TABLE 2. Results of the Quantitative Determination of Flavonoids in Kapli Landyshevo-pustyrnikovye by a Chromato-mass Spectrophotometric Method

Sample No.	Flavonoids found, calculated as rutin., mg/100 g, $\bar{x}$	Metrological characteristics		
		$s_{\bar{x}}$	E	A, %
1	4,89	0,0001	0,0002	4,76
2	5,48	0,0001	0,0001	2,07
3	5,23	0,0001	0,0001	1,71

determination of the flavonoids in the preparations studied. The procedures are simple and readily reproducible and permit the determination of the main active substances with adequate accuracy. Comparable results were obtained by the photocolorimetric and biological methods of analysis of the glycosides. The adequacy of the results of these methods have been confirmed by their correlation coefficient.

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SYNTHESIS OF 4α-ALKYLTHIOCARANE-3β-THIOLS

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UDC 547.597.1

Addition reactions of thiols to β-3,4-epithiocarane under conditions of base catalysis have been studied. The reaction takes place regio- and stereospecifically with the formation of 4α-alkylthiocarane-3β-thiols.

One of the most promising directions in the chemistry of terpenoids is the synthesis of sulfur-containing derivatives of this series, since it is known that the terpene sulfides present in Nature in trace amounts possess valuable practical properties [1, 2].

We propose a method for synthesizing 4α-thiocarane-3β-thiols according to the following scheme: 3-carene→α-3,4-epoxycarane→β-3,4-epithiocarane→4-alkylthiocarane-3β-thiol. With this aim, we have developed a convenient method for obtaining β-3,4-epithiocarane (II) by the reaction of α-3,4-epoxycarane (I) with thiourea in the presence of equimolar amounts of sulfuric acid (by analogy with the procedure of [3]). The spectral characteristics (PMR) and physicochemical constants (bp and n_D^{20}) of compound (II) agreed with those described

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TABLE 1. PMR Spectra of Compounds (III-VI) (δ, ppm)

Compound	2H-1,6	6H 8.9	3H-10	SH	SR
III (R=Me)	0,57—0,83	1,07 s	1,43 s	1,5—2,3	2,2 s
IV (R=Et)	0,57—0,83	1,07 s	1,46 s	1,5—2,8	1,43 t, 2,61 q
V (R=H-Bu)	0,57—0,83	1,07 s	1.4 s	1,4—2,63	1,4—2.63
VI (R=Ph)	0,57—0,83	1,03 s	1,43 s	1,6—3,0	7,1 m

TABLE 2. Physicochemical Constants and Yields of Compounds (III)-(VI)*

Compound	Empirical formula	n_D^{20}	R_f (hexane—ether (30:1))	Yield, %
III (R=Me)	$C_{11}H_{20}S_2$	1,5176	0,54	46
IV (R=Et)	$C_{12}H_{22}S_2$	1,5214	0·52	60
V (R=H-Bu)	$C_{14}H_{26}S_2$	1,5192	0,52	39
VI (R=Ph)	$C_{16}H_{22}S_2$	—	0,43	40

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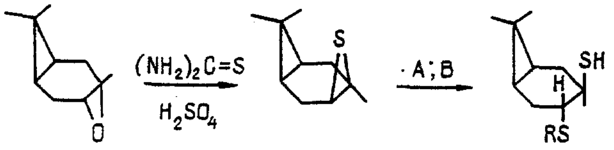
*Melting point of compound (VI) 113-114°C.

in the literature [4]. The β-3,4-epithiocarane (II) obtained was caused to react with thiols (RSH; R = Me, Et, n-Bu, Ph) under conditions of base catalysis by two methods: A — the thiol mixed with sodium thiolate; B — the thiol mixed with sodium ethanolate.



I II III-VI

R = Me(III), Et(IV), H-Bu(V), Ph(VI)

The addition products (III-VI) were isolated by column chromatography on silica gel (with hexane as eluent). The structures of compounds (III-VI) were confirmed by their IR and PMR spectra and the results of elementary analysis, which agreed with the calculated figures. The IR spectra of all the compounds (III-VI) had the characteristic band of the vibrations of a SH group of medium intensity [$\nu_{(SH)}$ 2560 cm^{-1}]. The PMR spectra contained the signals of the hydrogens of the carane skeleton: of the gem-dimethyl fragment, of the methyl group at C^3, and of the cyclopropane protons, and the signals of the protons of the sulfhydryl group and of the hydrocarbon radicals of the SR groups (Table 1).

EXPERIMENTAL

The PMR spectra were measured on a Tesla spectrometer (60 MHz) in CCl_4 solutions with HMDS as internal standard. Refractive indices n_D^{20} were measured on a IRF-454 BM refractometer, and IR spectra were recorded in CCl_4 solutions on a UR-20 spectrometer. The melting point of (VI) was determined in a Kofler instrument.

α-3,4-Epoxycarane (I) was obtained by the procedure described in [5].

Synthesis of β-3,4-Epithiocarane (II). After the addition of 8 g (0.1 mole) of thiourea to a solution of 3 ml (0.1 equiv.) of H_2SO_4 in 35 ml of water, the mixture was cooled to 0-5°C, and 16 g (0.1 mole) of α-3,4-epoxycarane (I) was added in drops. The temperature of the bath was then raised to 60-70°C, and 10.6 g (0.1 mole) of Na_2CO_3 in 50 ml of water was added to the reaction mixture. The oil so obtained was separated off, and the aqueous solution was extracted with ether (4 × 50 ml); the combined extracts were dried with Na_2SO_4 and distilled in vacuum. bp 37-39°C (0.1 mm Hg), n_D^{20} 1.5151. Yield 9.0 g (51%).

Synthesis of Compound (III). To a solution of EtONa obtained from 0.3 g (0.013 g-atom) of Na and 20 ml of absolute ethanol were added 2.0 g (0.012 mole) of β-3,4-epithiocarane and 2 ml of DMSO, and 0.208 mole of MeSH was passed through this reaction mixture over 0.5 h. After being stirred at room temperature for 4 hours, it was diluted with 100 ml of water and extracted with ether (5 × 50 ml), and the extract was washed with aqueous NH_4Cl and dried with Na_2SO_4. The product was isolated by chromatography on silica gel (hexane).

Synthesis of Compounds (IV) and (V). To a solution of the sodium thiolate obtained from 0.0086 g-atom of Na and 0.89 mole of RSH (R = Et, n-Bu) were added 0.0089 mole of β-3,4-epithiocarane (II) and 2 ml of DMSO. The reaction mixture was stirred at room temperature for 15 h and was then diluted with 100 ml of water and extracted with ether (5 × 50 ml); the extracts were washed with NaCl and dried with Na_2SO_4. The products were isolated by chromatography on silica gel (hexane).

Synthesis of Compound (VI). To the solution of sodium ethanolate obtained from 0.28 g (0.012 g/atom) of Na and 10 ml of absolute ethanol were added 1.68 g (0.015 mole) of PhSH, 2.0 g (0.012 mole) of β-3,4-epithiocarane (II), and 2 ml of DMSO. The reaction mixture was stirred at room temperature for 40 h and was then diluted with water and extracted with ether (5 × 50 ml), and the extracts were washed with aqueous NH_4Cl and dried with Na_2SO_4. The product was isolated by chromatography on silica gel (hexane) and was additionally purified by recrystallization from acetone.

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SYNTHESIS OF 12-DEOXYSCALAROLACTONE AND 12-DEOXYSCALARADIAL

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12-Deoxyscalarolactone and 12-deoxyscalaradial and substances related to them have been synthesized from methyl scalar-16-en-19-oate.

As is known [1], marine organisms serve as a source of scalarane sesterterpenoids. A whole series of scalaranoids functionalized at C-12, C-19, and C-20 has been isolated from them, and some of these possess biological activity. However, these compounds have hitherto remained little-studied, since the amount of them in marine organisms is, as a rule, low and the syntheses of them that have been described involve many stages and are inefficient [2-4].

Having developed a convenient and highly effective route for obtaining compound (I) [5], as a consequence of which it has become relatively accessible, we decided to use it as a basis for the synthesis of two analogues of the natural scalaranoids — 12-deoxyscalarolactone (II) and 12-deoxyscalaradial (III) (see scheme on following page).

The reaction of the ester (I) with selenium dioxide gave a complex mixture of substances difficult to separate. The product of the reduction of the ester (I), which has also been obtained by the superacid cyclization of aliphatic or bicyclic sesterterpene alcohols [6, 7], reacted with selenium dioxide more smoothly. From the reaction product, by careful chromatography on silica gel, it was possible to isolate compounds (III)-(VI) in order of increasing polarity.

The structure of the crystalline hydroxy ether (III) was shown by spectral methods. Its IR spectrum contained the maxima of primary hydroxyl and ether groups and of a trisubstituted double bond, and its PMR spectrum contained the signals of five methyl groups

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