of the aforementioned salt to potassium cyanide[16a,17] in hot dimethylformamide[16b,18] produced the ring cleaved α and β nitriles **7c** in a 4:1 ratio, respectively (58% yield).[19] The nitriles could also be prepared *via* the chloroindolenine route[19,16b] from 14,15-dehydroquebrachamine (**7e**).[13] Acid hydrolysis of either nitrile provided 14,15-dehydroquebrachamine, locating the nitrile function at C-16. The respective α and β esters **7d** were prepared from the corresponding nitriles by saponification and subsequent esterification with diazomethane.[16b] The same mixture of esters could be obtained (tlc comparison) by reduction of (−)-tabersonine according to Le Men.[20] Oxidation of the major isomer, α-ester **7d**, with platinum–oxygen in ethyl acetate according to Schmid[21] afforded (±)-tabersonine (hydrochloride, mp 187° dec), whose identity with an authentic sample of (−)-tabersonine[22] was demonstrated by comparative thin layer chromatography and solution infrared, ultraviolet, and mass spectroscopy.

Whereas allocatharanthine (**9**) is produced from tabersonine in hot acetic acid solution, no sign of allocatharanthine was observed (tlc) in the oxidative cyclization.[23] Similar selective oxidations with platinum–oxygen have recently been reported[24] in related systems.

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(25) National Institutes of Health Predoctoral Fellow, 1968–1971.

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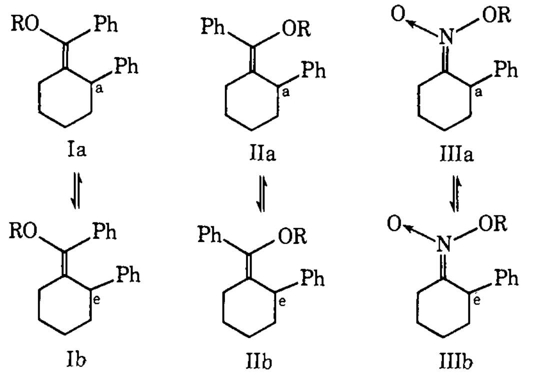
Allylic$^{(1,3)}$ Strain. A Defense

Sir:

In 1965 we published[1] two stereochemical theorems dealing with allylic strain in six-membered rings. These ideas were applied[2,3] among other ways in explaining (a) the preferred conformation in the ground state of molecules such as I, II, and III and (b) the stereochemical consequences of C protonation of I, II, and III (R = H or metal). In essence we contended that the cyclohexane ring in these molecules assumes, dominantly, conformation Ia, IIa, or IIIa in which the phenyl ring is axially oriented in order to minimize the Ph–Ph or Ph–OR interaction, as the case may be, in conformation Ib, IIb, or IIIb. With regard to C protonation of the enolic forms of these molecules we suggested that protonation occurs "axially" (*i.e.*, from the least-hindered side[4]) and produces largely the cis isomer of benzoyl- or nitro-2-phenylcyclohexane.



These ideas have been criticized recently (a) by Zimmerman and Mariano,[5] who have cast doubt on the validity of the nmr data that formed the experimental underpinning of the $A^{(1,3)}$ strain concept, and (b) by Bordwell and his coworkers,[6–8] who have carried out extensive kinetic studies on the protonation of acinitro compounds such as III (R = alkali metal) and on the deprotonation of the related nitro compounds. These results, together with ultraviolet data, and an examination of molecular models, led the latter workers to conclude[8] that (1) the ground state of III (R = alkali metal) is IIIb and (2) the preferred transition state for the C protonation of II (R = alkali metal) does not have geometry around C-1 similar to that of II.

Whereas we reserve comment on the second conclusion, our recent results, which are discussed below, lead us to reject the first contention, completely.

In connection with the conformational preference of I (R = Ac) and II (R = Ac), we have compared the nmr values of their benzylic protons with those of a series of model compounds in which the orientation of the corresponding hydrogen atom is known (Table I).

The results indicate that our original suggestion is correct, *i.e.*, that the sum of two gauche coupling constants ($J_{AX} + J_{BX}$) as observed for an equatorial benzylic proton is significantly less than the sum of a gauche and trans coupling required for the corresponding axial proton and thus *the width at half-height*[9] *for the benzylic proton is a valid probe* for assessing the conformational preference of I and II, and also undoubtedly of III.

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(9) The benzylic resonance which is the X of an ABX spin system can display a wide variety of splitting patterns which depend on the chemical shift and coupling constants involved. For clarification purposes the results in Table I are expressed as $J_{AX} + J_{BX}$ since in all systems considered here the line width at half-height or separation of the outside peaks, as the case may be, represent at worst an upper limit for this sum, assuming all coupling constants have the same sign.

Table I

Compd	$(J_{AX} + J_{BX})$, Hz
I	7.88
II	8.98
2-Phenylcyclohexanone	16.75
2-Phenylcyclohexanone oxime (anti)	13.96
trans-2,6-Diphenylcyclohexanone	13.10
cis-2,6-Diphenylcyclohexanone	17.56
III (R = H)[a]	9.0
trans-2,6-Diphenylcyclohexanone oxime	
Syn proton	7.56
Anti proton	16.86
cis-2,6-Diphenylcyclohexanone oxime[b]	
Syn proton	7.69
Anti proton	11.22

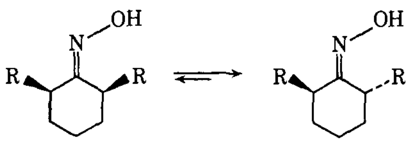
[a] Reference 2. [b] We believe that the low values observed here are due to distortion in the cyclohexylidene ring arising from the strong interaction between the hydroxyl group and the C-2 phenyl ring. An attempt is being made to determine the exact structure of this oxime by means of X-ray analysis.

In benzene-d_6 the nmr spectrum of I shows two sets of aromatic resonances centered at δ 7.08 and 7.49, each having narrow frequency distributions. Decoupling the benzylic proton causes pronounced multiplicity changes in the upfield aromatic signals showing them to be associated with the phenyl group on the cyclohexylidene ring. Double irradiation of the low-field group results in a 15.9% enhancement in the integral of the benzylic resonance. This NOE could only be observed if the C-2 hydrogen is dominantly equatorial. No such effect is observed with II (R = OAc) as might be anticipated, since the acetate hydrogens are too remote from the benzylic hydrogen in question.

Both I (R = Ac) and II (R = Ac) were submitted for X-ray structure determination. Gratifyingly, but as we expected, both compounds, as can be seen from the accompanying communication,[10] have (1) the C-2 phenyl group *in a perfectly axial orientation* and (2) *an alicyclic ring that is relatively strain free.*

Thus both in solution and in the solid state our evidence points conclusively to Ia and IIa *as the stable conformations* for these molecules, respectively.

Due to the instability associated with compounds such as III we did not attempt X-ray or further nmr analyses. Instead we chose to examine, by way of close analogy, the thermodynamic equilibrium between the oximes IV and V in which R is either methyl or phenyl.[11] The results of these equilibrations[12] (Table II) are quite dramatic in that *in each case the trans isomer V having an axial phenyl group is the more stable.* By simple calculation (based on average figures) one can calculate[13] that the OH–CH$_3$ nonbonded interaction is $\sim$2.5 kcal/mol[14] and that for IV (R = Ph) the OH–Ph interaction is[15] $\sim$5 kcal/mol.[14] We also believe that this latter value must approximate the OAc–2-Ph interaction in Ib. With regard to III (R = alkali metal) we consider that the equilibrium IIIb $\rightleftarrows$ IIIa should be even further to the right than that for IV $\rightleftarrows$ V (R = Ph), since not only is O^- intrinsically larger than O but it is attended by a gegenion and a solvent shell both of which might be expected to increase the steric bulk of the acinitro group *in toto*, as has been shown in the case of enolate anions.[16] Other results in support of the above conclusions will be reported later.



IV V

Table II

Starting oxime	% IV at equilibrium	% V at equilibrium
IV (R = CH$_3$)	18.0	82.0
V (R = CH$_3$)	19.7	80.3
IV (R = Ph)[a]	8.9	91.1
V (R = Ph)	5.8	94.2

[a] The nmr integration in this case was complicated by the presence of a small impurity whose absorption resonance overlapped that of the benzylic proton, rendering accuracy difficult. Thus, we believe that the values reported for the trans isomer (V, R = Ph) are the more accurate.

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[11] The structures of all new compounds appearing in this paper and the relationship between the oximes and their corresponding ketones have been proven rigorously by chemical and physicochemical means.

[12] Equilibrations were carried out at 80° in ethanol for 3 weeks using a small amount of hydroxylamine acetate as the catalyst. In the cases where R = CH$_3$ small amounts of 2,6-dimethylcyclohexanone were found in the final mixture (analyzed by glc) but in those cases where R = Ph the oximes were recovered quantitatively and estimated by nmr.

[13] Based on data derived from 2,6-dialkylcyclohexanone equilibria [B. Rickborn, *J. Amer. Chem. Soc.*, **84**, 2414 (1962)].

[14] These values are approximate because the $-\Delta G_X{}^\circ$ values of ref 13 and 15 refer to room temperature whereas our equilibria were determined at 80°.

[15] A $\Delta G_X{}^\circ$ for phenyl = 3.1 was used, as reported by E. L. Eliel, N. L. Allinger, S. J. Angyal, and G. A. Morrison in "Conformational Analysis," Interscience, New York, N. Y., 1965, p 44.

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Direct Proof of the Molecular Conformation of the Geometrical Isomers of α-Acetoxy-α,2-diphenyl(methylenecyclohexane)*

Sir:

In the preceding communication Johnson and Dix[1] have discussed the ground-state conformations of methylenecyclohexanes substituted at, and allylically to, the double bond, and of 2-substituted cyclohexanenitronate ions. Their equilibrium studies and analysis of nmr spectra are consistent only with a conformation in which the 2-phenyl substituent assumes an axial position in solution, as required by Johnson and Malhotra's theory of $A^{(1,3)}$ strain.[2]

In a supportive effort single-crystal X-ray diffraction studies of the α,α-disubstituted 2-phenyl(methylene-

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