reaction with *n*-butylmagnesium bromide. The product IIIb had $[\alpha]_D$ +63.2° and thus was a mixture of 66.9% (+)-III:33.1% (−)-III, in perfect accord with the figures predicted from the composition of the precursor.

Reaction of *p*-iodobenzenesulfinyl chloride and (−)-menthol under identical conditions gave a diastereomeric mixture of (−)-menthyl *p*-iodobenzenesulfinates, $[\alpha]_D$ −20.9° (IIa). From the rotations of the pure diastereomeric components[6] the composition of IIa is 25.9% (−)-II:74.1% (+)-II.

In the synthesis of I and II, the (+) isomer is the more rapidly formed. Since steric factors unquestionably control the relative abundance of the diastereomeric product ratios, *it follows that (−)-I and (−)-II have corresponding configurations.* This conclusion is buttressed by the following observation. Reaction of 1-butanesulfinyl chloride and (−)-menthol at −78° gave a diastereomeric mixture of (−)-menthyl 1-butanesulfinates which afforded IIIc, $[\alpha]_D$ +99°, on treatment with *p*-tolylmagnesium bromide. Since the signs of IIIa and IIIc are opposite, it follows that the absolute configuration around sulfur in the predominant diastereomer leading to IIIa and IIIc must be the same. We shall discuss in a separate paper the relevance of the present findings to the resolution of the other discrepancy which we had earlier remarked upon.[3]

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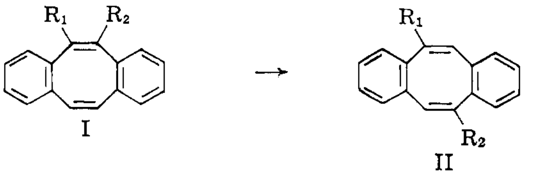
Thermal and Photochemical Rearrangement of Substituted Dibenzo[*a,e*]cyclooctatetraenes

Sir:

5,6-Diphenyldibenzo[*a,e*]cyclooctatetraene (Ia) is available from the reaction of phenylacetylene with benzyne.[1] Heating this hydrocarbon to temperatures of 140–200°, either as the pure melt or as a solution in decalin or triglyme, leads to the remarkable rearrangement shown in eq. 1.[2]



(1)

a, $R_1 = R_2 = C_6H_5$; b, $R_1 = R_2 = p\text{-}CH_3C_6H_4$; c, $R_1 = R_2 = p\text{-}BrC_6H_4$; d, $R_1 = C_6H_5$; $R_2 = p\text{-}BrC_6H_4$; e, $R_1 = R_2 = CO_2CH_3$

Hydrocarbon IIa [λ_{max} 260 mμ (ε 34,700)] was formed in 96% yield. Hydrogenation (Pd–charcoal) furnished a tetrahydro derivative, m.p. 174–174.5°, the n.m.r. spectrum of which exhibited a ratio of aromatic:methine:methylene hydrogens equal to 18.2:2.0:3.9. Ozonization of IIa yielded *o*-benzoylbenzoic acid.

The di-*p*-tolyl (Ib) and di-*p*-bromophenyl (Ic) compounds were prepared from benzenediazonium-2-carboxylate and the appropriately substituted phenylacetylene. Similar generation of benzyne in the presence of methyl propiolate yielded the 5,6-dicarbomethoxy compound (Ie). An equimolar mixture of phenylacetylene and *p*-bromophenylacetylene reacted with benzyne to furnish the monobromo compound (Id) in addition to Ia and Ic. Treatment of either Ic or Id with butyllithium, followed by hydrolysis, succeeded in removing bromine to produce Ia in yields of 53% and 33%, respectively.

Each of the 5,6-disubstituted dibenzocyclooctatetraenes Ib–e underwent isomerization to the 5,11- isomer under conditions similar to those described for Ia. The yields of IIb–e were 93%, 87%, 95%, and 75%, respectively. Table I lists first-order rate constants and activation parameters for the rearrangement of Ia–d.

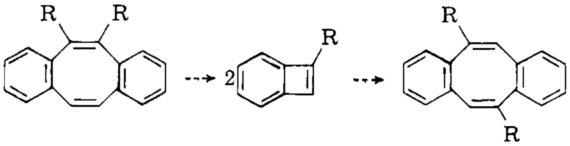
TABLE I

RATES OF REARRANGEMENT OF I TO II[a]

Compd.	Solvent (temp., °C.)	10^5k, sec.$^{-1}$	ΔH^*, kcal.	ΔS^*, e.u.
Ia	Decalin (164.5)	4.8	28.9	−13
	Triglyme (164.0)	4.6	29.1	−13
Ib	Decalin (164.9)	7.1	29.1	−12
Ic	Decalin (164.8)	5.3	31.7	−7
Id	Decalin (164.8)	4.9	30.1	−10

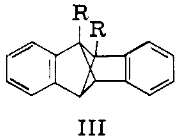
[a] The reactions were followed by spectrometric determination of product appearance at λ_{max}. The rates were cleanly first order over the measured course of the reaction, which was one to three half-lives.

Isomerization of an equimolar mixture of Ia and Ic in triglyme at 195° produced a 99% yield of a mixture of IIa and IIc, with no contamination by IId, as shown by thin-layer chromatography. Furthermore, the isomerization of Id yielded IId which contained no detectable IIa or IIc. These two experiments eliminate an obvious possibility for the mechanism, a dissociation–recombination such as that of eq. 2.



(2)

A reaction path which would explain most simply the rearrangement of I to II includes the "twisted" intermediate III. The structure of III is such that reversion to the dibenzocyclooctatetraene structure could lead to either I or II. The feasibility of structure III as an intermediate may be argued from the results of Srinivasan,[3] who reported that photolysis of *cis,cis*-1,5-cyclooctadiene yielded tricyclo[4.2.0.0^{2,6}]octane, which possesses the carbon skeleton central to III.



III

Photolysis of a solution of hydrocarbon Ia in methylcyclohexane (Hanovia lamp, Pyrex filter) at 0° produced a 36% yield of isomer IIa. The remainder was starting material, with no evidence for other isomers by thin-layer chromatography.

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[1] M. Stiles, U. Burckhardt, and A. Haag, *J. Org. Chem.*, **27**, 4715 (1962).

[2] Satisfactory elemental analyses were obtained for all the compounds described. Melting points obtained were: Ib, 168–169°; Ic, 222–222.5°; Id, 197.5–198°; Ie, 176.5–177°; IIa, 183–184°; IIb, 181–183°; IIc, 204–204.5°; IId, 170–171°; IIe, 187.5–188°.

[3] R. Srinivasan, *J. Am. Chem. Soc.*, **85**, 819, 3048 (1963).

The activation parameters for the thermal rearrangement of Ia–d are remarkably close to those found by Mislow and Perlmutter[4] for the racemization of 2-bromodibenzo[*a,e*]cyclooctatetraene-6,11-dicarboxylic acid (IV) at 120–140°. This similarity in ΔH^* and ΔS^* for the thermal reactions of such similar compounds suggests that the transition states for the rearrangement of I and the racemization of IV may bear a close resemblance. It should be noted that an intermediate of the type III is capable in principle of explaining the racemization as well as the rearrangement.

(4) K. Mislow and H. D. Perlmutter, *J. Am. Chem. Soc.*, **84**, 3591 (1962).

(5) Grateful acknowledgment is made of a grant in support of this work from the Petroleum Research Fund of the American Chemical Society.

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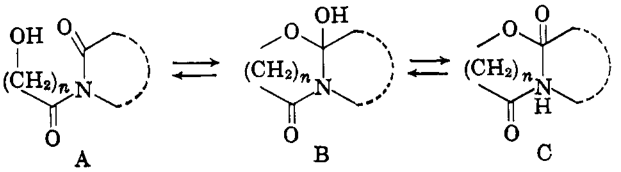
Amide–Amide Interaction *via* a Cyclol

Sir:

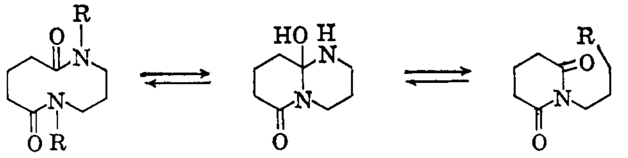
The original proposal by Wrinch[1] that a significant contribution to protein structure might arise *via* cyclols resulting from amide–alcohol, amide–amine, and amide–amide interaction received little support. However, the occurrence of such a structure in the peptide portion of the ergot alkaloids, as established by the synthesis of ergotamine,[2] and the application of this type of interaction to the synthesis of large-ring depsipeptides[3] have stimulated current interest. These syntheses[4] involved amide–alcohol and amide–ester intereactions, both in linear and cyclic systems, as illustrated by the general reaction



A B C

We wish to report the first example of a transannular amide–amide reaction, *via* cyclolization, demonstrating the facility of amide–amide interaction in a suitable steric environment.[5,5a]

1,5-Cyclooctanedione[6] (m.p. 71–72°) was prepared by cyclization of 2,2-bis(3-cyanopropyl)-1,3-dioxolane[7] followed by hydrolysis, or more conveniently by oxidation of 5-hydroxycyclooctanone.[8] The dioxime ditosylate (m.p. 118–119°), on warming in aqueous dioxane containing potassium bicarbonate, rearranged to 6,10-dioxo-1,5-diazacyclodecane (I, m.p. 233–234°[9]); in the presence of sodium acetate, the acetyl derivative II (m.p. 91–92°) was obtained. Both compounds were purified by crystallization and sublimation and were homogeneous by thin-layer chromatography. Total hydrolysis of the pure compound or the crude reaction mixture in each instance gave only glutaric acid and 1,3-diaminopropane; no γ-aminobutyric acid could be detected. Thus, rearrangement in the present case gave only one of the two isomers usually found with other cyclic diketones.[10]



I, R = H
II, R = C(O)CH₃

III

IV, R = NH₂
V, R = OH
VI, R = OTs
VII, R = N₃

The transannular cyclolization of I to III and ring opening to IV could be followed in 0.1 *N* hydrochloric acid by appearance of an ultraviolet maximum at 208 mμ, which reached a constant value after 2 days at room temperature. Concentration of this acid solution *in vacuo* led to isolation of IV as the hydrochloride (m.p. 194–195°, λ_{max} 208 mμ (ε 14,500)); alkalization of this acid solution with potassium bicarbonate and continuous extraction with methylene chloride led to quantitative recyclization to I. Thus, either form I or IV could be isolated, depending on the pH of the solution; in neutral solution an equilibrium probably exists among I, III, and IV as indicated by the very complex n.m.r. spectrum in deuterium oxide.

The structure of N-(3-aminopropyl)glutarimide (IV) was established by synthesis. Glutaric anhydride and 3-aminopropanol gave the N-(3-hydroxypropyl)imide (V, m.p. 59–60°, λ_{max} 211 (ε 14,600)) which was converted to amine IV *via* tosylate VI, azide VII, and hydrogenation of the latter. The compound prepared in this manner and isolated as the hydrochloride was identical in all respects with IV isolated from I, and by dissolution in aqueous bicarbonate was converted to I.

In addition to this conclusive evidence for an amide–amide interaction *via* a transannular cyclol, an interesting comparison now can be made between cyclolization *via* amino and hydroxyl groups. Whereas the N-(3-aminopropyl)imide IV rapidly forms I in aqueous bicarbonate, the N-(3-hydroxypropyl)imide V remains unchanged after several weeks. Clearly,

(1) D. Wrinch, *Nature*, **137**, 411 (1936); **138**, 241 (1936); reviewed and summarized: **199**, 564 (1963).

(2) A. Hofmann, A. J. Frey, and H. Ott, *Experientia*, **17**, 206 (1961).

(3) M. M. Shemyakin, Yu. A. Ovchinnikov, V. K. Antonov, A. A. Kiryushkin, V. T. Ivanov, V. I. Shchelokov, and A. M. Shkrob, *Tetrahedron Letters*, **No. 1**, 47 (1964), and references therein; also reviewed by M. M. Shemyakin at the 3rd International Symposium on Chemistry of Natural Products, Kyoto, Japan, April 15, 1964.

(4) See also R. C. Sheppard, *Experientia*, **19**, 125 (1963).

(5) A product which might result from amide–amide interaction has been prepared; however, it was formed from a linear system *via* amide carbonyl–Δ^2-oxazolinone nitrogen interaction [D. S. Jones, G. W. Kenner, and R. C. Sheppard, *ibid.*, **19**, 126 (1963)].

(5a) NOTE ADDED IN PROOF.—Amide–amide interaction has been invoked to explain, in part, the mass spectral fragmentation pattern of 9- and 11-membered cyclodipeptides [V. K. Antonov, Ts. E. Agadzhanyan, T. R. Telesnina, M. M. Shemyakin, G. G. Dvoryantseva, and Yu. N. Sheinker, *Tetrahedron Letters*, **No. 13**, 727 (1964)].

(6) Satisfactory analyses (combustion and spectral) were obtained for all new compounds; ultraviolet spectra were taken in water, infrared spectra were taken as potassium bromide wafers, and n.m.r. spectra were taken in deuterium oxide.

(7) R. B. Smith, Thesis, University of California, Berkeley; D. Hartley, *J. Chem. Soc.*, 4722 (1962).

(8) H. Moell and O. Schlichting, German Patent 1,029,368 (May 8, 1958), assigned to Badische Anilin und Soda-Fabrik. We are indebted to BASF for a sample of this material.

(9) This structure was assigned to material of m.p. 268°, obtained in 1% yield from the reaction of glutaryl chloride and 1,3-diaminopropane [J. Dale and R. Coulon, *J. Chem. Soc.*, 182 (1964)]. See also H. Stetter and J. Marx, *Angew. Chem.*, **69**, 439 (1957), for the preparation of cyclic diamides from diacid chlorides and diamines.

(10) M. Rothe and R. Timler, *Ber.*, **95**, 783 (1962), and references therein to rearrangements with dioximes of cyclohexanedione, cyclodecanedione, and other homologs.