



Part I - Pinacol rearrangement Part II - chemistry of 4,7,8,9-tetrahydrophthalans Part III - a synthesis of frontalin

by Rodney Dale Otzenberger

A thesis submitted to the Graduate Faculty in partial Fulfillment of the requirements for the degree of DOCTOR OF PHILOSOPHY in Chemistry

Montana State University

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Abstract:

An attempt was made to study the effects of ring size and glycol stereochemistry on the pinacol rearrangement using cis- and trans-perhydropindan-8, 9-diols. Since only the more stable of the two possible spiroketone products, spiro [4,4 ] nonan-1-one, was obtained, it was concluded that under the conditions used product distribution was determined by product stability, The effect of the oxygen in the tetrahydrophthalans upon the reactivity of the alkene bond was investigated using competitive oxymercuration experiments, A trans-annular stabilization of positive charge by the oxygen non-bonding electrons was proposed to account for the increased reactivity of cis-4, 7,8,9-tetrahydrophthalan, A new synthesis of frontalin, a sex attractant pheromone of the southern pipe beetle, *Dendroctonus frontalis*, is described utilizing the Diels-Alder reaction of methyl vinyl ketone with methyl methacrylate, lithium aluminum hydride reduction of the adduct to the corresponding alcohol, and cyclization to 1,5-dimethyl-6, 8-dioxabicyclo [3,2,1 ] octane, frontalin, by oxymercuration-demercuration.

PART I — PINACOL REARRANGEMENT  
PART II — CHEMISTRY OF 4,7,8,9-TETRAHYDROPHTHALANS  
PART III — A SYNTHESIS OF FRONTALIN

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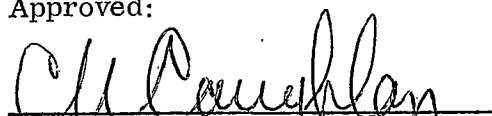
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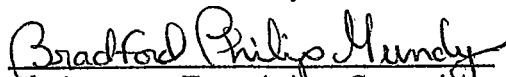
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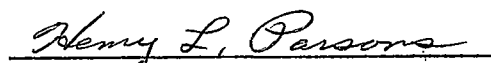
in

Chemistry

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MONTANA STATE UNIVERSITY  
Bozeman, Montana

August, 1971

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To

Del, Bret, and Danny

## ACKNOWLEDGMENTS

I would like to take this opportunity to express my gratitude to the many people, faculty and fellow graduate students, who helped make this thesis possible. In particular I would like to thank my wife, Del, and my advisor, Brad Mundy, who were the ever shining lights at each end of a sometimes dark street and my parents who gave me the ability and the desire to complete such an undertaking.

A special thank you goes to Gail Peterson for typing the rough draft of this thesis as well as a multitude of letters, and to Dick DeBernardis for his many hours of help and companionship. Also, Professor Henry Gerry deserves thanks for allowing us to "borrow" many pieces of laboratory equipment.

Acknowledgment is also due to the National Defense Education Act for the support provided by a fellowship, Montana State University for support in the form of a teaching assistantship, and Dr. James Lotan of the United States Forest Service for the donation of frontalin.

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ABSTRACT

An attempt was made to study the effects of ring size and glycol stereochemistry on the pinacol rearrangement using cis- and trans-perhydroindan-8, 9-diols. Since only the more stable of the two possible spiroketone products, spiro [4,4]nonan-1-one, was obtained, it was concluded that under the conditions used product distribution was determined by product stability.

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A new synthesis of frontalin, a sex attractant pheromone of the southern pine beetle, Dendroctonus frontalis, is described utilizing the Diels-Alder reaction of methyl vinyl ketone with methyl methacrylate, lithium aluminum hydride reduction of the adduct to the corresponding alcohol, and cyclization to 1,5-dimethyl-6,8-dioxabicyclo [3,2,1] octane, frontalin, by oxymercuration-demercuration.

"Never measure the height of a mountain, until you have reached the top.  
Then you will see how low it was."

--Dag Hammarskjöld

PART I

The Effects of Ring Size and Glycol Stereochemistry  
on the Pinacol Rearrangement

## INTRODUCTION

Since its discovery in 1860 by Fittig, the pinacol rearrangement has been extensively studied.<sup>1-33</sup>

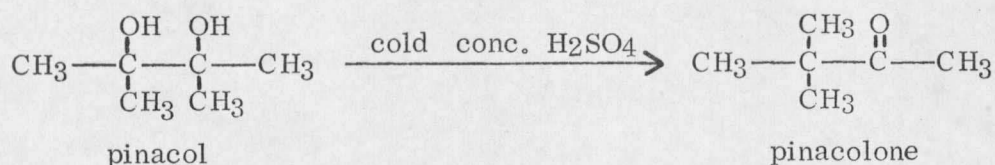
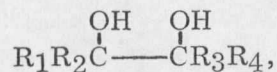


Figure 1. The Pinacol Rearrangement

The term, pinacol rearrangement, has been used to describe the acid catalyzed rearrangement of any glycol of the general structure,



where  $\text{R}_1$ ,  $\text{R}_2$ ,  $\text{R}_3$ , and  $\text{R}_4$  can be alkyl, aryl, and hydrogen or any combination thereof. Rearrangements of  $\alpha$ -halo- and  $\alpha$ -aminoalcohols have also been described as "pinacol type" rearrangements. Collins<sup>1</sup> and Pocker<sup>21</sup> have reviewed the pinacol rearrangement.

Kinetics, kinetic isotope effects, isotope tracer studies, and acidity function correlations have been used to establish the mechanism shown in Figure 2.<sup>1-33</sup> Linear plots of Hammett's acidity function,  $\text{H}_0$ , versus the log of the rate constant indicate that the pinacol rearrangement is an A-1 (acid catalyzed-first order) reaction with the rate determining step being the loss of water from (B) to form the carbonium ion (C).<sup>30</sup> The protonation step, (A) to

















































































































































































































































































































































































