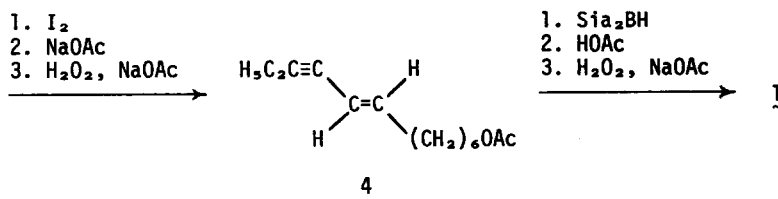
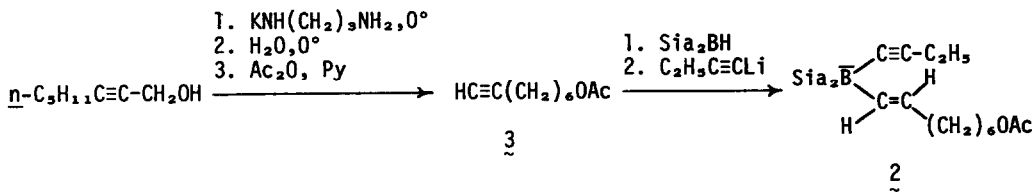
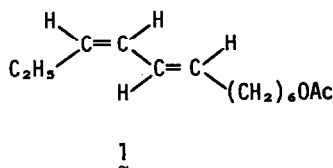


A HIGHLY EFFICIENT CHEMO-, REGIO-, AND STEREOSELECTIVE  
 SYNTHESIS OF (7E, 9Z)-DODECADIEN-1-YL ACETATE, A SEX PHEROMONE  
 OF LOBESIA BOTRANA, VIA A FUNCTIONALIZED ORGANOBORATE

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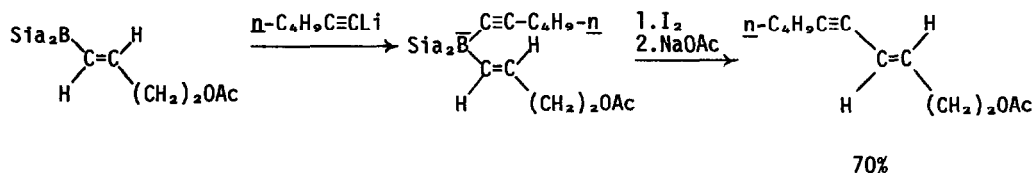
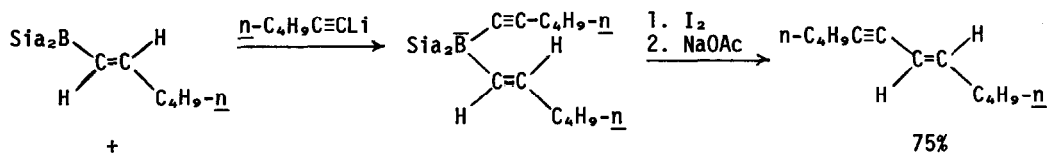
(Received in USA 17 November 1976; received in UK for publication 6 January 1977)

Herein described is a highly efficient, four-step synthesis of a natural sex pheromone of the European grape vine moth, Lobesia botrana, (7E, 9Z)-7,9-dodecadien-1-yl acetate (1).<sup>1</sup>



A total synthesis of the title compound was achieved recently in no less than eight steps and in no more than ca. 10% yield from 1-butyne, acrolein and 3-bromopropanol,<sup>1</sup> the stereoselectivity being ca. 80%. It was evident that the stereoselective conjugated diene synthesis developed recently by us<sup>2</sup> was eminently applicable to the synthesis of 1. However, the development of an efficient chemoselective procedure based on this diene synthesis, which would not involve any protection-deprotection sequence, required the generation of the crucial borate intermediate containing an acetoxy group (2). Virtually no information concerning this point was available.

To test such a possibility we therefore treated a mixture consisting of 5 mmoles each of (E)-1-hexenyldisiamylborane (sia=3-methyl-2-butyl) and n-butyl acetate dissolved in THF with 5 mmoles of 1-hexynyllithium in hexane-THF at  $-78^\circ$ , followed by gradual warming to room temperature. GLC analysis of the mixture revealed the presence of 5 mmoles of n-butyl acetate, indicating that the reaction took place selectively between the organoborane and 1-hexynyllithium to form the corresponding borate.<sup>2</sup> This was confirmed by obtaining (E)-5,7-dodecenyne in 75% after treatment of the reaction mixture with iodine followed by sodium acetate.<sup>3</sup> Encouraged by these observations we then treated 4-acetoxy-1-butenyldisiamylborane sequentially with 1-hexynyllithium, iodine, and sodium acetate. There was obtained in 70% yield (E)-3,5-decenyne-1-yl acetate which was >99% E by GLC. These preliminary results not only demonstrate that, under these conditions, even reasonably hindered triorganoboranes are much more reactive toward alkynyllithiums than the acetoxy group, but also point to a hitherto unexplored, potentially general possibility of generating various functionalized organoborates<sup>4</sup> and utilizing these reagents in chemoselective syntheses.



7-Octynyl acetate (3), bp 66-67° (0.9 mm), required for the generation of the organoborate 2 was prepared in 72% yield in 2 steps from 1-heptyne via the acetylene "zipper" reaction<sup>6</sup> of 2-octyn-1-ol with 2.5 equivalents of potassium 3-aminopropylamide at 0°, followed by acetylation of the crude worked-up mixture. The alkynyl acetate (3) was converted into (E)-7,9-dodecenyln-1-yl acetate (4) by sequential treatment with disiamylborane (1 equiv, 0°, -30°, 1 hr then 0°, 1 hr), 1-butyryllithium (1 equiv, -78 to -50°, 1-2 hr), iodine (1 equiv, -78 to 0°, 2-3 hr), and sodium acetate (1 equiv, 0 to 25°, 0.5 hr), followed by extraction (ether), washing (H<sub>2</sub>O), oxidation (30% H<sub>2</sub>O<sub>2</sub> and sodium acetate, 30-40°), washing (H<sub>2</sub>O, sodium bisulfide, H<sub>2</sub>O) and column chromatography (neutral alumina, activity 4). The yield of 98% pure 4 was 60% (70% by GLC), and the isomeric purity of the purified 4 as well as the crude reaction mixture was ca. 99% by GLC and <sup>13</sup>C NMR.<sup>7</sup> The spectral data for 4 are as follows: <sup>1</sup>H NMR (CDCl<sub>3</sub>, TMS) δ 1.12 (t, J = 7 Hz, 3H), 0.8-1.8 (m, 8H), 2.02 (s, 3H), 1.8-2.5 (m, 4H), 4.05 (t, J = 6 Hz), 5.42 (d, J = 16 Hz, 1H), and 6.05 (dt, J = 16 and 7 Hz, 1H) ppm; <sup>13</sup>C NMR (CDCl<sub>3</sub>, TMS) δ 13.05, 14.05, 20.87, 25.88(2H), 28.69, 28.82, 64.46, 78.85, 89.91, 110.33, 142.73, and 170.85 ppm; ir (neat) 2210(w), 1735(s), 1235(s), 955(m) cm.<sup>-1</sup>.

The conversion of 4 into the target diene 1 was carried out as reported previously<sup>1,3</sup> by the hydroboration of 4 with 1 equivalent of disiamylborane, followed by protonolysis with acetic acid (50°, 6 hr), evaporation at reduced pressure, oxidation with 30% H<sub>2</sub>O<sub>2</sub> and sodium acetate. <sup>13</sup>C NMR examination of the crude reaction mixture indicated that the isomeric purity of the dienic product was ≥ 98%.<sup>8</sup> After column chromatography (neutral alumina, activity 4), pure 1, ≥ 98% isomeric purity, was obtained in 93% yield, <sup>1</sup>H NMR (CDCl<sub>3</sub>, TMS) δ 0.99 (t, J = 7 Hz, 3H), 1.1-1.9 (m, 8H), 2.03 (s, 3H), 1.9-2.5 (m, 4H), 4.07 (t, J = 6 Hz, 2H), and 5.05-6.65 (m, 4H) ppm; <sup>13</sup>C NMR (CDCl<sub>3</sub>, TMS) δ 14.33, 21.04, 25.85, 28.63, 28.86, 29.31, 32.80, 64.55, 125.77, 128.08, 131.68, 134.29, and 171.04 ppm; ir (neat) 1740(s), 1235(s), 990(s), 950(m) cm.<sup>-1</sup>. The GLC and spectral behaviors of the product were indistinguishable from those of an authentic sample.<sup>1</sup> The overall yield based on 1-butyne and 1-heptyne is ca. 40%.

**Acknowledgments.** We thank Dr. J. N. Labowitz of Zoecon, Corp., for providing an authentic sample of 1 and spectral data, and Dr. C. A. Brown of IBM for informing us of the details of the acetylene "zipper" reaction prior to publication. This work was supported by the donors of the Petroleum Research Funds, administered by the American Chemical Society, the National Science Foundation (MPS75-06106) and Syracuse University.

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(c) J. C. Lindhoudt, G. L. van Mourik, and H. J. J. Pabon, Tetrahedron Letters, 2565 (1976).
7. The (Z)-isomer has a slightly shorter GLC retention time (SE-30) and exhibits the olefinic <sup>13</sup>C NMR signals at  $\delta$  109.6 and 141.8 ppm.
8. Simple GLC analysis with 1/8 in. columns has failed to separate the isomers of 1. However, they are separately observable by <sup>13</sup>C NMR. The (E,E)- isomer exhibits the olefinic <sup>13</sup>C signals at  $\delta$  129.48, 130.65, 132.06, and 133.95 ppm.