carbon signals were observed in the ^{13}C NMR spectrum. The methine carbons resonating at δ 135.6 and 115.7 can be assigned to the vinylenic carbons (*vide supra*). The quaternary (δ 165.9) and methine carbons (δ 150.6) correspond to olefinic carbons with O-functions. The methine carbon (δ 98.6) is assigned to a carbon with two O-functions.

Pyrolysis of **1** in dimethyl sulfoxide (DMSO) at 100°C for 48 h gave the compound (**4**), $C_{12}H_{11}NO_4$, by loss of acetic acid. Its ^1H NMR spectrum showed aromatic proton signals for a fur-3-yl moiety at δ 8.21 (br s, W_H 4 Hz), 7.87 (br s, W_H 4 Hz) and 6.75 (d, *J* 2 Hz). Treatment of **1** with ammonia afforded the compound (**5**), $C_{12}H_{12}N_2O_3$, by loss of acetic acid and replacement of an oxygen atom by an imino group. The presence of a pyrrol-3-yl moiety in **5** was confirmed by the ^1H NMR data [δ 11.21 (br s, exchangeable with deuterium oxide), 7.29 (dt, *J* 3 and 1.5 Hz), 6.95 (q, *J* 1.5 Hz) and 6.40 (dt, *J* 3 and 1.5 Hz)]. From these results, it is apparent that **1** has a 2-acetoxy-2,3-dihydrofur-4-yl moiety in the framework.

Ozonization of **1** followed by treatment with potassium iodide gave the compound (**6**), $C_{14}H_{15}NO_8$. Further ozonization of **6** and subsequent reduction with sodium borohydride afforded 1,2,4-trihydroxybutane (**7**) and the compound (**8**), $C_7H_9NO_4$. The structure of **7** was confirmed by direct comparison with an authentic sample. The compound (**9**), which was derived from benzoylation of **7** with benzoyl chloride/pyridine, was also identified as 1,4-dibenzoyloxy-2-hydroxybutane by comparison of the spectral data with those for an

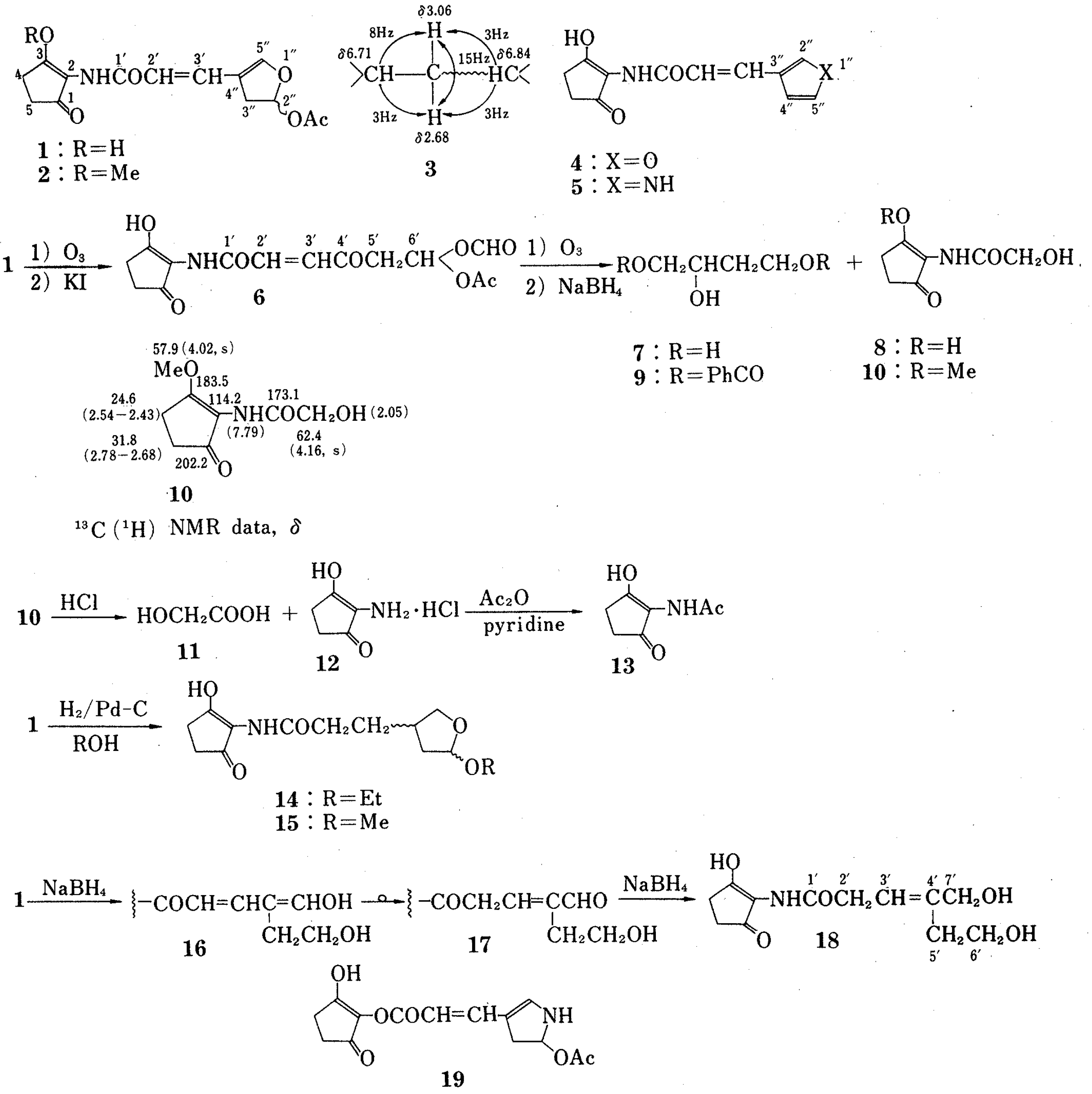

Chart 1

authentic sample[3] and by melting point determination. The IR spectrum of **8** showed a carbonyl band for an amide group (1630 cm^{-1}) and characteristic bands for an enolic 1,3-cyclopentanedione [1700, 1650 (sh) and 1620 (sh) cm^{-1}].[2] Methylation of **8** with diazomethane provided the compound (**10**), $C_8H_{11}NO_4$ [^{1}H NMR: δ 4.02 (s) for OMe]. One methyl, three methylene and four quaternary carbon signals were observed in the ^{13}C NMR spectrum. Thus, the structure of **10** was deduced to be 2-glycolamido-3-methoxy-2-cyclopenten-1-one on the basis of the spectral data (see Chart 1). Hydrolysis of **10** with hydrochloric acid gave glycolic acid (**11**) and the compound (**12**), $C_5H_7NO_2 \cdot HCl$. The structure of **11** was confirmed by direct comparison with an authentic sample. Acetylation of **12** with acetic anhydride/pyridine afforded the compound (**13**), $C_7H_9NO_3$, which was identified as 2-acetamido-3-hydroxy-2-cyclopenten-1-one by comparison of the spectral data with those for an authentic sample[4] and by melting point determination. From the facts that **1** had a 2-acetoxy-2,3-dihydrofur-4-yl moiety, and the two-step ozonolysis of **1** gave **7** and **8** accompanied by loss of three carbon atoms, **1** is established as 2-3′-2″-acetoxy-2″,3″,-dihydrofur-4″,-ylacrylamido-3-hydroxy-2-cyclopenten-1-one. This structure is in accord with the spectral data observed (*vide supra*).

At this stage, we return to the structures of **6** and compounds obtained by reduction of **1**. From comparison of the spectral data for **6** with those for **1**, it can be seen that **6** has a 3-acetoxy-3-formyloxy-1-oxopropyl group as a result of the 4″,5″-bond cleavage in **1** instead of the dihydrofuran moiety.

Hydrogenation of **1** over palladium-carbon in ethanol gave the compound (**14**), $C_{14}H_{21}NO_5$, as a result of the 2′,3′- and 4″,5″-bond saturations, and ethanolysis at the 2″-position. The compound (**14**) was a mixture of the *cis* and *trans* isomers, and the ^{13}C NMR spectrum showed two signal sets for the carbons in the tetrahydrofuran moiety and its surroundings (see "Experimental"). Hydrogenation of **1** in methanol afforded the 2″-methoxy isomer (**15**).

Reduction of **1** with sodium borohydride gave the compound (**18**), $C_{12}H_{17}NO_5$. The spectral data showed remarkable changes in the *N*-substituent, including the dihydrofuran moiety, in **1**. The ^1H NMR spectrum exhibited no signal for the 2′-, 3′- and 5″-protons, or for the 2″-acetoxy group seen in **1**. Instead, signals for three methylene groups were newly observed. The structure of **18** shown in Chart 1 is in accord with the spectral data observed (see "Experimental"). It is thought that **18** is formed by reductive cleavage of the 1″,2″-bond (**1**→**16**) and successive reduction of the formyl group in **17** derived from double bond shifts in **16**.

Shimizu *et al.* recently reported the structure of reductiomycin (**19**) from *Streptomyces griserorubiginosus* nov. sp., in which the positions of the nitrogen atom in the ring and the oxygen atom in the side-chain were reversed compared to those in **1**.[5] Because of the similarity of the spectral properties and mass fragmentations, both compounds are deduced to be the same.

Experimental

Melting points were determined on a micro hot-stage apparatus and are uncorrected. Optical rotations were taken on a JASCO DPI-181 polarimeter. Spectral data were recorded on the following spectrometers: ultraviolet (UV), Hitachi EPS-2U; circular dichroism (CD), JASCO J-20; IR, JASCO IR-G in chloroform unless otherwise noted; ^1H NMR, JEOL JNM PS-100 (100 MHz) and Varian EM-390 (90 MHz) in deuteriochloroform unless otherwise noted; ^{13}C NMR, JEOL PS-100 (25.1 MHz) in deuteriochloroform; MS, JEOL JMS-01S. The signal assignments in the NMR spectra were made by comparison with the data for related compounds. Preparative thin-layer chromatographies (prep. TLC) were performed on silica gel plates.

Isolation of 1——Strain AM-6201 was isolated from a soil sample collected in Atsugi City, Kanagawa Prefecture, Japan, and was identified as a strain of *Streptomyces xanthochromogenus* in the usual way.[6]

A seed medium (100 ml) in a 500-ml Sakaguchi flask was inoculated with strain AM-6201 and incubated at 27°C. A 48-h culture was transferred into a production medium (30 l) in a 50-l jar fermenter, and the fermentation was carried out at 27°C for 68 h. The seed medium (pH 7.0 before sterilization) contained glucose (1%), starch (2%), peptone (0.5%), yeast extract (0.5%) and $CaCO_3$ (0.4%). The production medium (pH 7.0 before sterilization) contained glycerol (2%), soybean meal (2%) and NaCl (0.3%).

The culture broths containing mycelia were extracted with ethyl acetate (15 l), and the extracts were concentrated *in vacuo* to *ca.* 1 l. The precipitate was collected by filtration, and washed with hexane and ethanol, then recrystallized twice from ethyl acetate to yield **1** (845 mg) as pale yellow needles of mp 216—220°C.

Characterization of 1——Pale yellow needles of mp 232—233°C (from benzene). $[\alpha]_D^{25}$ +306° (c=0.26, acetone). IR ν_{max} cm^{-1}: 3380 (NH and OH), 1750 (OC=O), 1630 (NC=O), 1690, 1650 (sh), 1600 (enolic β-diketone). UV λ_{max} (methanol) nm (ε): 282 (26300); (0.1 N HCl/methanol): 290 (25995). CD (c=0.001, methanol) $[\theta]^{25}$ (nm): 0 (380), +19700 (282) (positive maximum), 0 (246), −7880 (218) (negative maximum), 0 (206). ^1H NMR (100 MHz) δ: 13.71 (1H, s, 3-OH),[7] 7.84 (1H, s, 2-NH),[7] 7.48 (1H, d, J 15 Hz, 3′-H), 6.84 (1H, t, J 3 Hz, 5″-H), 6.71 (1H, dd, J 8 and 3 Hz, 2″-H), 5.86 (1H, d, J 15 Hz, 2′-H), 3.06 (1H, ddd, J 15, 8 and 3 Hz, 3″-H), 2.68 (1H, dt, J 15 and 3 Hz, 3″-H), 2.68—2.45 (4H, m, 4- and 5-H_2's), 2.10 (3H, s, 2″-OAc). ^{13}C NMR δ: 197.2 (s, C-1), 173.9 (s, 2″-O$\underline{\text{C}}$OMe), 169.4 (s, C-1′), 165.9 (s, C-3), 150.6 (d, C-5″), 135.6 (d, C-3′), 115.5 (d, C-2′), 115.2 (s, C-2),[8] 114.8 (s, C-4″),[8] 98.6 (d, C-2″), 34.4 (t, C-3″), 32.3 (t, C-5), 25.7 (t, C-4), 20.9 (q, 2″-OCO$\underline{\text{Me}}$). *Anal.* Calcd for $C_{14}H_{15}NO_6$: C, 57.33; H, 5.16; N, 4.78. Found: C, 57.12; H, 4.99; N, 4.60. MS *m/e*: M^+, 293.090 (M, 293.089 for $C_{14}H_{15}NO_6$).

2-3′-2″-Acetoxy-2″,3″-dihydrofur-4″-ylacrylamido-3-methoxy-2-cyclopenten-1-one (**2**)——An excess of ethereal diazomethane was added to a solution of **1** (16.0 mg) in chloroform (3 ml), and the mixture was stirred at room temperature for 24 h. After concentration *in vacuo*, the residue was purified by prep. TLC (chloroform/methanol=10/1, v/v) to yield **2** (12.0 mg), *Rf* 0.44, as light yellow granules of mp 88—90°C (from benzene/hexane). IR ν_{max} cm^{-1}: 3380 (NH), 1745 (OC=O), 1625 (NC=O), 1710, 1680, 1600 (enol ether of β-diketone). ^{1}H NMR (100 MHz) δ: 7.47 (1H, s, 2-NH),7) 7.39 (1H, d, *J* 15 Hz, 3′-H), 6.74 (1H, t, *J* 3 Hz, 5″-H), 6.69 (1H, dd, *J* 8 and 3 Hz, 2″-H), 5.74 (1H, d, *J* 15 Hz, 2′-H), 4.06 (3H, s, 3-OMe), 3.04 (1H, ddd, *J* 15, 8 and 3 Hz, 3″-H), 2.81—2.47 (5H, m, 4- and 5-H$_2$'s, and 3″-H), 2.11 (3H, s, 2″-OAc). MS Calcd for $C_{15}H_{17}NO_6$: M, 307.105. Found *m/e*: M$^+$, 307.103.

2-3′-Fur-3″-ylacrylamido-3-hydroxy-2-cyclopenten-1-one (**4**)——A solution of **1** (8.0 mg) in DMSO (1 ml) was stirred at 100°C for 48 h. The reaction mixture was diluted with chloroform and washed with water. Work-up gave **4** (5.0 mg) as light yellow needles of mp 235—240°C (from methanol). IR ν_{max}^{KBr} cm^{-1}: 3250 (NH and OH), 1620 (NC=O), 1695, 1660, 1595 (enolic β-diketone). ^{1}H NMR (100 MHz) (DMSO-d_6) δ: 13.87 (1H, s, 3-OH),7) 10.05 (1H, s, 2-NH),7) 8.21 (1H, br s, W_H 4 Hz, 5″-H), 7.87 (1H, br s, W_H 4 Hz, 2″-H), 7.63 (1H, d, *J* 15 Hz, 3′-H), 7.02 (1H, d, *J* 15 Hz, 2′-H), 6.75 (1H, d, *J* 2 Hz, 4″-H), 2.50 (4H, s, 4- and 5-H$_2$'s). MS Calcd for $C_{12}H_{11}NO_4$: M, 233.068. Found *m/e*: M$^+$, 233.070.

2-3′-Pyrrol-3″-ylacrylamido-3-hydroxy-2-cyclopenten-1-one (**5**)——A solution of **1** (20.0 mg) in 2.5% aq. ammonia (0.7 ml) was stirred at room temperature for 24 h. The reaction mixture was concentrated *in vacuo* and acidified with 0.1 N HCl, then extracted with ethyl acetate. Work-up gave an oil which was purified by prep. TLC (chloroform/methanol=10/1, v/v) to yield **5** (5.0 mg), *Rf* 0.56, as light yellow granules of mp 135—137°C (from benzene/ethyl acetate). IR ν_{max}^{KBr} cm^{-1}: 3270 (NH and OH), 1625 (NC=O), 1690, 1650, 1580 (enolic β-diketone). ^{1}H NMR (100 MHz) (DMSO-d_6) δ: 14.35 (1H, s, 3-OH),7) 11.21 (1H, br s, 1″-H),7) 9.79 (1H, s, 2-NH),7) 7.65 (1H, d, *J* 15 Hz, 3′-H), 7.29 (1H, dt, *J* 3 and 1.5 Hz, 5″-H), 6.94 (1H, q, *J* 1.5 Hz, 2″-H), 6.83 (1H, d, *J* 15 Hz, 2′-H), 6.40 (1H, dt, *J* 3 and 1.5 Hz, 4″-H), 2.50 (4H, s, 4- and 5-H$_2$'s). On addition of D$_2$O, the following signals changed: δ 7.29 (5″-H) dt→dd, *J* 3 and 1.5 Hz; δ 6.94 (2″-H) q→t, *J* 1.5 Hz; δ 6.40 (4″-H) dt→dd, *J* 3 and 1.5 Hz. Decoupling: δ 7.65 (3′-H)→δ 6.83 (d→s, 2′-H); δ 6.83 (2′-H) →δ 7.65 (d→s, 3′-H); δ 7.29 (5″-H)→δ 6.40 (dt→t, *J* 1.5 Hz, 4″-H); δ 6.40 (4″-H)→δ 7.29 (dt→t, *J* 1.5 Hz, 5″-H). MS Calcd for $C_{12}H_{12}N_2O_3$: M, 232.084. Found *m/e*: M$^+$, 232.082.

2-6′-Acetoxy-6′-formyloxy-4′-oxo-2′-hexenamido-3-hydroxy-2-cyclopenten-1-one (**6**)——O$_3$ was passed through a solution of **1** (30.0 mg) in dichloromethane (30 ml) under dry ice/acetone cooling for 20 min. Acetic acid (0.5 ml) and saturated aq. KI (0.7 ml) were added, and the mixture was stirred at room temperature for 10 min. The organic phase was washed with saturated aq. Na$_2$S$_2$O$_3$ and water, then dried over Na$_2$SO$_4$. Work-up gave **6** (28.0 mg) as yellow needles of mp 161—163°C (from benzene). IR ν_{max}^{KBr} cm^{-1}: 3250 (NH and OH), 1775, 1720 (OC=O), 1680 (C=O), 1615 (sh) (NC=O), 1680, 1640, 1610 (enolated β-diketone). ^{1}H NMR (100 MHz) δ: 13.28 (1H, s, 3-OH),7) 9.03 (1H, s, 2-NH),7) 8.09 (1H, s, 6′-OCHO), 7.26, 7.11 (1H each, d, *J* 16 Hz, 2′- and 3′-H's), 7.16 (1H, t, *J* 6 Hz, 6′-H), 3.20 (2H, d, *J* 6 Hz, 5′-H$_2$), 2.74—2.52 (4H, m, 4- and 5-H$_2$'s), 2.09 (3H, s, 6′-OAc). Decoupling: δ 7.16 (6′-H)→δ 3.20 (d→s, 5′-H$_2$); δ 3.20 (5′-H$_2$)→δ 7.16 (d→s, 6′-H). ^{13}C NMR δ: 198.0 (s, C-1), 193.2 (s, C-4′), 175.9 (s, 6′-O$\underline{\text{C}}$OMe), 168.6 (s, C-1′), 163.6 (s, C-3), 158.9 (d, 6′-OCHO), 137.1, 132.5 (d each, C-2′ and -3′), 115.1 (s, C-2), 87.1 (d, C-6′), 44.4 (t, C-5′), 32.2 (t, C-5), 25.9 (t, C-4), 20.6 (q, 6′-OCOMe). *Anal.* Calcd for $C_{14}H_{15}NO_8$: C, 51.69; H, 4.31; N, 4.44. Found: C, 51.87; H, 4.44; N, 4.28. MS *m/e*: M$^+$, 325.083 (M, 325.079 for $C_{14}H_{15}NO_8$).

1,2,4-Trihydroxybutane (**7**) **and 2-Glycolamido-3-hydroxy-2-cyclopenten-1-one** (**8**)——O$_3$ was passed through a solution of **6** (12.0 mg) in dichloromethane (30 ml) under dry ice/acetone cooling for 40 min. After addition of ethanol (7 ml), a solution of NaBH$_4$ (15 mg) in 50% ethanol (2 ml) was added dropwise over 5 min. The mixture was stirred with cooling for 30 min and then at room temperature for 30 min. After concentration *in vacuo*, the residue was acidified with 10% HCl, and extracted with chloroform.

The water phase was concentrated *in vacuo* and extracted with chloroform. Work-up afforded **7** (2.5 mg) as a colorless oil. MS Calcd for $C_4H_{10}O_3$–CH$_2$OH: M–CH$_2$OH, 75.044. Found *m/e*: (M–CH$_2$OH)$^+$, 75.045.

Work-up of the organic phase gave **8** (3.9 mg) as colorless needles of mp 142—143°C (from benzene/hexane). IR ν_{max} cm^{-1}: 3350 (NH and OH), 1630 (NC=O), 1700, 1650 (sh), 1620 (sh) (enolic β-diketone). ^{1}H NMR (90 MHz) (acetone-d_6) δ: 13.15 (1H, s, 3-OH),7) 8.81 (1H, s, 2-NH),7) 5.44 (1H, t, *J* 5 Hz, 2′-OH),7) 4.25 (2H, d, *J* 5 Hz, 2′-H$_2$), 2.58 (2H, t, *J* 6 Hz, 5-H$_2$), 2.53 (2H, t, *J* 6 Hz, 4-H$_2$). On addition of D$_2$O, the doublet at δ 4.25 (2′-H$_2$) changed to a singlet. Decoupling: δ 5.44 (2′-OH)→δ 4.25 (d→s, 2′-H$_2$); δ 4.25 (2′-H$_2$)→δ 5.44 (t→s, 2′-OH). MS Calcd for $C_7H_9NO_4$: M, 171.053. Found *m/e*: M$^+$, 171.053.

1,4-Dibenzoyloxy-2-hydroxybutane (**9**)——A solution of benzoyl chloride (10 mg) in anhydrous pyridine (0.5 ml) was added to a solution of **7** (4.0 mg) in anhydrous pyridine (0.5 ml), and the mixture was stirred at −10°C for 24 h. The reaction mixture was concentrated *in vacuo* and extracted with chloroform. Work-up gave **9** (2.5 mg) as colorless plates of mp 71—72°C (from hexane). *Anal.* Calcd for $C_{18}H_{18}O_5$: C, 68.78; H, 5.77. Found: C, 68.77; H, 5.70.

2-Glycolamido-3-methoxy-2-cyclopenten-1-one (**10**)——An excess of ethereal diazomethane was added to a solution of **8** (7.5 mg) in chloroform/methanol (1/1, v/v) (1 ml), and the mixture was stirred at room temperature for 24 h. After concentration *in vacuo*, the residue was purified by prep. TLC (chloroform/methanol=10/1, v/v) to yield **10** (6.0 mg), *Rf* 0.15, as colorless plates of mp 134—136°C (from benzene/hexane). IR ν_{max} cm^{-1}: 3375 (NH and OH), 1630 (NC=O), 1700 (sh), 1690, 1620 (sh) (enol ether of β-diketone). ^{1}H and ^{13}C NMR: Chart 1. MS Calcd for $C_8H_{11}NO_4$: M, 185.068. Found *m/e*: M$^+$, 185.068.

Glycolic Acid (11) and 2-Amino-3-hydroxy-2-cyclopenten-1-one Hydrochloride (12)——A solution of **10** (9.5 mg) in 3 N HCl (0.5 ml) was stirred at 60°C for 4 h. After concentration *in vacuo*, the residue was extracted with ether.

The ethereal extracts gave an oil which was purified by sublimation to yield **11** (1.5 mg) as colorless granules of mp 76—78°C. MS Calcd for $C_2H_4O_3$: M, 76.016. Found *m/e*: M+, 76.016.

Vacuum drying of the ether-insoluble crystals gave **12** (7.0 mg) as hygroscopic crystals. IR $\nu_{\max}^{\text{KBr}}$ cm^{-1}: 3400 (OH), 2910 (NH_3^+), 1725, 1656, 1637 (enolic β-diketone). ^{1}H NMR (90 MHz) (methanol-d_4) δ: 2.67 (4H, s, 4- and 5-H_2's).

2-Acetamido-3-hydroxy-2-cyclopenten-1-one (13)——Acetic anhydride (0.1 ml) was added to a solution of **12** (5.0 mg) in anhydrous pyridine (0.3 ml), and the mixture was stirred at room temperature for 24 h. Work-up of the reaction mixture gave **13** (4.0 mg) as colorless needles of mp 166—168°C (from chloroform/hexane). IR $\nu_{\max}^{\text{CCl}_4}$ cm^{-1}: 3370 (NH), 3270 (OH), 1640 (NC=O), 1705, 1655 (sh), 1615 (enolic β-diketone). ^{1}H NMR (90 MHz) δ: 12.95 (1H, s, 3-OH),7) 7.78 (1H, s, 2-NH),7) 2.54 (4H, s, 4- and 5-H_2's), 2.16 (3H, s, 2-NH$\underline{\text{Ac}}$). MS Calcd for $C_7H_9NO_3$: M, 155.058. Found *m/e*: M+, 155.057.

2-3′-2″-Ethoxytetrahydrofur-4″-ylpropionamido-3-hydroxy-2-cyclopenten-1-one (14) and The 2″-Methoxy Isomer (15)——a) A solution of **1** (10.0 mg) in ethanol (12 ml) was shaken with H_2 over 10% Pd-C (5 mg) for 75 min. Work-up of the reaction mixture afforded **14** (7.2 mg) as colorless needles of mp 82—84°C (from hexane). $[\alpha]_D^{31}$ −16° (*c*=0.24, acetone). IR $\nu_{\max}$ cm^{-1}: 3400 (NH and OH), 1625 (NC=O), 1700, 1640 (sh), 1610 (sh) (enolated β-diketone). ^{1}H NMR (100 MHz) δ: 13.12 (1H, s, 3-OH),7) 7.97 (1H, s, 2-NH),7) 5.08 (1H, dd, *J* 6 and 1 Hz, 2″-H), 4.05 (1H, t, *J* 8 Hz, 5″-H), 3.69 (1H, dd, *J* 8 and 6 Hz, 5″-H), 3.53 (2H, q, *J* 7 Hz, 2″-O$\underline{CH_2}$Me), 2.63—1.45 (11H, m, 4-, 5-, 2′-, 3′- and 3″-H_2's, and 4″-H), 1.19 (3H, t, *J* 7 Hz, 2″-$OCH_2\underline{Me}$). ^{13}C NMR δ: 197.6 (s, C-1), 173.3 (s, C-1′), 114.9 (s, C-2), 104.1, 103.8 (d, C-2″), 71.8, 71.3 (t, C-5″), 63.0, 62.7 (t, 2″-O$\underline{CH_2}$Me), 39.0, 38.6 (t, C-2′), 37.7, 36.6 (d, C-4″), 34.6, 34.5 (t, C-3″), 32.2 (t, C-5), 29.6, 28.9 (t, C-3′), 25.5 (t, C-4), 15.2 (q, 2″-$OCH_2\underline{Me}$). The C-3 signal was not observed. MS Calcd for $C_{14}H_{21}NO_5$: M, 283.141. Found *m/e*: M+, 283.137.

b) A solution of **1** (10.0 mg) in methanol (15 ml) was shaken with H_2 over 10% Pd-C (8 mg) for 45 min. Work-up of the reaction mixture afforded **15** (4.0 mg) as colorless needles of mp 130—132°C (from hexane). $[\alpha]_D^{31}$ −17° (*c*=0.27, acetone). IR $\nu_{\max}$ cm^{-1}: 3365 (NH and OH), 1630 (NC=O), 1705, 1655 (sh), 1620 (sh) (enolic β-diketone). ^{1}H NMR (90 MHz) δ: 12.93 (1H, s, 3-OH),7) 7.70 (1H, s, 2-NH),7) 4.97 (1H, dd, *J* 6 and 1 Hz, 2″-H), 4.02 (1H, t, *J* 8 Hz, 5″-H), 3.47 (1H, dd, *J* 8 and 6 Hz, 5″-H), 3.30, 3.28 (1.5H each, s, 2″-OMe), 2.63—1.41 (11H, m, 4-, 5-, 2′-, 3′- and 3″-H_2's, and 4″-H). MS Calcd for $C_{13}H_{19}NO_5$: M, 269.126. Found *m/e*: M+, 269.125.

3-Hydroxy-2-6′-hydroxy-4′-hydroxymethyl-3′-hexenamido-2-cyclopenten-1-one (18)——$NaBH_4$ (15 mg) was added to a solution of **1** (10.0 mg) in ethanol (15 ml), and the mixture was stirred at room temperature for 1.5 h. Work-up of the reaction mixture gave an oil which was crystallized from chloroform/hexane to yield **18** (6.0 mg) as colorless needles of mp 106—108°C. IR $\nu_{\max}$ cm^{-1}: 3350 (NH and OH), 1620 (NC=O), 1695, 1650 (sh), 1610 (sh) (enolic β-diketone). ^{1}H NMR (90 MHz) δ: 13.07 (1H, s, 3-OH),7) 8.97 (1H, s, 2-NH),7) 5.71 (1H, t, *J* 8 Hz, 3′-H), 4.10 (2H, s, 7′-H_2), 3.80 (2H, t, *J* 6 Hz, 6′-H_2), 3.18 (2H, d, *J* 8 Hz, 2′-H_2), 2.59—2.36 (8H, m, 4-, 5- and 5′-H_2's, and 6′- and 7′-OH's).7) Decoupling: δ 5.71 (3′-H)→δ 3.18 (d→s, 2′-H_2); δ 3.18 (2′-H_2)→δ 5.71 (t→s, 3′-H); δ 2.41 (5′-H_2)→δ 3.80 (t→s, 6′-H_2). MS Calcd for $C_{12}H_{17}NO_5$: M, 255.110. Found *m/e*: M+, 255.110.

References and Notes

1) Y. Konda, M. Onda, K. Hinotozawa, and S. Ōmura, *J. Antibiot.* (Tokyo), **34**, 1222 (1981).
2) The IR spectrum (chloroform) of 1,3-cyclopentanedione showed bands at 1705, 1665 and 1590 cm^{-1}. 3-Methoxy-2-cyclopenten-1-one also showed bands at 1705, 1680 and 1590 cm^{-1}.
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7) On addition of deuterium oxide, this signal disappeared.
8) Assignments may be reversed.