This method has been used in our laboratory in the investigation of some aspects of the biosynthesis of collagen. The method could also be used in studying the incorporation of labelled compounds into other proteins, and can be especially valuable in studies on collagen because proline and hydroxyproline are easily separated by thin layer chromatography. Also there is no significant loss of material in the procedure. When comparing the analysis time of this method with others it should be remembered that no time is required here for the preparation of samples. Furthermore, this method has the particular advantage that it enables the incorporation of practically all collagen amino acids to be studied simultaneously and from a single experiment on the same thin layer plates. In addition, it is not necessary to use a separate method for the isolation of the different labelled collagen amino acids, a fact that facilitates the comparison of incorporation of the different amino acids.

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## Heteroaromatic Boron Compounds

## IV. 3,2-Borazaropyridine. A New Aromatic System

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During the last years, there has been a considerable interest in preparing the boraza analogue of benzene, viz. borazarene.

The first derivative of this new monocyclic boron-nitrogen containing system was synthesised by Dewar et al. in 1962, who reported the preparation of 2,3-diphenyl - 6 - (2 - carbomethoxy-ethyl)-2,1borazarene (II) by desulphurization of 2carbomethoxy-5,6-diphenyl-5,4-borazaro-benzothiophene (I). Later, White <sup>2</sup> pre-pared 2-phenylborazarene and Dewar *et al.*<sup>3</sup> recently published the synthesis of some other simple borazarene derivatives. The UV-spectrum of 2-phenylborazarene closely resembles that of 2-phenylpyridine and gives evidence for the aromatic nature of this compound. The above mentioned compounds have only been prepared in small amounts and little is known about their chemical properties.

Gronowitz et al.<sup>4-6</sup> have prepared derivatives of the three possible borazarothienopyridines. From these systems, it should be possible to prepare derivatives of the boraza analogue of pyridine, namely 3,2borazaropyridine, which as far as we know has not been prepared before.

We have succeeded in preparing 4-ethyl-3- hydroxy-2- methyl-3,2- borazaropyridine (IV) in 49 % yield by desulphurization of 4- hydroxy -5- methyl -4,5- borazarothieno

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[2,3-c]pyridine (III). As III is easily obtained from commercially available 3-bromothiophene, this method appears to be a preparatively useful route to 3,2-borazaropyridines, making possible a detailed study of the chemistry of this new

Our structural proof for IV is based on a correct elementary analysis for  $C_6H_{11}BN_2OS$ , and on the MS-spectrum, which shows strong peaks at m/e=137-138, corresponding to the molecular ions. Further, this spectrum shows strong peaks at m/e=122-123 and m/e=110-111, which correspond to  $[M-CH_3]^+$  and  $[M-HCN]^+$ . The last fragmentation is characteristic for nitrogen-containing

heterocyclic compounds.

The structural proof is further based on the completely resolved NMR-spectrum. The NMR-spectrum in deuterochloroform shows six bands; two doublets at  $2.34 \tau$  and  $3.03 \tau$ , two singlets at  $4.40 \tau$  and  $6.39 \tau$ , a quartet at 7.53 \tau and a triplet at 8.82 \tau, with relative intensities of 1:1:1:3:2:3, respectively. The bands at  $7.55 \tau$  and 8.82 $\tau$  can be assigned to the ethyl group and show a coupling constant of 7.5 c/s. The bands at  $4.40 \tau$  and  $6.39 \tau$  can be assigned to the OH and N-CH<sub>3</sub> hydrogens, respectively. The bands at  $2.34 \tau$  and 3.03 $\tau$ , which show a coupling constant of 4.4 c/s, can be assigned to the 5- and 6-hydrogens. If the band at 3.03  $\tau$ , which is rather broad, belongs to the 5hydrogen, the broadening can be due to a small long-range coupling to the methylene hydrogens in the ethyl group. Decoupling brought about by irradiation of the methylene group caused better resolution of the 3.03  $\tau$  band indicating coupling between the 5-hydrogen and the methylene hydrogens. The band at lowest field (2.34 τ) must therefore belong to the 6-hydrogen. In analogy with pyridine, it is also to be expected that the resonance of the hydrogen at the azomethine carbon occurs at lowest field.

The UV-spectrum of IV in ethanol shows maxima at 228 m $\mu$  ( $\varepsilon$  2410) and at 273 m $\mu$  ( $\varepsilon$  7930) and shows resemblance to the UV-spectrum of 3-hydroxypyridine in ethanol. It is most probable that the measured spectrum is that of the ethyl ether as compounds of this type undergo exchange of RO groups attached to boron very rapidly. No change was observed in the UV-spectrum of IV in 1 N hydrochloric acid and 1 N sodium hydroxide over a period of one week. This, together with

the fact that the double bond in the boroncontaining ring remained intact during the desulphurization of III, indicates that IV is an aromatic compound of considerable stability.

Experimental. 4-Ethyl-3-hydroxy-2-methyl-3,2-borazaropyridine. To a solution of 6.64 g (0.04 mole) of 4-hydroxy-5-methyl-4,5-borazarothieno[2,3-e]pyridine 5 in 200 ml of ethanol was added 60 g of Raney nickel catalyst (LS-S-32). After refluxing for 3 h, the catalyst was filtered off and the filtrate evaporated in vacuo. The residue (4.0 g) was chromatographed on a silica gel column and eluted with ether. The first fraction was evaporated in vacuo and the residue recrystallized from hexane, giving 2.7 g (49 %) of 4-ethyl-3-hydroxy-2methyl-3,2-borazaropyridine in colourless crystals, m.p. 63-70°C. Upon standing or distillation, some ether formation occurred. UV (ethanol):  $\lambda_{\text{max}} \ \text{m} \mu \ (\varepsilon \times 10^{-3}) \ 228 \ (2.41); \ 273$ (7.03). NMR (CDCl<sub>3</sub>):  $\tau_6$  2.34,  $\tau_5$  3.03,  $\tau_{OH}$  4.40,  $\tau_{NCH_5}$  6.39,  $\tau_{CH_5CH_5}$  7.55 – 8.82;  $J_{56}$  = 4.40 c/s, and  $\tau_{CH_5CH_5}$  = 7.75 c/s. (Found: C 52.04; H 7.49; N 20.84. Mol.wt. 137 – 138. Calc. for C<sub>6</sub>H<sub>11</sub>BN<sub>2</sub>OS (138.0): C 52.22; 7.04; N 20.29). The NMR-spectrum was obtained on a Varian A-60 NMR-spectrometer using tetramethylsilane as internal standard. The IR-spectrum was obtained on a Perkin Elmer 257 grating infrared spectrophotometer. The UV-spectra were obtained on a Unicam SP 800 ultraviolet spectrophotometer. The MS-spectrum was obtained on an LKB-9000 mass-spectrometer using a direct inlet system. The elementary analyses were carried out by Miss Ilse Beetz, Mikroanalytisches Laboratorium, Kronach.

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