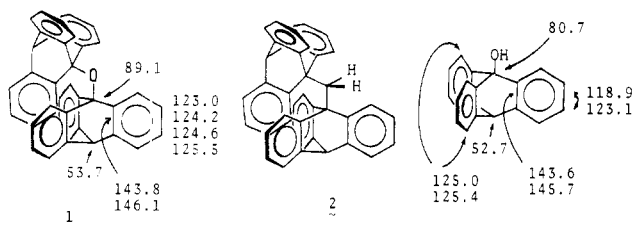


Communications

Unconventional Synthesis and Conformational Flexibility of Bis(1-triptycyl) Ether

Summary: The title compound was prepared by the thermolysis in perfluorodecalin of 1-triptycyl 1-triptyceneperoxycarboxylate which in turn was obtained by the reaction of 1-triptycyl lithium with oxygen followed by treatment with 1-triptycencarbonyl chloride. No sign of restricted rotation around the bridgehead-to-oxygen bonds of the ether was indicated by the ^1H and ^{13}C NMR spectra in spite of its overcrowded molecular framework.

Sir: It was recently found that the potential-energy barriers to rotation around the single bond connecting two four-coordinated carbon atoms can be high enough in triptycene and benzobarrelene derivatives to bring the rotation around the bond extending out of the bridgehead carbons to a halt.¹ In contrast to these high rotational barriers due to high nonbonded interaction, the idea of geared rotation has been put forward to explain the unexpectedly fast rotation in apparently congested molecules.² The coupled rotation of two parts of a molecule may become energetically more feasible than the independent rotation of a single group. We have prepared bis(1-triptycyl) ether (1) as one of the most dramatic demonstrations of the conformational mobility in overcrowded molecules.



A conventional route to bis(1-triptycyl) derivatives would be the addition of benzyne to the corresponding bis(9-anthryl) derivatives. This approach proved to be useful for bis(1-triptycyl)methane (2) (mp 416 °C;³ ^1H NMR (CDCl_3) δ 4.79 (s, 2 H), 5.40 (s, 2 H), 6.6–7.0 (m, 12 H), 7.3–7.6 (m, 12 H)), although a large excess of the benzyne precursors had to be employed. A similar reaction could not be used for the synthesis of 1, since it was difficult to get any reasonable amount of bis(9-anthryl) ether according to the method in the literature.⁴ All efforts to couple 9-anthrol and 9-bromoanthracene under the Ullmann conditions were unsuccessful; anthracene and some anthraquinone were always obtained.

Thermal decomposition of a peroxy ester proved to be very effective. 1-Bromotriptycene in benzene/diethyl ether

(1:2 v/v) was treated with 1.2 equiv of 1.6 M butyllithium in hexane at -50 °C. The lithio compound thus obtained was added slowly at -70 °C to diethyl ether through which dry oxygen was bubbled. The reverse addition of oxygen gas to the solution of 1-triptycyl lithium gave the undesired alkoxide in preference to the expected hydroperoxide.⁵ To the resultant clear solution was added a solution of 1-triptycencarbonyl chloride in THF. Chromatography of the crude reaction mixture on silica gel with hexane/dichloromethane gave 1-triptycyl 1-triptyceneperoxycarboxylate (3) as white flakes (49% overall yield) which showed signs of decomposition without melting at 105–155 °C.³ ^1H NMR (CDCl_3) δ 5.38 (s, 1 H), 5.40 (s, 1 H), 6.8–7.1 (m, 12 H), 7.3–7.5 (m, 6 H), 7.7–7.9 (m, 6 H); IR (KBr) 1780 cm^{-1} (C=O). Triptycene (30%) and 1-hydroxytriptycene (4) (17%) were obtained as byproducts. Peroxy ester 3 was suspended in a small amount of perfluorodecalin and heated at 130–150 °C for 30 min to give 1, a colorless solid (mp 470 °C;³ IR (KBr) 1235 cm^{-1} (COC)), in quantitative yield.⁶

The last reaction appears to provide the highest yield record of an ether product from peroxy esters. There are a number of reasons conceivable for the success of this cage recombination reaction. Firstly, the peroxy ester could be so insoluble in perfluorodecalin that decomposition might have taken place in the solid where diffusion of radical pairs may be neglected. Secondly, when the peroxy ester was in solution, the translational and/or overall rotational escape out of the solvent cage must have been hampered by the steric bulk of the 1-triptycyl and 1-triptycyloxy radicals to give efficient recombination between these pairs of radicals. Thirdly, the bridgehead cation is inherently unstable and therefore some degree of polar character, $\text{R}^+\cdots\text{CO}_2\cdots\text{OR}$, which is often present in the transition state for the decomposition and can be responsible for the complication of the reaction as a result of rearrangement in the R^+ moiety, should be absent here. The triptycyl radical itself has no tendency toward rearrangement.⁷ In view of some of these reasonings, the above synthetic route may be extended as a general method for 1,1'-oxybis(bicyclo) compounds.

Ether 1 gave rather simple NMR spectra which correspond to a structure with six benzene rings being equivalent: ^1H NMR (CDCl_3) δ 5.50 (s, 2 H), 6.7–7.1 (m, 12 H), 7.50 (dd, 6 H), 7.74 (dd, 6 H). The proton decoupled ^{13}C NMR spectrum shows only six signals due to the aromatic carbons in addition to two kinds of bridgehead carbons: ^{13}C NMR (CDCl_3) δ 53.7, 89.1, 123.0, 124.2, 124.6, 125.5, 143.8, 146.1. Their chemical shift values agree nicely with those of 4. Since the ground state of 1 is considered to have C_s symmetry and to be degenerate sixfold, the observed spectral pattern can be rationalized only in terms of a rapid interconversion among the degenerate conformers. Otherwise, the benzene rings in four different environments

(1) H. Iwamura, *J. Chem. Soc., Chem. Commun.*, 232 (1973); M. Ōki, *Angew. Chem., Int. Ed. Engl.*, 15, 87 (1976); L. H. Schwartz, C. Koukotas, and C. Yu, *J. Am. Chem. Soc.*, 99, 7710 (1977), and references cited therein.

(2) W. D. Hounshell, L. S. Iroff, R. J. Wroczynski, and K. Mislaw, *J. Am. Chem. Soc.*, 100, 5212 (1978), and ref 1 and 2 cited therein.

(3) Measured by differential-scanning calorimetry on a Du Pont 990 thermal analyzer. The extrapolated onset temperature of the endothermic curve obtained with a scanning rate of 5 °C/min was taken as a good measure of the melting point. Decomposition of 3 was shown by a broad exothermic curve.

(4) W. H. Cooke, I. M. Heilbron, and G. H. Walker, *J. Chem. Soc.*, 127, 2250 (1925).

(5) S.-O. Lawesson and N. C. Yang, *J. Am. Chem. Soc.*, 81, 4230 (1959).

(6) Satisfactory elemental analyses were obtained for all new compounds. NMR spectra were obtained at 100 MHz with a JEOL FX-100 spectrometer.

(7) P. D. Bartlett and E. S. Lewis, *J. Am. Chem. Soc.*, 72, 1005 (1950); P. D. Bartlett and F. D. Greene, *J. Am. Chem. Soc.*, 76, 1088 (1954).

would have been detected. Inspection of molecular models reveals that **1** should be considerably overcrowded and that the dynamic process may become feasible only by literally geared rotation around the bridgehead-to-oxygen bonds. Then rotation by 15° will produce without difficulty the transition state which has C_2 symmetry and is again degenerate sixfold.

In order to form an estimate of the barrier height for the degenerate conformational change, we investigated the low-temperature NMR measurements in dichloromethane- d_2 . Even at -94°C , no spectral change was noted both in ^1H and ^{13}C NMR. Some lowering of the peak height due to the tertiary carbons relative to the quaternary carbons was found. The phenomenon is, however, nothing more than diminution of the nuclear Overhauser effect, since no appreciable line broadening accompanied it. The magnetic environment of ^1H and ^{13}C nuclei in the benzene rings will be different, depending on whether they are flanked by the two benzene rings of the other triptycene moiety or they are situated outside. According to molecular models and the ring current models of Johnson and Bovey,⁸ the difference in chemical shifts of the corresponding nuclei on different benzene rings is estimated to be 1–3 ppm. The above results that the chemical-shift difference of this magnitude may still be averaged out at -94°C appear to indicate that the barrier height, if present, is not greater than ca. 8 kcal mol $^{-1}$. This low barrier should be taken as quite a contrast to the usually high barrier associated with triptycenes carrying more or less axially symmetric substituents.¹ Note that interaction between the opposing peri substituents is so significant that there is a substantial barrier even in 1,2-bis(1-triptycyl)acetylene.⁹ It is interesting that, once the alignment is lost and the correlated rotation becomes possible, the barrier can get extremely low.

One may attribute the observed rapid conformational change in **1** to a possible inversion at the oxygen. The inversion at the divalent oxygen is, however, predicted by the Walsh rule to be unlikely,¹⁰ and has been ruled out.¹¹ We also add that, just as in **1**, **2** showed no change in its NMR spectrum at -94°C and therefore is conformationally flexible.

Registry No. **1**, 73611-45-7; **2**, 73611-46-8; **3**, 73597-15-6; **4**, 73597-16-7; benzyne, 462-80-6; bis(9-anthryl)methane, 15080-14-5; diethyl ether, 60-29-7; 1-triptycyl lithium, 59239-90-6; 1-triptycene-carbonyl chloride, 73597-17-8; triptycene, 477-75-8.

(8) C. E. Johnson, Jr., and F. A. Bovey, *J. Chem. Phys.*, **29**, 1012 (1958).

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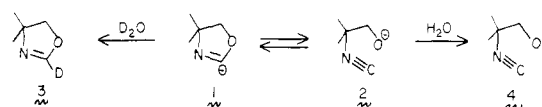
Oxazoles in Organic Chemistry. 2. Application to the Synthesis of Benzyloquinoline Alkaloids.

Summary: A conceptually new route to the benzyloquinoline alkaloids has been devised. The reaction of 2-lithiooxazoles with aromatic aldehydes to generate the thermodynamically favored 2-substituted oxazoles constitutes the key step in this process. A single-pot two

carbon-carbon bond-joining reaction leading to an oxazoline suitable for further transformation to a phenethylamide is also described.

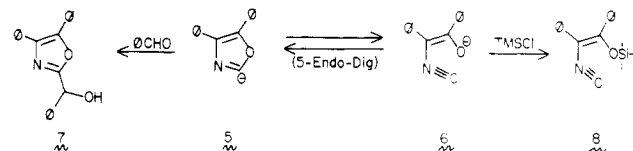
Sir: In continuation of our studies on the use of oxazoles for the construction of therapeutically important alkaloids,¹ we were led to explore the chemistry of the 2-metalated derivatives of this class of heterocycles. It was our desire to introduce specific carbon electrophiles at the 2-position of the oxazole nucleus, for we had envisioned that achievement of this goal would engender a new route to the benzyloquinoline alkaloids.

Our work was guided by several observations recorded by previous workers on the metalation of oxazolines and oxazoles. Meyers and Collington had shown that *n*-butyllithium effectively deprotonates C-2 of 4,4-dimethyloxazoline by quenching with deuterium oxide to obtain the 2-deuteriooxazoline **3**.² This oxazoline anion **1** was further



shown to be in equilibrium with its open-chain isomer **2**, since careful hydrolysis of the reaction mixture afforded β -hydroxyethylisocyanide **4**, in addition to the starting oxazoline.

The existence of the same type of mobile equilibrium between open-chain tautomer and oxazole has been recorded by Schöllkopf and co-workers; when 4,5-diphenyloxazole was metalated and then treated with chlorotrimethylsilane, the α -isocyano enolate anion **6** was ki-



netically trapped as the open-chain enol ether **8** (85%, *E* and *Z* isomers). In contrast, when benzaldehyde was added as the trapping agent, the thermodynamically favored 2-substituted oxazole **7** was generated (68%).³ The formation of this product constitutes to our knowledge the sole literature example of the reaction of a 2-metalated oxazole with an electrophilic agent to produce a new substituted oxazole.⁴

These observations, in conjunction with the known ease of preparation of 5-aryl-substituted oxazoles from aromatic aldehydes by employment of van Leusen's reagent, tosylmethyl isocyanide,⁵ and the reported facile hydrogenolytic cleavage of 2-aryloxazoles,⁶ suggested a simple scheme for the preparation of the benzyloquinoline alkaloids. Since these alkaloids and their synthetic analogues

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