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Steroids. VII.[1] Photolysis of 3β,5α-Diacetoxy-6-nitriminocholestane

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Photolysis of 3β,5α-diacetoxy-6-nitriminocholestane (**1**) gives 3β,5α-diacetoxycholestan-6-one (**2**), 3β-acetoxy-5α-cholestan-6-one (**8**), 3β,5α-diacetoxy-6-hydroximinocholestane (**9**), and 3β,5α-diacetoxy-6-iminocholestane (**10**) as nitrate. The structure of **10** is proved by its catalytic reduction and subsequent acetylation to 6β-acetamido-3β,5α-diacetoxycholestane (**11**). The structure of **9** is identified by its reduction with titanium trichloride to **10**. Also, formation pathways of these photo-products are briefly examined.

We have previously reported interesting reactions of the nitrimine (**1**). On hydrogenation over platinum oxide in dioxane **1** gave the ketones (**2**) and (**3**) and no compound containing the nitrogen atom.[3] The nitrimine (**1**) converted with alumina into the oxadiazoles (**4**) and (**5**) and ketones (**2**) and (**6**).[1,4] In this connection, we examined photolysis of **1**.

Irradiation of **1** in methanol for 3 hr afforded the imine nitrate (**7**) (20%), the diacetoxy ketone (**2**) (33%), the acetoxy ketone (**8**) (8%), and the oxime (**9**) (15%). Treatment of **7** with 10% aq. Na_2CO_3 gave the imine (**10**) in quantitative yield. The infrared (IR) spectrum (CCl_4) of **10** displays the bands due to the C=N group (1648 cm^{-1}) in addition to two OAc groups (1745 and 1738 cm^{-1}). The mass fragment over *m/e* 300 of **10** are recorded in Table I. The peak at *m/e* 354 is suggested to be formed from the one at *m/e* 381 by the loss of HCN. These facts appear to show the presence of the C=NH group. The structure of **10** was proved by its catalytic reduction and subsequent acetylation to the amide (**11**).[3] The ketones (**2**) and (**8**) were identified as 3β,5α-diacetoxycholestan-6-one and 3β-acetoxy-5α-cholestan-6-one,[3,5] respectively, by mixed mp and comparisons of the IR and nuclear magnetic resonance (NMR) spectra. On the basis of the molecular formula and spectral data similar to those of **10**, **9** is deduced to be 3β,5α-diacetoxy-6-hydroximinocholestane. An outstanding difference that **9** shows the one proton quartet at δ 3.24 (*J*12 and 4 Hz) in the NMR spectrum seems to be ascribed to the 7β-H down-field shifted by influence of the *syn* N–OH group.[6,7] Oximation of **2** with hydroxylamine did not afford **9**. The oxime (**9**) resisted strictly to catalytic reduction over platinum oxide in acetic acid and did not give the amine (**12**). However, the structure of **9** was proved by its reduction[8] with titanium trichloride to **10**.

Plausible formation pathways of the photo-products are considered as follows. The nitrimine (**1**) would rearrange to the N-nitrite (**13**) and O-nitrite (**14**) which convert into the radical (**15**) by the loss of the NO radical. The radical (**15**) captures the hydrogen atom from solvent to give **9**. Photo-hydrolysis[9] of the N–ONO group in **14** would give **7**. Also, another

1) Part VI: M. Onda, R. Yabuki, K. Takeuchi, and Y. Konda, *Chem. Pharm. Bull.* (Tokyo), **24**, 1795 (1976).
2) Location: *Minato-ku, Tokyo 108, Japan.*
3) M. Onda and A. Azuma, *Chem. Pharm. Bull.* (Tokyo), **20**, 1467 (1972); M. Onda, Y. Konda, and R. Yabuki, *ibid.*, **23**, 611 (1975).
4) M. Onda and K. Takeuchi, *Chem. Pharm. Bull.* (Tokyo), **21**, 1287 (1973).
5) R.M. Dodson and B. Riegel, *J. Org. Chem.*, **13**, 424 (1948); L.F. Fieser and S. Rajagopalan, *J. Am. Chem. Soc.*, **71**, 3938 (1949).
6) 3β-Acetoxy-6-hydroximino-5α-cholestane and 3β-acetoxy-6-hydroximinocholestan-5α-ol show the NMR signals for the 7β-H at δ 3.34 (q, *J* 12 and 4 Hz) and 3.03 (q, *J* 12 and 4 Hz), respectively.
7) Y. Komeichi, T. Iwasaki, Y. Ito, and F. Aida, *Steroids*, **19**, 47 (1972).
8) G.H. Timms and E. Wildsmith, *Tetrahedron Letters*, **1971**, 195.
9) Water may come from solvent and/or nitrogen.

pathway to **7** *via* photo-hydrolysis[9] of the $N-NO_2$ group in **1** is considered to be possible. Since, under the same condition employed for **1**, photolyses of **7** and **9** resulted in recovery of the starting compounds in almost quantitative yield, it is clear that pathway from **9** to **7**

Table I. Mass Fragments over *m/e* 300 of the Imine (**10**)

m/e (Calcd.)	Relative intensity (%)	Formula
501.3847 (501.3818)	24	$C_{31}H_{51}O_4N$
441.3622 (441.3607)	12	$C_{29}H_{47}O_2N$ M^+-AcOH
381.3402 (381.3396)	48	$C_{27}H_{43}N$ $M^+-2\times AcOH$
366.3158 (366.3161)	100	$C_{26}H_{40}N$ $M^+-(2\times AcOH+Me)$
354.3273 (354.3286)	12	$C_{26}H_{42}$ $M^+-(2\times AcOH+HCN)$
328.2281 (328.2276)	7	$C_{21}H_{30}O_2N$ $M^+-(AcOH+C_8H_{17})$

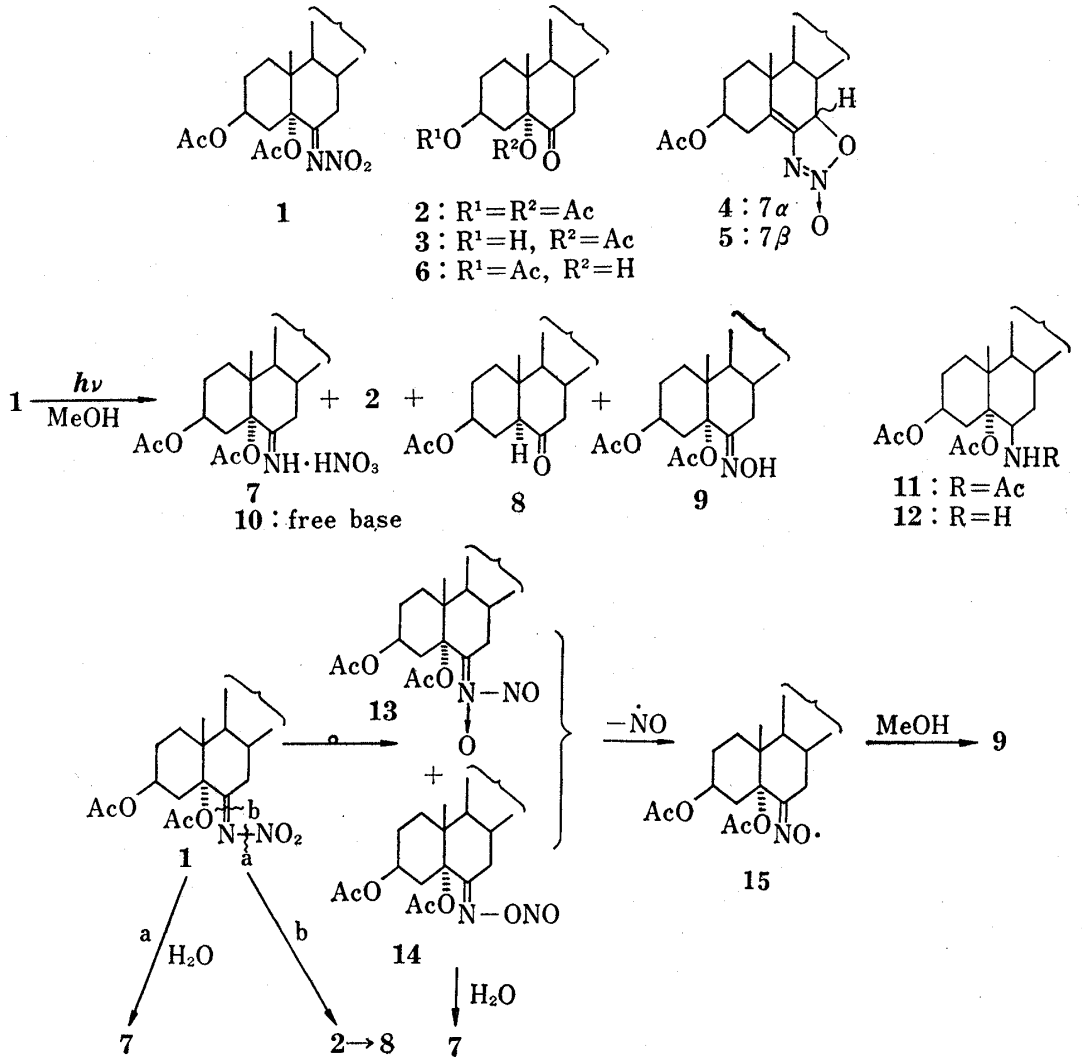

Chart 1

can be deniable[10] and that **2** is directly formed from **1** by photo-methanolysis of the C=N group and not from **7** and **9**. The diacetoxy ketone (**2**) is known to be photolysed to give **8**.[11] Accordingly, in our case, formation of **8** is also likely considered to pass through **2** originally formed from **1**.

Experimental

Melting points were determined on a micro hot-stage and are uncorrected. IR spectra were recorded on a JASCO IR-G. NMR spectra were measured on a Varian T-60 for deuteriochloroform solution. Mass spectra were taken on a JEOL JMS-01S.

Photolysis of 3β,5α-Diacetoxy-6-nitriminocholestane (1)——A solution of **1** (512 mg) in methanol (170 ml) was irradiated with a 40 W low pressure mercury lamp under nitrogen at room temperature for 3 hr. After removal of solvent *in vacuo*, the residue (500 mg) was treated with hexane. The portion insoluble in hexane gave 3β,5α-diacetoxy-6-iminocholestane nitrate (**7**) (110 mg, 20%) as colorless plates of mp 185—188° (from ethyl acetate). *Anal.* Calcd. for $C_{31}H_{52}O_7N_2$: C, 65.93; H, 9.28; N, 4.96. Found: C, 65.75; H, 9.28; N, 4.95. Treatment of **7** with 10% aq. Na_2CO_3 gave the imine (**10**) in quantitative yield as colorless needles of mp 148—150° (from hexane). NMR: δ 7.50 (bs, NH),[12] 4.83 (bs, W_H 24 Hz, 3α-H), 2.68 (q, J 16 and 5 Hz, 4α-H), 2.12 (s, 5α-OAc), 2.03 (s, 3β-OAc), 0.93 (s, 10β-Me). *Anal.* Calcd. for $C_{31}H_{51}O_4N$: C, 74.21; H, 10.25; N, 2.79. Found: C, 74.41; H, 10.37; N, 2.78. The portion (385 mg) soluble in hexane was chromatographed on silica gel (22 g). The first fraction eluted with benzene afforded 3β-acetoxy-5α-cholestan-6-one (**8**) (34 mg, 8%) as colorless needles of mp 131—133° (from hexane). IR $\nu_{max}^{CCl_4}$ cm^{-1}: 1735 (OAc), 1715 (CO). NMR: δ 4.67 (bs, W_H 24 Hz, 3α-H), 2.02 (s, 3β-OAc), 0.91 (s, 10β-Me). *Anal.* Calcd. for $C_{29}H_{48}O_3$: C, 78.33; H, 10.88. Found: C, 78.52; H, 10.99. The second fraction eluted with benzene gave 3β,5α-diacetoxycholestan-6-one (**2**) (156 mg, 33%) as colorless needles of mp 176—178° (from methanol). IR $\nu_{max}^{CCl_4}$ cm^{-1}: 1748, 1738 (OAc), 1729 (CO). NMR: δ 4.80 (bs, W_H 24 Hz, 3α-H), 2.15 (s, 5α-OAc), 2.00 (s, 3β-OAc), 0.90 (s, 10β-Me). *Anal.* Calcd. for $C_{31}H_{50}O_5$: C, 74.06; H, 10.02. Found: C, 73.91; H, 10.20. The third fraction eluted with benzene–chloroform (1 : 1) gave 3β,5α-diacetoxy-6-hydroximinocholestane (**9**) (70 mg, 15%) as colorless needles of mp 160—162° (from methanol). IR $\nu_{max}^{CCl_4}$ cm^{-1}: 3600 (OH), 1745, 1738 (OAc), 1650 (C=N). NMR: δ 8.00 (bs, OH),[12] 4.83 (bs, W_H 24 Hz, 3α-H), 3.24 (q, J 12 and 4 Hz, 7β-H), 2.70 (q, J 17 and 5 Hz, 4α-H), 2.09 (s, 5α-OAc), 2.02 (s, 3β-OAc), 0.92 (s, 10β-Me). *Anal.* Calcd. for $C_{31}H_{51}O_5N$: C, 71.92; H, 9.93; N, 2.71. Found: C, 71.70; H, 10.09; N, 2.60.

Reaction of 3β,5α-Diacetoxy-6-iminocholestane (10)——A solution of **10** (71 mg) in acetic acid (8 ml) was hydrogenated over platinum black obtained from PtO_2 (120 mg) at room temperature for 8 hr. The work-up gave an oily material (69 mg) whose acetylation with acetic anhydride gave 6β-acetamido-3β,5α-diacetoxycholestane (**11**) (63 mg) as colorless needles of mp 254—255° (from methanol). IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 3460 (NH), 1723 (OAc), 1673 (NAc). Mass Spectrum m/e: 485.388, $(M-C_2H_4O_2)^+$. Calcd. for $C_{33}H_{55}O_5N-C_2H_4O_2$: M, 485.387.

Conversion of 3β,5α-Diacetoxy-6-hydroximinocholestane (9) into 3β,5α-Diacetoxy-6-iminocholestane (10)——To a solution of **9** (59 mg) in dioxane (5 ml) was added a solution of ammonium acetate (120 mg) in 50% acetic acid (0.15 ml) and then 20% aq. $TiCl_3$ (2 ml). The resulting mixture was stirred at room temperature for 2 hr. The product was extracted with ether, washed successively with saturated aq. NaCl, aq. $NaHCO_3$ and a small amount of H_2O, and dried over Na_2SO_4. Removal of solvent afforded **10** (34 mg) as colorless needles of mp 148—150° (from hexane).

10) K.H. Grellmann and E. Tauer, *Tetrahedron Letters*, **1974**, 3707; They proposed the photochemical formation of ketimines from ketoximes.
11) R.C. Cookson, R.P. Gandhi, and, in part, R.M. Southam, *J. Chem. Soc.* (*C*), **1968**, 2494.
12) On addition of D_2O this signal disappears.