The Question of *quasi*-Enamine Reactivity of Aminocyclopropanes. Rearrangement of Isomeric 1-(Morpholino)-7-chloro-7-phenylbicyclo[4,1,0]heptanes

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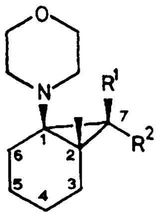
Summary Comparison of the course of thermal rearrangement of isomeric chlorobicycloheptanes (**1**) and (**2**) reveals that the formation of products from (**2**) can be interpreted in terms of "*quasi*-enamine" reactivity.

In the light of the known *quasi*-double bond character of the cyclopropane ring it is an interesting question whether suitable aminocyclopropanes can display a "*quasi*-enamine" reactivity. An essential feature of such reactivity would be the involvement of the nitrogen electron-pair in initiating the ring opening of the cyclopropyl system. The thermal ring-opening of cyclopropanes, comprising a cyclopropyl → allylic-cation transformation, constitutes a disrotatory electrocyclic process, permitted by the orbital-symmetry rules.[1] The course of thermal rearrangement of stereoisomeric 1-(morpholino)-7-chloro-7-phenylbicyclo[4,1,0] heptanes (**1**) and (**2**) would be expected to provide information on the subject of *quasi*-enamine character of aminocyclopropanes. If the ring-opening reaction is initiated by a nucleophilic relay of the nitrogen *p*-electrons, to result in the formation of dipolar intermediates (**3**) or (**4**), little or no difference would be anticipated between the behaviour of the two isomers. On the other hand, rearrangement based upon the orbital-symmetry conservation principle should allow ring-opening in the case of *endo*-isomer (**1**), but not in that of *exo*-isomer (**2**).

The bicycloheptanes (**1**) and (**2**) were obtained as crystalline products by addition of phenylchlorocarbene to 1-(morpholino)cyclohexene. *endo*-Chloro isomer (**1**) exhibits considerable shielding of the morpholine methylene protons [δ (CDCl$_3$) 2·37, m, $-CH_2-N-CH_2$; 3·42 p.p.m., m, $-CH_2-O-CH_2-$] consistent with *cis*-stereochemistry of the benzene and morpholine rings. The morpholine protons of (**2**) resonate at normal δ values: 2·79, m, $-CH_2-N-CH_2$; 3·75, t, $-CH_2-O-CH_2$.

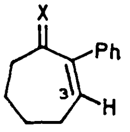
When a solution of (**1**) in pyridine was refluxed for 2 h, it was quantitatively converted (after hydrolysis) into 2-phenylcycloheptene-2-one. Under similar conditions isomer (**2**) was unaffected. The formation of (5) can be readily accounted for in terms of a disrotatory ring-opening of (**1**), leading to iminium ion (**5a**), which serves as a precursor of ketone (5). The fact that (**2**) remains entirely unchanged, implies the non-involvement of the nitrogen electron-pair, under the aforementioned conditions, in initiating the C(1)–C(2) bond cleavage.

When (**2**) was subjected to prolonged heating (refluxing pyridine, 45 h), the reaction mixture, after hydrolysis, was found to contain (**6**) (70%), (**5**) (20%), and (**7**) (10%) (g.l.c. and spectral analysis). The *exo*-phenyl configuration of (**7**) rests upon the chemical shifts of C(2)H_2 and C(4)H_2: δ 2·49 p.p.m., td, which, in analogy to a model bicyclo-[4,1,0]heptane-6-one system,[2] do not exhibit a shielding influence by the phenyl group, expected for the *endo*-phenyl isomer. Furthermore, the C(7)H resonates at a field typical for a tertiary benzyl proton (δ 3·12 p.p.m., t), lacking the diamagnetic influence of the carbonyl function.



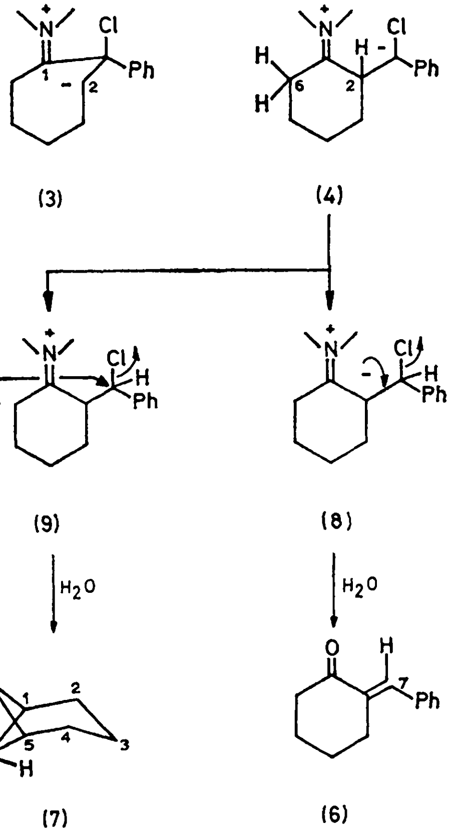
(1) R^1 = Ph, R^2 = Cl

(2) R^1 = Cl R^2 = Ph



(5) X = O

(5a) X = N^+ O



The formation of (**5**)—(**7**) from (**2**), is of considerable mechanistic interest. Since a pathway involving an electrocyclic ring opening is sterically prohibited to (**2**), the system, under forcing reaction conditions, invokes a *quasi*-enamine reactivity, resulting in a second mode of ring opening leading to dipolar intermediates (**3**) and (**4**). While (**3**) is the obvious precursor of (**5**), (**4**) leads to ketones (**6**) and (**7**) *via* loss of chloride ions from enamines (ionic structures) (**8**) and (**9**), respectively. It is noteworthy that the *quasi*-enamine ring opening of (**2**), reflected in the relative amounts of (**5**) versus (**6**) and (**7**), is consistent with the preferred C(1)–C(7) bond cleavage leading to resonance stabilized intermediate (**4**).

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[1] R. B. Woodward and R. Hoffmann, 'The Conservation of Orbital Symmetry,' Verlag Chemie GmbH, Weinheim, 1970, p. 56.

[2] G. Brieger, D. L. Hachey, and D. Ciaramitaro, *J. Org. Chem.*, 1969, **34**, 220.