Synthesis of *syn*-Substituted Triptycenes *via* Heteroatom-directed Metallation

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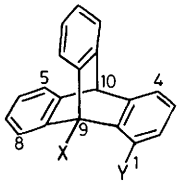
Heteroatoms in 9-substituted triptycenes direct *syn*-lithiation at the benzene rings, providing a new method for the synthesis of 1,9-di- and 1,8,9-tri-substituted triptycenes.

syn-Substituted triptycenes with, *e.g.*, 1,8,13-tri- and 1,8,9,13-tetra-substitution, are of interest in terms of spatial interactions between the substituents, which are closely spaced with parallel bonding to the rigid carbon framework of triptycene, in host–guest chemistry, *etc.* Although several of these compounds have been synthesised *via* benzyne–anthracene cycloaddition reactions, as yet no selective synthesis has been described.[1]

In view of the regioselective *ortho*-lithiation of aromatic compounds assisted by heteroatoms,[2] it is expected that an appropriate heteroatom functionality in the substituent at the bridgehead (C-9 and C-10) of triptycene might direct, in

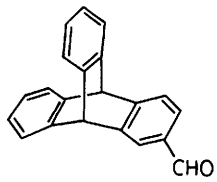


(1) X = Y = H
(2) X = H, Y = CHO
(4) X = OMe, Y = H
(5) X = OMe, Y = CHO
(7) X = CH_2OMe, Y = H
(8) X = CH_2OMe, Y = CHO
(9) X = CONHMe, Y = H
(12) **a**; X = CONHMe, Y = OH
b; X = CONHMe, Y = CH(OH)Ph
c; X = CONHMe, Y = Br

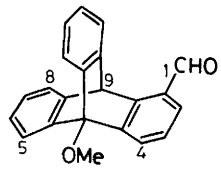
principle, up to three *syn*- metallations at C-1, C-8, and C-13, by taking advantage of the D_{3h} symmetry and nearly independent nature of the three benzene rings of triptycene. We report here the selective synthesis of 1,9-di- and 1,8,9-trisubstituted triptycenes by heteroatom directed *syn*-lithiation.

Triptycene (**1**) itself was lithiated only slowly and non-selectively by treatment with the base complex Bu^nLi–TMEDA (TMEDA = tetramethylethylenediamine) (1 : 1; 2 equiv., ether, N_2, room temp., 12 h) followed by addition of excess dimethylformamide (DMF) at 0 °C, to afford 1- and 2-formyltriptycene (**2**) and (**3**)[3] in 21 and 8% yields, respectively, with 69% recovery of (**1**). Under similar conditions, the lithiation of 9-methoxytriptycene (**4**) proceeded more smoothly and preferentially at C-1, to give, on formylation, 1-formyl-9-methoxytriptycene (**5**) and 1-formyl-10-methoxytriptycene (**6**)† in 47 and 7% yields [28% recovery of (**4**)]. 9-Methoxymethyltriptycene (**7**), in which the oxygen atom can approach C-1, C-8, and C-13 more closely than that of (**4**), was lithiated even more effectively and selectively, leading to 1-formyl-9-methoxymethyltriptycene (**8**) in 70% yield [15% recovery of (**7**)]. Use of 3 equivalents of the base increased the yield of (**8**) to 86% after 5 h of lithiation. However, no 1,8-diformyl compounds were formed by *syn*-1,8-dilithiation with these ethers, although some 1,5-diformyl compounds were isolated in poor yields under more forcing conditions.

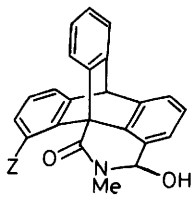
The *syn*-dilithiation and the highly efficient monolithiation were substantiated using the bidentate and highly directive *sec*-carboxamide.[4] Thus, lithiation of *N*-methylamide (**9**) with the base (3 equiv.) at 0 °C for 15 min gave, after formylation, the hydroxylactam (**10**) in 88% yield; a similar reaction using 4 equivalents of the base at 25 °C for 40 min gave the formyl lactam (**11**) (a mixture of two possible stereoisomers) in 60% yield in addition to (**10**) (32%). The dilithiated intermediate is (**14**). Other bidentate functional groups such as acetal and oxazoline, however, were ineffective, resulting mostly in decomposition or recovery of the starting materials.



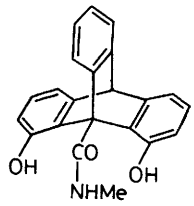
(**3**)



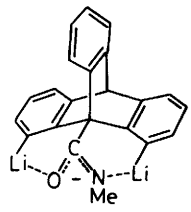
(**6**)



(**10**) Z = H
(**11**) Z = CHO



(**13**)



(**14**)

These *syn*-lithiations allow the synthesis of a variety of 1,9-di- and 1,8,9-tri-substituted triptycenes, in particular functionalised ones; for example, (**12a—c**) were obtained in good yields, *via* monolithiation of (**9**) upon quenching with oxygen (60%), benzaldehyde (88%), and 1,2-dibromoethane (67%), respectively. The dilithiation and oxygen-quenching of (**9**) afforded diphenol-amide (**13**) (52%) together with (**12a**) (32%).

To conclude, *syn*-substituted triptycenes are accessible through heteroatom-directed metallation. Suitable tridentate heteroatom functionality at C-9 position would enable *syn*-trimetallation and -functionalisation of triptycenes.

Received, 16th October 1989; Com. 9/04461B

† Satisfactory analytical and spectral data were obtained for all new compounds. The structures of (**5**) and (**6**) were determined from their ^1H NMR spectra, in comparison with those of (**2**) and (**3**), particularly the splitting of the formylated benzene ring protons, the chemical shifts of the bridgehead protons and formyl protons. For (**5**): m.p. 224 °C, ^1H NMR ($CDCl_3$, 500 MHz) δ 4.28 (3H, s), 5.39 (1H, s, H-10), 7.00 (1H, t, *J* 7.6 Hz), 7.09—7.17 (4H, m), 7.44 (1H, d, *J* 7.4 Hz), 7.47 (2H, d, *J* 7.4 Hz), 7.54 (1H, d, *J* 7.8 Hz), 7.69 (2H, d, *J* 7.1 Hz), 11.39 (1H, s, CHO) (long range coupling omitted). For (**6**): m.p. 196 °C, ^1H NMR ($CDCl_3$, 100 MHz) δ 4.33 (3H, s), 6.76 (1H, s, H-9), 6.96—7.50 (8H, m), 7.55—7.70 (2H, m), 7.82 (1H, d, *J* 7.5 Hz, H-2), 10.23 (1H, s, CHO).

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