sodium bicarbonate solution, washed with water, and dried over magnesium sulfate. The filtrate was concentrated, diluted with ethyl acetate, and the product (VI), 45.5 mg., m.p. 148–151° dec., was crystallized from ethyl acetate–petroleum ether. The product was further purified by partition chromatography on a 20-g. Celite[18] diatomaceous earth column using a solvent system composed of water, methanol, dioxane, and cyclohexane in the volume ratio 2:2:6:10. This system gave an apparent separation into two fractions which were shown to be identical. The main fraction provided 17.5 mg. of VI, m.p. 154–155° dec., $[\alpha]^{25}_D$ +21.7° (chloroform). This product and a sample of VI prepared from 7α-methylthiotestosterone acetate (I) with monoperphthalic acid as described above, were identical by infrared absorption and paper chromatographic data. A mixture melting point showed no depression.

Anal. Calcd. for $C_{22}H_{32}O_5S$ (408.54): C, 64.67; H, 7.90. Found: C, 64.24; H, 8.12.

Acknowledgment. We wish to thank Dr. H. G. Arlt, Jr., and associates for the supply of 7α-methylthiotestosterone acetate, Mr. W. Fulmor and associates for the spectral and polarimetric determinations, Mr. L. M. Brancone and associates for microanalyses, Dr. M. J. Weiss and Mr. R. E. Schaub for samples of the two 7α-methylsulfinyltestosterone acetates (IV and V), and Mr. D. Munkelt for assistance with the column chromatography.

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Chemistry of *Aegiceras majus* Gaertn. IIb. Isolation of 28-Norolean-12,17-dien-3β-ol

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The isolation of genin-A and isorhamnetin from the bark of *Aegiceras majus* Gaertn (Syn. *A. corniculatum* Blanco) was reported earlier.[1] Herein is described the isolation of the first naturally occurring C_{29} triterpene alcohol[2] and its identification as 28-norolean-12,17-dien-3β-ol[3] (Ia) (norechinocystadienol[4]) by direct comparison[5] with an authentic specimen.

The dienol (Ia) was isolated by acid hydrolysis of the glycosides of the bark followed by chromatography of the neutral fraction and was purified *via* its benzoate derivative. It gave a pink color in the Liebermann-Burchard reaction and its analysis conformed to a molecular formula $C_{30}H_{48}O$ (± CH_2). It formed an acetate (Ib) and a benzoate and the nature of the oxygen function as hydroxyl was confirmed by their infrared spectra (*vide* experimental). Oxidation of the dienol with chromium trioxide-pyridine reagent[6] led to the dienone (Ic) which formed an oxime, gave a positive Zimmermann reaction[7] for 3-keto group and on sodium borohydride reduction furnished the dienol again.

The dienol developed a light brown color with tetranitromethane for unsaturation and had absorption maxima in the ultraviolet at 237 and 244 mμ for a conjugated heteroannular diene. Hydrogenation of the dienyl acetate (Ib) over platinum in acetic acid yielded a dihydro derivative which was identified as 28-norolean-17-en-3β-yl acetate[8] (IIb) by direct comparison[9] of the corresponding ketone (IIc) with an authentic sample.

EXPERIMENTAL[10]

Isolation of the dienol. Air-dried powdered bark (1.2 kg.) of *A. majus*[11] Gaertn was defatted with light petroleum and then extracted with 95% and 70% ethanol under reflux and the solvent removed. The residue was freed from non-glycosidic material by two precipitations of its solution in minimum amounts of 95% ethanol with large volumes of ether. The ether-insoluble glycosidic portion was heated under reflux for 4 hr. with aqueous ethanol (1:1, 1 l.) and concentrated hydrochloric acid (200 cc.). The aglycones were collected, washed, dried, and extracted with benzene in a Soxhlet apparatus for 30 hr. The residue from the benzene extract after removal of genin-A as described before[1] was chromatographed in benzene solution on alumina (300 g.). Elution with light petroleum-benzene (3:2) and subsequent crystallization of the residue from methanol, yielded the crude dienol (0.6 g.) as colorless needles, m.p. 170–178°.

28-Norolean-12,17-dien-3β-yl benzoate. The crude dienol (600 mg.) was benzoylated with benzoyl chloride (2 cc.) and pyridine (5 cc.) for 2 hr. at 100°. The reaction product was poured into water and isolated by means of ether. Two crystallizations of the residue (left on removal of ether) from benzene-ethanol yielded the dienyl benzoate as prisms, m.p. 229–231°, $[\alpha]_D$ +81° (*c*, 2.25); lit.,[3] m.p. 227–229°, $[\alpha]_D$ +81°; lit.,[4] m.p. 231–233°.

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(2) Referred to as aegiceradienol in our brief communication: Part IIa, K. V. Rao and P. K. Bose, *Science & Culture*, **24**, 486 (1959).

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(5) We are greatly indebted to Prof. C. R. Noller, Stanford University, Calif., for the mixed m.p. and infrared comparison of the benzoates.

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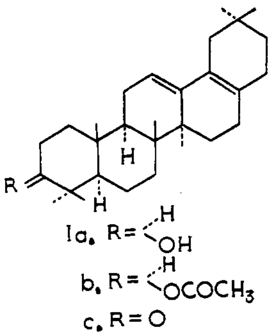
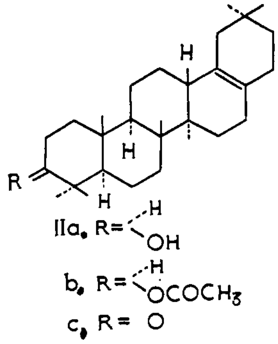
(9) We thank Prof. D. H. R. Barton, F.R.S., Imperial College, London, for the mixed m.p. determination.

(10) All melting points are uncorrected. Ultraviolet absorption spectra were done on a Beckman model DU quartz spectrophotometer in ethanol solution and optical rotations were determined in chloroform at room temperature. Light petroleum refers to fraction, b.p. 60–80°, and alumina used is of Brockmann's (E. Merck) grade. Samples for analysis were dried *in vacuo* over phosphorus pentoxide at 110° for 12 hr.

(11) The plant material was collected for us by the Divisional Forest Officer, 24 Parganas, West Bengal, to whom our thanks are due.





Anal. Calcd. for $C_{36}H_{50}O_2$: C, 84.0; H, 9.8. Found: C, 84.19; H, 10.02.

The infrared spectrum of a solid film included peaks at 1710 (benzoate), 1625 (aromatic band), and 710 cm.$^{-1}$ (unsubstituted phenyl).

28-Norolean-12,17-dien-3β-ol (Ia). The dienyl benzoate (400 mg.) was refluxed for 4 hr. with alcoholic potassium hydroxide (50 cc.; 5%). Dilution with water and extraction by means of ether furnished the analytical sample of the dienol (Ia) which crystallized from chloroform-methanol as needles, m.p. 185–188°, $[\alpha]_D$ +74° (*c*, 0.83); lit.,[3] m.p. 189–191°, $[\alpha]_D$ +79°; lit.,[4] m.p. 192–195°, $[\alpha]_D$ +82° (dioxan). The compound developed a pink color in the Liebermann-Burchard test and a pale brown color with tetranitromethane in chloroform solution.

Anal. Calcd. for $C_{29}H_{46}O$: C, 84.8; H, 11.3. Found: C, 84.42; H, 11.22.

In chloroform solution, Ia had absorption bands at 3630 (OH) 1030 and 995 (other bands for hydroxyl) and 1365 and 1385 cm.$^{-1}$ (*gem*-dimethyl). Ia remained unaffected when its chloroform solution was saturated with dry hydrogen chloride gas at 0° for 3 hr.

28-Norolean-12,17-dien-3β-yl acetate (Ib). The dienol (Ia, 250 mg.), acetic anhydride, and pyridine (3 cc. each) were kept on the steam bath for 3 hr. Addition of water to the cold solution gave the dienyl acetate (Ib) crystallizing from ethyl acetate–methanol as needles, m.p. 187–188°, $[\alpha]_D$ +62° (*c*, 0.84); lit.,[3] m.p. 187–188°, $[\alpha]_D$ +66°.

Anal. Calcd. for $C_{31}H_{48}O_2$: C, 82.05; H, 10.65. Found: C, 82.24; H, 10.58.

Ib had λ_{max} at 237 and 244 mμ (log ϵ, 4.25 and 4.18, respectively). The infrared spectrum of this compound had absorption maxima at 1725 (acetate) and 1370 and 1250 cm.$^{-1}$ (other acetate bands).

Ib reacted with 2.48 moles of chloroformic perbenzoic acid in 24 hr. It was recovered unchanged when left with osmium tetroxide in dry pyridine at room temperature for 4 days.

28-Norolean-12,17-dien-3-one (Ic). A solution of the dienol (Ia, 500 mg.) in pyridine (10 cc.) was treated at 0° with a suspension of chromium trioxide (200 mg.) in pyridine (10 cc.) and the mixture left at room temperature for 16 hr. After adding much water, the material was extracted with ether. The ether solution was washed well with dilute hydrochloric acid, water, dried, and evaporated to yield a yellow gum. Chromatography of a benzene solution over alumina (30 g.) and elution with light petroleum gave the dienone (Ic) crystallizing from methanol as microcrystalline needles, m.p. 121–123°, $[\alpha]_D$ +114° (*c*, 0.73).

Anal. Calcd. for $C_{29}H_{44}O$: C, 85.29; H, 10.78. Found: C, 85.23; H, 10.78.

The compound developed a pink color in the Zimmermann test[7] with *m*-dinitrobenzene and alcoholic potash.

In ethanol, Ic had λ_{max} at 236 and 243 mμ (log ϵ, 4.23 and 4.30, respectively) and 292 mμ (log ϵ, 1.8). In chloroform solution this compound absorbed at 1702 (C=O) and 1456 cm.$^{-1}$ (adjacent methylene group).

The *oxime* of Ic was prepared by heating Ic (50 mg.) with hydroxylamine hydrochloride (100 mg.), pyridine (5 cc.), and absolute ethanol (1 cc.) on the steam bath for 2 hr. The solution was poured into water and the product was collected and crystalliz3d from ethyl acetate–methanol; prisms, m.p. 215° (decomp.).

Anal. Calcd. for $C_{29}H_{45}ON$: N, 3.3. Found: N, 3.45.

Sodium borohydride reduction of 28-norolean-12,17-dien-3-one (Ic). A solution of the dienone (Ic, 100 mg.) in dioxan (10 cc.) was treated with sodium borohydride (50 mg.) in aqueous dioxan (1:1; 10 cc.). After keeping for 10 hr. at room temperature, the reaction mixture was poured into excess of dilute hydrochloric acid and extracted with ether. Crystallization of the ether-soluble part from methanol yielded the dienol (Ia), m.p. and mixed m.p. 183–185°.

28-Norolean-17-en-3β-yl acetate (IIb). Adam's platinum oxide catalyst (200 mg.) in glacial acetic acid (20 cc.) was saturated with hydrogen and then shaken with a solution of the dienyl acetate (Ib, 450 mg.) in acetic acid (40 cc.) in an atmosphere of hydrogen (at 30°; 754 mm.). The reaction was complete in 10 min. and a total of 26 cc. of hydrogen at N.T.P. was taken up (theoretical for one double bond 24.8 cc.). The solution was filtered to remove the catalyst, diluted with water, and the residue collected. Crystallization from chloroform-methanol gave IIb as shining flakes, m.p. 204–206°, $[\alpha]_D$ +43° (*c*, 1.9); lit.,[8] m.p. 201–204°, $[\alpha]_D$ +47°.

Anal. Calcd. for $C_{31}H_{50}O_2$: C, 81.93; H, 11.0. Found: C, 81.63; H, 10.92.

The compound developed a yellow color with tetranitromethane in chloroform. In ethanol, IIb exhibited no selective absorption above 215 mμ.

28-Norolean-17-en-3β-ol (IIa). A solution of IIb (300 mg.) in ethanol (75 cc.) was refluxed for 3 hr. with potassium hydroxide (3 g.). The reaction mixture was poured into excess of water and the precipitated solid collected and crystallized from chloroform-methanol; shining plates of IIa, m.p. 224–226°, $[\alpha]_D$ +53° (*c*, 0.96); lit.,[8] m.p. 221–224°, $[\alpha]_D$ +56°.

Anal. Calcd. for $C_{29}H_{48}O$: C, 84.46; H, 11.64. Found: C, 84.34; H, 11.44.

28-Norolean-17-en-3-one (IIc). A solution of IIa (150 mg.) in pyridine (5 cc.) was oxidized with chromium trioxide (150 mg.) in pyridine (7 cc.) and the product was worked up as described for Ic. The resultant gum on chromatography over alumina and crystallization from methanol furnished IIc as microcrystalline needles, m.p. 176–178°, $[\alpha]_D$ +94° (*c*, 0.47); lit.,[8] m.p. 174–176°, $[\alpha]$ +96°.

Anal. Calcd. for $C_{29}H_{46}O$: C, 84.8; H, 11.3. Found: C, 84.76; H, 11.18.

Acknowledgment. The authors wish to thank Dr. D. M. Bose, Director, Bose Institute, Calcutta, for his interest in the work and encouragement, Mrs. C. Dutta, University College of Science, Calcutta, for the microanalyses and Prof. T. R. Govindachari, Presidency College, Madras, for the infrared spectra.

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Hawaiian Plant Studies. VIII.[1] Isolation of Chelerythrine and Dihydrochelerythrine from *Fagara semiarticulata*

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Fagara semiarticulata is an endemic Hawaiian rutaceous shrub. Its range is confined to the Koolau mountains on the island of Oahu and it was found to be rich in alkaloids.[2] The hexane extract of the root and trunk bark gave a positive test with Mayer's reagent; after removal of waxy material and of two neutral solids it was treated with 2% hydrochloric acid. A mixture of yellow salts formed at the interface during the extraction. The two major components of this mixture were identified as chelerythrine and dihydrochelerythrine chlorides.

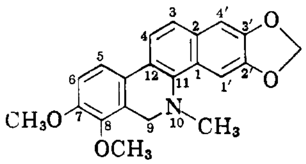
The free dihydro base could be isolated by dissolving and filtering the hot aqueous solution of chlorides. The weak dihydro base was hydrolyzed under these conditions and precipitated. It was recrystallized from methanol as colorless platelets, m.p. 161–165°. Addition of dilute nitric acid to the aqueous filtrate precipitated chelerythrine nitrate as a yellow amorphous solid. It was purified by crystallization from dilute nitric acid and absolute ethanol, m.p. 240°. Zinc-hydrochloric acid reduction of chelerythrine nitrate furnished dihydrochelerythrine, m.p. 160–162°, identical with the compound isolated from the plant. The dihydro plant base in turn, could be oxidized with mercuric acetate and the nitrate of the oxidation product was identical with our chelerythrine nitrate.

Analytical and ultraviolet spectral data indicated that the principal base was a naphthaphenanthridine alkaloid and its identity with chelerythrine was established as follows. A 9-ethyl ether of the free base, m.p. 239–242°, could be prepared by shaking a suspension of the nitrate in chloroform with ammonia and crystallizing the crude base from ethanol; and a pseudocyanide, m.p. 229–233°, by treatment of the free base in a solution of chloroform and methanol with aqueous potassium cyanide. Preparation of the 9-oxo compound, which is reported to proceed with ease in the case of chelerythrine[3] as well as sanguinarine,[4] was finally achieved, albeit in small yield, by heating at elevated temperature with alkaline ferricyanide, m.p. 199–201°.

The dioxymethylene ring of the dihydro base was cleaved with aluminum chloride in boiling benzene. The crude phenolic product upon treatment with diazomethane and purification yielded a product, m.p. 183–186°, in good agreement with the reported melting point range[5] of 182–192° for 7,8,2′,3′-tetramethoxy-9,10-dihydro-10-methyl-1,2-benzophenanthridine.

Finally, pyrolysis of our chelerythrine nitrate or chloride *in vacuo* furnished an *N*-norbase, m.p. 221–222°, which had an ultraviolet spectrum and Rf-value identical with those reported in the literature[6] for *N*-norchelerythrine. Mixture melting point of our norbase and an authentic sample obtained from Bailey[7] was undepressed.

Chelerythrine is of rather widespread occurrence in *Papaveraceae*.[8] It has been isolated as a minor constituent of several rutaceous plants, *Xanthoxylum rhetsa*,[9] *Zanthoxylum brachyacanthum*,[10] *Z. veneficum*[10] and *Toddalia aculeata*.[3] To our knowledge, this is the first instance of the isolation of dihydrochelerythrine. (I).



I

EXPERIMENTAL [11]

Isolation of chelerythrine nitrate and dihydrochelerythrine. The dried and ground bark (15.3 kg.) of the shrub *Fagara semiarticulata* was thoroughly extracted with hexane (9 l.,

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[11] All melting points were determined on a Kofler hot stage and are uncorrected. Infrared spectra were taken in potassium bromide on a Beckman IR-5 double-beam instrument. Analyses were performed by Dr. A. Bernhardt, Mülheim, Germany. All paper chromatograms were run on Whatman #1 paper in a system of n-butanol:water:acetic acid/63:27:10 by volume, which was equilibrated at room temperature for 48 hr. before use. The spots were visualized under long wave length ultraviolet light.