[Chem. Pharm. Bull. 16(2) 326—331 (1968)]

UDC 615.89-011 : 581.19

Constituents of Chinese Crude Drug "Wujiapi." I. Studies on the Aglycones of Steroidal Glycosides of Pei-wujiapi. (1)

Seiichi Sakuma, Sachiko Kawanishi, Junzo Shoji,[1a] and Shoji Shibata[1b]

School of Pharmaceutical Sciences, Showa University[1a] and Faculty of Pharmaceutical Sciences, University of Tokyo[1b]

(Received June 1, 1967)

The chemical constituents of Chinese crude drug "Pei-wujiapi" (北五加皮) were studied. Four out of six steroidal substances which were obtained by hydrolysis of the glycoside fraction with dilute acid were identified as Δ^5-pregnene-3β,20α-diol, Δ^5-pregnene-3β, 17α, 20α-triol, Δ^5-pregnene-3β,16α,20α-triol, and periplogenin. Beside these substances, β-sitosterol, β-sitosterol-β-D-glucoside and 4-methoxysalicylaldehyde were isolated from the benzene soluble fraction.

As we reported in the preliminary communication[2] several constituents were isolated from Chinese crude drug "Wujiapi"(五加皮). The present paper deals mainly with the study on the chemical structures of steroidal aglycones of this drug.

The crude drug "Wujiapi" was described in Chinese literature since two thousands years ago and widely used as a tonic.

The original plants of this drug have been studied by many workers, and more than thirteen plants are recorded, many of which belong to Araliaceae, but only one, *Periploca sepium* Bge. (北五加皮), belongs to Asclepiadaceae[3a,b] (Table I).

It should be noted that some plants of different families are employed for the same purpose under the same name, so we commenced to study the chemical constituents of this drug from the pharmacological and chemotaxonomical interest.

Table I. The Original Plants of "Wujiapi" (五加皮)

	Araliaceae
1.	*Acanthopanax aculeatus* Seem.
2.	*A. Giraldii* Harms.
3.	*A. gracilistylus* W.W. Smith.
4.	*A. Henryi* (Oliv.) Harms. (*Eleutherococcus Henryi* Oliv.)
5.	*A. leucorrhizus* (Oliv.) Harms. (*E. leucorrhizus* Oliv.)
6.	*A. senticosus* (Maxim.) Harms. (*E. senticosus* Maxim.)[a]
7.	*A. sessiliflorus* (Rupr. & Maxim.) Seem.
8.	*A. setchuenensis* Harms.
9.	*A. Sieboldianus* Mak.
10.	*A. spinosus* Miq.
11.	*A. trifoliatus* (L.) Voss.
12.	*Aralia palmata* Tatarinov.
	Asclepiadaceae
13.	*Periploca sepium* Bge. (Pei-wujiapi) (北五加皮)

a) G.B. Elyakov: 11th Pacific Sci. Congr. Tokyo, 1966.

1) Location: a) *Hatanodai, Shinagawa-ku, Tokyo.* b) *Hongo, Bunkyo-ku, Tokyo.*
2) S. Sakuma, S. Kawanishi, J. Shoji, and S. Shibata, *Chem. Pharm. Bull.* (Tokyo), **15**, 720 (1967).
3) a) "Zhong Yao Zhi" (中葯志), Vol. III, p. 402, Pharmaceutical Institute, Chinese Academy of Medical Science, Peking, 1961. b) J. Sato, "On the Chinese Medicinal Plants," p. 34, Japan Society for Promotion of Science, Tokyo, 1959.

The drug material, "Pei-wujiapi" imported from China was ground and extracted with hot ethanol. After evaporation of the solvent *in vacuo*, the syrupy brown residue was dissolved in water and extracted with benzene (Chart 1).

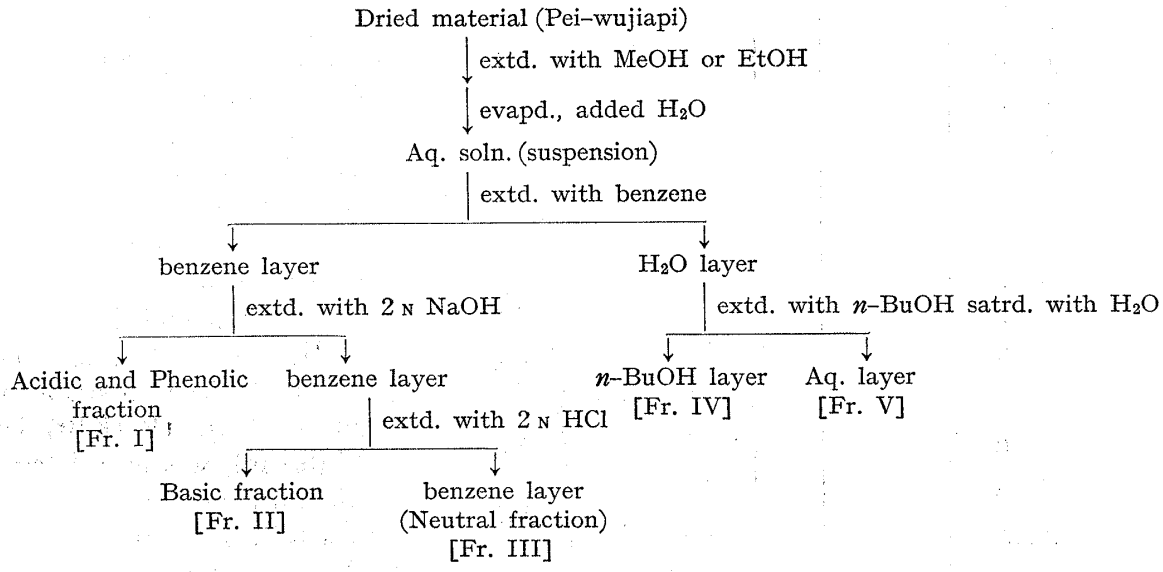

Chart 1. Extraction and Separation of the Pei-wujiapi Constituents

From the benzene soluble acidic fraction (Fr. I) 4-methoxysalicylaldehyde,[4] $C_8H_8O_3$, mp 41°, colorless leaflets (from 20% EtOH) (Oxime: mp 139°) was obtained by steam distillation.

Furthermore β-sitosterol and β-sitosterol-β-D-glucoside[5] were obtained from the benzene-soluble neutral fraction. These substances were identified in comparison with the authentic specimens. Besides these compounds several kinds of crystalline substances were obtained in pure state. The study on the chemical sturctures of these substances is now in progress and will be reported soon.

After removing benzene layer, the aqueous solution was extracted with *n*-butanol saturated with water. *n*-Butanol extracted fraction (Fr. IV) was revealed to contain many glucosidic substances (A—N) by TLC (Kieselgel H, solvent $CHCl_3$:MeOH:H_2O=65:35:10, lower layer[6]; color reagent, 10% H_2SO_4) (Fig. 1). Isolation of these glycosides is being investigated to obtain genuine aglycones.

The hydrolysis of Fr. IV was carried out under various conditions.

1. 0.05N H_2SO_4 —50% MeOH or EtOH refluxed for 30 min.[7]
2. 0.05N H_2SO_4 —50% Dioxane refluxed for 30 min.
3. 3N H_2SO_4 —50% MeOH or EtOH refluxed for 30 min.
4. 3N HCl:Dioxane:Benzene=3:1:1 refluxed for 4 hr.[8]
5. Conc. HCl:acetone=0.1:10 at room temp. for 1 week.[9]

The hydrolysis products were examined by thin-layer chromatography (Kieselgel H, solvent A, AcOEt; solvent B, $CHCl_3$:MeOH=95:5. color reagent, 10% H_2SO_4 or $SbCl_3$) (Fig. 2) to show the presence of more than fourteen products in the hydrolysate (P-I~P-XIV).

4) T. Shimano and T. Kubota, *The annual proceedings of Gifu college of pharmacy*, **1**, 2 (1952).
5) S. Ozeki, *Yakugaku Zasshi*, **82**, 766 (1962).
6) T. Kawasaki and K. Miyahara, *Chem. Pharm. Bull.* (Tokyo), **11**, 1546 (1963).
7) R.E. Winkler and T. Reichstein, *Helv. Chim. Acta*, **37**, 737 (1954).
8) C. Bighi and G. Saglietto, *J. Chromatog.*, **18**, 297 (1965).
9) C. Mannich and G. Siewert, *Ber.*, **75**, 737 (1942).

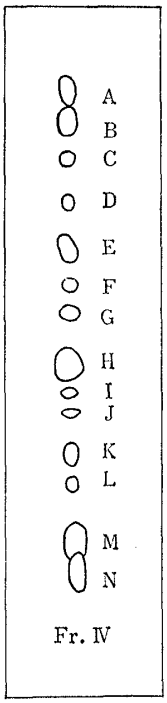

Fig. 1. Thin-layer Chromatogram of Pei-wujiapi Glycosides (Fr. IV) on Kieselgel H

Solvent: Lower layer of $CHCl_3$–MeOH–H_2O=65:35:10
Color reag.: 10% H_2SO_4

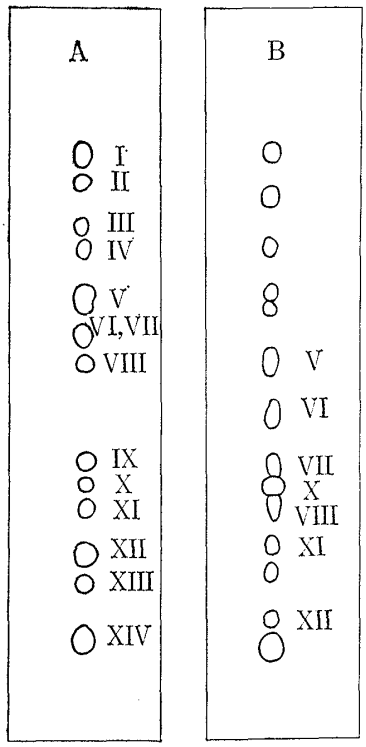

Fig. 2. Thin-layer Chromatogram of Pei-wujiapi Aglycones in Kieselgel H

A. Solvent: AcOEt
B. Solvent: $CHCl_3$–MeOH=95:5
Color reag.: 10% H_2SO_4

After hydrolysis with 0.05N H_2SO_4 –50% MeOH, the reaction mixture was extracted with chloroform and then purified on silica gel column developed with AcOEt. Five products, P-V (0.08% from dried material), P-VI (0.03%), P-VII (0.003%), P-VIII (0.05%), and P-XI (0.01%) were obtained in crystalline state, and the chemical structures of four of them were established.

The compound P-V, $C_{21}H_{34}O_2 \cdot \frac{1}{2}H_2O$, mp 182°, $[\alpha]_D^{32}$ –55.5° (c=1.44 $CHCl_3$), colorless leaflets (from AcOEt), IR (KBr) 3400 cm^{-1} (broad), was acetylated by acetic anhydride and pyridine to give a fully acetylated diacetate (P-V diacetate), $C_{25}H_{38}O_4$, mp 146°, $[\alpha]_D^{32}$ –55.3°(c=1.41 $CHCl_3$), IR (KBr) 1730, 1250 cm^{-1}, no OH band. Considering these data and NMR spectra, P-V was suggested to be Δ^5-pregnene-3β,20α-diol[10] (IIa) which was confirmed by the mixed mp and the comparison of TLC and IR spectra with the authentic sample which was kindly given us from Dr. G. Anner.

The second product, P-VI, $C_{21}H_{44}O_3$, mp 230°, $[\alpha]_D^{31}$ –69.2° (c=0.56 EtOH), colorless needles (from AcOEt), IR (KBr) 3400 cm^{-1} (broad), gave diacetate, $C_{25}H_{38}O_5$, mp 210°, $[\alpha]_D^{31.5}$ –72° (c=0.667 EtOH), needles (from AcOEt), IR (KBr) 3600, 1730, 1245 cm^{-1}. From these data, P-VI may possess two primary or secondary hydroxyl groups and one tertiary hydroxyl group which is unaffected by acetylation. Dehydration of P-VI diacetate was carried out with thionylchloride and pyridine under cooling for 20 hr. The reaction mixture was recrystallized repeatedly from MeOH. A crystalline product, $C_{25}H_{36}O_4$, mp 138°, colorless needles (from MeOH), showing no alcoholic absorption band in IR spectrum, was proved to be identical with $\Delta^{5,16}$-pregnene-3β,20α-diol diacetate[11] by comparing the IR, TLC, and mixed fusion with authentic sample which was given us from Dr. W.R. Benn. From these facts P-VI was assumed to be Δ^5-pregnene-3β,17α,20α-triol[12] (IIIa) and has been established to be identical with the authentic specimen kindly supplied from Dr. H. Hirschmann by the mixed fusion, TLC, and IR spectra.

The third compound, P-VIII, $C_{21}H_{34}O_3$, mp 251°, $[\alpha]_D^{32}$ –65.0° (c=0.25 EtOH), colorless needles (from AcOEt), IR (KBr) 3200—3400 cm^{-1}, was acetylated by acetic anhydride and pyridine. The acetylated product was triacetate, $C_{27}H_{40}O_6$, mp 183°, $[\alpha]_D^{32}$ –97° (c=0.63 EtOH), IR (KBr) 1740, 1240 cm^{-1}. Then P-VIII and its triacetate were proved to be

10) P. Wieland and K. Miescher, *Helv. Chim. Acta*, **32**, 1922 (1942).
11) W.R. Benn, *J. Org. Chem.*, **28**, 3557 (1963).
12) H. Hirschmann and F. B. Hirschmann, *J. Biol. Chem.*, **187**, 137 (1950).

identical with Δ^5-pregnene-3β,16α,20α-triol[13] (Va) and its triacetate respectively by the mixed fusion, TLC and the comparison of IR spectra with the authentic sample of Δ^5-pregnene-3β,16α,20α-triol triacetate which was given us from Dr. D.K. Fukushima and Dr. H. Hirschmann.

The chemical structures of P-XI, $C_{23}H_{34}O_5$, mp 238° (softens from 140°), $[\alpha]_D^{31.5}$ +27° (c=0.667 $CHCl_3$), prisms (from AcOEt or MeOH), UV λ_{max}^{EtOH} 217 mμ (ε=15000), IR (KBr) 3350—3500 (OH), 1736, 1632 cm^{-1} (unsaturated five membered lactone), and its monoacetate, $C_{25}H_{36}O_6$, mp 228°, $[\alpha]_D^{25.5}$ +49.9° (c=1.22 $CHCl_3$), UV λ_{max}^{EtOH} 217 mμ (ε=15000), IR (KBr) 3580—3530 (OH), 1730, 1620, 1230 (unsaturated five membered lactone and alcoholic acetate), were established to be periplogenin (VIa) and its monoacetate[14] (VIb) by the mixed fusion, TLC and IR spectra comparing with authentic samples which were kindly given us from Prof. T. Reichstein.

The minor product, P-VII, $C_{21}H_{30}O_5$, mp 239°, colorless needles (from AcOEt), IR (KBr) 3400, 1730, 1165 cm^{-1} was obtained in poor yield. The elucidation of the chemical structure is now in progress.

It is very interesting that Δ^5-pregnene-3β,20α-diol, Δ^5-pregnene-3β,17α,20α-triol and Δ^5-pregnene-3β,16α,20α-triol which have been known so far as animal metabolites, have now been isolated from plant.

It is of interest to note from the biogenetical view point the occurrence of cardiac glycoside and glycosides of hydroxypregnene derivatives in the same plant.

It would not be so unreasonable to assume that these steroidal substances are responsible for the tonic effect of this crude drug, and the pharmacological investigation is now being carried out.

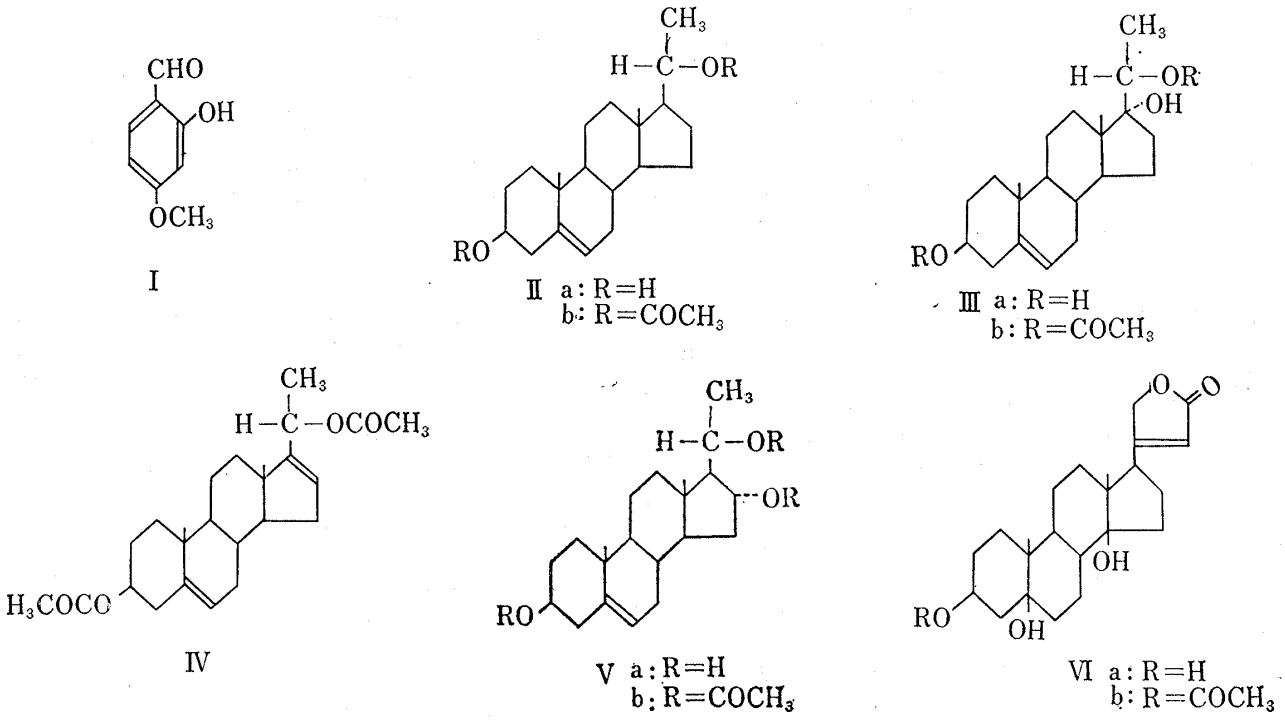

Chart 2

13) *a*) H. Hirschmann and F.B. Hirschmann, *J. Clin. Invest.*, **44**, 159 (1965). *b*) H. Hirschmann, F. B. Hirschmann, and M. A. Daus, *J. Am. Chem. Soc.*, **74**, 539 (1952). *c*) K.I.H. Williams, M. Smulowitz, and D.K. Fukushima, *J. Org. Chem.*, **28**, 2101 (1963).

14) *a*) E. Ruppol and I. Irukovic, *J. Pharm. Belg.*, **10**, 221 (1955). *b*) P. Brauchli, O. Schindler, and T. Reichstein, *Helv. Chim. Acta*, **44**, 904 (1961).

Experimental

All melting points were determined on Yanagimoto Micro Melting point apparatus and uncorrected. Ultraviolet absorption spectra were taken with Hitachi Recording Spectrophotometer, EPS-3, and Infrared absorption spectra were measured with Japan Spectroscopic Co., Ltd., model DS-402-G. Nuclear magnetic resonance spectra were measured with Japan Electron Co. J.N.M. C-60 spectrometer. Gas chromatograph used was Shimadzu gas chromatograph Model GC-1B with hydrogen flame ionization detector.

Extraction from "Pei-wujiapi"——Three kg of "Pei-wujiapi" which was imported from China was extracted with 30 liter of hot EtOH. After evaporation of the solvent under a reduced pressure, 800 g of the syrupy brown residue was obtained and dissolved in 8 liter of water and extracted with 24 liter of benzene. The benzene layer (85 g as a powder) was washed with 20 liter of 2N NaOH (Fr. I) (50.1 g) and then with 20 liter of 2N HCl (Fr. II) (0.9 g), and the benzene-soluble neutral fraction (Fr. III) (34 g) was obtained. The above water layer which contained the benzene insoluble fraction was extracted with 24 liter of *n*-BuOH saturated with water (Fr IV). From this crude glycoside fraction 104 g of powder was obtained which gave positive Liebermann-Burchard reaction, $SbCl_3$ reaction and $NaIO_4$-benzidine reaction.

Isolation of 4-Methoxysalicylaldehyde (I)——From Fr. I 4-methoxysalicylaldehyde was obtained by steam distillation. The distillate was crystallized from 20% EtOH to give colorless leaflets, mp 41°, *Anal.* Calcd. for $C_8H_8O_3$: C, 63.13; H, 5.30. Found: C, 63.19; H, 5.30. The oxime was obtained as colorless leaflets (from H_2O), mp 139°. (I), which were identified with authentic specimens by TLC, mixed fusion, and IR. The identity of (I) with 4-methoxysalicylaldehde was also proved by GLC (TMS derivs.) (1.5% SE 30 on Gaschrom-P & 1% NGS on Anakrom; 150 cm, column temp. 145°, detect temp. 200°, sample temp. 170°. N_2 gas 90 ml/min, H_2 gas 126 ml/min, air 1.3 ml/min. t_R, SE 30, 2.8 min; NGS, 3.9 min).

Detection of β-Sitosterol and Isolation of β-Sitosterol-β-D-glucoside——Fr. III was treated with petroleum ether. The soluble fraction was submitted to column chromatography of silica gel and eluted with benzene containing 5% MeOH. β-Sitosterol was proved in comparison with authentic specimen by GLC (column, 1.5% SE 30 on Gaschrom-P, 150 cm, column temp. 235°, detect temp. 280°, sample temp. 290. N_2 gas 90 ml/min, H_2 gas 126 ml/min, air gas 1.3 ml/min, t_R, 15 min).

On the other hand, from the insoluble fraction in petroleum ether β-sitosterol-β-D-glucoside was isolated by the column chromatography of silica gel eluting with AcOEt saturated with H_2O involving 10% MeOH and crystallized from $CHCl_3$-MeOH to needles, mp 299—300°, $[\alpha]_D^{24}$ −38.0° (c=0.73 in pyridine), *Anal.* Calcd. for $C_{35}H_{60}O_6 \cdot \frac{1}{2}H_2O$: C, 71.75; H, 10.49. Found: C, 71.80; H, 10.38. The identity with authentic specimen was proved by comparison with its acetate by mixed mp and TLC.

Acid Hydrolysis of (Fr. IV)——One hundred and forty g of Fr. IV was dissolved in 520 ml of MeOH, being refluxed for 30 min with 520 ml of 0.1N H_2SO_4 on a water bath. Methanol was evaporated *in vacuo* at room temperature and the residue was extracted with $CHCl_3$. The chloroform layer was washed with water, and dried over anhyd. Na_2SO_4. Removal of the solvent gave 14 g of a powder. Thin-layer chromatogram on silica gel plate which was developed by solvent A (AcOEt), and solvent B ($CHCl_3$:MeOH(95:5)) showed by spraying 10% H_2SO_4 more than fourteen spots.

Separation of the Aglycones by Column Chromatography——Fourteen g of the $CHCl_3$ extract obtained by the acid hydrolysis of Fr. IV was submitted to column chromatography over 280 g of silica gel and developed with AcOEt. The eluate was rechromatographed and recrystallized to isolate the five substances.

P-V (Δ5-Pregnene-3β,20α-diol) (IIa)——P-V was recrystallized from AcOEt to colorless leaflets, mp 182°, $[\alpha]_D^{32}$ −55.5° (c=1.44 $CHCl_3$). *Anal.* Calcd. for $C_{21}H_{34}O_2 \cdot \frac{1}{2}H_2O$: C, 77.01; H, 10.77. Found: C, 77.12; H, 10.32. IR ν_{max}^{KBr} cm^{-1}: 3500—3300. UV λ_{max}^{EtOH} mμ 210. NMR $\delta_{TMS}^{CDCl_3}$: 0.67 3H (s), 1.06 3H (s), 1.22 3H (d), 2.28 2H (d), 3.50 2H (m), 5.36 1H (tri). P-V 25 mg was dissolved in 1 ml of pyridine, and 1 ml of Ac_2O was added and allowed to stand for 48 hr at room temperature. The product was worked up as usual and recrystallized from AcOEt to obtain colorless leaflets, mp 146°, $[\alpha]_D^{32}$ −55.3° (c=1.41 $CHCl_3$). *Anal.* Calcd. for $C_{25}H_{38}O_4$: C, 74.59; H, 9.51. Found: C, 74.91; H, 9.36. IR ν_{max}^{KBr} cm^{-1}: 1730, 1250. NMR $\delta_{TMS}^{CDCl_3}$: 0.69 3H (s), 1.06 3H (s), 1.22 3H (d), 2.00 3H (s), 2.02 3H (s), 2.30 2H (d), 4.60 1H (m), 4.90 1H (tri), 5.36 1H (tri).

P-V was identified as Δ5-pregnene-3β,20α-diol (IIa) and P-V diacetate was as Δ5-pregnene-3β,20α-diol diacetate (IIb) by comparing with the authentic sample by mixed mp, TCL and IR spectra.

P-VI (Δ5 -Pregnene-3β,17α,20α-triol) (IIIa)——P-VI was recrystallized from EtOH and AcOEt to colorless needles, mp 230°. $[\alpha]_D^{31}$ −69.2° (c=0.56 EtOH). *Anal.* Calcd. for $C_{21}H_{34}O_3$: C, 75.40; H, 10.25. Found: C, 75.05; H, 10.27. IR ν_{max}^{KBr} cm^{-1}: 3600—3300. UV λ_{max}^{EtOH} mμ<210. NMR $\delta_{TMS}^{CDCl_3}$: 0.75 3H (s), 1.02 3H (s), 1.20 3H (d), 1.59 3H (s), 2.27 2H (d), 3.60 1H (m), 3.85 1H (q), 5.37 1H (d). P-VI was acetylated by Ac_2O in pyridine for 48 hr at room temperature and worked up by usual method. The product was recrystallized from AcOEt to a bundle of needles, mp 210°, $[\alpha]_D^{31.5}$ −72.0° (c=0.67 EtOH), *Anal.* Calcd. for $C_{25}H_{38}O_5$: C, 71.74; H, 9.15. Found: C, 71.75; H, 9.08. IR ν_{max}^{KBr} cm^{-1}: 3600, 1730, 1245. UV λ_{max}^{EtOH} mμ<210. NMR $\delta_{TMS}^{CDCl_3}$: 0.76 3H (s), 1.01 3H (s), 1.21 3H (d), 1.60 1H (s), 2.02 3H (s), 2.03 3H (s), 2.30 2H (d), 4.56 1H (m), 5.10 1H (q), 5.38 1H (d).

Dehydration of P-VI Diacetate——The hundred mg of P-VI diacetate was dissolved in 1 ml of pyridine and added at −10° 0.1 ml of $SOCl_2$ which was freshly distilled, and the mixture was allowed to stand for 20 hr at 0°. The solution was poured into ice–water and extracted with $CHCl_3$. The chloroform solution was washed with water and dired over anhyd. Na_2SO_4, and concentrated to dryness under a reduced pressure. The residue was crystallized from MeOH to colorless needles, mp 138°, *Anal.* Calcd. for $C_{25}H_{36}O_4$: C, 74.96; H, 9.06. Found: C, 74.95; H, 9.04. IR ν_{max}^{KBr} cm^{-1}: 1730, 1245.

From these facts P-VI was identified as Δ^5–pregnene–3β,17α,20α–triol, P-VI diacetate was as Δ^5–pregnene–3β,17α,20α–triol–3,20–diacetate (IIIb) and dehydro–P-VI diacetate was as $\Delta^{5\,16}$–pregnadiene–3β,20α–diol diacetate (IV) respectively by comparing with the authentic samples by mixed mp, TLC and IR spectra.

P-VIII (Δ^5-Pregnene-3β,16α,20α-triol) (Va)——P-VIII was recrystallized from AcOEt to colorless needles, mp 251°, $[\alpha]_D^{32}$ −65.0° (c=0.246 EtOH). *Anal.* Calcd. for $C_{21}H_{34}O_3$: C, 75.40; H, 10.25. Found: C, 75.42; H, 9.99. IR ν_{max}^{KBr} cm^{-1}: 3400—3200. NMR $\delta_{max}^{CDCl_3}$: 0.69 3H (s), 1.02 3H (s), 1.29 3H (d), 2.30 2H (d), 3.50 2H (m), 4.30 1H (m), 5.40 1H (tri). P-VIII was acetylated with Ac_2O in pyridine for 48 hr at room temperature and worked up as usual. The product was recrystallized from AcOEt to needles, mp 183°, $[\alpha]_D^{32}$ −97° (c=0.63 EtOH). *Anal.* Calcd. for $C_{27}H_{40}O_6$: C, 70.40; H, 8.70. Found: C, 70.71; H, 8.56. IR ν_{max}^{KBr} cm^{-1}: 1740, 1240. NMR $\delta_{TMS}^{CDCl_3}$: 0.72 3H (s), 1.02 3H (s), 1.23 3H (d), 1.95 3H (s), 2.02 6H (s), 2.30 2H (d), 4.60 1H (m), 5.00 1H (m), 5.10 1H (m), 5.20 1H (tri). P-VIII was identified as Δ^5–pregnene–3β, 16α,20α–triol, P-VIII diacetate was as Δ^5–pregnene–3β,16α, 20α–triol triacetate (Vb) by comparing with the authentic samples by mixed mp, TLC and IR spectra.

P-XI (Periplogenin) (VIa)——P-XI was recrystallized from AcOEt or MeOH to prisms, mp 238° (softens from 140°), $[\alpha]_D^{31.5}$ +27° (c=0.667 $CHCl_3$), *Anal.* Calcd. for $C_{23}H_{34}O_5$: C, 70.74; H, 8.78. Found: C, 70.93; H, 8.70. IR ν_{max}^{KBr} cm^{-1}: 3500—3350, 1736, 1632. UV λ_{max}^{EtOH} mμ: 217 (ε=15000). NMR $\delta_{TMS}^{CDCl_3}$: 0.87 3H (s), 0.93 3H (s), 3.27 3H (s), 4.15 1H (m), 4.90 2H (s), 5.84 1H (s). P-XI was acetylated with Ac_2O in pyridine at room temperature for 48 hr, and worked up as usual. The product was recrystallized from AcOEt to colorless prisms, mp 228°, $[\alpha]_D^{25.5}$ +49.9° (c=1.22 $CHCl_3$). *Anal.* Calcd. for $C_{25}H_{36}O_6$: C, 69.42; H, 8.39. Found: C, 69.79; H, 8.56. IR ν_{max}^{KBr} cm^{-1}: 3580, 3530, 1730, 1620, 1230. UV λ_{max}^{EtOH} mμ: 217 (ε=15000). NMR $\delta_{TMS}^{CDCl_3}$: 0.87 3H (s), 0.93 3H (s), 2.03 3H (s), 4.83 2H (s), 5.20 1H (m), 5.84 1H (s).

P-XI was identified as periplogenin and P-XI acetate was as periplogenin monoacetate (VIb) by mixed fusion, TLC and IR spectra with authentic samples.

P-VII——P-VII was recrystallized from AcOEt to colorless needles, mp 239°, $[\alpha]_D^{24}$ −46.5° (c=0.322 $CHCl_3$). IR ν_{max}^{KBr} cm^{-1}: 3400 (broad), 1730, 1165. UV λ_{max}^{EtOH} mμ<210. P-VII was acetylated with Ac_2O in pyridine for 48 hr at room temperature and worked up as usual. The product was recrystallized from AcOEt to needles, mp 199°. IR ν_{max}^{KBr} cm^{-1}: 3400, 1730, 1240, 1165.

Acknowledgement We are deeply grateful to Prof. T. Reichstein, Institut für Organische Chemie der Universität Basel, to Dr. G. Anner, CIBA Ltd., Basel, to Dr. D.K. Fukushima, Institute for Steroid Research, Montefiore Hospital and Medical Center, to Dr. H. Hirschmann, Department of Medicine, Lakeside Hospital, Western Reserve University, to Dr. W.R. Benn, G.D. SEARLE & Co., and to Dr. J. Okano, Daiichi Seiyaku Co., Ltd. for their kind supply of the authentic samples.

Thanks are also due to Dr. Y. Kawazoe, National Cancer Research Center Institute, Tokyo, to Dr. T. Hino, National Institute of Radiological Sciences for NMR Spectral measurement, to the members of Analytical Laboratory of the Faculty of Pharmaceutical Sciences, University of Tokyo for elemental analysis and IR spectra and to the members of Botanical Institute of Tokyo Metropolitan University for their kind suggestion about plant materials.