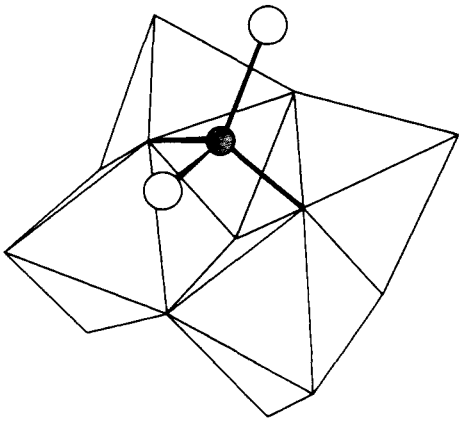

Figure 1. Structure of $[(CH_3)_2AsMoO_{14}OH]^{2-}$: O, CH_3; ●, As; octahedra represent MoO_6 groups.

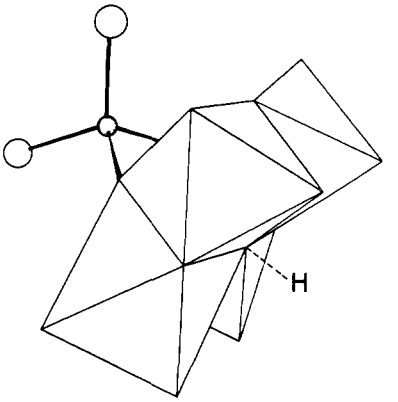

Figure 2. View of the $[(CH_3)_2AsMoO_{14}OH]^{2-}$ structure showing probable location of the hydrogen atom: O, CH_3; ●, As; octahedra represent MoO_6 groups.

As part of a program to explore and develop the chemistry of organic derivatives of heteropoly complexes,[3] we have synthesized some molybdate complexes of dialkyl and diaryl arsinic acids. The complexes have the general formula $[R_2AsMo_4O_{14}(OH)]^{2-}$ with R = CH_3, C_2H_5, and C_6H_5. Ten salts, with sodium, potassium, guanidinium, tetramethyl-, and tetrabutylammonium counterions have been crystallized and characterized by elemental analysis and uv, ir, and NMR measurements. Salts of the dimethyl derivative appear to have been prepared earlier by Rosenheim and Bilecki[4] but were not investigated further.

The heteropoly complexes are readily prepared from stoichiometric quantities of sodium molybdate and the appropriate arsinic acid at pH 4-5. The anions thus formed are stable within the pH range 2-6 according to uv spectra (maximum at ca. 250 nm).

The guanidinium salt, $(CN_3H_6)_2[(CH_3)_2AsMo_4O_{14}(OH)]\cdot H_2O$, crystallizes as large monoclinic blocks with the following crystal data (Mo $K\alpha_1$, λ 0.70926 Å): space group $P2_1/c$; $Z = 4$; $a = 8.531$ (2), $b = 8.527$ (2), $c = 30.129$ (5) Å; $\beta = 95.49$ (2)^0; $\rho_{calcd} = 2.65$, $\rho_{obsd} = 2.62$ (2) g cm^{-3}. X-Ray intensity data were collected by automated diffractometer and the solution and refinement of the structure were carried out by standard methods. The final conventional unweighted R based on 2519 observed reflections was 0.045. The details of the structure determination will appear in a later publication.

The remarkably compact and symmetrical anion consists of a ring of four alternately face- and edge-shared MoO_6 octahedra capped by the $(CH_3)_2AsO_2$ tetrahedron as shown in Figure 1. The structure represents only the second example[5] of a heteropoly complex containing face-shared octahedra. The metal-to-oxygen bond distances are similar to those found in other heteropoly molybdates and can be classified into distinct groups according to the type of oxygen involved. Metal-oxygen distances for each group range as follows: (1) terminal oxygens, 1.689 (8)-1.721 (8) Å, (2) oxygens bridging two metals, 1.901 (7)-1.940 (7) Å, (3) oxygens bridging two metals and an arsenic, 2.267 (7)-2.339 (7) Å. The unique basal oxygen is asymmetrically located. Three molybdenum-oxygen distances are 2.375 (7), 2.341 (7), and 2.393 (7) Å while the fourth is 2.542 (7) Å. The unique oxygen lies 0.725 (7) Å below the 3.16 × 3.36 Å rectangular plane formed by the metals.

The stoichiometry of all the salts prepared indicates that the anion contains a proton which is not directly revealed by the X-ray data. Although potentiometric titrations with sodium hydroxide show only a single well-defined end point corresponding to the reaction

$$R_2AsMo_4O_{14}(OH)^{2-} + 7OH^- \rightarrow R_2AsO_2^- + 4MoO_4^{2-} + 4H_2O$$

the presence of the proton is confirmed by a narrow line at 1.98 ppm in the NMR spectrum of $(Bu_4N)_2[(CH_3)_2AsMo_4O_{14}(OH)]$ in dichloromethane and by a sharp infrared absorption at 3615 cm^{-1} in a Nujol mull of the same salt. The integrated intensity of the NMR line is one-sixth that of the $As(CH_3)_2$ protons, which occurs at 2.19 ppm. The chemical shift of the OH proton is some 4 ppm upfield from that of the "internal" protons[6] in the metatungstate ion, $H_2W_{12}O_{40}^{6-}$ and indicates absence of hydrogen bonding in the molybdoarsinate case. The 1.98 ppm resonance disappears when methanol is added to the solution, showing that the proton is labile. The most probable location of the proton is the unique basal oxygen of the Mo_4O_{15} group as shown in Figure 2. This position is consistent with the X-ray data for the guanidinium salt which show a tightly bound water of hydration 2.8 Å from the oxygen in question. The asymmetric location of the basal oxygen mentioned above presumably accommodates this hydrogen bonding arrangement. That a proton attached to the exterior of a heteropoly oxoanion should be effectively nonacidic in aqueous solution is highly unusual. Many possibilities exist for the further derivativization of such complexes.

References and Notes

(1) Supported by the Office of Naval Research through Contract No. N00014-69-A-0220-0009.
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The Thermal Isomerization of 5-Acetyl-5-methylbicyclo[2.1.0]pentane. Endo-Exo Stereomutation and Cyclopropyl-Allylic Rearrangement of the Endo Ketone on Separate Potential Energy Surfaces

Sir:

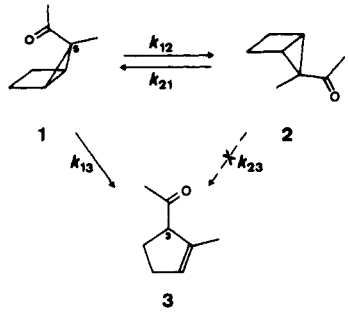
The concurrent thermal endo-exo stereomutation of 5-acetylbicyclo[2.1.0]pentanes and rearrangement to 3-acetyl-1-cyclopentenes have been described previously by ourselves[1] and by Jorgenson,[2] and the cyclopropyl-allylic rearrangement, e.g., **1** → **3**, was shown to involve 1,2-migration

Table I. First-Order Rate Constants at 200° and Activation Parameters of the Thermal Reactions of the 5-Acetyl-5-methylbicyclo[2.1.0]pentanes 1 and 2 in Benzene

Reaction	k,[a] sec^{-1}	$\Delta H^{\ddagger}$,[b] kcal/mol	$\Delta S^{\ddagger}$,[b] eu
1 → 2	(9.30 ± 0.22) × 10^{-2}	33.4 ± 0.8	−1.5 ± 1.7
2 → 1	(2.42 ± 0.15) × 10^{-2}	33.9 ± 0.9	−3.0 ± 2.0
1 → 3	(1.96 ± 0.22) × 10^{-3}	22.2 ± 2.2	−33.0 ± 4.7
2 → 3	<2.96 × 10^{-7}		

[a] Ca. 0.16 *M* solutions of **1** in sealed glass tubes; VPC analysis on a Carbowax K1540 capillary column at 120° of five samples at each of ten time intervals. For k_{23} see also footnote 6. The rate constants remained the same within experimental error when ~3% pyridine was added to a solution of **1** at 200°. [b] Activation parameters calculated from rate data at 160, 180, 200, and 220°. Errors are standard deviations, and the correlation coefficients are 0.998 (1 → 2), 0.997 (2 → 1), and 0.996 (1 → 3).

of the acetyl group.[3] We now report that the rearrangement to **3** occurs specifically from the *endo*-acetylbicyclopentane (**1**) and that this process and the endo–exo interconversion **1** ⇄ **2** do not involve a common intermediate.



The thermolyses of ketones **1** and **2** were carried out in benzene solution at 160, 180, 200, and 220°, compound **3** remaining unchanged under these conditions.[4] Best-fit rate constants were then calculated using programs designed to handle up to four components linked by equilibria,[5] and these data and associated activation parameters are shown in Table I.

Our kinetic results provide a clear mechanistic differentiation of the two fundamental thermal isomerization processes observed in 5-acetylbicyclo[2.1.0]pentanes. The order in rate constants, $k_{12} > k_{21} > k_{13}$ and $k_{23} \sim 0$,[6] and the significant gap in activation entropies between the stereomutations **1** ⇄ **2** and the rearrangement **1** → **3** strictly preclude that the two types of reaction involve a common intermediate.[7]

The unusually large negative entropy of activation for **1** → **3** indicates that the rearrangement proceeds through a highly ordered transition state and is suggestive of a concerted electrocyclic process involving the four electrons of the internal cyclopropane and the C(5)-acetyl bonds. Disrotatory opening of the former bond would selectively permit the *endo*-acetyl substituent of **1** to transfer by forming a transom of appropriate Möbius topology.[8,9]

A cyclopentane 1,3-biradical path constitutes one possible mechanism for the endo–exo interconversion **1** ⇄ **2**,[11] and indeed cleavage of the central bond has been demonstrated experimentally for 5-benzoyloxybicyclo[2.1.0]pentanes.[12] However, such π-donating substituents on C-5 lower the isomerization barrier[10,13] by enhancing the antibonding character in the central bond,[14] and therefore both an analogous path and the alternative cleavage of an external cyclopropane bond[15] remain possible for the endo–exo stereomutation of **1** and **2**. Work with 5-acetyl-1,5-dimethylbicyclo[2.1.0]pentane to clarify this question is in progress.

Acknowledgment. This work was supported by the Fonds National Suisse de la Recherche Scientifique and by Firmenich SA, Geneva. Professor R. W. Rozett, Fordham University, provided his computer programs (KIN1 and KIN4) and the University of Geneva allotted us free time on the CDC 3800 computer.

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(6) The rate constant k_{23} given in Table I is the *maximum* value computed to comply with the other rate data.
(7) A referee has taken the alternate view that there may indeed be a common intermediate by suggesting that the formation of **3** from **1** could also follow the cyclopentane 1,3-biradical path; i.e., **2** could give rise to **1** solely by external bond cleavage whereas **1** could afford **2** by *both* internal and external bond cleavage. This difference in cleavage specificities is to be rationalized in terms of the difference in overlap between the external bond and the π-bond of the carbonyl group in **1** and **2** (which in fact is apparent from the ir spectra of these ketones at room temperature[4]). However, if this were so, the reactions **1** → **2** and **1** → **3** would be expected to have similar $\Delta S^{\ddagger}$ values rather than exhibit a drastic difference in entropy of activation as observed.
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Molecular Basis for Prostaglandin Potency. I. The Case for Biological Significance of Media Dependent Conformational Changes

Sir:

We have for some time been intrigued by the problem of deciphering the stereostructural requirements for pharmacological action[1] of the classical prostaglandins, PGE's and PGF's.[2] Unlike most natural substances of such extraordinary potency the prostaglandins do not present a spatially well-defined skeleton for the contemplation and manipulation of the student of structure–activity relationships (SAR), rather an a priori floppy array in which the several chiral centers can adopt very different relative spatial orientations.[3] As a result of reviewing the SAR data in the open literature,[4] we have proposed, as a working hypothesis, that the ready attainment of a conformation (designated the hairpin[4,5]) in which the two side chains are closely and specifically aligned[5] is a feature of those E- and F-type prostaglandins showing high potency in stimulating contraction of smooth musculature.[9] We now present evidence that $PGF_{2\alpha}$ and the related primary alcohol display media-dependent changes in the CD spectrum in the olefinic span (185–220 nm) which are best rationalized as the result of side-chain alignment in protic media and further that less potent diastereomers do not display these features.