γ-FLUOROSUBSTITUTED 1-PROPYLSILATRANES*

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Fluorosubstituted organosilicon compounds of the type $F_mH_{3-m}CCH_2CH_2Si(OR')_n(OR'')_{3-n}N$ were prepared and their physiological activity and toxicity were tested.

The great theoretical interest in silatranes and much attention paid at the present time to their application are connected with both special features of their structure and their high biological activity. Especially 1-phenyl- and 1-*p*-tolylsilatranes are the most toxic of all the organosilicon compounds so far known[1]. Our interest in novel toxic derivatives of silatrane type which could be utilized as zoocides and insecticides has led us to synthesize silatranes containing phosphorus[2] and sulphur[3-5]. In this work we elaborated synthesis of γ-fluoropropylsilatranes of the type $F_mH_{3-m}CCH_2CH_2Si(OR')_n(OR'')_{3-n}N$ (where $m = 1-3$; $n = 0-3$; $R' = CH_2CH_2$ $R'' = CH(CH_3)CH_2$) and tested toxicity of these compounds.

The above substances were prepared from the corresponding γ-fluorosubstituted propyltrialkoxysilanes reported earlier[6] and tris(2-oxyalkyl)amines in the presence of catalytic amounts of an alkali metal alcoholate or hydroxide (equation (*A*) (where

$$F_mH_{3-m}CCH_2CH_2Si(OR)_3 + (HOR')_n(HOR'')_{3-n}N \longrightarrow 3\,ROH + F_mH_{3-m}CCH_2CH_2Si(OR')_n(OR'')_{3-n}N \qquad (A)$$

$m = 1, 3$; $R = CH_3, C_2H_5$; $R' = CH_2CH_2$; $R'' = CH(CH_3)CH_2$; $n = 0-3$).

Prepared compounds were colourless, crystalline, readily soluble in chloroform, lower alcohols, and ether and less soluble in aromatic hydrocarbons. C-methyl-sub-

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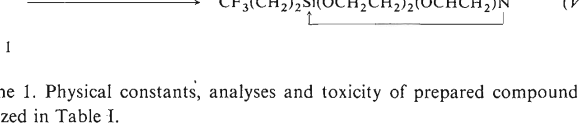
stituted γ-trifluoropropylsilatranes could be distilled *in vacuo*. When undercooled they can be stored as viscous liquids for a long time. Of special interest is 1-(γ-trifluoropropyl)-3-trifluoromethylsilatrane which was obtained by the way depicted



(*VII*)

SCHEME I

in Scheme 1. Physical constants, analyses and toxicity of prepared compounds are summarized in Table I.

Their IR spectra show bands characteristic of stretching vibrations of the C–N bond (940–970 cm^{-1}). The Si—O—C linkage is characterized by strong bands at 780 and 1050–1150 cm^{-1}. Characteristic frequencies in the spectra of the compounds containing substituted ring are ν_{CH_3} 1380 and 2970 cm^{-1}. Substituted atrane ring is characterized by the frequencies 540 and 560 cm^{-1}, the unsubstituted one by one frequency in the 570–580 cm^{-1} region.

^{19}F-NMR spectra of compounds *I*, *II*, and *V*, *VI* show triplets located in the stronger field compared to $CFCl_3$. The spectrum of C-trifluoromethyl-substituted 1-(γ-trifluoropropyl)silatrane (*VII*) exhibits the above triplet and a doublet of the trifluoromethyl group on the atrane ring (91·3 ppm). The spectrum of derivative *VI* is a complex multiplet.

On intraperitoneal injection of prepared compounds to white mice, the clinical picture is essentially the same, although there exist some pecularities in some cases. When used in greater dosage compounds *IV* and *V* bring about instantaneous death, while compound *II* does it in 10–15 min. Instaneous death is accompanied by tonico-clonical convulsions which are obviously due to paralysing effect of the compounds on the central nervous system. With all the compounds, characteristic symptoms were violent excitement, restlessness, twitch of muscles, spasm of abdominal muscle, tremor and salivation.

On injection of compound *II*, it is possible to observe nasal bleeding of individual animals which speaks for veiny disturbance. Contrary to the other substances, the compound supresses the reactivity to sound and pain stimulations and righting reflex.

The introduction of methyl groups on the atrane ring lowers thus essentially the toxicity. In small doses the compounds *I*–*III* exhibit relaxing effect on the central nervous system of small laboratory animals, in contradistinction to stimulating effect of γ-trifluoropropyl- and γ-fluoropropyltriethoxysilane.

TABLE I

Fluorosubstituted 1-Propylsilatranes $F_mH_{3-m}CCH_2CH_2Si(OCH_2CH_2)_n(OCHRCH_2)_{3-n}N$

Compound	R	n	m	M.p. °C	B.p. °C/Torr	n_D^{20}	Yield %	(^{19}F)[a]:LD_{50} ppm mg/kg	
I[b]	CH_3	2	3	36	122/1	1·4393	91	70	260
II	CH_3	0	3	58	136/1·5	—	98	69·7	240
III	CH_3	3	1	72	—	—	96	—	220
IV	CH_3	0	1	61	154/2	1·4660	95	112·4	90
V	CH_3	3	3	108	—	—	78	70·0	5
VI	CH_3	1	3	32	150/4	1·4404	90	69·8	260
VII	CF_3	2	3	63	123/1	1·4218	96	70·0	54

[a] Chemical shift with respect to $CFCl_3$. [b] d_4^{20} 1·2329, MR_D calculated 61·58, found 60·91.

EXPERIMENTAL

γ-Fluoropropylsilatrane. To boiling mixture of 8·3 g (0·054 mol) of triethanolamine and 0·083 g KOH in 15 ml of dry ethanol, 12·0 g (0·054 mol) of γ-(fluoropropyl)triethoxysilane were added; after cooling, 10 ml of heptane were added and the alcohol was removed by distillation. The precipitate was washed with ether and dried *in vacuo*. The product (m.p. 66°C) which was obtained in 96% yield (12·7 g) was recrystallized from chloroform to give 11·7 g (92%) of γ-fluoropropylsilatrane, m.p. 72°C.

γ-Trifluoropropyl-3-methylsilatrane. To 6·95 g (0·42 mol) of diethanolisopropanolamine, 3 drops of 5% sodium ethoxide solution and 9·3 g (0·042 mol) of trifluoropropyltrimethoxysilane were added and theoretical amount of the alcohol was removed by distillation. A yellow oily product was obtained in a total amount of 11·1 g (90%). Vacuum distillation afforded 10·5 g (86%) of γ-trifluoropropyl-3-methylsilatrane (colourless liquid), b.p. 122°C/1 Torr.

IR spectra were recorded with UR-20 spectrometer (KBr pellets or chloroform solution). ^{19}F-NMR spectra were measured on Tesla BS 427 (80 MHz) instrument at infinite dilution in chloroform. Trifluorobenzene was used as internal reference. Chemical shifts were related to $CFCl_3$.

Biological effects and toxicity were determined by the method of intraperitoneal injection of the emulsions of compounds *I*—*III* in a sterile twin to white mice according to Karber[7].

(*Continued*)

Formula	Calculated, %				Found, %			
	C	H	Si	F	C	H	Si	F
$C_{10}H_{18}F_3NO_3Si$	42·09	6·36	9·83	19·98	42·07	6·40	10·20	19·70
$C_{12}H_{18}F_3NO_3Si$	45·90	7·07	8·96	18·18	46·00	7·10	8·90	17·94
$C_9H_{18}FNO_3Si$	45·93	7·71	8·96	8·07	45·92	7·70	11·31	7·73
$C_{12}H_{24}FNO_3Si$	51·95	8·72	10·12	6·85	51·82	8·04	10·02	6·54
$C_9H_{16}F_3NO_3Si$	39·98	5·94	10·35	21·00	39·63	5·93	11·18	21·15
$C_{11}H_{16}F_3NO_3Si$	44·13	6·73	9·38	19·04	45·48	6·73	9·37	18·62
$C_{10}H_{15}F_6NO_3Si$	35·40	4·46	—	33·59	36·87	4·47	—	33·26

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