Molecular rearrangements in longipinane derivatives

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Abstract. Suitable oxygen substituted 2,6,6,9-tetramethyltricyclo[5.4.0.02,8]undec-9-ene (longipinene) derivatives or their saturated analogues, which are both isolated as esters from nature, can be transformed to several new ring-system containing molecules, which include 4,8,8-trimethyl-9-methyleneperhydro-1,5-methanonaphthalene, 4,8,8-trimethyl-9-methylene-1,2,4a,5,6,7,8,8a-octahydro-1,5-methanonaphthalene, 8,8,9-trimethyl-4-methyleneperhydro-1,3,5-methanonaphthalene, 2,6,6,11-tetramethyltricyclo[5.4.0.04,8]undecane, 2,6,6,9-tetramethyltricyclo[5.4.0.04,8]undecane and 4,4,8,9-tetramethylperhydro-1,7-methanonaphthalene derivatives.

INTRODUCTION

Longipinines deserve their name from the parent hydrocarbon, α-longipinene (1), described as a constituent of Pinus sylvestris (1). Compounds with this sesquiterpene skeleton and with different degrees of oxydation (2-3) have been found in Stevia (2-6), Critonia (3), Polypteris (7) and Artemisia (8). During the last decade, we established the stereochemistry (5), absolute configuration (6) and conformation (6) of these structurally complex sesquiterpenes and described a full characterization of many of these molecules.

Since these tricyclic strained longipinane and longipinene derivatives offer the possibility to generate new ring systems, because bond migration can be promoted to release the four-membered ring strain, we describe at present the transformation of compounds of types 2-3 into several new ring-system containing molecules.
4,8,8-TRIMETHYL-9-METHYLENEPERHYDRO-1,5-METHANONAPHTHALENE AND 4,8,8-
TRIMETHYL-9-METHYLENE-1,2,4a,5,6,7,8,8a-OCTAHYDRO-1,5-METHANONAPHTHA-
LENE DERIVATIVES.

Treatment of 3 (R is angelate) with TsOH affords 4 (R is tiglate) in
93% yield (9). Similarly 3 (R is acetate) was converted to 4 (R is
acetate) in 89% yield by means of BF₃·Et₂O. However, when the α,β-un-
saturated carbonyl analogue of 3 (R is acetate) was treated under the
latter reaction conditions, it afforded 5 in only 21% yield, while the
conversion of the analogue of 3 (R is acetate) having the secondary
methyl group with the β configuration afforded 6 in 64% yield.

![Diagram](image)

When diol 7 was subjected to the molecular rearrangement with TsOH it
afforded 8 in 36% yield and 9 in 54% yield.

![Diagram](image)

The mechanism for the transformation of 7 to 8 and 9 involves the pro-
tonation of the C-9 hydroxyl group to provide the intermediate that
meets the requirements for the antiperiplanar C-4/C-10 bond migration.
The tertiary carbonium ion at C-10 can eliminate a proton from the
methyl group to yield 8, or it can undergo an intramolecular transan-
nular hydride migration assisted by the C-7 hydroxyl group to provide
9. This hydride migration was demonstrated by deuterium labeling.

8,8,9-TRIMETHYL-4-METHYLENEPERHYDRO-1,3,5-METHANONAPHTHALENE DERIVA-
TIVE.

Suitable substituted longipinene derivatives can also be rearranged
under basic reaction conditions.
Treatment of dimesylate 10 with KOH afforded the Wagner-Meerwein rearrangement product 11 in 26% yield, together with the further rearranged product 12 in 54% yield. The structure of 11 was tested by correlation with 8, while that of 12 was verified by X-ray studies.

2,6,6,11-TETRAMETHYLTRICYCLO[5.4.0.0^4,8]UNDECANE DERIVATIVES.

Treatment of 13 with KOH provided the stereoisomers 14 and 15 in 58% and 21% yield, respectively. The structure and stereochemistry of both reaction products were determined by X-ray studies.

A plausible reaction mechanism assumes the hydrolysis of the angelate groups followed by the subtraction of the proton from the 8-hydroxyl group. An oxygen assisted 1,2-hydride shift from C-8 to C-9 eliminates the mesylate group, to provide a 7-hydroxy-8-ketolongipinane. The 7-hydroxyl group epimerizes to a mixture of two compounds. Each of them can then loose a proton from C-9 and the C-9 carbanion can form a C-9/C-10 double bond with the simultaneous C-10/C-11 bond migration to C-11/C-8.

2,6,6,9-TETRAMETHYLTRICYCLO[5.4.0.0^4,8]UNDECANE DERIVATIVE.

The double bond on the six-membered ring has a marked influence on the reaction outcome, as is evident when the unsaturated molecule 16 is treated under the basic reaction conditions.

In this case, 16 provides the single rearrangement product 17 in 67% yield. Here the C-4/C-10 bond migrates to C-4/C-8, instead of the C-10/C-11 bond that migrates when a saturated six-membered ring is present. The structure and stereochemistry of the rearrangement product 17 was again verified by X-ray analysis.
4,4,8,9-TETRAMETHYLPERHYDRO-1,7-METHANONAPHTHALENE DERIVATIVE.

The last molecular rearrangement we describe herein is again performed under acid conditions. Treatment of 3 (R is acetate) with TsOH affords 4 (R is acetate) in 42% yield and the new skeleton containing compound 18 in 33% yield. Its structure and stereochemistry were established by X-ray studies.

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3 \rightarrow 4 + 18
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The reaction mechanism for the transformation assumes the protonation of the 9-hydroxyl group followed by the antiperiplanar bond migration. The derived C-10 carbonium ion can trap a molecule of water to provide the tertiary alcohol and the C-10/C-11 bond can migrate to C-2/C-10, which is also alpha to the carbonyl group.

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REFERENCES