gation was undertaken to address this question.

Since the segment from Leu-189 to Arg-215 labeled with [^{125}I]TID in vesicular complex[4], our interest was to cleave off the C-terminal segment including this stretch from apo A-I. For this purpose, apo A-I preparation was treated with 2 M hydroxylamine (1-5 mg/ml) in 6 M guanidine hydrochloride and the pH was adjusted to 9.6. This solution was incubated for 4 h at 45℃. Under this condition it is expected that the peptide bond between Asn-184 and Gly-185 is cleaved[5]. The reaction was terminated by introducing formic acid to bring the pH to 2-3. The C-terminal-depleted apo A-I (C^- apo A-I) was isolated using the gel elution method and its purity was confirmed by Laemmli SDS-PAGE[6]. Unilamellar ^{3}H-DPPC vesicle was prepared by the reverse phase evaporation method[7]. The size range of the vesicle was reduced to 500-700 Å in diameter with a Heat System Sonifier cell disrupter.

Figure 1 shows the elution profiles of DPPC vesicle/apo A-I protein complexes at molar ratios of 5000 and 100, respectively, and that of DPPC vesicle/C^- apo A-I protein complex at the molar ratio of 100. These profiles were obtained by incubating vesicle/protein mixture for 24 h at 42℃ and then passing through a Sepharose CL-4B column (1.4×40 cm). The lipid concentration was determined by liquid scintillation counting. The concentration of the apo A-I protein was monitored by measuring fluorescence intensity of dansylated protein[8]. The C^- apo A-I concentration was obtained by the Lowry method[9].

Figure 1c, when compared with Figure 1a and b, shows that C^- apo A-I is present in the vesicular complex as well as in the micellar complex. This may, in turn, mean that the C-terminal section of apo A-I is not indispensable for breaking down the vesicles. The reduced micellization capability of C^- apo A-I as compared to that of intact protein may be simply due to the decreased length of the polypeptide chain.

In view of an earlier obsevation that only the C-terminal segment of apo A-I protein interacts with the vesicles when the lipid/protein value is large[4], the appreciable binding of C^- apo A-I to the vesicles as shown in Figure 1c is somewhat unexpected. The only explanation we have now is that parts other than the C-terinal region, which remains attached to the vesicles when digested with trypsin, also initially bind to the vesicle. Further digestion experiments with C^- apo A-I protein is required to shed light on this problem.

Acknowledgement. Supported in part by the Korea Science and Engineering Foundation which is gratefully appreciated.

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Reaction of *arachno*-$S_2B_7H_8^-$ with $(CO)_5Cr\{C(OCH_3)R\}$: Synthesis and Characterization of *arachno*-4-RCH_2-6,8-$S_2B_7H_8$ (R=CH_3, IIa; C_6H_5, IIb).

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Received November 18, 1991

Arachno-$S_2B_7H_8^-$ has been shown to react with a variety of polarizable organic compounds[1] such as nitriles and ketones to generate the corresponding *hypho*-$CH_3CNS_2B_7H_8^-$[2] and *hypho*-$S_2B_6H_9$,[-3] respectively.

$$S_2B_7H_8^- + CH_3CN \rightarrow \textit{hypho}\text{-}CH_3CNS_2B_7H_8^- \quad (1)$$

$$S_2B_7H_8^- + (CH_3)_2CO \rightarrow \textit{hypho}\text{-}S_2B_6H_9^- \quad (2)$$

The result of the reactions above suggests that the *arachno*-$S_2B_7H_8^-$ anion might also readily attack other polarized multiple bonds. We have found that *arachno*-$S_2B_7H_8^-$ anion readily reacts with Fisher-type carbene complexes[4] at room temperature. In contrast to the reactions with nitriles and ketones, cage addition results in the production of new alkyl substituted thiaboranes, *arachno*-4-RCH_2-6,8-$S_2B_7H_8$ (R=CH_3 **IIa**; C_6H_5 **IIb**), in good yield.

In a typical experiment, a solution of $Na^+S_2B_7H_8^-$ was prepared by the reaction *in vacuo* of excess NaH(~0.1 g, 4.2 mmol) with *arachno*-6,8-$S_2B_7H_9$[5] (0.45 g, 3 mmol) in tetrahydrofuran (~25 mL) at ~−20℃. To this solution 0.80 g (3.2 mmol) of $(CO)_5Cr\{C(OCH_3)CH_3\}$[6] in THF was added at −78℃ and allowed to warm slowly to room temperature and continued to stir overnight. The solution gradually turned dark green, suggesting the formation of a chromathiaborane complex. Protonation with HCl followed by extraction with hexane gave a reddish-yellow solid. Subsequent separation was performed by flash chromatography with hexane to give 0.18 g (1.01 mmol) of *arachno*-4-CH_3CH_2-6,8-$S_2B_7H_8$ **IIa**. This corresponds to a 34% yield based on consumed *arachno*-6,8-$S_2B_7H_9$.

In an analogous reaction, 0.45 g (3 mmol) of *arachno*-6,8-$S_2B_7H_9$, ~0.1 g (4.2 mmol) of NaH, and 1.0 g (3.2 mmol) of $(CO)_5Cr\{C(OCH_3)C_6H_5\}$[7] were reacted in ~30 mL of THF *in vacuo*. The reaction mixture was initially warmed to −20 ℃ whereupon the solution also gradually turned dark green.

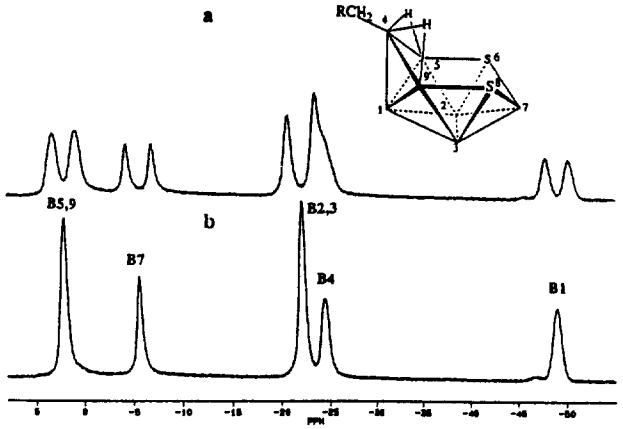


Figure 1. The 64.2 MHz ^{11}B NMR spectrum of **IIa**. Spectrum b is proton spin decoupled.

The reaction was then allowed to react at 0℃ for 1 h. The solution was stirred for another 18 h at room temperature, resulting in a color change to dark brown. Protonation, followed by TLC separation of the resulting reaction mixture gave 0.21 g (0.9 mmol) of *arachno*-4-$C_6H_5CH_2$-6,8-$S_2B_7H_8$ **IIb**. This corresponds to a 30% yield based on consumed *arachno*-6,8-$S_2B_7H_9$.

Exact mass measurements support the proposed composition of $CH_3CH_2S_2B_7H_8$ **IIa**[8] and $C_6H_5CH_2S_2B_7H_8$ **IIb**[9]. ^{11}B spectra of both **IIa** and **IIb** (Figure 1) exhibit a 2 : 1 : 2 : 1 : 1 intensity ratio indicating the presence of a molecular mirror plane. In addition, the resonances at $\partial = -24.6$ (**IIa**) and $\partial = -25.1$ (**IIb**) ppm are singlets, indicating alkyl substitution at the 4-position boron atom. The ^1H NMR spectrum of **IIa** and **IIb** contain upfield resonances, consistent with the presence of bridging hydrogens. The ^1H NMR spectrum of **IIa** contains a triplet and quartet indicative of an ethyl group. The ^1H NMR spectrum of **IIb** contains signals consistent with the presence of a benzyl group.

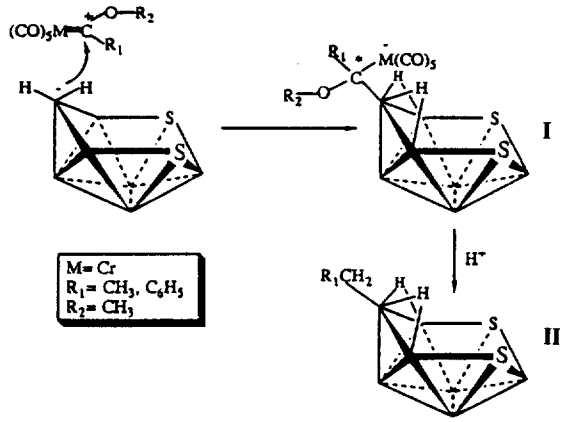
The formation of **IIa** and **IIb** suggests the following reaction route is involved.

$$S_2B_7H_8^- + (CO)_5Cr\{C(OCH_3)(R)\} \rightarrow [(CO)_5Cr\{C(OCH_3)(R)(S_2B_7H_8)\}]^-\mathbf{I} \quad (3)$$

$$\mathbf{I} \xrightarrow{H^+} \textit{arachno}\text{-}4\text{-}RCH_2\text{-}6,8\text{-}S_2B_7H_8 \quad (R = CH_3\ \mathbf{IIa},\ C_6H_5\ \mathbf{IIb}) \quad (4)$$

We postulate that the mechanism involves the reaction of *arachno*-$S_2B_7H_8^-$ with the polarized metal-carbon bond of $(CO)_5Cr\{C(OCH_3)CH_3\}$ to form an intermediate complex of $(CO)_5Cr\{C(OCH_3)(CH_3)S_2B_7H_8\}^-$**I**, which is the expected addition product. The ^{11}B NMR spectrum[10] of **I** shows seven resonances, where the peak at −21.5 ppm exhibits a singlet upon proton coupling. This splitting pattern arises from the attachment at the 4-position of *arachno*-$S_2B_7H_8^-$ to the assymetric center of $(CO)_5Cr\{C(OCH_3)CH_3\}$. Due to the unstable nature of this intermediate **I**, we were unable to isolate this complex.

We provide a reasonable synthetic route to the *arachno*-4-RCH_2-6,8-$S_2B_7H_8$ (R = CH_3 **IIa**, C_6H_5 **IIb**) dithiaborane system. These results suggest that nucleophilic *arachno*-$S_2B_7H_8^-$ may be able to attack other polarized metal-carbon bonds



providing a new synthetic route to cage carbon dithiaborane clusters. We are continuing to study both the scope of these reactions and the chemistry of these unique alkylated dithiaborane clusters.

Acknowledgment. The present studies were supported in part by the Basic Science Research Institute program, Ministry of Education, 1990 and Non Directed Research Fund, Korea Research Foundation 1989. We thank Professor Larry G. Sneddon for his help in obtaining NMR results and for his useful discussions and suggestions.

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8. ^{11}B NMR (64.2 MHz, ppm, C_6D_6) 2.0 (d, $B_{5,9}$, J_{BH} = 155 Hz), −5.7 (d, B_7, J_{BH} = 170 Hz), −22.2 (d, $B_{2,3}$, J_{BH} = 180 Hz), −24.6 (s, B_4), −49.0 (d, B_1, J_{BH} = 150 Hz); ^1H NMR (200.13 MHz, ppm, C_6D_6, ^{11}B spin-decoupled) 0.9 (t, CH_3), 0.7 (q, CH_2), −1.2 (br, BHB); exact mass calcd for $^{11}B_7{}^{12}C_2{}^1H_{11}{}^{32}S_2$ 176.0954, found 176.1007; Rf = 0.98 in Hexane; IR spectrum (KBr pellet, cm^{-1}) 2950 m, 2920 w, 2860 w, 2570 s, 1455 w, 1255 m, 1090 m, br, 1050 w, 1020 m, br, 925 w, 900 w, 850 w, 800 m, 750 w, 695 w, 590 w.
9. ^{11}B NMR (64.2 MHz, ppm, C_6D_6) 2.6 (d, $B_{5,9}$, J_{BH} = 160 Hz), −5.8 (d, B_7, J_{BH} = 170 Hz), −21.2 (d, $B_{2,3}$, J_{BH} = 190 Hz), −25.1 (s, B_4), −48.1 (d, B_1, J_{BH} = 150 Hz); ^1H NMR (200.13 MHz, ppm, C_6D_6) 7.15 (m, CH of C_6H_5), 7.10 (m, CH of C_6H_5), 6.98 (m, CH_2 of C_6H_5), 2.11 (s, CH_2), −1.1 (broad, BHB); exact mass calcd for $^{11}B_7{}^{12}C_7{}^1H_{13}{}^{32}S_2$ 238.1110, found 238.1082; Rf = 0.42 in Hexane; IR spect-

rum (KBr pallet, cm^{-1}) 3070 w, 3020 w, 2920 w, 2890 w, 2570 s, 2360 w, 1600 w, 1495 m, 1450 w, 1380 w, 1260 w, 1070 w, 1030 s, 1000 w, 980 w, 970 w, 940 w, 900 w, 860 m, 800 w, 755 m, br, 740 m, br, 700 s, 670 w, 650 w, 620 w, 600 w, 530 w, 485 w, 470 w.

10. ^{11}B NMR (160.5 MHz, ppm, CD_3CN) 11.3 (d, $J_{BH}=160$ Hz), 8.4 (d, $J_{BH}=145$ Hz), −7.0 (d, $J_{BH}=145$ Hz), −8.8 (d, $J_{BH}=145$ Hz), −16.8 (d, $J_{BH}=130$ Hz), −21.5 (s), −42.6 (d, $J_{BH}=130$ Hz).

Stereochemical Process in the 1,4-Addition of a Hydroxyl Group to α,β-Unsaturated Carboxylic Esters

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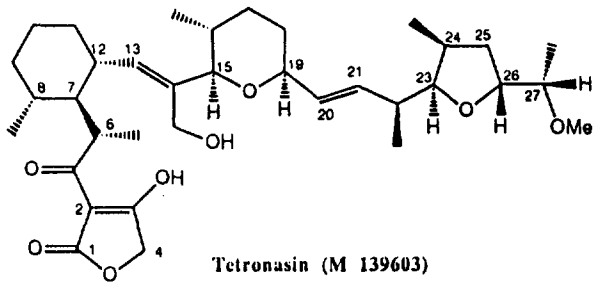
Received December 9, 1991

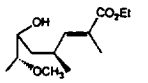
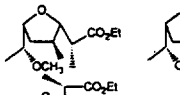
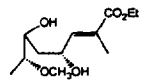
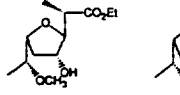
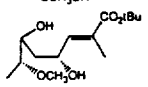
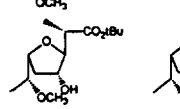
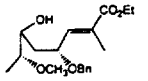
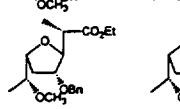
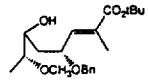
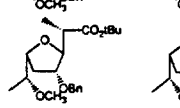
As a part of our synthetic effort toward tetronasin[1] we had a plan of the construction of tetrahydrofuran fragment utilizing the intramolecular 1,4-addition reaction of a hydroxyl group to α,β-unsaturated esters. And it was necessary for us to investigate the stereochemical process about this kind of reaction because the stereochemical outcome of this reaction was crucial in our synthetic scheme. Herein we report stereochemical process in the synthesis of tetrahydrofuran rings *via* 1,4-addition of a hydroxyl group to α,β-unsaturated carboxylic esters.



Tetronasin (M 139603)

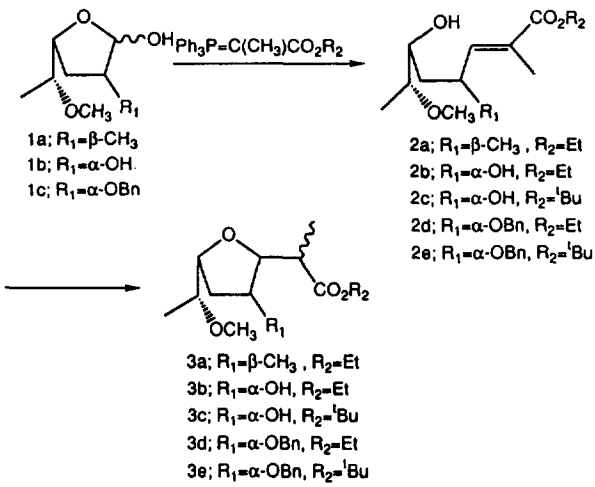
During our synthetic routes to tetronasin, Witting reaction[2] of tetrahydrofuranoid hemiacetal **1a-1c** gave the esters of (*E*)-6-hydroxy-2-enoic acids (**2a-2e**), which were subsequently converted to the corresponding tetrahydrofuran rings **3a-3e** *via* intramolecular 1,4-addition. To see the stereochemical outcome for the formation of the tetrahydrofuran rings, we examined the role of γ-substituents in the stereochemical induction and the results are outlined in Table 1. The stereochemical assignment of the tetrahydrofuranyl esters was determined by ^1H-NMR spectroscopy[3,4]. Furthermore, in order

Table 1. Cyclization of α,β-Unsaturated Esters

Entry	α,β-Unsaturated Esters	Method[a]	Products	Yield[b] (ratio[c])
1		A		94% (2 : 1)
2		A		92% (3 : 1)
3		B		93% (4 : 5)
4		A		84% (2 : 3)
5		B		62% (1 : 3)

[a]Method A: NaOEt (2 eq). Method B: NaO^{t}Bu (2 eq.). [b]Yields refer to isolated products after chromatographic purification. [c]Ratios refer to isomeric products and are based on 300 MHz ^1H-NMR analysis of reaction mixtures.

to determine the stereochemistry of the compound **3a**, the compound **2a** was converted to the reduced alcohol derivative of **3a** *via* a series of reactions including epoxidation-cyclization process[5].



It is noteworthy that all of the compounds **2a-2e** ended as 2,3-*trans* derivatives of tetrahydrofuran rings. The *trans* relationship between C-4 substituent and side chain of the tetrahydrofuranyl ester at C-1 can be accounted by the cyclization *via* more stable conformation as shown Figure 1, where R_M and R_L stand for medium and large substituents at γ-position of the α,β-unsaturated ester, respectively.

Relating to the stereochemical role of the hydroxyl substituents at γ-position of the α,β-unsaturated esters, Felkin's model predicts that the nucleophile would attack the face opposite to the allylic oxygen function because of the anti-bonding effects of secondary orbital[6]. Thus, conformations of **2a-2e** contributing to the cyclization to tetrahydrofuran rings in our system are shown in the Figure 1. Accordingly,