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STEREOSELECTIVE SYNTHESIS OF A SEX ATTRACTANT OF THE CODLING MOTH[1]

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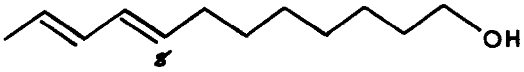
The codling moth, *Laspeyresia* (*Carpocapsa*) *pomonella* (Lepidoptera: Tortricidae:Olethreutinae) is a major worldwide pest of apple orchards. The isolation of the sex pheromone produced by the virgin female was reported in 1969,[3] but the structure of the sex attractant remained unknown until Roelofs and co-workers proposed[4] that the codling moth attractant compound was *trans*-8, *trans*-10-dodecadien-1-ol (**1**). The synthetic compound **1** was shown to be very attractive to the male moths in the field.[4,5] We wish to describe here a short stereoselective synthesis of **1** starting from cyclopropyl bromide and tetrahydropyran.



1

Reaction of cyclopropylmagnesium bromide with freshly distilled *trans*-crotonaldehyde in tetrahydrofuran at -30° gave in 60% yield 4-cyclopropyl-2-buten--4-ol (**2**) [bp 57° (7mm)]. Ring opening of this secondary cyclopropylcarbinol by rapid stirring with 48% aqueous HBr at 0° for 15 minutes according to the method of Julia[6] gave in 90% yield the homoallylic bromide **3** [bp 63° (6mm); nmr ($CDCl_3$) δ:multiplet of 4 olefinic H at 6.4-5.1, triplet (*J*=7Hz) at 3.38 ($C\underline{H}_2Br$), quartet at 2.67, doublet (*J*=6.0Hz) at 1.75 ppm (CH_3-CH=C); ir (film) 990 (*trans*,*trans*), 950 cm^{-1} (*trans*,*cis*)]. Glc analysis of the latter indicated that it was a mixture of the *trans*,*trans*-isomer (90%) and the *trans*,*cis*-isomer (10%); however, in view of the final isomer ratio obtained in the synthetic product (Table I), 3 probably only contained *ca.* 80% of the *trans*,*trans*-isomer.

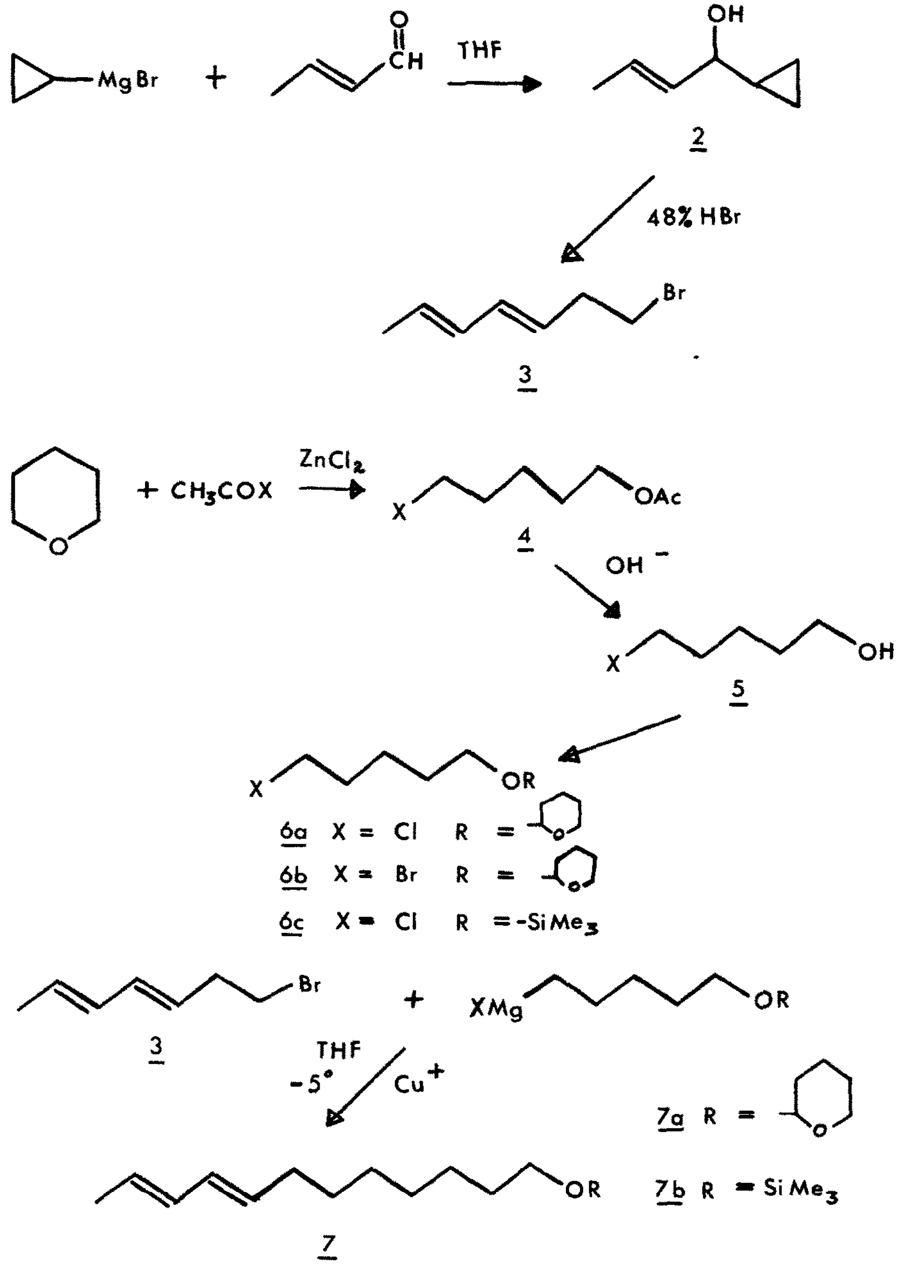
The C-5 halo alcohols 5 were prepared by the opening of tetrahydropyran with acetyl chloride (or acetyl bromide) and a zinc chloride catalyst, followed by hydrolysis of the intermediate halo acetates 4.[7] The alcohol group was protected using either a tetrahydropyranyl mixed acetal function (6a and 6b)[8] or a trimethylsilyl ether group (6c).[9] Coupling of the Grignard reagent prepared from the C-5 halo ether 6 in tetrahydrofuran with the C-7 homoallylic bromide 3 was carried out at -5° via the organo-copper (I) intermediate using catalytic quantities (*ca.* 0.3%) of dilithium tetrachlorocuprate[10] to give 7 in good yield (Table I).

TABLE I

 6	 7	
	Yield of 7 (from 6) after distillation	% *trans*,*trans*-isomer*
X = Cl R = 	85%	78%
X = Br R = 	60%	79%
X = Cl R = $-SiMe_3$	80%	77%

(*determined by glc after removal of the protecting group and distillation.[11])

Hydrolysis of the protecting group in 7a [*p*-toluenesulfonic acid in aqueous methanol, 50° for 2 hr] or 7b [aqueous ethanol, reflux 2 hr] gave in high yield the free alcohol 1 [bp 89-90° (0.2mm)] containing *ca.* 80% of the *trans*,*trans* isomer.[11] This material readily crystallized and recrystallization from pentane at -5° gave a high recovery of the pure *trans*,*trans*-isomer 1 [mp 29-30°, nmr ($CDCl_3$) δ:multiplet of 4 olefinic H at 6.4-5.2, triplet (*J*=7Hz) at 3.63 (CH_2OH), two allylic H at 2.05; doublet (*J*=6.0Hz) at 1.73 ppm ($CH_3-CH=C$); ir (film) 3380, 1060, 990 cm^{-1}].[12]


MgBr
+
CH
THF
OH
2
48% HBr
Br
3
+ CH3COX
ZnCl2
X
OAc
4
OH −
X
OH
5
X
OR
6a X = Cl R =
6b X = Br R =
6c X = Cl R = -SiMe3
Br
3
+
XMg
OR
THF
-5°
Cu+
7a R =
OR
7b R = SiMe3
7

The alternative coupling procedure, that of reaction of the Grignard prepared from **3** with **6b** under copper salt catalysis as above, gave a 60% yield (after distillation) of **7a** but the product contained only 68% of the *trans*,*trans*-isomer, indicating some loss of stereochemistry during either the formation of the Grignard reagent from **3** or during the coupling reaction.

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(1) Contribution No. 8 from the Research Laboratory of Zoecon Corporation.

(2) Zoecon postdoctoral fellow, 1971-1972.

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(11) All 4 isomers of **1** could be resolved by careful glc analysis. The pure *trans*,*trans*-isomer was more attractive to the male moths in the field than were the other isomers of **1** or mixtures containing predominantly the *trans*,*trans*-isomer.[4,5]

(12) All new compounds were fully characterized. The recrystallized sex attractant of mp 29-30° was shown to be 99+% pure by careful glc analysis.