124. Sterols with Cyclopropane-Containing Side Chains: Synthesis and Acid Isomerization

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Dedicated to Professor *A. S. Dreiding* on the occasion of his 60th birthday

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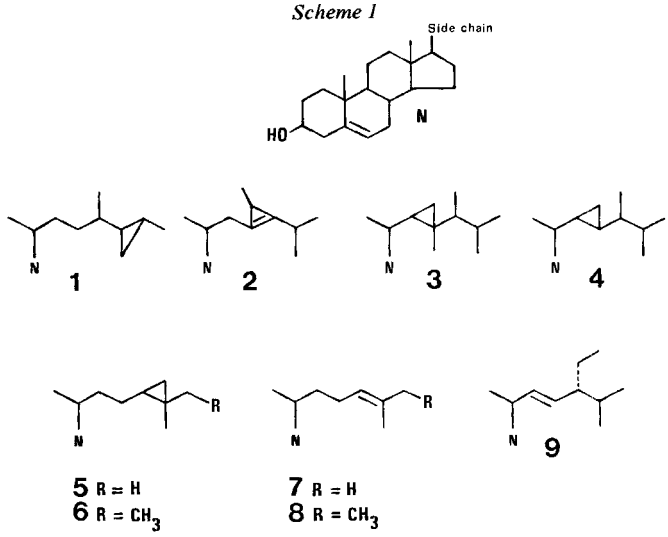
Summary

To test the eventual involvement of sterols with a cyclopropane containing side chain in bio-methylation processes, 24,25-methanocholest-5-en-3β-ol (**5**) and 24,25-methano-26-methylcholest-5-en-3β-ol (**6**) were synthesized. Together with the naturally occurring cyclopropane petrosterol (**1**), they were submitted to acid isomerization to provide chemical models for some of their potential metabolites.

Sterols with various side chains alkylation patterns are commonly found in plants, algae and marine invertebrates. In all cases studied so far the extra carbon atoms are introduced *via* S-adenosyl methionine [1]. The possibility of the existence of cyclopropane-containing intermediates in this bio-alkylation step was postulated [2], but none of the methylation mechanisms studied so far involve such inter-

Scheme 1



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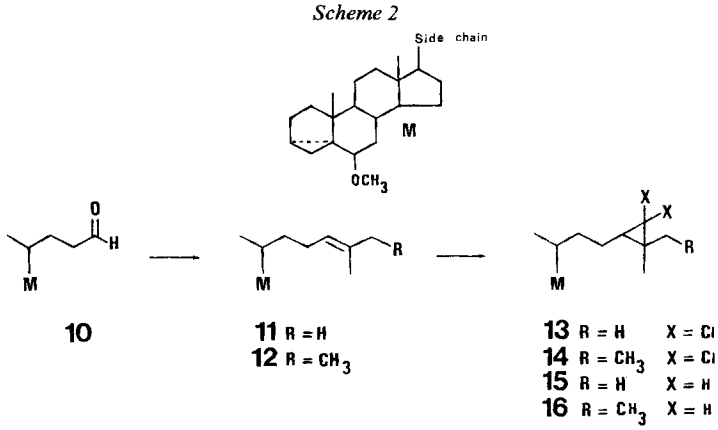
mediates [1]. Since *Lederer*'s original postulate [2], sterols containing a cyclopropane ring in their side chain have been found among marine invertebrates: petrosterol **1** [3] [4] and calysterol **2** [5] in sponges, gorgosterol **3** [6] [7] and 23-demethylgorgosterol **4** [8] in coelenterates. Furthermore one enzyme capable of isomerizing a cyclopropane is already known: The cycloeucalenol-obtusifoliol isomerase involved in phytosterol biosynthesis [9].

Therefore we considered it interesting to investigate the acid isomerization of synthetic and natural cyclopropane-containing sterols. In some cases these sterols might not just be metabolic dead-ends [10], in which case their acid-isomerization might be a biomimetic counterpart to an enzymatic cyclopropane cleavage. Thus, the chemical reaction might provide us with some of their probable metabolites already predicted but not yet found in living organisms. Consequently, we have studied the acid catalyzed isomerization of petrosterol (**1**), (24*RS*)-24,25-methanocholest-5-en-3β-ol (**5**) and (24*RS*,25*RS*)-24,25-methano-26-methylcholest-5-en-3β-ol (**6**). The synthetic sterols **5** and **6** were also needed for comparison with trace sterols of natural origin [4].

Cyclopropane-containing sterols are efficiently prepared by addition of dichlorocarbene to the corresponding unsaturated precursor, followed by dissolving metal reduction [11–13]. Thus **5** and **6** can be synthesized from desmosterol (**7**) and 26-methyldesmosterol (**8**) respectively, provided that dichlorocarbene reacts selectively with the side-chain double bond. Such a selectivity has indeed been claimed by *Ikan et al.* [12] in the case of desmosterol (**7**) and stigmasterol (**9**), but at least in the latter case, a completely contradictory result, namely selective 5,6-addition, was observed in our laboratory [13].

To avoid this ambiguity, we protected the 5,6-double bond of the sterols **7** and **8** by preparing their 6β-methoxy-3,5-cyclo derivatives. The starting material 6β-methoxy-3,5-cyclocholan-24-al (**10**) was obtained from methyl 3β-hydroxy-5-cholenate by known procedures [14]. *Wittig* reaction with isopropyltriphenylphosphorane or (1-methylpropyl)-triphenylphosphorane gave the protected desmosterol (**11**) and 26-methyldesmosterol (**12**, mixture of *E* and *Z* isomers), respectively. Treatment with chloroform, concentrated aqueous sodium hydroxide and a catalytic

Scheme 2



10

11 R = H
12 R = CH_3

13 R = H X = Cl
14 R = CH_3 X = Cl
15 R = H X = H
16 R = CH_3 X = H

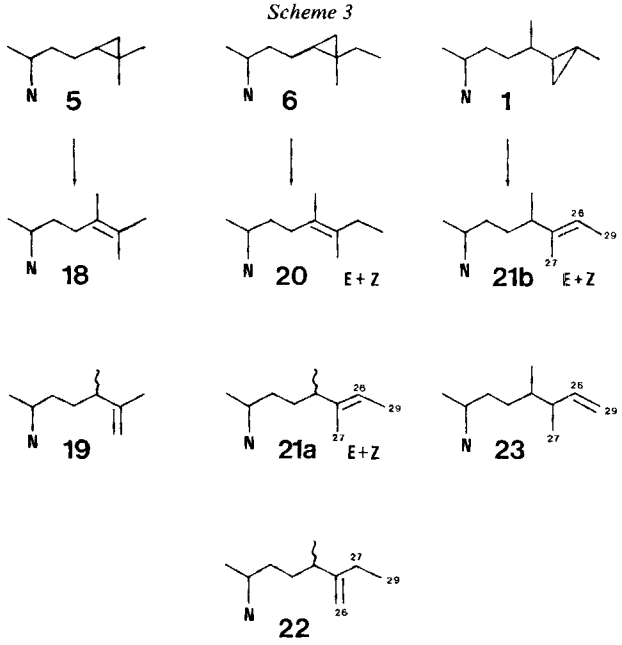
amount of benzyltriethylammonium chloride [15] afforded the 1,1-dichlorocyclopropane adducts **13** and **14**. Reduction with lithium in ammonia led to the cyclopropanes **15** and **16**, which were deprotected [16] to the desired sterols **5** and **6**.

The adduct **5** was different (m.p., MS.) from the one described by *Ikan et al.* [12]. In addition, protected stigmasterol [16] did not react at all with dichlorocarbene. Examination of *Ikan*'s stigmasterol adduct[1]) showed that it was mainly composed of unchanged stigmasterol containing some cyclopropane derivative (most likely the 5,6-adduct), thus explaining the reported [12] but very unlikely $M^+ - 14$ mass spectroscopic fragmentation.

Comparison of the mass and 360-MHz-^{1}H-NMR. spectra of **5** with those of a previously detected natural sterol [4] which we believed to be 24,25-methanocholest-5-en-3β-ol on the basis of its mass spectrum proved that this assignment was incorrect. The identity of this unknown compound is currently under investigation.

The isomerization procedure using gaseous hydrogen chloride in chloroform has proved useful [17] for the isomerization of other cyclopropane-containing steroids and triterpenoids such as 3,5-cyclocholestan, cycloartenol and phyllanthol. The mild conditions do not affect the Δ^5-double bond as was demonstrated in a model experiment with cholesteryl acetate. The results of such treatment with the cyclopropanes **1**, **5** and **6** are summarized in *Scheme 3*. As expected, the direction of the cyclopropane cleavage appears to be in full accord with the *Markownikoff* addition

Scheme 3



N, s. *Scheme 1*

[1]) We thank Prof. *Ikan* for providing a sample.

rule [18]. The configuration at C(24) is not affected by the reaction: starting material and reaction products have the same configuration when the C(24) atom is asymmetric (*e.g.*, **1**→**21b**+**23**). According to the 360-MHz-NMR. results [19–21] the isomerization products **19**, **21a** and **22** of the synthetic sterols **5** and **6** are a 1:1 mixture of their two epimers at C(24) resulting from a non-stereoselective dichlorocarbene addition on the C(24),C(25)-double bond, whereas in the case of the natural petrosterol (**1**), only one diastereoisomer at C(24) could be detected in the sterols **21b** or **23**.

Sterol **21a** is an unresolved mixture of four isomers (24*R*, 24*S*, 25*E* and 25*Z*). These isomers have the same GC. and HPLC. retention times, but can be distinguished by their 360-MHz-^{1}H-NMR. spectra [19–21]. Sterol **21b**, derived from natural petrosterol, has the 24*R* configuration but is also a mixture of the two isomers 25*E* and 25*Z* as shown by the two signals observed for the C(28) and C(29) methyl groups and for the proton located at C(26).

Some of these sterols obtained from these cyclopropane isomerizations were already described: 24-methyl desmosterol (**18**) has been encountered in the plant *Whitania somnifera* [22]. Sterol **19** is a mixture of two diastereoisomers, the algal sterol codisterol (24*S*), isolated from two *Codium sp.* [23] [24] and its 24*R*-epimer, which has just been encountered for the first time in the sponge *Verongia cauliformis* [24] and which may be the key biosynthetic precursor to petrosterol (**1**) as well as many other recently isolated [10] marine sterols, which are alkylated at C(26) and C(27). The synthetic route from desmosterol *via* acid opening of **5** may be a convenient way of preparing labeled precursors needed for biosynthetic incorporation experiments, and these are currently under way. The 24*R*-isomer of sterol **22** (25,26-dehydroaplysterol) has recently been isolated by us from the same sponge [21]. It remains to be seen whether the presently described acid-catalyzed isomerization have their enzymatic counterpart in nature.

We wish to express our appreciation to Dr. *Lois Durham* for obtaining the ^{1}H-NMR. spectra. We thank *Annemarie Wegmann* and *R.G. Ross* for mass spectra obtained on the *MAT* 711 and *MS*-9 spectrometer. We acknowledge financial support from the *National Institutes of Health* (Grants GM-06840, AM-04257) and use of a 360-MHz-NMR. spectrometer made possible by grants from the *National Science Foundation* (GP 23633) and the *NIH* (RR-0711). *C.T.* thanks the *'Fonds National Suisse de la Recherche Scientifique'* for a grant.

Experimental Part

General. – GLC. was performed on a *Hewlett Packard* 402 chromatograph equipped with a 'U' shaped column (1.8 m×4 mm) packed with 3% OV-17 on Gas Chrom Q (100–120 mesh) and with a flame ionization detector. Oven temperature; 260°. The carrier gas is helium, and the flow rate 100 ml/min. The mass spectra of pure compounds were recorded at 70 eV on an *AEI* MS-9 mass spectrometer using a direct inlet system. High resolution MS. and GC./MS. analyses were performed on a *Varian* MAT 711 system using the conditions previously reported [25]. ^{1}H-NMR. spectra were recorded in $CDCl_3$ on *Varian* T-60 (60 MHz), *Varian* XL-100 (100 MHz), or *Bruker* HXS-360 (360 MHz) spectrometers. The chemical shifts are given in ppm using TMS as internal standard. Preparative HPLC. was performed on our system previously described [25], using a *Whatman Partisil* M9 10/50 ODS-2 column (500 mm×8 mm). Melting points (m.p.) (uncorrected) were determined on a *Thomas-Hoover* 'Uni-Melt' capillary melting point apparatus.

6β-Methoxy-3,5-cyclocholest-24-ene (**11**). A 57% NaH dispersion in oil (1.80 g, 42.8 mmol) was washed several times with dry pentane under nitrogen atmosphere. Dry dimethylsulfoxide (DMSO)

(25 ml) was added and the mixture stirred at 75–80° for 1 h. After cooling in an ice-bath, a solution of 18.5 g (42.8 mmol) of isopropyltriphenylphosphonium iodide in 150 ml dry DMSO was added and the dark red solution stirred 15 min; 4.00 g (10.7 mmol) of aldehyde **10** [14] in 15 ml of dry ether was then added and stirring was continued for 3 h. The reaction mixture was poured into 400 ml of cold methanol/water 50:50 and extracted with 200 ml of pentane. The pentane solution was washed several times with methanol/water, dried ($CaSO_4$) and the solvent evaporated. Purification of the residue by silica gel chromatography (2% ethyl acetate in hexane) gave 2.70 g (63%) of **11** as a colorless oil which slowly solidified and which was used in the next step without further purification. – ^{1}H-NMR. (60 MHz, CCl_4): 0.72 (*s*, 3 H–C(18)); 0.91 (*d*, *J* = 6, 3 H–C(21)); 0.99 (*s*, 3 H–C(19)); 1.56 and 1.64 (2*s*, 3 H–C(26) and 3 H–C(27)); 2.6 (*m*, H–C(6)); 3.21 (*s*, OCH_3); 4.97 (*t*, *J* = 6, H–C(24)).

6β-Methoxy-26-methyl-3,5-cyclocholest-24-ene (**12**). Similar treatment of 1.07 g (2.87 mmol) of **10** with (1-methylpropyl)-triphenylphosphorane gave 328 mg (28%) of **12**. – ^{1}H-NMR. (60 MHz): 0.72 (*s*, 3 H–C(18)); 0.91 (*d*, *J* = 6, 3 H–C(21)); 0.96 (*t*, *J* = 7, 3 H–C(28)); 1.01 (*s*, 3 H–C(19)); 1.59 and 1.64 (2*s*, 3 H–C(27), *E* and *Z* isomers); 2.7 (*m*, H–C(6)); 3.30 (*s*, OCH_3), 5.07 (*t*, *J* = 6, H–C(24)).

24,25-Dichloromethano-6β-methoxy-3,5-cyclocholestane (**13**). A 435 mg (1.09 mmol) sample of **11** in 7 ml of chloroform was mixed with 5.5 ml of 50% aqueous NaOH-solution in the presence of 50 mg benzyltriethylammonium chloride (BTEAC). After 48 h, a solution of 30 mg BTEAC in 1 ml of chloroform was added, and stirring was continued for a total of 117 h. Dilution with water and extraction with ether, followed by silica gel chromatography of the evaporated residue (5% ethyl acetate in petroleum ether) gave 522 mg of **13** as a colorless oil. – ^{1}H-NMR. (60 MHz, CCl_4): 0.76 (*s*, 3 H–C(18)); 0.8–1.0 (*m*, unresolved 3 H–C(19), 3 H–C(21), 3 H–C(26) and 3 H–C(27)); 2.6 (*m*, H–C(6)); 3.28 (*s*, OCH_3).

24,25-Dichloromethano-6β-methoxy-26-methyl-3,5-cyclocholestane (**14**). Repetition of the above procedure with 325 mg (0.787 mmol) **12** gave 335 mg **14**. – ^{1}H-NMR. (60 MHz): 0.73 (*s*, 3 H–C(18)); 0.9–1.1 (*m*, unresolved 3 H–C(19), 3 H–C(21), 3 H–C(27) and 3 H–C(29)); 2.7 (*m*, H–C(6)); 3.30 (*s*, OCH_3).

(*24*RS)-*24,25-Methanocholest-5-en-3β-ol* (**5**). The dichlorocyclopropane **13** (522 mg, 1.08 mmol) in 100 ml of dry ether was added dropwise to a solution of 0.50 g lithium in 250 ml of liquid ammonia. The mixture was stirred 1 h on a bath maintained between −50 and −35°, and then quenched with ethanol/ether 1:2 until disappearance of the blue color. After evaporation of the ammonia and dilution with water, the mixture was extracted with ether. The organic solution was washed with water, dried ($CaSO_4$) and the solvent evaporated, leaving an oily residue. Deprotection with acetic acid and zinc acetate [16] gave the acetate of **5** (442 mg, 92%), m.p. 123–125°. Alkaline saponification (89% yield) of the acetate and recrystallization (methanol/water) afforded the sterol **5** (177 mg), m.p. 144–145°. $[\alpha]_D^{20} = -40°$ ($CHCl_3$). – ^{1}H-NMR. (360 MHz): −0.16 (*m*, H–C(24)); 0.37 (*m*, 2 H–C(28)); 0.680 (*s*, 3 H–C(18)); 0.912 (*d*, *J* = 6.4, 3 H–C(21)); 1.009 (*s*, 6 H) and 1.022 (*s*, 3 H–C(19), 3 H–C(26) and 3 H–C(27)); 3.53 (*m*, H–C(3)); 5.37 (*m*, H–C(6)). – MS.: 398 (25, M^+), 383 (19, $M^+ - CH_3$), 380 (8, $M^+ - H_2O$), 365 (21, $M^+ - CH_3 - H_2O$), 314 (4), 299 (16), 271 (98, M^+-side chain − 2 H), 255 (17, M^+-side chain − H_2O), 253 (20, 271 − H_2O), 231 (14, ring D cleavage), 213 (26, (231 − H_2O), 55 (100). – High resoluted MS.: 398.3553 (M^+, calc. 398.3549).

(*24*RS,*25*RS)-*24,25-Methano-26-methylcholest-5-en-3β-ol* (**6**). Repetition of the above procedure with 335 mg (0.676 mmol) **14** gave the acetate of **6** (221 mg, 72%), m.p. 119–121°, and after saponification the free sterol **6**, m.p. 133–135°. – ^{1}H-NMR. (100 MHz): −0.17 (*m*, H–C(24)); 0.35 (*m*, 2 H–C(28)); 0.68 (*s*, 3 H–C(18)); 0.91 (*d*, *J* = 6, 3 H–C(21)); 0.97 (*t*, *J* = 7, 3 H–C(29)); 1.01 (*s*, 3 H–C(19) and 3 H–C(27)); 3.5 (*m*, H–C(3)); 5.35 (*m*, H–C(6)). – MS.: 412 (6, M^+), 397 (6, $M^+ - CH_3$), 394 (3, $M^+ - H_2O$), 379 (5, $M^+ - CH_3 - H_2O$), 299 (6), 285 (4), 271 (36, M^+-side chain − 2 H), 255 (9, M^+-side chain − H_2O), 253 (9, 271 − H_2O), 231 (8, ring D cleavage), 213 (17, 231 − H_2O), 55 (100). – High resoluted MS.: 412.3690 (M^+, calc. 412.3705).

Acid Isomerization of Cyclopropane-Ring Containing Sterols. The sterol acetate (10 to 30 mg) was dissolved in dry, ethanol-free chloroform (2 ml). Dry hydrogen chloride was bubbled at room temperature through the solution for 1 h in the case of **5** and **6**, whereupon no starting material remained. In the case of petrosterol (**1**), no significant isomerization occurred under these conditions even after 6 h. Therefore, the chloroform was replaced by 2 ml abs. chloroform/glacial acetic acid, and dry hydrogen chloride was bubbled through the solution for 6 h at room temperature. The solvents were removed *in vacuo* and the sterol acetates separated on silica gel thin layer plates impregnated with silver nitrate

(10%) using hexane/benzene 1:1, two migrations. Sterols **18**, **19**, **22** and **23** could be obtained pure by this method, after cleaving the acetates with $LiAlH_4$. Sterols **21a** and **21b** were purified by HPLC. All sterols were identified by their NMR. and mass spectra. Only sterol **20**, which could not be purified, was identified by high resolution GC.-MS. The total free sterol fraction of the sponge *Petrosia filiciformis* [3][2]), containing about 80–90% of petrosterol, was used after acetylation for the petrosterol acetate isomerization. The major sterols (**21b** and **22**) obtained after isomerization, were not present in the sponge.

Ergosta-5,24-dien-3β-ol (**18**). – ^{1}H-NMR. (100 MHz): 0.681 (*s*, 3 H–C(18)); 0.97 (*d*, J=6, 3 H–C(21)); 1.007 (*s*, 3 H–C(19)); 1.62 (*s*, 3 H–C(25), 3 H–C(26) and 3 H–C(27)); 3.48 (*m*, 1 H–C(3)); 5.30 (*m*, 1 H–C(6)). – MS.: 398 (M^+), 383 (M^+-CH_3), 380 (M^+-H_2O), 365 ($M^+-H_2O-CH_3$), 314 (*McLafferty* rearrangement induced by the C(24),C(25)-double bond), 300, 299, 281, 271 (M^+-side chain – 2 H), 229, 213 (ring D Cleavage).

(*24*RS)-*24-Methylcholesta-5,25-dien-3β-ol* (codisterol and epicodisterol) (**19**). – ^{1}H-NMR. (360 MHz): 0.673 (*s*, 3 H–C(18)); 0.912 and 0.915 (2*d*, J=6.5, 3 H–C(21)); 0.987 and 0.992 (2*d*, J=6.8, 3 H–C(28)); 1.007 (*s*, 3 H–C(19)); 3.53 (*m*, 1 H–C(3)); 4.66 (*s*, 2 H–C(26)); 5.35 (*m*, 1 H–C(6)). – MS.: 398.3539 (100, M^+, $C_{28}H_{46}O_1$), 383.3296 (8, M^+-CH_3, $C_{27}H_{43}O_1$), 380.3438 (13, M^+-H_2O, $C_{28}H_{44}$), 365.3211 (6, $M^+-CH_3-H_2O$, $C_{27}H_{41}$), 328.2774 (6, $C_{23}H_{36}O_1$), 314.2592 (19, $C_{22}H_{34}O_1$), 299.2368 (18, $C_{21}H_{31}O_1$), 271.2053 (25, $C_{19}H_{27}O_1$), 255.2131 (7, $C_{19}H_{27}$), 231.1764 (6, $C_{16}H_{23}O_1$), 213.1658 (9, $C_{16}H_{21}$).

(*24*EZ)-*24,26-Dimethylergosta-5,24-dien-3β-ol* (**20**). – MS. (high resolution GC./MS.): 412.3797 (100, M^+, $C_{29}H_{48}O_1$), 397.3553 (16, $C_{28}H_{45}O_1$, M^+-CH_3), 394.3637 (16, $C_{29}H_{46}$, M^+-H_2O), 379.3413 (12, $C_{28}H_{43}$, $M^+-H_2O-CH_3$), 327.3076 (7, $C_{24}H_{39}$), 314.2682 (26, $C_{22}H_{34}O_1$, *McLafferty* rearrangement induced by the C(24),C(25)-double bond), 301.2868 (6, $C_{22}H_{37}$), 299.2335 (14, $C_{21}H_{31}O_1$), 271.2072 (36, $C_{19}H_{27}O_1$), 255.2112 (7, $C_{19}H_{27}$), 231.1808 (8, $C_{16}H_{23}O_1$), 213.1615 (15, $C_{16}H_{21}$).

(*24*RS,*25*EZ)-*24,26-Dimethylcholesta-5,25-dien-3β-ol* (**21a**). – ^{1}H-NMR. (360 MHz): 0.668 (*s*, 3 H–C(18)); 0.899 and 0.905 (2*d*, J=6.5, 3 H–C(21)); 0.932, 0.941, 0.944 and 0.949 (4*d*, J=6.9, 3 H–C(28)); 1.006 (*s*, 3 H–C(19)); 1.486 and 1.500 (2*s*, 3 H–C(27)); 1.546 and 1.567 (2*s*, 3 H–C(29)); 3.52 (*m*, 1 H–C(3)); 5.16 and 5.19 (*qa*, J=6.6, 1 H–C(26)); 5.35 (*m*, 1 H–C(6)). – MS.: 412.3707 (100, M^+, $C_{29}H_{48}O_1$), 397.3436 (12, M^+-CH_3, $C_{28}H_{45}O_1$), 394.3582 (13, M^+-H_2O, $C_{29}H_{46}$), 379.3358 (9, $M^+-CH_3-H_2O$, $C_{28}H_{43}$), 328.2748 (21, $C_{23}H_{36}O_1$), 314.2606 (19, $C_{22}H_{34}O_1$), 299.2378 (25, $C_{21}H_{31}O_1$), 271.2050 (25, $C_{19}H_{27}O_1$), 255.2087 (12, $C_{19}H_{27}$), 213.1641 (17, $C_{16}H_{21}$).

(*24*R,*25*EZ)-*24,26-Dimethylcholesta-5,25-dien-3β-ol* (**21b**). – ^{1}H-NMR. (360 MHz): 0.667 (*s*, 3 H–C(18)); 0.905 (*d*, J=6.6, 3 H–C(21)); 0.934 and 0.944 (2*d*, J=6.8, 3 H–C(28)); 1.006 (*s*, 3 H–C(19)); 1.48 and 1.50 (2*s*, 3 H–C(27)); 1.545 and 1.568 (2*s*, 3 H–C(29)); 3.53 (*m*, 1 H–C(3)); 5.18 (*m*, 1 H–C(26)); 5.35 (*m*, 1 H–C(6)). – MS.: 412.3718 (100, M^+, $C_{29}H_{48}O_1$), 397.3452 (9, M^+-CH_3, $C_{28}H_{43}$), 328.2750 (20, $C_{23}H_{36}O_1$), 314.2588 (48, $C_{22}H_{34}O_1$), 299.2379 (28, $C_{21}H_{31}O_1$), 271.2057 (51, $C_{19}H_{27}O_1$), 255.2085 (10, $C_{19}H_{27}$), 213.1657 (21, $C_{16}H_{21}$).

(*24*RS)-*24,27-Dimethylcholesta-5,26-dien-3β-ol* (*= 25,26-didehydroaplysterol*) (**22**). – ^{1}H-NMR. (360 MHz): 0.670 (*s*, 3 H–C(18)); 0.909 (*d*, J=6.6, 3 H–C(21)); 0.992 and 0.998 (2*d*, J=6, 3 H–C(28)); 1.006 (*s*, 3 H–C(19)); 1.031 (*t*, J=7.4, 3 H–C(29)); 3.52 (*m*, 1 H–C(3)); 4.68 and 4.72 (2*s*, 2 H–C(26)); 5.36 (*m*, 1 H–C(6)). – MS.: 412.3727 (100, M^+, $C_{29}H_{48}O_1$), 397 (13, M^+-CH_3, $C_{28}H_{45}O_1$), 394.3631 (12, M^+-H_2O, $C_{29}H_{46}$), 379.3389 (5, $M^+-H_2O-CH_3$, $C_{28}H_{43}$), 328.2777 (10, $C_{23}H_{36}O_1$), 314.2610 (28, $C_{22}H_{34}O_1$), 299 (21, $C_{21}H_{31}O_1$), 271.2065 (29, $C_{19}H_{26}O_1$), 255.2107 (10, $C_{19}H_{27}$), 213.1646 (16, $C_{16}H_{21}$).

(*24*R)-*24,26-Dimethylcholesta-5,26-dien-3β-ol* (**23**). – ^{1}H-NMR. (360 MHz): 0.677 (*s*, 3 H–C(18)); 0.796 (*d*, J=6.7, 3 H–C(27)); 0.902 (*d*, J=6.5, 3 H–C(28)); 0.932 (*d*, J=6.9, 3 H–C(21)); 1.008 (*s*, 3 H–C(19)); 3.51 (*m*, 1 H–C(3)); 4.92 (2*s*, 2 H–C(29)); 5.35 (*m*, 1 H–C(6)); 5.74 (*m*, 1 H–C(26)). – MS.: 412.3693 (100, M^+, $C_{29}H_{48}O_1$), 397.3471 (14, M^+-CH_3, $C_{28}H_{45}O_1$), 394.3594 (21, M^+-H_2O, $C_{29}H_{46}$), 379.3345 (9, $M^+-H_2O-CH_3$, $C_{28}H_{43}$), 327.3039 (14, $C_{24}H_{39}$), 314.2613 (6, $C_{22}H_{34}O_1$), 301.2587 (18, $C_{22}H_{37}$), 273.2232 (12, $C_{19}H_{29}O_1$), 271.2074 (9, $C_{19}H_{27}O_1$), 255.2107 (10, $C_{19}H_{27}$), 231.1741

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[2]) We thank Prof. *D. Sica* for providing us with the sterols of *Petrosia filiciformis*.

(8, $C_{16}H_{23}O_1$), 213.1642 (13, $C_{16}H_{21}$). The monosubstituted C(26),C(29)-double bond does not induce a *McLafferty* rearrangement. The same observation was made for the mass spectrum of synthetic 26,27-bisnorcholesta-5,24-dien-3β-ol [26].

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