

Unexpected Synthesis of a 1*H*-Pyrrolo[2,3-*e*]-1,2,4-triazine

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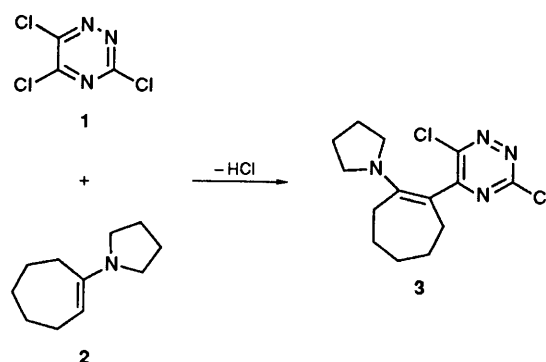
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3,6-Dichloro-5-(2-pyrrolidin-1-ylcyclohept-1-enyl)-1,2,4-triazine was found to undergo a facile thermal intramolecular rearrangement; an X-ray crystal structure determination showed the product to be derived from a novel heterocyclic system, 1*H*-pyrrolo[2,3-*e*]-1,2,4-triazine.

As part of a program investigating the Diels–Alder reactions of 3,5,6-trichloro-1,2,4-triazine **1**,¹ we have investigated the reactivity of **1** with 1-pyrrolidin-1-ylcycloheptene **2** anticipating a resulting [4 + 2] cycloaddition product^{2–4}. Instead the major product formed was 3,6-dichloro-5-(2-pyrrolidin-1-ylcyclohept-1-enyl)-1,2,4-triazine **3** resulting from alkylation of the triazine by the enamine (Scheme 1). We expected that **3** should act as a heterodiene in the inverse electron demand reactions typical of 1,2,4-triazine⁵ and heated **3** with bicyclo[2.2.1]hepta-2,5-diene intending to form a pyridine after addition of the dienophile and elimination of nitrogen and cyclopentadiene.^{6,7} At 90 °C the starting material was rapidly consumed and replaced by one product. On isolation, the product was found to have a molecular formula of C₁₄H₁₈Cl₂N₄, suggesting that no dienophile had been incorporated and that the new product had arisen *via* intramolecular thermal rearrangement of **3**.

This hypothesis was confirmed when **3** was heated in inert solvents. Typically, **3** when heated in toluene for 0.5 h gave a



Scheme 1

90% yield of a product identical with that obtained in the presence of bicyclo[2.2.1]hepta-2,5-diene. In order to characterise the product unambiguously, a single crystal X-ray

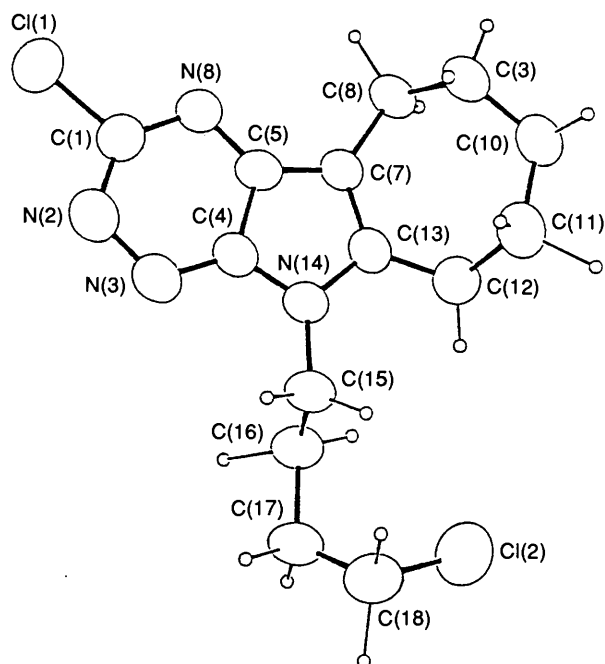
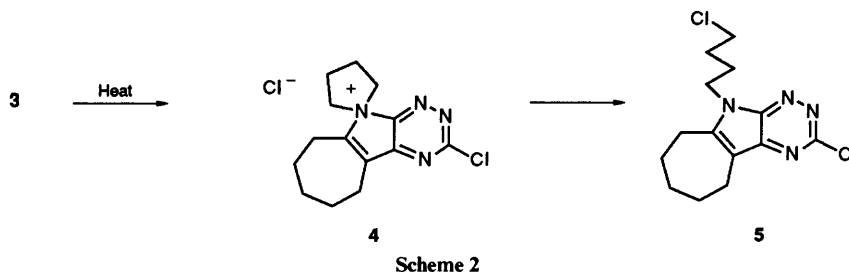


Fig. 1 ORTEP Diagram of 5

determination was carried out[†]. The structure of the product, 5, is based on a novel heterocyclic system in which the triazine nucleus has been maintained and annulated with a pyrrole ring. The molecular dimensions of the triazine unit of 5 fall within the ranges of other 1,2,4-triazines that have been examined by X-ray crystallography.[‡]

The mechanism for formation of 5 is proposed in Scheme 2. The annulation arises *via* a nucleophilic displacement of chloride at C-6 of the triazine to give the tetracyclic quaternary salt 4. This intermediate is not isolated but is converted into the final product by chloride ion-assisted opening of the pyrrolidine ring. A strong driving force for this reaction would be derived from aromatisation of the pyrrole ring.

[†] Crystal data for Compound 5: C₁₄H₁₈Cl₂N₄, *M* = 313.23, triclinic, *PT*, *a* = 9.060(2) Å, *b* = 11.174(2) Å, *c* = 9.061(2) Å, α = 108.65(2)°, β = 116.64(2)°, γ = 96.71(2)°, *U* = 739.1(6) Å³, *D_c* = 1.407 g cm⁻³, *Z* = 2, *F*(000) = 328. Data were collected on an Enraf-Nonius CAD-4 diffractometer using Cu-K α radiation. A total of 2806 reflections were measured. The structure was solved with the MULTAN 80 direct methods procedures⁹ and refined to *R* = 0.0759 and *R_w* = 0.0774, for 2365 observations with *I* \geq 3 σ (*I*), 6.0.F. = 1.858.

[‡] Selected bond lengths (Å) and angles (°) for 5. Atomic numbering as shown in Fig. 1. Bond lengths C(1)–N(2) 1.336(5), N(2)–N(3) 1.361(4), N(3)–C(4) 1.311(4), C(4)–C(5) 1.438(4), C(5)–N(6) 1.341(4), N(6)–Cl(1) 1.320(4), C(5)–C(7) 1.389(5), C(7)–C(13) 1.382(5), C(13)–N(14) 1.402(4), N(14)–C(4) 1.354(4). Bond angles N(6)–C(1)–N(2) 130.1(3), C(1)–N(2)–N(3) 118.0(3), N(2)–N(3)–C(4) 115.5(3), N(3)–C(4)–C(5) 124.5(3), C(4)–C(5)–N(6) 118.9(3), C(5)–N(6)–C(1) 113.0(3), C(4)–C(5)–C(7) 107.5(3), C(5)–C(7)–C(13) 106.9(3), C(7)–C(13)–N(14) 109.7(3), N(14)–C(4)–C(5) 108.0(3), N(6)–C(5)–C(7) 133.5(3), N(3)–C(4)–N(14) 127.4(3).

Thus the overall product from the reaction between 1 and 2 arises from a regiospecific double nucleophilic displacement by the enamine at C-5 and C-6 of the triazine. This reaction provides a facile route to a potentially very interesting novel heterocyclic system.

Experimental

3,6-Dichloro-5-(2-pyrrolidinocyclohept-1-enyl)-1,2,4-triazine 3.—3,5,6-Trichloro-1,2,4-triazine 1 (1.5 g, 8 mmol) was dissolved in anhydrous ether (75 ml) and cooled to 0 °C. A solution of 1-pyrrolidinocycloheptene 2 (1.32 g, 8 mmol) in anhydrous ether (20 ml) was added dropwise. After the addition, the reaction mixture was stirred at 0 °C for 0.5 h and the resulting precipitate isolated by filtration. The precipitate was dissolved in water (200 ml) and the pH adjusted to 8 with Na₂CO₃. The product was extracted into CHCl₃ (4 \times 100 ml), the extract dried (MgSO₄) and the solvent removed under reduced pressure. The resulting red oil was further purified by column chromatography on silica gel using ethyl acetate as the eluent. The final product was solidified by trituration with hexane–ether (1 : 1) to give the *title compound* 3 (0.95 g, 38%) m.p. 118–120 °C (decomp) (Found: C, 53.95; H, 5.85; N, 17.75. C₁₄H₁₈Cl₂N₄ requires C, 53.68; H, 5.79; N, 17.89%). Satisfactory IR, ¹H and ¹³C NMR spectra were also obtained.

1H-Pyrrolo[2,3-e]-1,2,4-triazine 5.—Compound 3 (0.75 g, 2.4 mmol) was dissolved in toluene (30 ml) and heated to reflux for 30 min. The solution was applied to a silica column and the toluene removed using hexane. The product was eluted using ethyl acetate–hexane (1 : 1). Crystals suitable for X-ray analysis were obtained by recrystallising the crude product from acetone–hexane to give the *title compound* 5 (0.65 g, 87%), m.p. 108–109 °C (Found: C, 53.6; H, 5.85; N, 17.7. C₁₄H₁₈Cl₂N₄ requires C, 53.68; H, 5.79; N, 17.89%). Satisfactory IR, ¹H and ¹³C NMR spectra were also obtained.

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