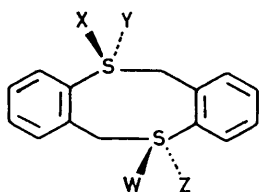


Conformation and Relative Configuration of the Stereoisomeric 2,8-Dihydrodibenzo[*b,f*][1,5]dithiocin 1,7-Dioxides

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The stereoisomeric 1,7-dioxides (3) and (4) of 2,8-dihydrodibenzo[*b,f*][1,5]dithiocin have been prepared and their relative configuration (*cis* or *trans*) has been assigned by variable-temperature ^1H n.m.r. spectroscopy and partial resolution of the *cis*-bis(dioxide) (3).

RECENTLY we investigated the conformational mobility of 5,6,11,12-tetrahydrodibenzo[*a,e*]cyclo-octene and of a number of its heterocyclic analogues, among them that of 2,8-dihydrodibenzo[*b,f*][1,5]dithiocin (1) and its 1,1,7,7-tetraoxide (2).¹ In solution at room temperature (1) existed as a 1 : 4 mixture of the chair form and one of the possible boat type conformers, whereas (2) consisted of a single conformer of unknown type.



- (1) X = Y = W = Z = lone pair
 (2) X = Y = W = Z = O
 (3) X = W = O, Y = Z = lone pair
 (4) X = Z = O, Y = W = lone pair
 (5) X = O, Y = W = Z = lone pair
 (6) X = Y = W = O, Z = lone pair

In this paper further studies are reported which establish the conformation and relative configuration of the stereoisomeric 1,7-dioxides (3) and (4) derived from (1) and which also prove that the preferred conformation of the tetraoxide (2) is of the boat type.

RESULTS AND DISCUSSION

The dioxides (3) and (4) can be obtained as a mixture by controlled oxidation of (1) by perlaucic acid.² Preparation of the monoxide (5) and of the trioxide (6) is also possible under these conditions. The mixture of (3) and (4) was separated by column chromatography to give the pure diastereoisomers of m.p. 230–231 °C [compound (A)] and m.p. 226–228 °C [compound (B)].

The ^1H n.m.r. spectrum of (A) showed in the temperature range of –40 to +100 °C one quartet for the methylene protons. The ^1H n.m.r. spectrum of (B) at room temperature exhibited for the methylene protons two quartets of equal intensity, which coalesced on heating (T_c ca. 50 °C) into one quartet. The free energy of activation for this conformational interconversion was determined as ΔG^\ddagger 17 kcal mol⁻¹. It is interesting to note that the methylene region of the ^{13}C n.m.r. spectrum of the original mixture of (3) and (4) showed three peaks with the intensity ratio of 1 : 1.76 : 1.

Considering the symmetry of the possible conformers of (A) and (B) their spectral behaviour can only be interpreted when it is assumed that in solution both are conformationally homogeneous and that both exist in the same type of conformation.

The presence of the chiral sulphoxide centres in (A) and (B) determines that the relationship of the geminal methylene protons is inherently diastereotopic. Methylene groups in both the *cis*- (3) and *trans*-sulphoxide (4) are therefore expected to give rise to at least one AB quartet in the ^1H n.m.r. spectrum at any given temperature. The spectrum of (A) contains only one AB quartet and this means that (A) must take up only one of the symmetrical conformations C^1_{trans} , C^2_{trans} , $boat^1_{cis}$, and $boat^2_{cis}$.[†] Earlier it was shown¹ that below –35 °C all conformational changes of (1) become slow on the n.m.r. time scale. Since the single methylene quartet of the dioxide (A) remains unchanged down to –40 °C, it is unlikely that this compound is present in solution as a rapidly equilibrating mixture of two conformers. By similar reasoning the spectrum of (B) is most reasonably assigned to a pair of asymmetrical, slowly equilibrating superimposable or enantiomeric conformers, *i.e.* either to $C_{cis} \rightleftharpoons C_{cis}$ or to $boat_{trans} \rightleftharpoons boat_{trans}$. A pair of equilibrating symmetrical conformers of either (3) or (4) can be excluded, because such pairs are diastereoisomeric and hence of unequal stability, and cannot therefore give rise in the ^1H n.m.r. spectrum to quartets of equal intensity for the methylene protons.

Assignment of the chiral *cis* configuration to (A) (the compound exhibiting a single AB quartet) requires that it should exist in a symmetrical conformation, *i.e.* in one of the boat forms (probably $boat^1_{cis}$). Conversely, if compound (A) possessed the achiral *trans* configuration, then it ought to exist exclusively in one of the symmetrical C conformations (probably C^1_{trans}). Since it was shown that for (1) conformer C was less stable than the boat,¹ and because the C_{cis} conformer of the *cis*-bis-sulphoxide (3) is further destabilised by two 1,4-quasi-diaxial O···H non-bonded interactions, the exclusive occurrence of this form is unlikely and the first assignment is preferred. This means that compound (B) is the *trans*-epimer (4) present as an equilibrating mixture of two asymmetric enantiomeric boat

[†] For one particular diastereoisomer all possible boat-type conformers, *i.e.* the proper boat, the distorted boat, and the twisted boat, are of identical symmetry and are denoted as 'boat' throughout this paper.

conformers ($\text{boat}_{trans} \rightleftharpoons \text{boat}_{trans}$). This structural assignment was supported by the successful partial resolution of compound (4) by chromatography on acetylcellulose and confirmed that it was the *cis* isomer (3).

The fact that both (3) and (4) assume a boat conformation indicates that in solution (2) should also exist in the boat form because its C conformation would be destabilised by two $\text{O} \cdots \text{H}$ non-bonded interactions.

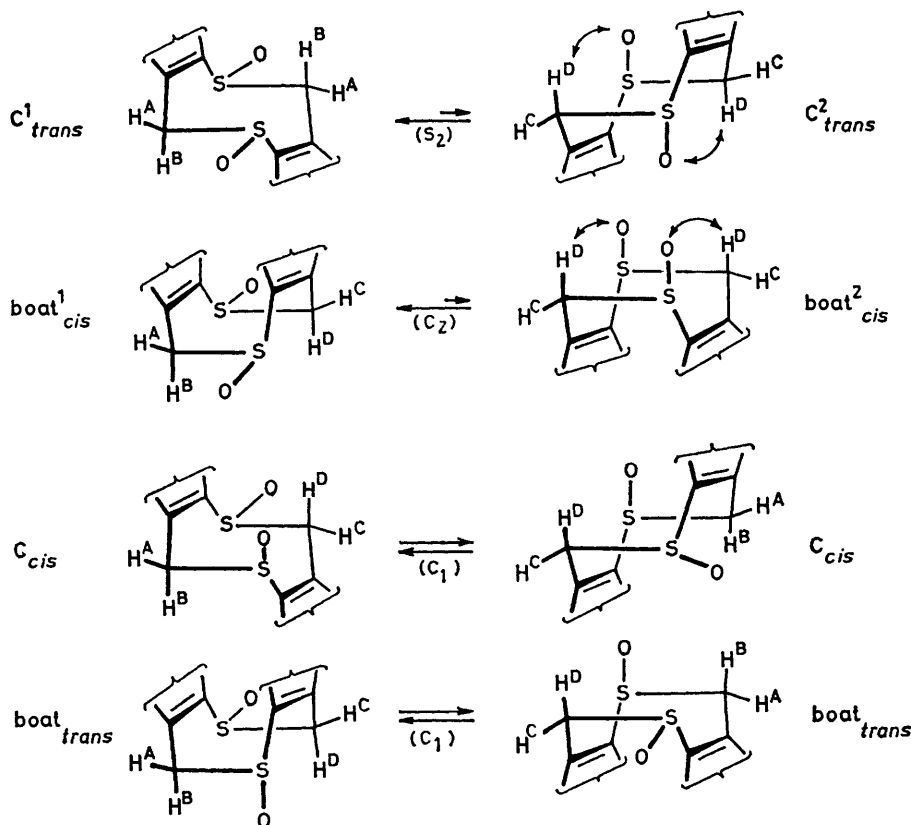
EXPERIMENTAL

N.m.r. spectra for ^1H were recorded at 100 MHz with a Varian HA 100 and for ^{13}C at 25.16 MHz with a Varian XL 100 spectrometer. Mass spectra were recorded on an MS 12 instrument, and o.r.d. measurements were performed on a Zeiss Opton instrument.

cis- and *trans*-2,8-Dihydrodibenzo[b,f][1,5]dithiocin 1,7-Dioxide (3) and (4).—Compound (1)³ (0.65 g) was dissolved in chloroform (10 ml) and perlauric acid (1.44 g, 80%) was

(85 mg), m.p. 230–231 °C (from MeOH); $\delta_{\text{H}}(\text{CDCl}_3)$ 3.94 (d) and 4.37 (d) (AB quartet, J 14 Hz, CH_2), and 7.0–7.5 (m, 8 H, aromatic-H); then after mixed fractions the *trans*-dioxide (4) (240 mg), m.p. 226–228 °C (from MeOH), was obtained; $\delta(\text{CDCl}_3, 35^\circ\text{C})$ 3.74 (d) and 5.02 (d) (AB quartet, J 14 Hz, CH_2), and 4.8–5.6 (m, aromatic-H).

Partial Resolution of the Racemic cis-Dioxide (3).—A column of 10 mm internal diameter was filled with dry acetylcellulose (Woelm, 50 g) and benzene was passed through it until the whole column became translucent. A solution of (3) (50 mg) in benzene (1 ml) was adsorbed onto the column and eluted with benzene. Fractions (5 ml) were taken, examined by o.r.d. for rotation and by u.v. for concentration. Maximum rotations of $\alpha_{\text{D}}^{25} + 0.047$ and -0.016° were measured in fractions 5 and 25 respectively, corresponding to $[\phi]_{\text{D}}^{25} + 400 \pm 40$ and $-190 \pm 20^\circ$ respectively. Comparison with the rotation of PhCH_2SOPh ($[\phi]_{\text{D}}^{25} 5200^\circ$)⁴ showed that the optical purity of even the best fractions was poor. A similar experiment with (4) produced no fractions with measurable optical rotation.



added in portions during 4 d. Evaporation to dryness and trituration of the residue with pentane afforded a mixture of (3) and (4) as a sharp-melting mixture (colourless plates, 0.60 g), m.p. 206–208 °C, which was recrystallised for analysis from MeOH (Found: C, 60.7; H, 4.51; S, 23.5%; M^+ , 276. $\text{C}_{14}\text{H}_{12}\text{O}_2\text{S}_2$ requires C, 61.0; H, 4.4; S, 23.2%; M , 276); $\delta(^{13}\text{C})$ (p.p.m. from SiMe_4) (relative intensity in parentheses) 57.81 (45) and 58.97 (45) [CH_2 of (4)], 58.76 (79) [CH_2 of (3)], and 125.19–132.57 (10 lines, aromatic C).

The crude mixture of (3) and (4) was chromatographed on fine grain (200 mesh) silica gel [80 g, benzene–acetone (4 : 1)]. First eluted was the pure racemic *cis*-dioxide (3)

(\pm)-2,8-Dihydrodibenzo[b,f][1,5]dithiocin 5-Oxide (5).—Compound (1) (0.40 g) in chloroform (5 ml) was treated with perlauric acid (0.35 g, 80%) at 0 °C for 24 h. Evaporation of solvent, trituration of the residue with light petroleum, and chromatography on silica gel [benzene–acetone (4 : 1)] afforded (5) (120 mg), m.p. 136–138 °C (from EtOH) (Found: C, 64.5; H, 4.7%; M^+ , 260. $\text{C}_{14}\text{H}_{12}\text{OS}_2$ requires C, 64.6; H, 4.7%; M , 260); $\delta[(\text{CD}_3)_2\text{SO}, \text{at } 80^\circ\text{C}]$ 4.00 (d) and 4.26 (d) (AB quartet, J 12 Hz, CH_2), 4.06 (d) and 5.04 (d) (AB quartet, J 14 Hz, CH_2), and 6.8–7.4 (m, 8 H, aromatic-H).

(\pm)-2,8-Dihydrodibenzo[b,f][1,5]dithiocin-1,1,7-trioxide (6).

—Compound (1) (0.34 g) in chloroform (5 ml) was treated with perlauric acid (0.90 g, 80%) at 0 °C for 24 h and worked up as described for (5) to yield colourless prisms (0.21 g), m.p. 253—254 °C (from AcOH) (Found: C, 57.6; H, 4.2%; M^+ , 292. $C_{14}H_{12}O_3S_2$ requires C, 57.5; H, 4.1%; M , 292]; $\delta(C_5D_5N)$ 4.0—6.0 (coalesced m for CH_2), 6.8—7.8 (m, aromatic-H).

Measurement of the Rate of Conformational Change of (4) by N.M.R. Spectroscopy.—Spectra of (4) were recorded in $(CD_3)_2SO$ from +25 to +120 °C at intervals of 10 °C and the spectra simulated as described earlier¹ with the aid of a computer program written for four-site exchange [program TLS(c)] to obtain the rate constants, from which ΔG^\ddagger (17.0 ± 0.2 kcal mol⁻¹) of the inversion process was calculated.

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