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Useful procedures for preparing a novel tetraazacyclotetradecadiene and a pentaazacyclotetradecatriene are reported.

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Earlier studies (1) have demonstrated that quinoline undergoes ring fission with thiophosgene and base to give *o*-isothiocyanato-*E*-cinnamaldehyde (1). Base, in the form of malonate ion, ring closes the aldehyde (1) to the quinoline thione conveniently isolated as its sodium derivative (2). We now wish to report the facile preparation of some 14-membered ring compounds from these two intermediates.

Although only low yields of the sulphone (4) were obtained on oxidation of the methylthio derivative (3) with permanganate (17%) or *m*-chloroperbenzoic acid (7%) we found that periodate at laboratory temperature over two days gave good yields (82%) of the corresponding sulphanyl derivative (5). The mass spectrum

(M^+ 394) on the reaction product from ethylene diamine and the sulphanylquinoline (5) indicated the formation of a 14 membered pentacyclic compound (42%) rather than the diazepine (8). Of the two possible structures (6 and 7) for this compound, structure 6 was apparent from nmr studies as the spectrum obtained using deuteropyridine as solvent gave a complex multiplet for the methylene groups (δ 3.3-3.9). A much simpler pattern would have been obtained for the methylene groups of 7. It is of interest that in the analogous reaction of ethylenediamine with the methoxymethylthioquinoline (9) (2) ring closure took place to yield the 7-membered tricyclic diazepine (10) (m/e 277).

In a second approach to a 14-membered compound we found that the *S*-methylthiosemicarbazone (11), conveniently prepared from the α - β unsaturated aldehyde (1), reacted with ethylenediamine and yielded the pentaazadicyclic (12) in 35% yield. The elemental and spectroscopic data support the assigned structure. The uv spectrum (in neutral or alkaline solution) shows similarities to *N*-phenylthiourea and inconsistencies with quinoline-2-thione and so the isomeric structure (13) may be discounted.

EXPERIMENTAL

Melting points were taken on a Büchi Melting point apparatus and were uncorrected. Uv spectra were recorded on a Unicam SP 8000 spectrophotometer. Nmr spectra were obtained either on a Varian HA 100 spectrometer or a Varian A60 spectrometer using TMS as internal reference. Unless otherwise stated, the solvent was deuteriochloroform. Mass spectra were measured on either an AEI MS12 or MS9 spectrometer.

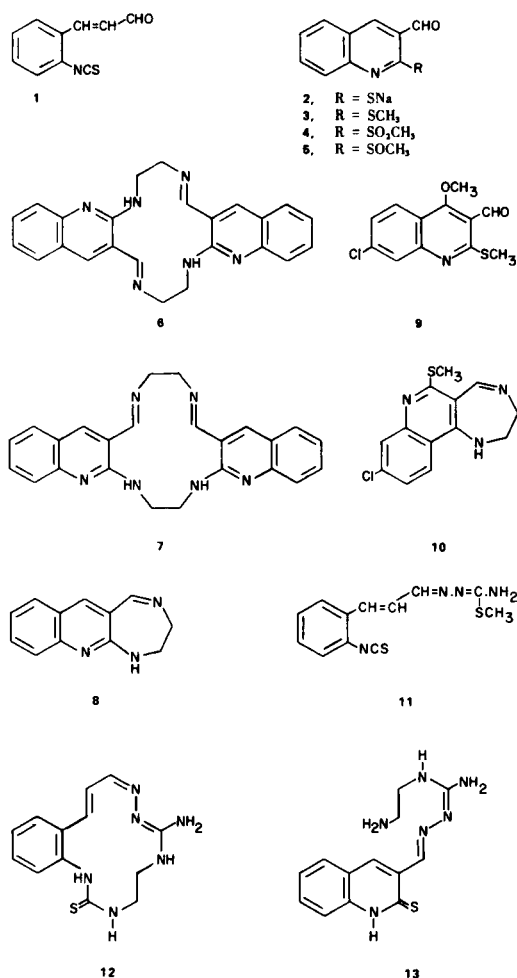
2-Methylthioquinoline-3-carbaldehyde (3).

Iodomethane (1.55 ml., 0.025 mole) was added dropwise to a stirred solution of the thione (2) (1) (5.0 g., 0.024 mole) in DMF (100 ml.) at 40° over 5 minutes. After standing overnight at ambient temperature, the reaction mixture was screened from a little insoluble material and the filtrate poured into warm water (600 ml.) and the resulting precipitate was stirred for 2 hours. The product was filtered off, washed with water and recrystallized from cyclohexane (2.8 g., 58%) m.p. 110°; nmr: δ 2.8 (s, 3H, CH₃), 7.55 (m, 5H, aromatics), 8.52 (s, 1H, CHO).

Anal. Calcd. for C₁₁H₉NOS: C, 65.0; H, 4.45; N, 6.9. Found: C, 64.8; H, 4.4; N, 7.1.

2-Methylsulfonylquinoline-3-carbaldehyde (4).

Potassium permanganate (1.7 g., 0.011 mole) was added



portionwise to a stirred solution of the methylthio compound (3) (1.02 g., 0.005 mole) in acetone (90 ml.) and glacial acetic acid (10 ml.). The resulting dark brown solution was stirred for 72 hours at ambient temperature. After decolorizing the mixture with sodium bisulfite solution, the solvent was evaporated off *in vacuo* to give an oil. After trituration with ether the crude product was filtered off and crystallised from ethanol (0.2 g., 17%) m.p. 151-153°; nmr: δ 3.6 (s, 3H, CH₃), 7.8-8.2 (m, 4H, H_{5,6,7,8}), 8.9 (s, 1H, H-4), 11.0 (s, 1H, CHO).

Anal. Calcd. for C₁₁H₉NO₃S: C, 56.2; H, 3.8; N, 6.0. Found: C, 56.5; H, 3.9; N, 6.0.

Using *m*-chloroperbenzoic acid in chloroform as oxidising agent instead of potassium permanganate only 7% yield of pure 4 was obtained.

2-Methylsulfinylquinoline-3-carbaldehyde (5).

A solution of sodium periodate (6.4 g., 0.03 mole) in water (50 ml.) was added to a solution of the methylthio compound (3) (4.1 g., 0.02 mole) in methanol (200 ml.) and the resulting solution stood at ambient temperature for 72 hours. After filtering off the inorganic precipitate, the filtrate was evaporated to dryness. The solid residue was trituated with ether and the product filtered off (3.6 g., 82%) m.p. 178-180°. An analytical sample from ethanol had m.p. 180-181°; nmr: δ 3.0 (s, 3H, SOCH₃), 7.8-8.5 (m, 4H, H_{5,6,7,8}), 8.8 (s, 1H, H-4), 10.5 (s, 1H, CHO); ms: *m/e* 219 (M⁺).

Anal. Calcd. for C₁₁H₉NO₂S: C, 60.3; H, 4.1; N, 6.4. Found: C, 60.6; H, 4.2; N, 6.2.

o-Isothiocyanato-*E*-cinnamaldehyde *S*-Methylthiosemicarbazone (11).

A solution of *S*-methylthiosemicarbazide hydriodide (3) (2.6 g., 0.011 mole) and sodium acetate (0.9 g., 0.011 mole) in water (10 ml.) was added to a solution of 1 (1) (1.89 g., 0.01 mole) in ethanol (15 ml.). The product, which precipitated out immediately, was filtered off, washed with a little ethanol and crystallised from methanol/acetone (1:1) (1.1 g., 72%) m.p. 154°; nmr: δ 2.65 (s, 3H, CH₃), 5.6 (br s, 2H, NH₂), 7.3 (m, 5H, 3 aromatic protons + terminal CH's), 7.8, 8.4 (m's, 1H, 1H, middle CH + aromatic proton).

Anal. Calcd. for C₁₂H₁₂N₄S₂: C, 52.2; H, 4.3; N, 20.3. Found: C, 51.9; H, 4.3; N, 20.0.

7,8,18,19-Tetrahydro-6*H*,17*H*,-diquinolino[2,3-*e*:2,3-*i*][1,4,8,11]-tetraazacyclotetradeca-7,14-diene (6).

1,2-Diaminoethane (1.08 ml., 0.016 mole) was added to a solution of the methylsulfinyl compound (5) (0.88 g., 0.004 mole) in methanol (20 ml.). After refluxing for 18 hours, the reaction mixture was filtered. The yellow crystalline solid was recrystallised

from methanol (0.3 g., 42%) m.p. > 320°; nmr (perdeuterio-acetic acid): δ 4.1 (s, 8H, 4 x CH₂), 7.5-8.0 (m, 8H, fused benzene aromatics), 8.6 (s, 2H, 2 x CH=N or 2 x H-4), 8.8 (s, 2H, 2 x H-4 or 2 x CH=N); (deuteropyridine): δ 3.3-3.9 (m, 8H, CH₂'s), 7.2-7.7 (m, 8H, fused benzene aromatics) 8.3 (s, 2H, 2 x CH=N or 2 x H-4), 8.5 (s, 2H, 2 x H-4 or 2 x CH=N); ms: *m/e* 394 (M⁺) with abundant fragment peaks at 211 and 183.

Anal. Calcd. for C₂₄H₂₂N₆: C, 73.0; H, 5.6; N, 21.3. Found: C, 72.8; H, 5.7; N, 21.4.

9-Chloro-6-methylthio-2,3-dihydro-1*H*[1,4]diazepino[6,5-*c*]-quinoline (10).

1,2-Diaminoethane (0.28 ml., 0.004 mole) was added to a solution of 9 (2) (1.0 g., 0.004 mole) in THF (80 ml.). After stirring the solution at ambient temperature for 30 minutes the solvent was evaporated off *in vacuo* leaving the product as a buff solid. The crude solid was crystallised from ethanol (0.6 g., 54%) m.p. 245-246°; nmr: (dimethylsulfoxide-*d*₆): δ 2.6 (s, 3H, SCH₃), 3.5 and 4.0 (br m's, 4H, CH₂'s) 7.3-7.6 (m, 2H, aromatic protons), 8.3-8.0 (m, 2H [1H on deuteration], NH + aromatic proton), 8.65 (s, 1H, CH=N); ms: *m/e* 277 (M⁺).

Anal. Calcd. for C₁₃H₁₂ClN₃S: C, 56.2; H, 4.4; N, 15.1. Found: C, 56.1; H, 4.3; N, 14.6.

7-Amino-2-thioxo-1,3,6,8,9-pentaazabenzocyclotetradeca-7,9,11-triene (12).

1,2-Diaminoethane (1.08 ml., 0.016 mole) was added to a solution of 11 (1.32 g., 0.004 mole) in methanol (20 ml.) and the solution was refluxed for 48 hours. The precipitated solid was filtered off and washed with methanol (0.4 g., 35%) m.p. > 320°; ms: *m/e* M⁺ (288) not seen, 286.0999 (M⁺-H₂, C₁₃H₁₄N₆S requires 286.1000); uv (pH 6.7): log ϵ 281 nm = 4.27, log ϵ 260 nm = 4.12, (pH 13.0): log ϵ 282 nm = 4.24, log ϵ 256 nm = 4.13. *N*-Phenylthiourea (4) (methanol): log ϵ 265 nm = 4.2, log ϵ 270 nm = 4.1. Quinoline-2-thione (5) (pH 7.0) log ϵ 275 nm = 4.35, log ϵ 376 nm = 4.14. (pH 12.0) log ϵ 266 nm = 4.37, log ϵ 288 nm = 4.03, log ϵ 354 nm = 3.94.

Anal. Calcd. for C₁₃H₁₆N₆S: C, 54.1; H, 5.5; N, 29.1. Found: C, 53.7; H, 5.1; N, 28.6.

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