

A NEW STEREOSPECIFIC SYNTHESIS  
OF SEX PHEROMONES OF INSECTS OF THE (Z)-ALKENYL-1-ACETATE SERIES  
BASED ON SELECTIVE OZONOLYSIS OF 1-METHYL-1Z,5Z-CYCLOOCTADIENE

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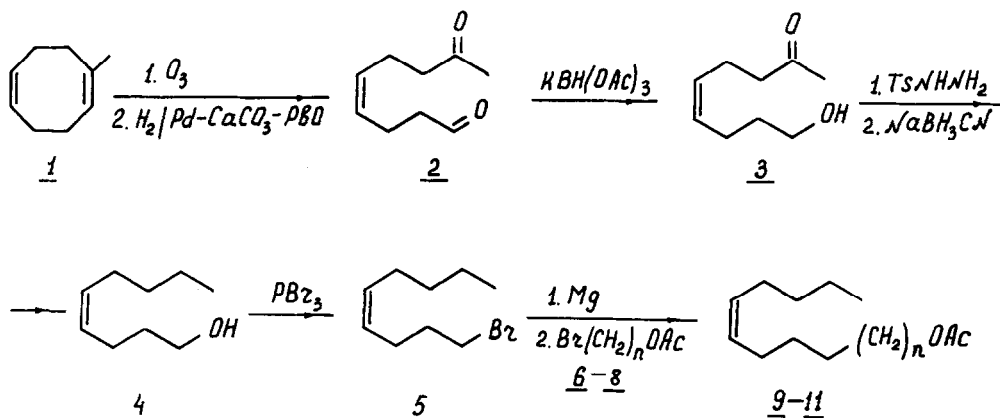
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Partial ozonolysis of 1-methyl-1Z,5Z-cyclooctadiene gives 8-oxo-4Z-nonene-1-al, which is converted to Lepidoptera pheromones after subsequent transformations.

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Synthesis of Lepidoptera pheromones of the (Z)-alkenyl-1-acetate series normally involves a route using acetylene. We have developed a new approach to the synthesis of sex pheromones of this class based on selective ozonolysis of 1-methyl-1Z,5Z-cyclooctadiene (1).

It has been established that in partial ozonolysis of 1 the trisubstituted double bond is selectively cleaved by ozone, and the resulting aldehyde contains a disubstituted double bond exclusively of (Z)-configuration. This fact has been used to construct the hydrocarbon skeleton of the title compound.

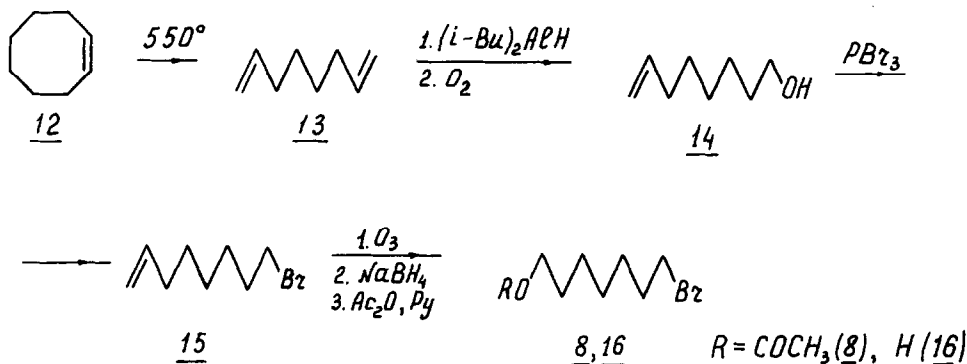
## Scheme 1



$n=3$ (6,9),  $5$  (7,10),  $7$  (8,11).

For selective ozonolysis of 1, use is made of 0.9 mol equiv. of  $\text{O}_3$  in cyclohexane at  $5^\circ\text{C}$  in the presence of 1 mol equiv. of MeOH, followed by selective hydrogenation of the ozonide over Lindlar catalyst at  $20^\circ\text{C}$ . This gives 8-oxo-4Z-nonene-1-al (2)<sup>3</sup> in 85% yield, b.p.  $74^\circ\text{C}/1 \text{ mm}$ . Selective reduction of 2 by treatment with a suspension of  $\text{KBH(OAc)}_3$  in benzene (2 mol equiv.  $\text{KBH}_4$ , 7 mol equiv. AcOH) yields 60% of 9-hydroxy-5Z-nonene-2-one (3).<sup>3</sup> The keto group is transformed to a methylene group by treatment of the tosylhydrazone 3 with  $\text{NaBH}_3\text{CN}$ ;<sup>5</sup> the yield of 4Z-nonene-1-ol (4)<sup>3</sup> is 60%. Bromination of 4 (1.33 mol equiv.  $\text{PBr}_3$  in dry benzene,  $100^\circ\text{C}$ , 1 h and then  $80^\circ\text{C}$ , 2 h) gives the key synthon 1-bromo-4Z-nonene (5)<sup>3</sup> in 85% yield after purification by chromatography ( $\text{Al}_2\text{O}_3$ , pentane). Reaction of the Grignard reagent obtained from 5 with 1-acetoxy-3-bromopropane (6),<sup>6</sup> 1-acetoxy-5-bromopentane (7)<sup>7</sup> and 1-acetoxy-7-bromoheptane (8) gives 1-acetoxy-7Z-dodecene (9), 1-acetoxy-9Z-tetradecene (10) and 1-acetoxy-11Z-hexadecene (11), the sex pheromones *Trichoplusia ni*,<sup>1</sup> *Spodoptera frugiperda*<sup>1</sup> and *Scotogramma trifoli*.<sup>8</sup>

The acetate 8 required for synthesis of the pheromone 11 is obtained from (Z)-cyclooctene (12) as outlined in Scheme 2.

Scheme 2

Pyrolysis of 12 by the method described in Ref.<sup>9</sup> gives 1,7-octadiene (13) in 95% yield at 35% conversion. Selective hydroaluminumation of 13 (0.34 mol equiv.  $(i\text{-Bu})_3\text{Al}$  in *n*-heptane at 100°C for 5 h) and subsequent oxidation of the organoaluminum compound (after dilution with  $\text{Et}_2\text{O}$ ) with air (25°C, 3 h) then with  $\text{O}_2$  (25°C, 2 h) gives, after hydrolysis of the reaction mixture with 10% HCl, 80% of 7-octene-1-ol (14).<sup>3</sup> Bromination of 14 (1.33 mol equiv.  $\text{PBr}_3$  in dry benzene at 10°C for 1 h, then 80°C, 2 h) gives 8-bromooctene-1 (15)<sup>3</sup> in 85% yield after chromatography ( $\text{Al}_2\text{O}_3$ , pentane). Ozonolysis of 15 (MeOH, -70°C) followed by reduction of ozonide with  $\text{NaBH}_4$  in MeOH yields 95% of 7-bromoheptane-1-ol, which is converted to 8 on treatment with  $\text{Ac}_2\text{O-Py}$  (2 : 3).<sup>3</sup>

A solution of the Grignard reagent obtained from 5 in THF is slowly added to 1 M equiv. of 8 and  $\text{Li}_2\text{CuCl}_4$ <sup>10</sup> (50 ml of 0.1 M solution of  $\text{Li}_2\text{CuCl}_4$  in THF to 1 mol of 8) in THF at 10 to 15°C to give 85% of the pheromone 11 after purification by chromatography ( $\text{Al}_2\text{O}_3$ , pentane). Similarly, coupling of 5 with 6 and 7 gives the pheromones 9<sup>3</sup> and 10<sup>3</sup> respectively.

Thus, the above five-stage synthesis gives six pheromones of the (Z)-alkenyl-acetate series in an overall yield of 20% based on the starting cyclic codimer of isoprene and 1,3-butadiene.

## REFERENCES AND NOTES

1. M.Jacobson, Sex Pheromones of Insects, "Mir" Publishers, Moscow, 1976, 246, 248 (in Russian).
2. C.A.Henrick, Tetrahedron, 33, 1845 (1977).
3. Analytical and Spectroscopic Data (IR, PMR, mass-spectr.) are consistent with the assigned structure.
4. G.W.Gribble and D.C.Ferguson, J. Chem. Soc., Chem. Commun., 1975, 535.
5. C.F.Lane, Synthesis, 1975, 135.
6. I.J.Borowitz, G.J.Williams, L.Gross, and R.Rapp, J. Org. Chem., 33, 2016 (1968).
7. J.Goldsmith, E.Kennedy, and R.G.Campbell, J. Org. Chem., 40, 3571 (1975).
8. D.L.Struble and C.E.Swaiels, Environ. Entomol., 4, 632 (1975).
9. U.S. Patent, 3388282 (1968); RZhKhim, 20 H, 30 (1969).
10. M.Tamura and J.Kochi, Synthesis, 1971, 303.
11. G.A.Tolstikov, U.M.Djemilev, and G.E.Ivanov, ZhOrKh, 11, 984 (1975).

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