taken up in ethyl acetate, washed with dilute sodium carbonate, dried (K_2CO_3), filtered, and concentrated to dryness to leave a crystalline residue (8.5 g), which was recrystallized from ethyl acetate–*n*-hexane to give 5.3 g (43%) of the (−) isomer: mp 84.0–85.5°; $[\alpha]^{25}D$ −49.5° (*c* 2.0, 95% ethanol). This material was purified for analysis through its oxalate salt to give pure (−)-ethyl 6,7-dimethoxy-1,2,3,4-tetrahydro-1-isoquinolineacetate (3.5 g): mp 86.0–87.0°; $[\alpha]^{25}D$ −51.0° (*c* 1.88, 95% ethanol) [lit.[6] $[\alpha]D$ −26.9° (ethanol)]; oxalate salt, mp 169.5–171.0°, $[\alpha]^{25}D$ −36.4° (*c* 1.64, water).

Anal. Calcd for $C_{15}H_{21}NO_4$: C, 64.49; H, 7.58; N, 5.01. Found: C, 64.64; H, 7.55; N, 5.14.

Resolution of (±)-6,7-Dimethoxy-1-β-hydroxyethyl-2-methyl-1,2,3,4-tetrahydroisoquinoline (V).—A warm solution of (±)-6,7-dimethoxy-1-β-hydroxyethyl-2-methyl-1,2,3,4-tetrahydroisoquinoline[12] (73.1 g, 0.292 mol) in 375 ml of 95% ethanol was treated with a warm solution of (2*R*:3*R*)-2′-nitrotartranilic acid (39.4 g, 0.146 mol) in 375 ml of 95% ethanol. After cooling the mixture at 5° for 20 hr, the crystals were collected (75.9 g) and recrystallized from 750 ml of 80% ethanol to give the pure (2*R*:3*R*)-2′-nitrotartranilic acid salt of (−)-6,7-dimethoxy-1-β-hydroxyethyl-2-methyl-1,2,3,4-tetrahydroisoquinoline[13] (69.8 g, 92%), mp 193.5–195.5°.

The above crystalline salt was decomposed with dilute sodium carbonate and extracted with ethyl acetate. Drying (Na_2SO_4) and concentration of the ethyl acetate extracts gave an oil (30 g) which was converted into its crystalline hydrochloride with concentrated hydrochloric acid (10 ml) in 2-propanol. Recrystallization from absolute ethanol yielded pure (+)-6,7-dimethoxy-1-β-hydroxyethyl-2-methyl-1,2,3,4-tetrahydroisoquinoline hydrochloride[13] (25.3 g, 60.5%): mp 177–180°; $[\alpha]^{25}D$ +22.7° (*c* 2.05, chloroform).

Anal. Calcd for $C_{14}H_{21}NO_3 \cdot HCl$: C, 58.43; H, 7.71; N, 4.87. Found: C, 58.67; H, 7.81; N, 4.63.

The mother liquor from the (2*R*:3*R*)-2′-nitrotartranilic acid salt formation was treated with an additional 1.0 g of (2*R*:3*R*)-2′-nitrotartranilic acid and concentrated to dryness. The resultant oil was taken up in ethyl acetate, filtered, washed with dilute sodium carbonate, dried (Na_2SO_4), and concentrated to dryness to leave an oil (33.6 g) which was converted into its hydrochloride in acetone with anhydrous hydrogen chloride. Recrystallization from 95% ethanol yielded pure (−)-6,7-dimethoxy-1-β-hydroxyethyl-2-methyl-1,2,3,4-tetrahydroisoquinoline hydrochloride (24.4 g, 58%): mp 177–179°; $[\alpha]^{25}D$ −22.8 (*c* 2.02, chloroform).

Anal. Calcd for $C_{14}H_{21}NO_3 \cdot HCl$: C, 58.43; H, 7.71; N, 4.87. Found: C, 58.41; H, 7.81; N, 4.67.

Registry No.—III-1, 17447-32-4; III-2, 17447-33-5; III-3, 17477-86-0; III-4, 17447-34-6; III-5, 17447-35-7; III-6, 17447-36-8; III-7, 17447-37-9; III-8, 17447-38-0; III-9, 17447-39-1; III-10, 17447-40-4; III-11, 17447-41-5; III-12, 17447-49-3; (+) IV, 17447-42-6; (+) IV [(2*R*:3*R*)-2′-nitrotartranilic acid salt], 17447-43-7; (+) IV (oxalate), 17447-44-8; (−) IV, 17447-45-9; (−) IV (oxalate), 17447-46-0; (−) V [(2*R*:3*R*)-2′-nitrotartranilic acid salt], 17477-87-1; (+) V hydrochloride, 17447-47-1; (−) V hydrochloride, 17447-48-2.

(12) The synthesis of this material will be described in a later paper.

(13) The rotation of the free base of this isomer is (−) in chloroform. The hydrochloride of this isomer rotates (+) in 95% ethanol.

24ξ-Methyl-9,19-cyclolanostan-3β-yl Palmitate. A New Liquid Crystal

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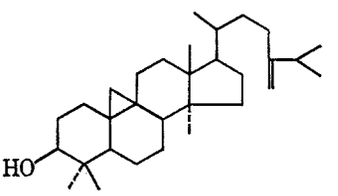
Since the work of Reinitzer[2] many examples of "liquid crystals" have been described. Friedel concluded that there were three classes of such substances, one of which displayed some rather unique optical properties.[3] Upon melting, these latter substances refracted light while passing from the crystalline to the isotropic liquid state. As an example, cholesteryl laurate was found to turn a violet color when melted.[4] Since a great majority of compounds behaving in this manner were esters of cholesterol, they were referred to as exhibiting a cholesteric phase. This phenomenon has not yet been observed with fatty acid esters of phytosterols. Gray, in collaboration with Kuksis and Beveridge, was unable to detect any cholesteric mesophase with β-sitosteryl laurate or myristate.[5]

During the course of identification of the sterol and triterpene constituents of banana peel we had occasion to examine the large ester fraction isolated from this tissue.[6] The major component of this fraction was purified by alumina column chromatography and crystallization from several solvents. The dihydro derivative was prepared by catalytic reduction. Upon melting this reduced form of the ester, a deep violet color was observed, indicative of a cholesteric phase. This was confirmed by a rather spectacular birefringence pattern in a Nalge–Axelrod apparatus. A cholesteric–isotropic transition temperature of 64° was determined. This effect was more noticeable upon cooling back to the melting point.

The naturally occurring ester was saponified, and a single component was isolated from the nonsaponifiable fraction, subsequently identified as 24-methylene cycloartanol, I (24-methylene-9,10-cyclolanostan-3β-ol).[7]



I

The saponifiable fraction contained only palmitic acid. The synthetic ester was prepared by esterification of I with palmitoyl chloride. The synthetic ester cochromatographed with the naturally occurring ester in several tlc systems. The ir spectra were essentially superimposable. The dihydro form of the synthetic ester also exhibited the violet color upon melting and displayed the same cholesteric–isotropic transition temperature.

The fact that the reduced form of this ester (24ξ-methyl-9,19-cyclolanostan-3β-yl palmitate) displays a color phenomenon associated with a cholesteric phase suggests a stereochemically controlled process. Steric effects have been correlated with nematic behavior.[8] Gray has pointed out that substituents that increase molecular breadth decrease the thermal stability of the paracrystalline state, and thus a mesomorphic effect

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(3) G. Friedel, *Ann. Phys.*, **18**, 273 (1922).

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may not be observed. Little work has been done in this area with respect to cholesteric crystals. It is known, however, that the orientation of the 3-hydroxyl group in various sterols determines whether or not a cholesteric mesophase will occur.[9] Because of this, cholesterol (choles-5-en-3β-ol) fatty acid esters display a cholesteric phase while epicholesterol (cholest-5-en-3α-ol) esters do not. In general, one requirement for mesomorphism is a long, linear molecule.

In the present case a similar requirement, involving the side chain, seems to be operating. It would seem that the steric strain imposed by the C-24 methylene group in I would contribute negligibly to the total degrees of freedom of the alkyl side chain. The results of the present study, however, seem to indicate that reduction of this double bond relieves a certain amount of strain. The side chain can thus assume a more favorable conformation such that the molecules can align themselves in a cholesteric mesophase. It is interesting, however, that the hydrochloride of this ester does not exhibit a cholesteric mesophase. This would further suggest a steric phenomenon.

Experimental Section

General.—Optical rotations were determined in chloroform solution in a 5-cm cell using a Model 200-S Rudolph photoelectric polarimeter. Melting points were determined in capillary tubes using a Thomas–Hoover Uni-Melt apparatus. Phase transitions were detected using a Nalge–Axelrod hot-stage polarizing microscope. Infrared spectra were recorded on a Perkin–Elmer Model 21 double-beam spectrophotometer in chloroform solution. Only selected high-intensity bands are usually given. The gas–liquid partition chromatographic analyses (glpc) were obtained using a Barber–Coleman Model 5000 instrument. Mass spectra were determined using a LKB Model 9000 single focusing instrument. Nuclear magnetic resonance spectra (nmr) were determined in carbon tetrachloride solution using a Varian Model 60 instrument. Thin layer chromatography (tlc) was carried out using silica gel G spread 250 μ thick on glass plates.

Isolation and Identification of 24-Methylene Cycloartanol Palmitate.—The total ethanol extract of dried banana peels was evaporated to low volume, an equal volume of water added, and KOH added to a final concentration of 15%. Saponification was performed by 2-hr reflux. After dilution with water the saponification mixture was extracted with three volumes of ethyl ether. The ether layer was washed with water and evaporated to yield a red, viscous oil. In a typical preparation 4.5 kg of dried banana peels yielded 361 g of nonsaponifiable material by this procedure. The nonsaponifiable residue was then chromatographed on Merck acid-washed alumina. A ratio of at least 20:1 of adsorbant to nonsaponifiable material was always used. The large ester fraction (representing approximately 30% of the total nonsaponifiable material) was eluted from such a column with petroleum ether (bp 30–60°). The fact that esterified material was found in the nonsaponifiable fraction was evidently due to the insolubility of these esters in the saponification mixture.

One major component was indicated in this fraction by tlc in a solvent system containing hexane–tetrahydronaphthalene, 75:25 (v/v). This material was further purified by rechromatography on alumina. Crystallization from acetone, ethyl acetate–ethanol, or petroleum ether–ethanol yielded an amorphous white solid, mp 53–54°; $[\alpha]^{26}D$ +38.2°. The ir spectrum had bands at 1732 (ester >C=O) and 1640 and 882 cm^{-1} (>C=CH_2). A sample of 125 mg of this material was dissolved in 25 ml of ethyl acetate; 24 mg of platinum oxide added; and the ester was reduced by shaking overnight at 40 psi of hydrogen. The product was obtained in the usual manner and crystallized from acetone to give a white solid, mp 61–62°, $[\alpha]^{26}D$ +37.1°. The vinyl bands were no longer present in the ir spectrum. At its melting point this dihydro derivative turned a dark violet color. The birefringence pattern was purple with the polaroids of the Nalge–Axelrod apparatus crossed at 90°. A cholesteric–isotropic transition temperature of 64° was determined. This phenomenon was reproducible upon heating and cooling. After treatment in this manner no decomposition products were detected by tlc.

A 6-g sample of the naturally occurring ester was dissolved in 70 ml of anhydrous ether. Dry HCl gas was passed through the solution for 5 hr. The product was crystallized from chloroform–methanol to give fine scales, mp 79.5–80.5°, $[\alpha]^{26}D$ +42.8°. *Anal.* Calcd for $C_{47}H_{83}O_2Cl$: Cl, 4.95. Found: Cl, 4.15. No cholestric–isotropic transition temperature was detected upon melting this sample. This presumably represents an HCl addition product at C-24.

The naturally occurring ester was saponified in benzene–ethanol–water, 10:80:10 (v/v/v), containing 15% KOH. This mixture was required for maximal solubility of the ester. The nonsaponifiable fraction was obtained in the usual manner. A single component was indicated by tlc in a system containing trimethylpentane–ethyl acetate–acetic acid, 80:40:0.4 (v/v/v), with an R_f of 0.62 (4,4-dimethylsterol region). Crystallization of this material from acetone or ethanol gave fine needles, mp 116–118°, $[\alpha]^{26}D$ +45.9°. The ir spectrum had bands at 3600 (—OH), 3050 (shoulder, cyclopropane ring), 1639 and 887 cm^{-1} (>C=CH_2). Likewise, the nmr spectrum showed the presence of vinylic protons at τ 5.34. This substance had the same retention time as an authentic sample of I by glpc analysis using several different columns (SE-30, 1%; XE-60 1%; QF-1, 3%; OV-1, 1%). The mass spectrum was also identical with that obtained for I with a molecular ion at *m/e* 440 and other peaks at *m/e* 425 (M − CH_3), 442 (M − HOH), 407 (M − CH_3 − HOH), 379, 353, 313, 300 (M − ring A), and 297 (M − side chain − HOH).

The aqueous layer from the saponification mixture was acidified to pH 1 with concentrated hydrochloric acid. Extraction with ethyl ether followed by several water washes of the organic layer yielded a white solid upon evaporation of the solvent. Crystallization of this substance from acetone gave flakes, mp 62–64°, with no rotation in chloroform. The ir spectrum as well as the tlc behavior of this material in several solvent systems was the same as that obtained for palmitic acid. A sample of 2 mg of this material was treated overnight with 5 ml of boron trifluoride–methanol. The methyl ester obtained had the same retention time on several columns as methyl palmitate.

Synthesis of 24-Methylene Cycloartanol Palmitate.—The synthetic ester was prepared by 2-hr reflux of 200 mg of I and 150 mg of palmitoyl chloride (Fisher, 95% purity) in 10 ml of pyridine and 90 ml of anhydrous benzene. The reaction mixture was diluted with 100 ml of water and extracted with three 200-ml portions of ethyl ether. The ether layer was washed with water and evaporated to yield a white solid. This material was dissolved in a small amount of petroleum ether and passed through an alumina column. The ester was eluted with benzene. In this manner contaminating palmitic acid remained on the column. The ester fractions were pooled and crystallized from acetone to give an amorphous white solid, mp 57–59°, $[\alpha]^{26}D$ +37.5°. The dihydro derivative was prepared in the same manner as before. Crystallization of the product from acetone gave an amorphous white solid, mp 64–65°, $[\alpha]^{26}D$ +35.1°. This substance likewise turned a deep violet color upon melting. It was found to be mesomorphic using the Nalge–Axelrod apparatus, with a cholesteric–isotropic transition temperature of 62.5°.

Registry No.—I, 1449-09-8; I palmitate, 17478-48-7; I palmitate hydrochloride, 17478-40-9; 24ξ-methyl-9,19-cycloanostan-3β-yl palmitate, 17478-39-6.

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