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222. Hiromu Mori and Joji Yamada: Studies on Steroidal Compounds. XI.[1] Reaction of 5-Ene Steroids with Sulfuryl Chloride in Pyridine.

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The chlorination of 3-oxo-4-ene steroids with sulfuryl chloride in pyridine was described in the previous paper,[2] and the replacement of hydroxyl group in steroids with chlorine by this reagent was also reported.[3] This paper describes the reaction of 5-ene steroids with this reagent.

3β-Acetoxypregn-5-en-20-one (Ia) was treated with sulfuryl chloride in pyridine to give 5α,6β-dichloro compound (Ⅱa), which was identical with the authentic sample obtained by chlorination of Ia with chlorine according to the method of Cutler, *et al.*[4] Ia was recovered by treatment of Ⅱa with zinc dust in acetic acid. Ⅱa was hydrolyzed to hydroxy compound (Ⅱb), which on oxidation with chromium trioxide in acetic acid gave 3-oxo compound (Ⅲa).[5] This ketone (Ⅲa) could be transformed into 6β-chloro-4-en-3-one (Ⅳa)[6] by refluxing with sodium acetate in methanol.

3β,17α-Diacetoxypregn-5-en-20-one (Ib) was also treated with sulfuryl chloride in pyridine as the same manner and 5α,6β-dichloro compound (Ⅱc) was obtained. The assignment of the configurations of chlorine atoms at C-5 and C-6 was based on further transformations. Ⅱc was partially hydrolyzed to 3β,17α-dihydroxy-5α,6β-dichloropregnan-20-one 17-acetate (Ⅱd), which on oxidation with chromium trioxide afforded 3-oxo compound (Ⅲb). Ⅲb was converted into the known 6β-chloro-17α-acetoxyprogesterone (Ⅳb)[6] by refluxing with sodium acetate in methanol. It is very important to prepare 6-chloro-6-dehydro-17α-acetoxyprogesterone effectively, because this compound has higher progestational activity than any gestagen which has ever known.[6] The preparation of this compound from Ⅲb or Ⅳb was already reported by Yasuda, one of staff member of this laboratory.[7]

On similar treatment of 3β-acetoxyandrost-5-en-17-one (Ⅶ) with sulfuryl chloride in pyridine was furnished dichloro compound (Ⅷa). Ⅶ was recovered on treatment of Ⅷa with zinc dust in acetic acid. The hydrolysis of Ⅷa gave hydroxy compound (Ⅷb). When Ⅷb was oxidized with chromium trioxide in aceitic acid in the same manner described above (rather in concentrated solution), 6α-chloro-3-oxo-4-ene compound (Ⅹ) was given unexpectedly. It is interesting to point that products were quite different on oxidation of Ⅱb and Ⅷb in the same condition. Nevertheless, any assignment of the configurations of C-5 and C-6 chlorine atoms in Ⅷa other than 5α,6β-dichloro was excluded from the following evidences.

The chlorination of Ⅶ with chlorine by the method which is known to give 5α,6β-dichloro compound,[4,8] afforded the same dichloro compound (Ⅷa). The conversion of Ⅷb to dichloro-3-oxo compound (Ⅺ) was accomplished by chromium trioxide oxidation

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[1] Part X. H. Mori, K. Tsuneda: This Bulletin, **11**, 1413 (1963).

[2] H. Mori: *Ibid.*, **10**, 429 (1962).

[3] H. Mori, S. Wada: *Ibid.*, **11**, 1409 (1963).

[4] F.A. Cutler, Jr.. L. Mandell, D. Shew, J.F. Fisher, J.M. Chemerda: J. Org. Chem., **24**, 1621 (1959).

[5] F.A. Cutler, J.F. Fisher, J.M. Chemerda: *Ibid.*, **24**, 1626 (1959).

[6] H.J. Ringold, E. Batres, A. Bowers, J. Edwards, J. Zderic: J. Am. Chem. Soc., **81**, 3485 (1959).

[7] K. Yasuda: This Bulletin, **11**, 1167 (1963).

[8] D.H.R. Barton, E. Miller: J. Am. Chem. Soc., **72**, 370 (1950).

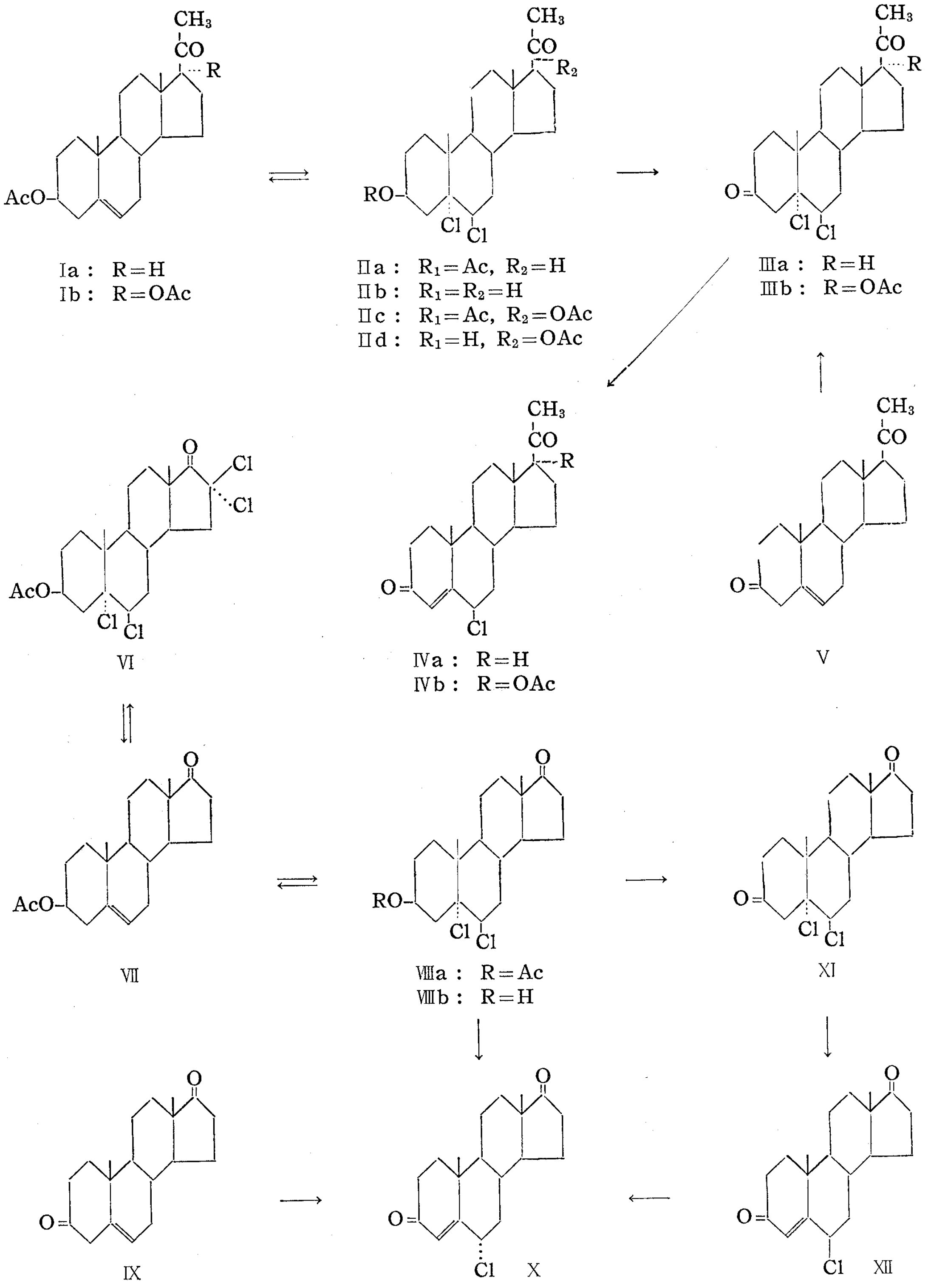

Chart 1.

in acetone at low temperature[9] or chromium trioxide oxidation in acetic acid in low concentration. XI was dehydrochlorinated by sodium acetate in methanol to give 6β-chloroandrost-4-ene-3,17-dione (XII), which showed strong absorption at 240 mμ in ultraviolet absorption spectrum characteristic for 6β-chloro-3-oxo-4-ene steroids,[6] and could

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[9] K. Bowden, I.M, Heilbron, D.R.H. Jones, B.C.L. Weeden: J. Chem. Soc., **1946**, 39.

be transformed into 6α-chloro compound (X) on treatment with hydrochloric acid in acetic acid. Thus the 6β-configuration of chlorine atom was fully established, because the configuration of halogen atom at C-6 was retained by the dehydrohalogenation procedure mentioned above.[10]

5α,6β-Dichloro-3-oxo compound (XI) was not stable at 60~80° or even at room temperature. It was observed that XI was converted into 6α-chloroandrost-4-ene-3,17-dione (X) by three hours' storage at 60~80°, and when XI was stored at room temperature for three days, it could be shown from ultraviolet observation that 30% of XI was transformed to dehydrochlorinated compound (X).

The chlorination of 3β-acetoxypregn-5-en-20-one (Ia) and 3β-acetoxyandrost-5-en-17-one (VII) with sulfuryl chloride in chloroform was also undertaken, in order to examine the difference between the reaction with sulfuryl chloride in pyridine and that with sulfuryl chloride in chloroform. Whereas Ia was converted to the same dichloro compound (IIa) as that on treatment with sulfuryl chloride in pyridine, tetrachloro compound (VI) was obtained from VII. In the infrared spectrum of VI, carbonyl band at C-17 was observed at 1777 cm^{-1} in addition to carbonyl band at 1725 cm^{-1} (C=O in C-3 acetoxy group), and higher band was considered as C-17 carbonyl band having two adjacent chlorine atoms.[11] Thus tetrachloro compound can be formulated as 3β-acetoxy-5α,6β,16,16-tetrachloroandrostan-17-one. When tetrachloro compound (VI) was treated with zinc dust in acetic acid, VII was recovered. Evidently, it may be noted that enolization of a steroidal ketone is depressed by pyridine, which is considered as the first step in halogenation reaction of active hydrogen adjacent to ketone group, and so that chlorination of active hydrogen adjacent to ketone group is not occured by sulfuryl chloride in pyridine.

When pregn-5-ene-3,20-dione (V) was chlorinated with sulfuryl chloride in pyridine, dichloro compound (III) was given. On the other hand, the chlorination of androst-5-ene-3,17-dione (IX) afforded 6α-chloroandrost-4-ene-3,17-dione (X). The difference of the products is considered to be depend upon the difference of stability of 5α,6β-dichloro-3-oxo compounds between androstan and pregnan series.

Experimental[*2]

3β-Acetoxy-5α,6β-dichloropregnan-20-one (IIa)——SO_2Cl_2 (2.0 ml.) was added dropwise to a solution of 3β-acetoxypregn-5-en-20-one (Ia, 4.0 g.) in dry pyridine (40 ml.) at 0° with stirring. After addition the solution was stirred for 3 hr. at room temperature and poured into H_2O. The product was extracted with Et_2O, and the ethereal extract was washed with 10% HCl, 5% Na_2CO_3, and H_2O, and dried over Na_2SO_4. Et_2O was evaporated to give yellow crystals, which on recrystallization from Me_2CO afforded 3β-acetoxy-5α,6β-dichloropregnan-20-one (IIa, 2.65 g.), m.p. 190~196°. Further recrystallization from Me_2CO gave an analytical sample as colorless plates, m.p. 199~200°, $[\alpha]_D^{20}$ +8° (c=1.00), which was identical with the compound obtained by chlorination of Ia with chlorine in infrared spectrum. (reported,[4]) m.p. 199.5~201°, $[\alpha]_D$ +7°). *Anal.* Calcd. for $C_{23}H_{34}O_3Cl_2$: C, 64.33; H, 7.98. Found : C, 64.12; H, 8.06.

3β-Hydroxy-5α,6β-dichloropregnan-20-one (IIb)——A solution of IIa (0.5 g.) in MeOH (16 ml.) and H_2O (1.2 ml.) containing $KHCO_3$ (0.37 g.) was refluxed for 1 hr., and poured into H_2O. The precipitates were collected by filtration, washed well with H_2O, and dried. Yield, 0.45 g., m.p. 154~158°. Recrystallization from Me_2CO-hexane gave an analytical sample as colorless prisms, m.p. 158~159°, $[\alpha]_D^{20}$ +15° (c=1.00). (reported, m.p. 160~160.5°). *Anal.* Calcd. for $C_{21}H_{32}O_2Cl_2$: C, 65.12; H, 8.32. Found : C, 65.41; H, 8.70.

5α,6β-Dichloropregnane-3,20-dione (IIIa)——a) From IIb : A solution of CrO_3 (50 mg.) in H_2O (three drops) and AcOH (0.5 ml.) was added to a solution of IIb (100 mg.) in AcOH (0.4 ml.). After storage at

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[*2] All melting points are uncorrected and all optical rotations are measured in chloroform solution.

10) A. Bowers : J. Am. Chem. Soc., **81**, 4107 (1959).

11) T. Nambara, J. Fishman : J. Org. Chem., **26**, 4569 (1961). E. Schwenk, C. G. Castle, E. Joachim : *Ibid.*, **28**, 136 (1963).

room temperature for 1 hr., the solution was poured into H_2O, and the precipitates were collected by filtration, washed with H_2O and dried. Yield, 60 mg., m.p. 130~135°. Recrystallization from Me_2CO-hexane gave an analytical sample as colorless prisms, m.p. 140°(decomp.), $[\alpha]_{\mathrm{D}}^{20}$ +39°(c=1.00). (reported, m.p. 140°(decomp.)).

b) From V : SO_2Cl_2(0.5 ml.) was added to a solution of pregn-5-ene-3,20-dione (V, 1.0 g.) in pyridine (20 ml.). After stirring at room temperature for 1 hr. and 45 min., the solution was poured into H_2O. The product was extracted with Et_2O, and ethereal solution was washed with 10% HCl, 5% Na_2CO_3, and H_2O, and dried over Na_2SO_4. Evaporation of the solvent gave IIIa as colorless prisms. No depression was observed on admixture with the compound described above.

6β-Chloropregn-4-ene-3,20-dione (IVa)——A solution of 5α,6β-dichloropregnane-3,20-dione (IIIa, 1.0 g.) in MeOH (10 ml.) containing AcONa (3.0 g.) was refluxed for 3 hr., and poured into H_2O. The precipitates was extracted with Et_2O, and ethereal solution was washed with H_2O, and dried over Na_2SO_4. After evaporation of the solvent, the residue was recrystallized from Me_2CO-hexane to give 6β-chloropregn-4-ene-3,20-dione (IV) as colorless prisms, m.p. 183~184°, $[\alpha]_{\mathrm{D}}^{20}$ +77°(c=1.16). UV : $\lambda_{\max}^{\mathrm{MeOH}}$ 240 mμ (ε 13,100).

3β,17α-Diacetoxy-5α,6β-dichloropregnan-20-one (IIc)——a) By chlorination with SO_2Cl_2 : SO_2Cl_2(1.0 ml.) was added dropwise to an ice-cold solution of 3β,17α-diacetoxypregn-5-en-20-one (Ib, 1.5 g.) in dry pyridine (15 ml.) and the solution was stirred for 1.5 hr., and poured into H_2O. The product was extracted with Et_2O, and ethereal solution was washed with 10% HCl, 5% Na_2CO_3 and H_2O, and dried over Na_2SO_4. After evaporation of the solvent, the residue was recrystallized from Me_2CO-hexane to give 3β,17α-diacetoxy-5α,6β-dichloropregnan-20-one (IIc, 1.0 g.), m.p. 213°(decomp.). Further recrystallization from the same solvent afforded an analytical sample as colorless needles, m.p. 213°(decomp.), $[\alpha]_{\mathrm{D}}^{20}$ −49°(c=0.80). *Anal.* Calcd. for $C_{25}H_{36}O_5Cl_2$: C, 61.60; H, 7.44. Found : C, 61.71; H, 7.54.

b) By chlorination with chlorine : The chlorination was undertaken according to the modified method described by Cutler, *et al.*[4] The resulting product was recrystallized from Me_2CO-hexane to give IIc (8.6 g., from 11.2 g. of Ib), m.p. 206~208°(decomp.). Further recrystallization from the same solvent afforded an analytical sample, identical with the sample obtained above in all respects.

3β,17α-Dihydroxy-5α,6β-dichloropregnan-20-one 17-Acetate (IId)——3β,17α-Diacetoxy-5α,6β-dichloropregnan-20-one (IIc, 1.2 g.) was added to a mixture of MeOH (200 ml.) and aqueous $KHCO_3$ (1.2 g. in 5.0 ml. of H_2O) and stirred at room temperature for 1 hr. The solution was allowed to stand overnight at room temperature, and poured into H_2O. The precipitates were collected by filtration, washed well with H_2O, and dissolved in a mixture of Et_2O and Me_2CO. The solution was dried over Na_2SO_4 and hexane was added. The solvent was evaporated until crystals came out. After cooling, colorless needles were collected by filtration; yield 0.8 g., m.p. 188~191°. Further recrystallization from Me_2CO-hexane gave an analytical sample, m.p. 185~187°, $[\alpha]_{\mathrm{D}}^{22}$ −60°(c=1.00). *Anal.* Calcd. for $C_{23}H_{34}O_4Cl_2$: C, 62.02; H, 7.69. Found : C, 61.88; H, 7.67.

17α-Acetoxy-5α,6β-dichloropregnane-3,20-dione (IIIb)——8*N* CrO_3 solution[12] (2.0 ml.) was added to a solution of 3β,17α-dihydroxy-5α,6β-dichloropregnan-20-one 17-acetate (IId, 1.0 g.) in EtOH free Me_2CO (40 ml.) with stirring at 0°. The resulting suspension was stored at room temperature for 10 min., and poured into H_2O. The precipitates were collected by filtration, washed well with H_2O, and dissolved in Me_2CO. After dried over Na_2SO_4, hexane was added and the solvent was evaporated until crystals came out. Colorless needles was collected by filtration; yield 0.85 g., m.p. 188°. Further recrystallization from Me_2CO-hexane afforded an analytical sample, m.p. 188°, $[\alpha]_{\mathrm{D}}^{24}$ −45°(c=1.00). *Anal.* Calcd. for $C_{23}H_{32}O_4Cl_2$: C, 62.30; H, 7.27. Found : C, 62.41; H, 7.31.

6β-Chloro-17α-acetoxypregn-4-ene-3,20-dione (IVb)——A solution of 17α-acetoxy-5α,6β-dichloropregnane-3,20-dione (IIIb, 800 mg.) and AcONa (4.0 g.) in MeOH (100 ml.) was refuxed for 2 hr.. and poured into H_2O. The precipitates were collected by filtration, washed well with H_2O, and dissolved in Me_2CO. The product was recrystallized from Me_2CO to give IVb (380 mg.), m.p. 203° (decomp.) as colorless needles, which showed the same IR spectrum as that for the authentic sample.[6]

3β-Acetoxy-5α,6β-dichloroandrostan-17-one (VIIIa)——a) By the chlorination with SO_2Cl_2 : SO_2Cl_2 (2.0 ml.) was added to a solution of 3β-acetoxyandrost-5-en-17-one (VII, 4.0 g.) in dry pyridine (40 ml.) at 0° with stirring. The solution was stirred at room temperature for 3 hr., and poured into H_2O. The product was extracted with Et_2O, and the ethereal solution was washed with 10% HCl, 5% Na_2CO_3 and H_2O, and dried over Na_2SO_4. After evaporation of the solvent, the residue was recrystallized from MeOH to give VIIIa (2.3 g.), m.p. 211.5~214°. Further recrystallization from MeOH afforded an analytical sample as colorless needles, m.p. 217~218°, $[\alpha]_{\mathrm{D}}^{20}$ +2°(c=1.00). *Anal.* Calcd. for $C_{21}H_{30}O_3Cl_2$: C, 62.84; H, 7.53. Found : C, 62.70; H, 7.59.

b) By the chlorination with chlorine : The chlorination was undertaken according to the modified method described by Cutler, *et al.*[4] A solution of chlorine in CCl_4 (2.33 ml., 0.215 g. per ml.) was added

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[12] A solution of CrO_3(26.72 g.) in H_2SO_4 (23 ml.) diluted with H_2O at a volume of 100 ml. was used.

to a solution of 3β-acetoxyandrost-5-en-17-one (VII, 1.0 g.) in dry benzene (32 ml.) and dry pyridine (0.2 ml.). The solution was washed with 10% HCl and H_2O immediately after addition of the chlorine solution, and dried over Na_2SO_4. After evaporation of the solvent, the residue was recrystallized from MeOH to give VIIIa (750 mg.), m.p. 214~216°. Further recrystallization from MeOH gave pure compound, m.p. 217~218°, which was iedntical with the sample described above.

3β-Hydroxy-5α,6β-dichloroandrostan-17-one (VIIIb)——a) Hydrolysis with hydrochloric acid: A solution of 3β-acetoxy-5α,6β-dichloroandrostan-17-one (VIIIa, 1.9 g.) in MeOH (100 ml.) containing 35% HCl (5.0 ml.) was refluxed for 1 hr., and poured into H_2O. The precipitates were collected by filtration, washed with H_2O, and dried. Recrystallization from Me_2CO-hexane to give VIIIb (1.3 g.), m.p. 169~171°. Further recrystallization from the same solvent gave an analytical sample as colorless prisms, m.p. 171~172°, $[\alpha]_D^{20}$ +6°(c=1.00). *Anal.* Calcd. for $C_{19}H_{28}O_2Cl_2$: C, 63.50; H, 7.85. Found: C, 63.59; H, 7.93.

b) Hydrolysis with $KHCO_3$: A solution of VIIIa (300 mg.) in MeOH (15 ml.) and H_2O (0.8 ml.) containing $KHCO_3$ (0.2 g.) was refluxed for 1 hr., and poured into H_2O. VIIIb (150 mg.), m.p. 171~172° was obtained on similar treatment described above.

6α-Chloroandrost-4-ene-3,17-dione (X)——a) From VIIIb: A solution of CrO_3 (60 mg.) in H_2O (three drops) and AcOH (0.3 ml.) was added to a solution of 3β-hydroxy-5α,6β-dichloroandrostan-17-one (VIIIb, 300 mg.) in AcOH (1.2 ml.). After storage at room temperature for 1.5 hr., the solution was poured into H_2O, and the precipitates were collected by filtration, washed with H_2O, and dried. Recrystallization from Me_2CO gave X (120 mg.), m.p. 216~218° as colorless prisms. $[\alpha]_D^{32}$ +141°(c=1.00), UV: λ_{max}^{MeOH} 234 mμ (ε 13,700). *Anal.* Calcd. for $C_{19}H_{25}O_2Cl$: C, 71.12; H, 7.85. Found: C, 70.96; H, 7.98.

b) From IX: SO_2Cl_2 (0.5 ml.) was added to a solution of androst-5-ene-3,17-dione (IX, 1.0 g.) in dry pyridine (10 ml.). After stirring for 2 hr., the solution was poured into H_2O, and the product was extracted with AcOEt. The AcOEt layer was washed with 10% HCl, 5% Na_2CO_3 and H_2O, dried over Na_2SO_4, and condensed to dryness. The residue was recrystallized from Me_2CO to give X (400 mg.), m.p. 209~210°. Further recrystallization from Me_2CO gave an analytical sample as colorless prisms, m.p. 216~218°, which showed the same IR spectrum as that for the compound described above.

c) From XII: A solution of XII (100 mg.) in AcOH (10 ml.) and 35% HCl (0.5 ml.) was allowed to stand overnight at room temperature, and poured into H_2O. The precipitates were collected by filtration, washed with H_2O, and dried. Yield 95 mg., m.p. 202~210°. Recrystallization from Me_2CO arose m.p. to 215~217°.

5α,6β-Dichloroandrostane-3,17-dione (XI)——8*N* CrO_3 solution[12] (4.0 ml.) was added to a solution of VIIIb (2.0 g.) in EtOH free Me_2CO (80 ml.) at −15~18°. After stirring for 5 min., the solution was poured into H_2O, and the precipitates were collected by filtration, and washed with H_2O. It was dissolved in Et_2O and the ethereal layer was dried over Na_2SO_4. The solvent was distilled *in vacuo* until crystals came out. The colorless needles was filtered to give XI (1.2 g.), m.p. 155~156°(decomp.), $[\alpha]_D^{23}$ +15°.

6β-Chloroandrost-4-ene-3,17-dione (XII)——A solution of XI (1.2 g.) in MeOH (125 ml.) containing AcONa (3.85 g.) was refluxed for 3 hr. The solution was poured into H_2O, and the precipitates were collected by filtration, washed with H_2O, and dried. Recrystallization from Me_2CO-hexane gave XII (780 mg.). m.p. 195~196°, $[\alpha]_D^{20}$ +81°(c=1.00). UV: λ_{max}^{MeOH} 240 mμ (ε 14,200).

3β-Acetoxy-5α,6β,16,16-tetrachloroandrostan-17-one (VI)——SO_2Cl_2 (0.5 ml.) was added to a solution of VII (1.0 g.) in $CHCl_3$ (20 ml.) and the solution was stirred for 2 hr. Et_2O was added, and the solution was washed with H_2O, 5% Na_2CO_3 and H_2O, and dried over Na_2SO_4. The solvent was evaporated to give yellow gum, which on recrystallized from MeOH gave VI (340 mg.), m.p. 190~195°. Further recrystallization from MeOH-Me_2CO gave an analytical sample as colorless needles, m.p. 229~232°, $[\alpha]_D^{20}$ 0°(c=1.07). *Anal.* Calcd. for $C_{21}H_{30}O_3Cl_4$: C, 53.40; H, 6.40. Found: C, 53.51; H, 6.03.

The Conversion of VI to 3β-Acetoxyandrost-5-en-17-one (VII)——Zn dust (500 mg.) was added in small portions to a solution of VI (500 mg.) in AcOH (20 ml.) and stirring was continued for 2 hr. After removal of Zn cake by filtration, the solution was poured into H_2O, and the product was extracted with Et_2O. The ethereal solution was washed with 5% Na_2CO_3 and H_2O, and dried over Na_2SO_4. The solvent was evaporated, and the residue was recrystallized from Me_2CO-MeOH to give VII (290 mg.), m.p. 165~170°.

The Conversion of VIIIa to 3β-Acetoxyandrost-5-en-17-one (VII)——Zn dust (2.0 g.) was added to a solution VIIIa (1.0 g.) in AcOH (40 ml.) maintained at 40~45° in small portions. After stirring was continued for 1.5 hr., Zn cake was removed by filtration, and the filtrate was poured into H_2O. The precipitates were collected by filtration, washed with H_2O, and dried. Yield 0.7 g., m.p. 162~167°. Recrystallization from MeOH gave pure sample, m.p. 168~170°.

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Summary

Some 3β-acetoxy-5-ene steroids were reacted with sulfuryl chloride in pyridine and the corresponding 3β-acetoxy-5α,6β-dichloro steroids were obtained. Dehydroepiandrosterone acetate (Ⅶ) was transformed into 5α,6β,16,16-tetrachloro compound (Ⅵ) on treatment with sulfuryl chloride in chloroform. The reaction of androst-5-ene-3,17-dione (Ⅸ) with sulfuryl chloride in pyridine gave 6α-chloroandrost-4-ene-3,17-dione (Ⅹ), whereas the same reaction on pregn-5-ene-3,20-dione (Ⅴ) afforded the corresponding 5α,6β-dichloro compound (Ⅲa). Some transformations of compounds above-mentioned were also written.

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223. Genshun Sunagawa, Yasunobu Sato, and Mitsuo Watatani : Studies on Seven-membered Ring Compounds. VIII.[*1] Syntheses of 5-Nitrosotropolone Derivatives.

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Anti-tumor activities of seven-membered ring compounds had been examined, owing to peculiar effects of colchicine on division cells of plants and animals.[1]

The authors also examined the anti-tumor activities of simple tropolone derivatives, and found that 5-nitrosotropolone (Ⅰ) possesses remarkable anti-tumor activity on Ehrlich ascites carcinoma.[2] Recently, it was also demonstrated that nitrosoresorcine derivatives possess the anti-tumor activity on Ehrlich ascites carcinoma.[3] Accordingly, it seemed of interest to examine various 5-nitrosotropolones. The present paper describes the syntheses of some new compounds of this series.

First, an attempt was made to synthesize 3-substituted 5-nitrosotropolones by reacting 3-formylamino- (Ⅱa),[4] 3-methoxy- (Ⅱb),[5] 3-methylthio- (Ⅱc)[6] and 3-phenylthiotropolone (Ⅱd)[6] with sodium nitrite in water or glacial acetic acid.

Nitrosation of Ⅱa gave only the normal corresponding nitroso compound. Its structure was considered to be 3-formylamino-5-nitrosotropolone (Ⅲa), which was confirmed by the following reactions. Catalytic reduction of Ⅲa afforded an amino compound, which was identical with 5-amino-3-formylaminotropolone (Ⅴa) obtained from 3-amino-5-nitrotropolone (Ⅵ).[7] A similar nitrosation of Ⅱb afforded only 3-methoxy-5-nitrosotropolone (Ⅲb).

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