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BOAT-CHAIR CONFORMATIONAL PREFERENCE OF EXO,EXO-9-OXOBICYCLO[3.3.1]NONANE-2,4-DICARBOXYLIC ACID

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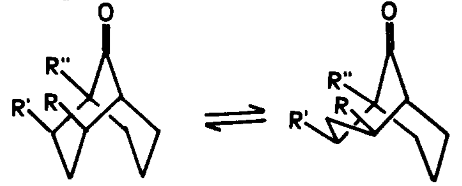
Abstract. The ^{1}H and ^{13}C nmr spectra of exo,exo-9-oxobicyclo[3.3.1]nonane-2,4-dicarboxylic acid, 3, in DMSO-d_6 or alkaline D_2O, clearly show that it exists in a boat-chair-conformation with equatorial carboxyl groups, thus being the first case of boat-chair preference of a bicyclo[3.3.1]nonan-9-one due to the presence of exo,exo-2,4-substituents.

The conformational analysis of bicyclo[3.3.1]nonane derivatives is a matter of continuing interest.[1] Bicyclo[3.3.1]nonane and bicyclo[3.3.1]nonan-9-one exist in a flattened chair-chair conformation due to the non-bonded H_{3endo}-H_{7endo} interaction, in rapid equilibrium with the less stable boat-chair conformation. While introduction of an endo substituent at C_3 shifts the equilibrium entirely towards the boat-chair-conformation,[1c] the effect of exo-substituents at C_2 and C_4 is not so drastic. In a recent publication[1b] we have described that exo,exo-2,4-dimethoxybicyclo[3.3.1]nonan-9-one, 1, in $CDCl_3$ solution, adopts preferently a chair-chair conformation with axial methoxy groups as shown by ^{1}H and ^{13}C nmr spectroscopy. More recently, Baker and Frazer[2] have also shown a chair-chair conformational preference for exo-2-acetoxy-4(exo),5-dimethylbicyclo[3.3.1]nonan-9-one, 2.

We describe herein that exo,exo-9-oxobicyclo[3.3.1]nonane-2,4-dicarboxylic acid,[3] 3, prepared in a straightforward manner by $KMnO_4$ oxidation of anti-tricyclo[4.3.1.1^{2,5}]undec-3-en-10-one,[4] under phase transfer catalysis conditions,[5] exists almost exclusively in the boat-chair conformation, in DMSO-d_6 or alkaline D_2O solution.

1, R = R' = OMe, R" = H
2, R = OAc, R' = R" = Me
3 R = R' = COOH, R" = H



The 200 MHz ^{1}H nmr spectrum of diacid 3 in DMSO-d_6 showed: a double triplet centered at δ 2.96 assigned to $H_2(H_4)$ with coupling constants $J_{H2-H3exo}$ = 13.0 Hz and $J_{H2-H3endo}$ = J_{H2-H1} = 4.3 Hz, a broad singlet at δ 2.57 assigned to $H_1(H_5)$, a double triplet at δ 2.17 assigned to H_{3endo} with $J_{H3endo-H3exo}$ = 13.0 Hz and $J_{H3endo-H2(4)}$ = 4.3 Hz, a quartet at δ 1.23 assigned to H_{3exo} with $J_{H3exo-H3endo}$ = $J_{H3exo-H2(4)}$ = 13.0 Hz, the rest of the protons appearing as a complex absorption at δ 1.4-2.0. On irradiation at δ 2.96, the absorptions corresponding to

H_{3exo} and H_{3endo} became doublets, and on irradiation at δ 2.57, the absorption corresponding to $H_2(H_4)$ became a double doublet while those corresponding to H_{3exo} and H_{3endo} remained unchanged. The high value of $J_{H3exo-H2(H4)}$ is indicative of a *trans-diaxial* relationship between H_{3exo} and $H_2(H_4)$, that can be only attained in the *boat-chair* conformation of 3. By contrast, the corresponding value for compound 1 is 3.90 Hz. Two other features are worth mentioning: a) the upfield shift of H_{3exo} in 3 (1.23 ppm) with respect to 1 (2.10 ppm), and b) the absence of a W coupling between $H_1(H_5)$ and H_{3exo} in 3, a type of coupling that was observed in 1. Both features confirm the *boat-chair* conformational preference of diacid 3, since in this conformation H_{3exo} is very close to the π cloud of the ketonic function,[6] and neither H_{3exo} nor H_{3endo} can W couple with $H_1(H_5)$.

This was additionally supported by the ^{13}C nmr spectrum[3] in DMSO-d_6, since the chemical shift for the sp^3 carbon atoms of 3 are in good agreement with those predicted taking the average values for *boat-chair*-bicyclo[3.3.1]nonan-9-one[7] and correcting them for the presence of *equatorial* carboxyl groups at C_2 and C_4. Specially significative is the shielding of C_7 (δ 15.7 ppm) for which a value of 15.7 ppm is predicted in the *boat-chair* conformation *vs* 21.0 ppm in the *chair-chair* one.

Similar conclusions can be drawn from the 200 MHz ^1H nmr spectrum of compound 3 in alkaline (NaOD) D_2O which is fully comparable[3] to the corresponding spectrum in DMSO-d_6. Thus, the sodium salt of 3 also exists preferently in *boat-chair* conformation in D_2O solution.

This is the first case of a *boat-chair* conformational preference of a bicyclo[3.3.1]nonan-9-one due to the presence of *exo*-substituents at C_2 and C_4. Work is in progress to prepare related compounds in which both the *chair-chair* and the *boat-chair* conformations are nearly equally populated.

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