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VINYLAMINES—XIV[1]

NITROALKYLATION OF ENAMINIC EQUILIBRIUM MIXTURES

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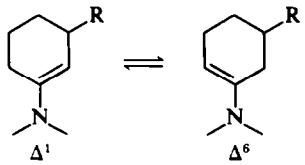
Abstract—A rapid equilibrium is present in enaminic systems derived from 3-substituted cyclohexanones. Their reactions with β-nitrostyrene have been studied and the stereochemical implications discussed.

Several authors[2,3] have reported that enaminic systems derived from 3-substituted cyclohexanones exist as equilibrium mixtures of Δ^1 and Δ^6 isomers:



Δ^1 Δ^6

In a previous paper[4] we have demonstrated this equilibrium to be rapid, even at low temperature. In fact, in reactions with β-nitrostyrene the 3-methyl, 3-phenyl and 3-*t*-butyl-cyclohexanone morpholine enamines gave, after hydrolysis, 2,5 disubstituted ketones (derived from the Δ^6 form) in yields which were much higher than the percentages of the Δ^6 isomers in the parent enamines (determined by NMR, Scheme 1 and Table 1).

We have found that β-nitrostyrene reacts with both the Δ^6 and Δ^1 isomers by the usual[5] stereospecific attack, giving a single diastereoisomer in each case. The assignments of the relative configurations and conformations of the reaction products were made on the basis of their relative thermodynamic stability as well as NMR.

In fact, the nitromethylenic proton signals showed patterns and chemical shifts characteristic for each configuration and conformation of the (α-phenyl-β-nitro)ethyl group (Table 2), shown using cyclohexanones bearing an (α-phenyl-β-nitro)ethyl group at C-2, of known configuration and conformation. The first two compounds were *erythro*-2-(α-phenyl-β-nitro)ethyl-cyclohexanone **9**, whose configuration has been established by X-ray analysis,[6] and its *threo* diastereoisomer **10**, obtained by equilibration of **9** (Scheme 2). As can be seen in Table 2, the nitromethylenic proton signals of **9** and **10** were distinctive. It is worth noting that **9** was converted into a 65:35 mixture of **9** and **10**, which indicates the greater stability (about 0·4 kcal/mole) of the *erythro* form with respect to the *threo*. Epimerization occured at C-2 only, and the benzylic hydrogen did not exchange with deuterium when the equilibration was carried out with TsOD in refluxing benzene. This behaviour is general for all our compounds. The third model compound was *trans-erythro*-2-(α-phenyl-β-nitro)ethyl-4-*t*-butyl-cyclohexanone **11** (Scheme 2), obtained from the reaction of 1-morpholino-4-*t*-butyl-cyclohexene with β-nitrostyrene. The configuration of **11** could be deduced easily, considering that its diastereoisomer **12** (obtained by equilibration of **11**)* had the *cis-threo* configuration, since its nitromethylenic proton signals were identical with those of **10** (Table 2).

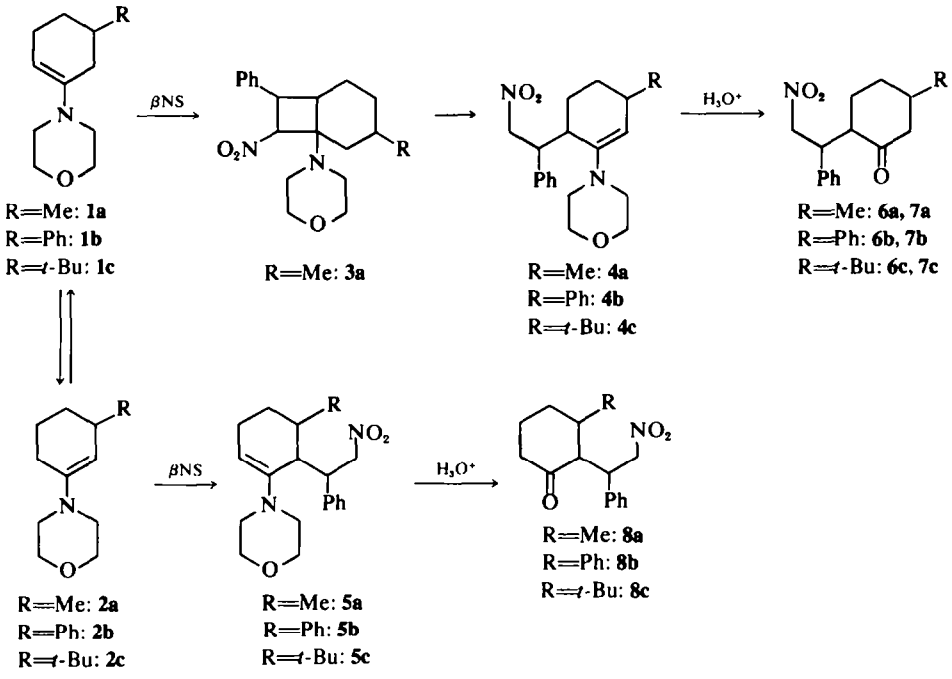
Taking the compounds **9**, **10**, **11** and **12** as model compounds, we can consider the stereochemistry of the reactions of the 3-substituted enamines with β-nitrostyrene. The Δ^6 isomers **1a**, **1b** and **1c** reacted with the nitro-olefin giving the trisubstituted

Table 1.

Ratio of parent enaminic isomers (from areas of NMR vinylic proton signals)		Ratio of nitroalkylated ketones	
$_6\Delta/_1\Delta$	%	Compounds	%
1a/2a	55/45[2]	**6a/8a**	80/20
1b/2b	~ 0/~ 100	**6b/8b**	80/20
1c/2c	45/55*	**6c/8c**	85/15

*The vinylic proton signals overlapped. The percentage of **2c** was determined from the integrated area of the *t*-butyl signal, which was slightly deshielded by the adjacent double bond.

*The thermodynamic composition of the **11**:**12** mixture was 50:50. This result is difficult to understand and it is in contrast with the general behaviour of 2-alkyl-4-*t*-butyl-cyclohexanones.[7]



SCHEME 1

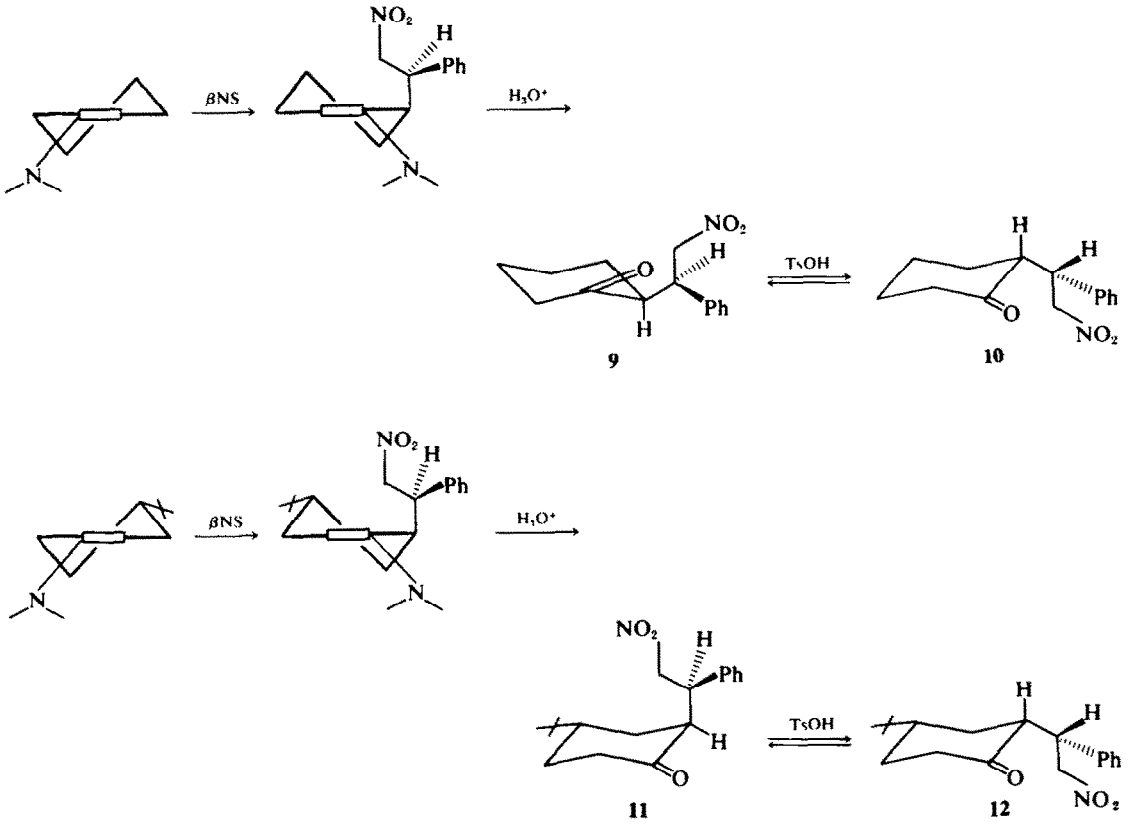
Table 2.

Configuration and conformation of the (α-phenyl-β-nitro) ethyl group	CH_2NO_2 pattern	Compounds	δ($CDCl_3$)	J_{AB} (Hz)
Erythro equatorial		**6a**	4·63	12·0
		8a	4·75	12·0
		8b	4·81	12·0
		8c	4·70	12·0
		9	4·65	12·0
Threo equatorial		**7a**	4·84	7·50
		7b	4·85	7·50
		7c	4·83	7·50
		10	4·88	7·25
		12	4·83	7·25
Erythro axial		**6b**	4·64	7·50
		6c	4·56	7·50
		11	4·54	7·50

enamines **4a**, **4b** and **4c** respectively (Table 2). They were hydrolysed under non-equilibrating conditions and furnished the ketones **6a**, **6b** and **6c** respectively, structures assigned by comparison of their NMR spectra with those of model compounds (Table 2). The product **6a** had *cis*-configuration* since the (α-phenyl-β-nitro)ethyl group was *erythro*-equatorial and the methyl group was axial (J = 7·25 Hz).[9]

Also **6b** and **6c** had the *cis*-configuration but the

*X-ray analysis[8] of **6a** has confirmed this assignment.



SCHEME 2

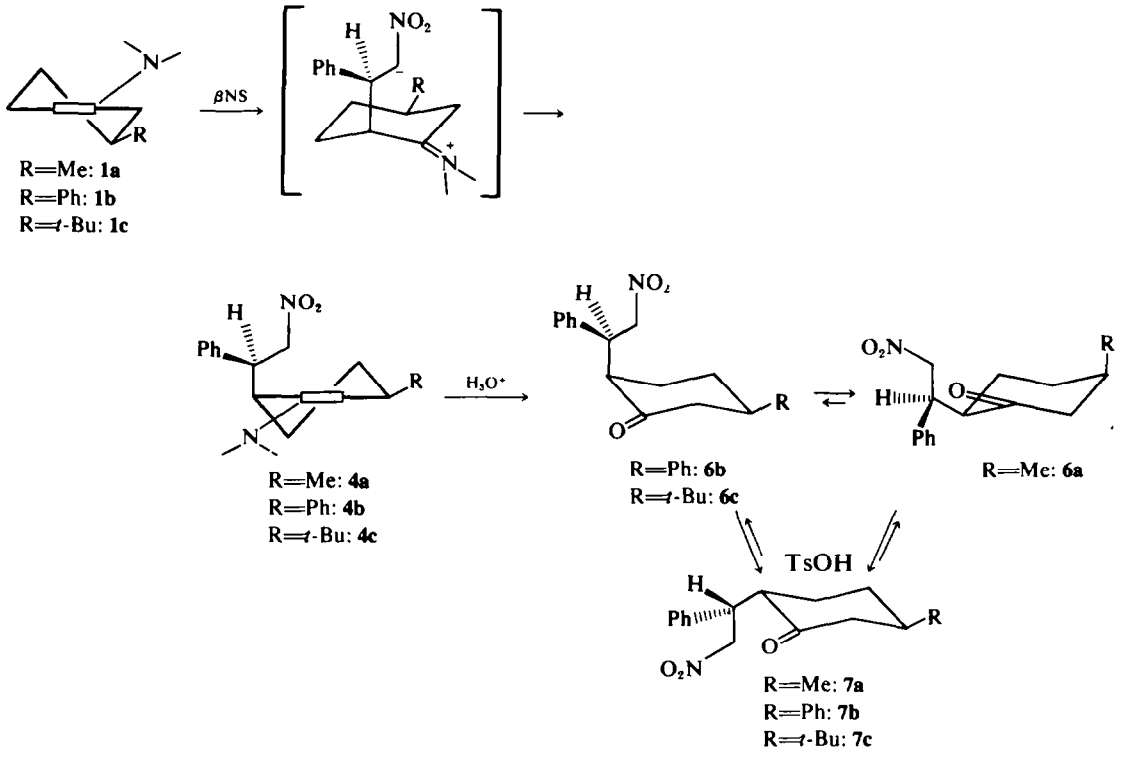
(α-phenyl-β-nitro)ethyl groups were clearly *erythro*-axial (Table 2). Since the ketones **6a**, **6b** and **6c** derived from hydrolysis carried out under non-equilibrating conditions, the same *cis-erythro* configuration could be assigned to the nitroalkylated enamines from which they were obtained. Therefore the enamines **4a**, **4b** and **4c** derived by antiparallel attack of β-nitrostyrene on the Δ^6 isomers **1a**, **1b** and **1c** (Scheme 3). In **4a**, **4b** and **4c** the alkyl group at C-2 was always quasi-axial in order to avoid Johnson strain[10] with the morpholine ring.

The acidic equilibration of **6a** gave a 2:3 mixture of **6a** and its *trans* isomer **7a**, in which the methyl was equatorial (J = 3·75 Hz)[9] and the alkyl group at C-2 had the *threo*-configuration (Table 2). The 2:3 ratio could be explained considering that, although **7a** had the bisequatorial conformation, the (α-phenyl-β-nitro)ethyl group had the less stable *threo*-configuration. The counterbalance of the two factors (methyl conformation and nitroalkyl group configuration) could account for the ratio obtained. The equilibration of **6b** and **6c** gave 1:4 mixtures of the same ketones and of their isomers **7b** and **7c** in which the configuration was *trans-threo*, as in **7a** (Table 2).

The Δ^1 isomers of **1a**, **1b** and **1c** reacted with β-nitrostyrene giving the trisubstituted enamines **5a**, **5b** and **5c** (Scheme 1), which were hydrolysed under non-equilibrating conditions and provided the ketones **8a**, **8b** and **8c** respectively. A comparison of NMR spectra with those of the model compounds indicated that the configuration of the (α-phenyl-β-nitro)ethyl group was *erythro*-equatorial in all these compounds.

Since in **8a** the methyl group was equatorial (J = 4·25 Hz), like phenyl in **8b** and *t*-butyl in **8c**, they were in a *trans erythro*-configuration. This could be confirmed by the fact that they did not undergo equilibration. This different behaviour in comparison with the 2,5-disubstituted ketones could be explained considering that in the eventual epimers the (α-phenyl-β-nitro)ethyl group should have the less stable *threo*-configuration; moreover, one group should be axial, causing severe 1,3-strains.

Therefore the trisubstituted enamines had the same configuration as the ketones, i.e. *trans-erythro*. This attribution required a parallel attack of the olefin on the Δ^1 isomers **2b** and **2c**. For **2a**, on the contrary, two modes of attack were possible, either a parallel attack on its equatorial conformer or an antiparallel one on its axial conformer. The



SCHEME 3

latter is much more probable than the former (Scheme 4).

Finally, something must be said about the formation of the cyclobutane adduct **3a**. When the dipolar intermediate was formed, the carbanion could neutralize its charge either collapsing on C-1, giving **3a**, or abstracting the proton at C-6, giving **4a**. The formation of the cyclobutane was evidently kinetically favoured over that of the enamine. In fact **3a** was very unstable, since it converted into the corresponding enamine, merely by solution in a solvent, in contrast to analogous cyclobutanes.[11]

The conclusion is that the nitroalkylation by β-nitrostyrene has been found to be high stereoselective, both for stereoelectronic and for steric requirements.

It attacks by an antiparallel mechanism, unless steric hindrance is present in the parent enamines. In the dipolar intermediate, the phenyl group at C-α always assumes the *anti*-conformation with respect to the ring. This high selectivity is not general for all the nitro-olefins. 1-Nitropropene, for instance, reacts with the same substrates by both parallel and antiparallel attack almost indifferently. This problem is under investigation and will be reported on later.

EXPERIMENTAL

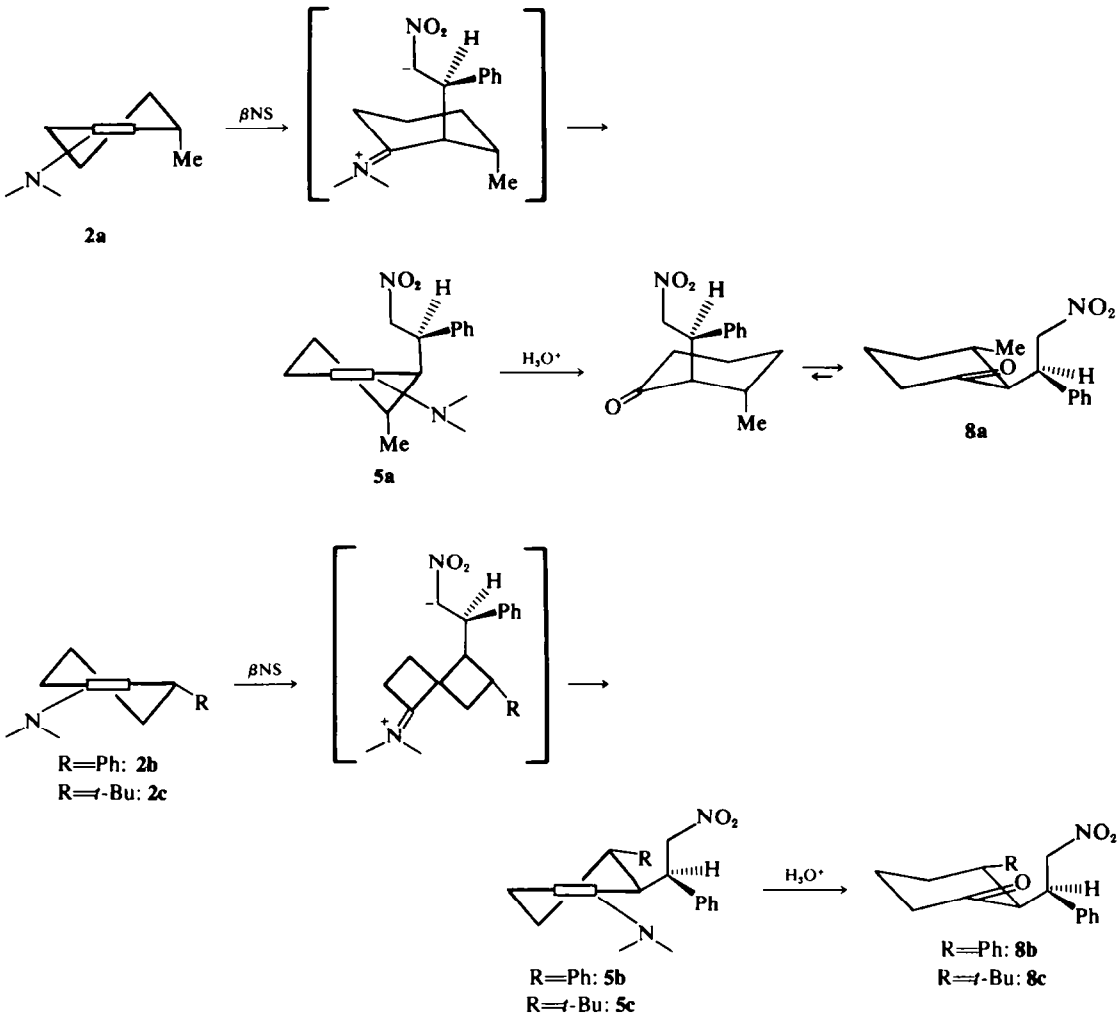
All m.ps are uncorrected. IR spectra were recorded for Nujol mulls with a Perkin-Elmer 257 spectrometer, and NMR spectra with a JNM-C-60HL spectrometer with TMS as internal standard for $CDCl_3$ soln, unless otherwise noted. Chromatographic columns were prepared using extra pure SiO_2 Merck (70–325 mesh ATMS).

Reaction of 1-N-*morpholino*-3(*and* 5)-*methyl-cyclohex*-1-*ene* (**1a** + **2a**) *with* β-*nitrostyrene*

(a) *Bicyclo*[4.2.0]-1-N-*morpholino*-3-*methyl*-7-*phenyl*-8-*nitro-octane* (**3a**). β-Nitrostyrene (1·49 g, 10 mmoles) in dry ether (5 ml) was added to a soln of **1a** + **2a** (1·81 g, 10 mmoles) in the same solvent (15 ml) at 5°. The mixture was kept in the refrigerator for 48 hr. **3a** (2·15 g, 65%) was obtained, m.p. 115°. (Found: C, 68·80; H, 8·17; N, 8·69. $C_{19}H_{26}N_2O_3$ requires: C, 69·06; H, 7·93; N, 8·49%). IR: 1531 cm^{-1} (NO_2); 1602, 1498, 742, 690 cm^{-1} (Ph).

(b) 1-N-*morpholino*-3-*methyl*-6-(α-*phenyl*-β-*nitro*)*ethyl-cyclohex*-1-*ene* (**4a**). The product **3a** appeared to be thermally very unstable. Crystallized from benzene-ligroin or anhydrous MeOH, it gave **4a**, m.p. 112–4°. (Found: C, 69·30; H, 8·03; N, 8·49. $C_{19}H_{26}N_2O_3$ requires: C, 69·06; H, 7·93; N, 8·48%). IR: 1632 cm^{-1} (N—C=C); 1600, 1580, 1500, 760, 700 cm^{-1} (Ph; 1548 cm^{-1} (NO_2). NMR: 7·14 δ (Ph); 4·82 δ ($C\underline{H}_2NO_2$, m, 2H); 4·76 δ (C=C$\underline{H}$, d(J = 3 Hz), 1H); 3·75 δ ($C\underline{H}_2$—O—C$\underline{H}_2$; C$\underline{H}$—Ph, m, 5H); 0·88 δ ($C\underline{H}_3$, d (J = 6·75 Hz), 3H).

(c) cis-erythro-2-(α-*phenyl*-β-*nitro*)*ethyl*-5-*methyl-cyclohexanone* (**6a**). Both **3a** and **4a** (2·15 g, 6·5 mmoles) underwent acid hydrolysis in water-acetone mixture with acetic acid (0·395 g, 6·5 mmoles) for 24 hr, giving quantitatively **6a**, m.p. 115–6°, from benzene–light petroleum. (Found: C, 68·57; H, 7·17; N, 5·32. $C_{15}H_{19}NO_3$ requires: C, 68·94; H, 7·33; N, 5·36%). IR: 1692 cm^{-1} (CO); 1600, 1495, 761, 700 cm^{-1} (Ph); 1550 cm^{-1} (NO_2). NMR: 7·18



SCHEME 4

δ (Ph); 4·63 δ ($C\underline{H}_2NO_2$, dq, AB part of an ABX system (J_{AB} = 12 Hz), 2H); 3·74 δ ($C\underline{H}$—Ph, m, 1H); 0·97 δ ($C\underline{H}_3$, d (J = 7·25 Hz), 3H).

(d) trans-threo-2-(*α-phenyl-β-nitro*)*ethyl-5-methyl-cyclohexanone* (**7a**). **6a** was equilibrated with TsOH in refluxing benzene for 18 hr. A 2:3 mixture of **6a** and **7a** was obtained. This ratio was determined by the method described by Purdy.[12] **7a** was separated by PLC, m.p. 108–9°. (Found: C, 67·40; H, 7·30; N, 5·15. $C_{15}H_{19}NO_3$ requires: C, 68·94; H, 7·33; N, 5·36%). IR: 1700 cm^{-1} (CO); 1600, 1581, 1492, 772, 750, 692 cm^{-1} (Ph); 1550 cm^{-1} (NO_2). NMR: 7·32 δ (Ph); 4·84 δ ($C\underline{H}_2NO_2$, d (J = 7·5 Hz) 2H); 3·98 δ ($C\underline{H}$—Ph, m, 1H); 1·00 δ (CH_3, d (J = 3·75 Hz), 3H).

(e) 1-N-*morpholino-5-methyl-6-(α-phenyl-β-nitro)ethyl-cyclohex-1-ene* (**5a**), β-Nitrostyrene (1·49 g, 10 mmoles) in dry ether (5 ml) was added to a soln of **1a** + **2a** (1·81 g, 10 mmoles) in the same solvent (15 ml). The product **3a** was collected and the evaporated mother liquors gave an oil from which **5a** was isolated, m.p. 119–21°. (Found: C, 68·7; H, 7·93; N, 8·44. $C_{19}H_{26}N_2O_3$ requires: C, 69·06; H, 7·93; N, 8·40%). IR: 1650 cm^{-1} (N—C=C); 1600, 1580, 713, 705, 658 cm^{-1} (Ph); 1548 cm^{-1} (NO_2). NMR: 7·27 δ (Ph); 5·00 δ ($C\underline{H}_2NO_2$, C=C$\underline{H}$, m, 3H)*; 3·75 δ ($C\underline{H}_2$—O—$C\underline{H}_2$, CH—Ph, m, 5H); 0·85 δ ($C\underline{H}_3$, d (J = 6·75 Hz), 3H).

(f) trans-erythro-2-(*α-phenyl-β-nitro*)*ethyl-3-methyl-cyclohexanone* **8a**. **5a** (2·15 g, 6·5 mmoles) hydrolysed in water-acetone with acetic acid (0·395 g, 6·5 mmoles) for 24 hr afforded quantitatively **8a**, m.p. 116–8°, from benzene:light petroleum. (Found: C, 69·90; H, 7·57; N, 5·39. $C_{15}H_{19}NO_3$ requires: C, 68·94; H, 7·33; N, 5·36%). IR: 1694 cm^{-1} (CO); 1598, 1590, 768, 742, 695 cm^{-1} (Ph); 1550 cm^{-1} (NO_2). NMR: 7·26 δ (Ph); 4·75 δ ($C\underline{H}_2NO_2$, dq, AB part of an ABX system (J_{AB} = 12 Hz), 2H); 3·74 δ ($C\underline{H}$—Ph, m, 1H); 1·0 δ ($C\underline{H}_3$, d (J = 4·25 Hz), 3H).

(g) The same reaction described in (a) was performed

*The signal of the vinylic proton was isolated from those of nitromethylenic ones using CD_3COCD_3 as solvent and D_2O as deuteriating agent. Under these conditions, the nitromethylenic hydrogens exchanged with deuterium but the enamine did not undergo hydrolysis.

without isolating the enaminic products, in order to determine the yields. After removal of the solvent the residue was treated with aq AcOH under stirring for 48 hr. The mixture was extracted with benzene and the residue, obtained after removal of solvent, gave **6a** + **7a** (2·15 g, 82%) and **8a** (0·50 g, 18%), after PLC.

Reaction of 1-N-*morpholino*-3-*phenyl-cyclohex*-1-*ene* (**1b** + **2b**) *with β-nitrostyrene*

(a) cis-erythro-2-(*α-phenyl-β-nitro*)*ethyl*-5-*phenyl-cyclo-hexanone* (**6b**). trans-erythro-2-(*α-phenyl-β-nitro*)*ethyl*-3-*phenyl-cyclohexanone* (**8b**). β-Nitrostyrene (3·0 g, 20 mmoles) in dry ether (5 ml) was added to a soln of **1b** + **2b** (5·0 g, 20 mmoles) in the same solvent (15 ml). After removal of the solvent, a viscous oil was obtained, IR (CCl_4): 1638 cm^{-1} (N—C=C); 1600, 1498, 697, 672 cm^{-1} (Ph); 1550 cm^{-1} (NO_2). NMR: 4·68 δ ($C\underline{H}_2NO_2$, C=C$\underline{H}$, m, 3H); 4·0 δ (C$\underline{H}$—Ph, m, 1H); NMR (CD_3-$COCD_3$): 4·88 δ (C=C$\underline{H}$, d (J = 3·0 Hz), 1H). The oil was hydrolysed with AcOH (1·2 g, 20 mmoles) in acetone-water, giving **6b**, m.p. 134–6°, from ligroin : ethyl acetate. (Found: C, 74·2; H, 6·57; N, 4·28. $C_{20}H_{21}NO_3$ requires: C, 74·28; H, 6·55; N, 4·33%). IR: 1695 cm^{-1} (CO); 1600, 1582, 1490, 752, 695 cm^{-1} (Ph); 1552 cm^{-1} (NO_2). NMR: 4·64 δ ($C\underline{H}_2NO_2$, d (J = 7·5 Hz), 2H); 3·88 δ (NO_2—CH_2—C$\underline{H}$—Ph, m, 1H) 3·22 δ (C$\underline{H}$—Ph, m, 1H). The mother liquors gave a mixture of **6b** and **8b**, which was separated by fractional crystallization, m.p. 144–5° from EtOH. (Found: C, 74·20; H, 6·16; N, 4·37. $C_{20}H_{21}NO_3$ requires: C, 74·28; H, 6·55; N, 4·33%). IR: 1700 cm^{-1} (CO); 1600, 1585, 755, 698 cm^{-1} (Ph); 1550 cm^{-1} (NO_2). NMR: 4·81 δ ($C\underline{H}_2NO_2$, dq, AB part of an ABX system (J_{AB} = 12 Hz), 2H); 3·79 δ (NO_2—CH_2—C$\underline{H}$—Ph, m, 1H). On TLC (acetone-benzene 2%) **8b** shows R_f greater than that of **6b**. The ratio **6b** : **8b** was 4 : 1.[12]

(b) trans-threo-2-(*α-phenyl-β-nitro*)*ethyl*-5-*phenyl-cyclo-hexanone* (**7b**). **6b** underwent acidic equilibration with TsOH in refluxing benzene for 18 hr to give **6b** and its isomer **7b**, separated by PLC. **7b** m.p. 114–5° from benzene : light petroleum. (Found: C, 73·3; H, 6·42; N, 4·34. $C_{20}H_{21}NO_3$ requires: C, 74·28; H, 6·55; N, 4·33%). IR: 1710 cm^{-1} (CO); 1600, 1587, 760, 699, 672 cm^{-1} (Ph); 1545 cm^{-1} (NO_2). NMR: 4·85 δ ($C\underline{H}_2NO_2$, d (J = 7·5 Hz), 2H); 4·03 δ (NO_2—CH_2—C$\underline{H}$—Ph, m, 1H). TLC gave for **6b** : **7b** a value 1 : 4.

Reaction of 1-N-*morpholino*-3(*and* 5)-t-*butyl-cyclohex*-1-*ene* (**1c** + **2c**) *with β-nitrostyrene*

(a) 1-N-*morpholino*-3-t-*butyl*-6-(*α-phenyl-β-nitro*)*ethyl-cyclohex*-1-*ene* (**4c**). β-Nitrostyrene (3·0 g, 20 mmoles) in dry ether (10 ml) was added dropwise to a soln of **1c** + **2c** (4·5 g, 20 mmoles) in the same solvent (15 ml). After removal of the solvent, the semi-solid residue was crystallized from ligroin, and gave **4c** (3·70 g, 50%), m.p. 109–12°. (Found: C, 71·30; H, 8·82; N, 7·29. $C_{22}H_{32}N_2O_3$ requires: C, 70·94; H, 8·66; N, 7·25%). IR: 1642 cm^{-1} (N—C=C); 1548 cm^{-1} (NO_2). NMR: 4·95 δ (C=C$\underline{H}$, d (J = 3 Hz)); 4·82 δ ($C\underline{H}_2NO_2$, m); 3·74 δ ($C\underline{H}_2$—O—$C\underline{H}_2$, C$\underline{H}$—Ph, m, 5H).

(b) cis-erythro-2-(*α-phenyl-β-nitro*)*ethyl*-5-t-*butyl-cyclohexanone* (**6c**). **4c** (1·5 g, 4 mmoles) was dissolved in water and acetone. Acetic acid (0·24 g, 4 mmoles) was added with stirring. After removal of the solvent, a crystalline product, **6c** was obtained in quantitative yield, m.p. 92–3° from ligroin. (Found: C, 70·90; H, 8·33; N, 4·98. $C_{18}H_{25}NO_3$ requires: C, 71·26; H, 8·31; N, 4·62%). IR: 1690 cm^{-1} (CO); 1600, 1580, 752, 698 cm^{-1} (Ph); 1545 cm^{-1} (NO_2). NMR: 4·56 δ ($C\underline{H}_2NO_2$, d (J = 7·5 Hz), 2H); 3·72 δ (C$\underline{H}$—Ph, m, 1H); 0·95 δ (*t*-Bu, s, 9H).

(c) trans-threo-2-(*α-phenyl-β-nitro*)*ethyl*-5-t-*butyl-cyclohexanone* (**7c**). **6c** was refluxed in benzene with TsOH for 4 hr. A solid was obtained, m.p. 70–2°, which was a 1 : 4 mixture of **6c** and **7c**, separated by PLC. **7c**, m.p. 95–7° from hexane. (Found: C, 71·5; H, 8·51; N, 4·65. $C_{18}H_{25}NO_3$ requires: C, 71·26; H, 8·31; N, 4·62%). IR: 1700 cm^{-1} (CO); 1600, 698, 678 cm^{-1} (Ph); 1545 cm^{-1} (NO_2). NMR: 4·83 δ ($C\underline{H}_2$—NO_2, d (J = 7·5 Hz), 2H); 3·95 δ (C$\underline{H}$—Ph, m, 1H); 0·82 δ (*t*-Bu, s, 9H).

(d) trans-erythro-2-(*α-phenyl-β-nitro*)*ethyl*-3-t-*butyl-cyclohexanone* (**8c**). The reaction leading to the ketone **8c** described above was repeated to determine the reaction yield. β-Nitrostyrene (0·67 g, 4·6 mmoles) was added to a soln of **1c** + **2c** (1·0 g, 4·6 mmoles) in dry ether. After removal of solvent, the residue was hydrolysed with 3 N HCl and extracted. A separation on chromatographic column gave **6c** + **7c** (1·10 g, 85%) and **8c** (0·20 g, 15%). **8c** was crystallized from EtOH; m.p. 98–100°. (Found: C, 71·3; H, 8·5; N, 4·52. $C_{18}H_{25}NO_3$ requires: C, 71·26; H, 8·31; N, 4·62%). IR: 1698 cm^{-1} (CO); 1580, 748, 693 cm^{-1} (Ph); 1547 cm^{-1} (NO_2). NMR: 4·70 δ ($C\underline{H}_2NO_2$, dq, AB part of an ABX system (J_{AB} = 12 Hz), 2H); 3·68 δ (C$\underline{H}$—Ph, m, 1H); 0·87 δ (*t*-Bu, s, 9H).

threo-2-(*α-phenyl-β-nitro*)*ethyl-cyclohexanone* (**10**)

The ketone **9** was equilibrated with TsOH in refluxing benzene for 18 hr, and afforded a 65 : 35 mixture[12] of **9** and **10**, which were separated on chromatographic column (acetone–benzene 2·5%). **10** had m.p. 65–6° from light petroleum. (Found: C, 65·90; H, 6·05; N, 5·66. $C_{14}H_{17}NO_3$ requires: C, 66·3; H, 6·55; N, 5·54%). IR: 1708 cm^{-1} (CO); 1603, 703 cm^{-1} (Ph); 1550, 1366 cm^{-1} (NO_2). NMR: 7·34 δ (Ph); 4·88 δ ($C\underline{H}_2NO_2$, d (J = 7·25 Hz), 2H); 4·03 δ (C$\underline{H}$—Ph, m, 1H).

trans-erythro-2-(*α-phenyl-β-nitro*)*ethyl*-4-t-*butyl-cyclo-hexanone* (**11**)

β-Nitrostyrene (4·9 g, 33 mmoles) in dry ether (10 ml) was added to a soln of 1-N-morpholino-4-*t*-butyl-cyclohexene (8·02 g, 33 mmoles) in the same solvent (40 ml). A crystalline product (12·9 g, 100%) was obtained, m.p. 114–5° from ligroin, identified as 1-N-morpholino-4-*t*-butyl-6-(*α*-phenyl-β-nitro)ethyl-cyclohexene. (Found: C, 70·51; H, 8·65; N, 7·32. $C_{22}H_{32}N_2O_3$ requires: C, 70·94; H, 8·66; N, 7·52%). IR: 1645 cm^{-1} (N—C=C); 1547 cm^{-1} (NO_2). NMR: 7·18 δ (Ph); 4·95 δ ($C\underline{H}_2NO_2$, C=C$\underline{H}$, m, 3H); 3·72 δ ($C\underline{H}_2$—O—$C\underline{H}_2$, C$\underline{H}$—Ph, m, 5H); 0·73 δ (*t*-Bu, s, 9H). The nitroalkylated enamine (3·0 g, 8 mmoles) was dissolved in aq acetone and hydrolysed with acetic acid (0·48 g, 8 mmoles) under stirring for 24 hr. After removal of the solvent, a solid was obtained, m.p. 100–1°, from aq MeOH. (Found: C, 71·60; H, 8·26; N, 4·37. $C_{18}H_{25}NO_3$ requires: C, 71·26; H, 8·31; N, 4·62%). IR: 1698 cm^{-1} (CO); 1546 cm^{-1} (NO_2). NMR: 7·17 δ (Ph); 4·54 δ ($C\underline{H}_2NO_2$, d (J = 7·5 Hz), 2H); 3·80 δ (C$\underline{H}$—Ph, m, 1H); 0·88 δ (*t*-Bu, s, 9H).

cis-threo-2-(*α-phenyl-β-nitro*)*ethyl*-4-t-*butyl-cyclohexa-none* (**12**). **11** was refluxed in benzene with TsOH for 18 hr. TLC indicated a 1 : 1 mixture of two products which was separated by PLC (acetone–benzene 1%), giving **12** m.p. 78–79°. (Found: C, 71·85; H, 8·53; N, 4·59. $C_{18}H_{25}NO_3$ requires: C, 71·26; H, 8·31; N, 4·26%). IR: 1710 cm^{-1} (CO); 1552 cm^{-1} (NO_2). NMR: 7·22 δ (Ph);

4·83 δ ($C\underline{H}_2NO_2$, d (J = 7·5 Hz), 2H); 3·75 δ ($C\underline{H}$—Ph, m, 1H); 0·73 δ (*t*-Bu, s, 9H).

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