Interatomic distances:

V — O = {1.59, 2.00 — 2.06 (4 distances), 2.28}

S — O = 1.43 Å (mean length within tetrahedron)

O — O = 2.34 Å (mean length within tetrahedron

O — O = 2.81 Å (mean length within octahedron)

The structure may be described as consisting of zig-zag chains running parallel to the *a*-axis and formed from distorted VO_6 octahedra linked together by sharing corners. The chains are coupled together by SO_4 groups, so that every VO_6 octahedron shares corners with four sulphate tetrahedra, each one of which shares corners with four octahedra, giving a three dimensional framework. A schematic drawing, showing the linking of octahedra and tetrahedra is given in Fig. 1.

Full details of this investigation and a discussion of the structure will be given elsewhere.

This investigation has received financial support from the *Swedish Natural Science Research Council* and from the *Malmfonden — Swedish Foundation for Scientific Research and Industrial Development.* Permission for the use of the computers FACIT EDB and BESK was granted by the *Computer Division of the National Swedish Rationalization Agency.*

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The Synthesis of Some Seleninic Acids

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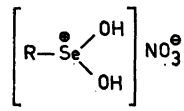
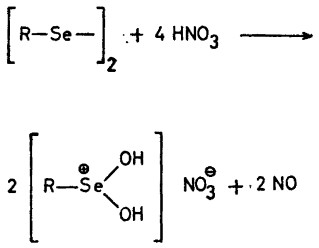
The interest in organo-selenium compounds was greatly increased by the discovery of their nutritional importance.[1] A great many compounds have been tested in biological experiments during recent years to investigate their Factor 3-activity and it was found that some diseleno-dicarboxylic acids have a comparatively high activity. For comparison, it was important to test some seleninic acids, analogous to these diselenides, and the synthesis of a series of such seleninocarboxylic acids was begun. The results from this synthetic work are given in this note.

Seleninic acids have been prepared from diselenides by two principal methods. Fredga [2] oxidized diselenides in acetone solution with hydrogen peroxide and Backer and van Dam [3] frequently used concentrated nitric acid as an oxidizing agent. In both cases it was possible to isolate the seleninic acids in good yields. However seleninic acids are comparatively unstable substances tending to decompose and liberate selenium when isolated. This complication can be avoided by isolating them as their heavy metal salts which are usually easily prepared. Besides, because of the amphoteric character of seleninic acids, they form salts with strong acids. Thus, it is possible to prepare, *e.g.*, their hydrochlorides and hydronitrates. The structure of such salts has been widely discussed. By infrared spectroscopy, Paetzold *et al.*[5] could prove the structure of seleninic acid hydrochlorides, and quite analogously the structure of their hydronitrates should be as follows:



It was found suitable for many reasons to isolate the present seleninic acids as such hydronitrates and a direct method of preparation of these compounds is communicated in this note. The method is on the whole that of Backer and van Dam. Thus, the diselenides were treated with an excess of fuming nitric acid with cooling. The reaction mixture was evaporated to dryness in a vacuum desiccator at room temperature and the residual crystals were, if found necessary, recrystallized from concentrated nitric acid. In this way the hydronitrates of the seleninic acids were isolated in almost quantitative yields. These compounds are fairly stable and can be stored for a long period without decomposition.



This investigation will be continued and further results on these and similar substances will be given later.

Experimental. All the melting points are uncorrected. The selenium analyses were performed as described by Fredga.[6]

General procedure. Analytical grade diselenide was suspended in a small amount of water in a beaker and cooled externally with ice. Fuming nitric acid was added dropwise until no more nitrous fumes were obtained. When oxidized, the diselenide dissolves and a clear solution is obtained. The beaker was placed in a vacuum desiccator over sodium hydroxide and the reaction mixture was evaporated to dryness without raising the temperature. Usually analytical pure seleninic acid hydronitrates were obtained in this way but if found necessary, the product was recrystallized from concentrated nitric acid. In that case the crude material was dissolved without heating in the nitric acid and the solution was evaporated slowly by placing it in a vacuum desiccator over sodium hydroxide. Room temperature gave a suitable rate of evaporation, and after some days colourless crystals were obtained. Since the products melt with decomposition, the melting points are given with some reserve.

Butaneseleninic acid hydronitrate. The oxidation of 5.3 g (0.02 mole) of dibutyl diselenide [7] gave 9.1 g (100 %) of butaneseleninic acid hydronitrate as colourless crystals, m.p. 92—94° (d)[8]. (Found: Equiv. wt. 115.6, Se 33.86. Calc. for $C_4H_{11}NSeO_5$: Equiv.wt. 116.05; Se 34.02).

4-Seleninobutyric acid hydronitrate. The oxidation of 4.6 g (0.014 mole) of 4,4′-diseleno-di-butyric acid [9] gave 7.1 g (98 %) of 4-seleninobutyric acid hydronitrate, m.p. 81.5—83° (d). (Found: Equiv.wt. 87.1; C 18.34; H 3.52; Se 29.99. Calc. for $C_4H_9NSeO_7$: Equiv. wt. 87.36; C 18.33; H 3.46; Se 30.13).

5-Seleninovaleric acid hydronitrate. The oxidation of 5.0 g (0.014 mole) of 5,5′-diselenodivaleric acid [10] gave 7.7 g (100 %) of 5-seleninovaleric acid hydronitrate. Recrystallization of the crude product from concentrated nitric acid gave an analytical sample, m.p. 99—102° (d). (Found: Equiv.wt. 91.3; C 21.78; H 3.99; Se 28.48. Calc. for $C_5H_{11}NSeO_7$: Equiv.wt. 92.04; C 21.75; H 4.02; Se 28.60).

3-Selenino-isovaleric acid hydronitrate. The oxidation of 2.0 g (0.006 mole) of 3,3′-diseleno-di-isovaleric acid [11] gave 3.0 g (98 %) of 3-selenino-isovaleric acid hydronitrate. Recrystallization of the crude product from concentrated nitric acid gave an analytical sample as colourless needles, m.p. 76—78° (d). (Found: Equiv.wt. 92.6; C 21.96; H 4.01; Se 28.69. Calc. for $C_5H_{11}NSeO_7$: Equiv.wt. 92.04; C 21.75; H 4.02; Se 28. 60).

4-Selenino-2,2-dimethylbutyric acid hydronitrate. The oxidation of 2.0 g (0.005 mole) of 4,4′-diseleno-di-(2,2-dimethyl) butyric acid[12] gave 3.0 mole (100 %) of 4-selenino-2,2-dimethylbutyric acid hydronitrate, m.p. 98—100° (d). (Found: Equiv.wt. 97.0. C 25.04; H 4.54; Se 27.29. Calc. for $C_6H_{13}NSeO_7$: Equiv. wt. 96.71; C 24.84; H 4.52; Se 27.21).

4-Selenino-3,3-dimethylbutyric acid hydronitrate. The oxidation of 2.6 g (0.007 mole) of 4,4′-diseleno-di-(3,3-dimethyl)butyric acid [12] gave 3.85 g (100 %) of 4-selenino-3,3-dimethylbutyric acid hydronitrate, m.p. 118—120° (d). (Found: Equiv.wt. 96.7; C 24.70; H 4.55; Se 27.13. Calc. for $C_6H_{13}NSeO_7$: Equiv. wt. 96.71; C 24.84; H 4.52; Se 27.21).

5-Selenino-3,3-dimethylvaleric acid hydronitrate. The oxidation of 2.6 g (0.006 mole) of 5,5′-diseleno-di-(3,3-dimethyl)valeric acid [12] gave 3.75 g (99 %) of 5-selenino-3,3-dimethylvaleric acid hydronitrate, m.p. 116—118° (d). (Found: Equiv.wt. 101.0; C 27.76; H 5.01; Se 25.85. Calc. for $C_7H_{15}NSeO_7$: Equiv.wt. 101.39; C 27.64; H 4.97; Se 25.96).

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The Preparation of 3-Halopropyl Isothiocyanates and 5,6-Dihydro-2-sulphanilamido-4*H*-1,3-thiazine

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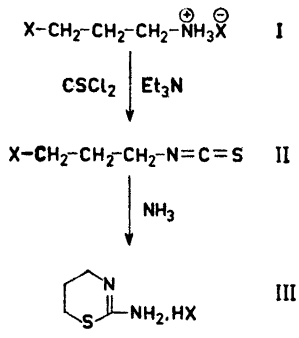
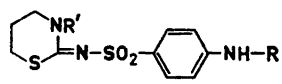
In connection with other work in this laboratory it became of interest to prepare the previously unknown 3-chloro- and 3-bromo-propyl isothiocyanates (II, X = Cl or Br). Both were readily obtained by reaction of the corresponding amine salt (I, X = Cl or Br) with thiocarbonyl chloride and triethylamine, conditions commonly utilized in isothiocyanate synthesis.

Upon treatment with methanolic ammonia, both isothiocyanates (II) cyclized as expected to the corresponding salts of 2-amino-5,6-dihydro-4*H*-1,3-thiazine (III, X = Cl or Br). Recently, Schöberl *et al.*[1,2] synthesized the hydrobromide (III, X = Br) by a cyanide-induced cyclization of 3-aminopropyl thiocyanate hydrobromide, whereas the hydrochloride (III, X = Cl) was produced from the hydrobromide *via* the free amine. The same authors also demonstrated that the reaction of 3-bromopropylamine with thiocyanate does not afford the cyclic compound (III, X = Br) as originally proposed by Gabriel and Lauer,[3] but rather 3-aminopropyl thiocyanate hydrobromide.[2]





IVa, R = Ac; R' = (p)-AcNHC$_6$H$_4$SO$_2$.
IVb, R = R' = H
IVc, R = Ac; R' = H

Upon reaction with *p*-acetamidobenzenesulphonyl chloride in pyridine the hydrobromide (III, X = Br) was transformed into the bis-derivative (IVa) which on acid hydrolysis was further converted into 5,6-dihydro-2-sulphanilamido-4*H*-1,3-thiazine (IVb, or the tautomeric form). Acetylation of the latter afforded the N-acetyl derivative (IVc).

We consider this to be the first synthesis of authentic specimens of these sulphonamides. Jensen and Possing[4] correctly interpreted the product obtained from the reaction between *p*-acetamidobenzenesulphonyl chloride and '2-amino-dihydrothiazine hydrobromide', followed by acid hydrolysis, as bis-3-sulphanilylaminopropyldisulphide. However, these authors, as well as others,[5,6] were obviously misled by the fact that their starting material, Gabriel and Lauer's 'Trimethylen-ψ-thioharnstoff'[3] in fact consisted of 3-aminopropyl thiocyanate hydrobromide.[2]

The sulphonamide (IVb) is presently being investigated for bacteriostatic activity.