Heterocyclic Rearrangements. Synthesis and Reactivity of Oximes of Some 3-Acylisoxazoles. A Reinvestigation

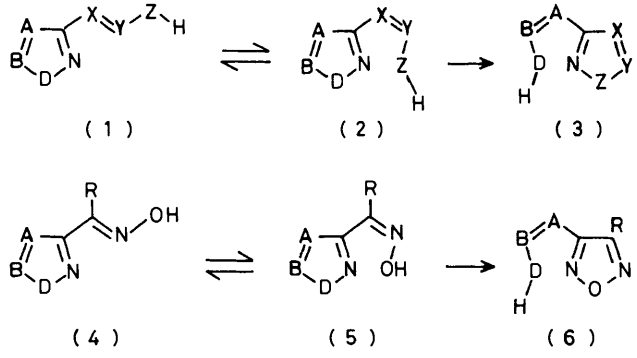
Nicolò Vivona,* Gabriella Macaluso, and Vincenzo Frenna
Institute of Organic Chemistry, University of Palermo, Via Archirafi 20, 90123 Palermo, Italy

The oximation reaction of some 3-acylisoxazoles with hydroxylamine hydrochloride and the geometry of the product oximes were reinvestigated. 3-Benzoylisoxazoles gave mixtures of (*E*)- and (*Z*)-isomers, whereas 3-acetylisoxazoles gave (*E*)-isomers only. The base-induced rearrangement of 3-acylisoxazole oximes to 1,2,5-oxadiazoles (furazans) was reinvestigated and was shown to depend on the geometry of the oximes since, when treated with aqueous potassium hydroxide, only (*Z*)-oximes readily rearranged.
On the basis of our findings, some discrepancies in the literature have been corrected.

As we have shown previously,[1] the general Scheme (2) ⟶ (3) [2] for mononuclear heterocyclic rearrangements (m.h.r.s) presupposes a *Z* geometry for the side chain with respect to the initial ring. Only in this case does the co-ordinate reaction account for a pure (one-step) m.h.r.; however, if the geometry is *E* as in structure (1), the rearrangement (when it occurs) probably proceeds through an initial *E* ⟶ *Z* isomerization.

Previous studies on this subject have been concerned with the behaviour of (*E*)- and (*Z*)-phenylhydrazones [3] and *N*-methyl-*N*-phenylhydrazones [1] of 3-benzoyl-5-phenyl-1,2,4-oxadiazole. Continuing our researches in this field for the purpose of clarifying the influence of the equilibrium (1) ⇌ (2) (Scheme 1) in heterocyclic rearrangements, we studied the oxime-type sequence (4) ⇌ (5) ⟶ (6). This paper refers to the oximes of some 3-acylisoxazoles.

Several examples of rearrangements of 3-acylisoxazole oximes into furazan derivatives are known; [4] however, no attention has apparently been paid to the influence of the geometry of the functional group on the reaction. Moreover, a wide variety of experimental conditions have been used for this rearrangement. In some instances (depending on the substituent and the reaction conditions) rearrangements of oximes are reported to occur, either in part or completely, during oximation of 3-acylisoxazoles. In connection with this we planned to reinvestigate (i) oximations of some 3-acylisoxazoles with hydroxylamine hydrochloride under standard conditions, and (ii) base-induced rearrangement of 3-acylisoxazole oximes as a function of their geometry. The following 3-acylisoxazoles were selected: 3-benzoyl-5-phenyl- (7), 3-benzoyl-5-methyl- (8), 3-benzoyl-4,5-diphenyl- (9), 3-acetyl-5-phenyl- (10), and 3-acetyl-5-methyl-isoxazole (11).



Scheme 1

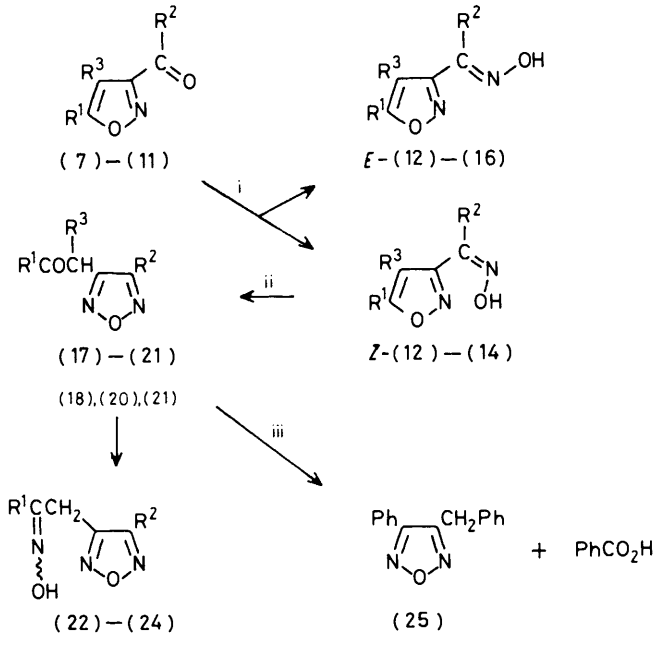
3-Benzoyl-5-phenylisoxazole (7).—Ajello [5] reported that oximation of 3-benzoyl-5-phenylisoxazole (7) with hydroxylamine hydrochloride gave a mixture of an isoxazole oxime (m.p. 115 °C; configuration not stated) and its rearrangement product (17; 'm.p. 137 °C') (Scheme 2). Separation of the two products was reported to be achieved by fractional crystallization from ethanol. In the same paper it was reported that rearrangement of the oxime with aqueous potassium hydroxide gave the rearranged product 3-phenacyl-4-phenylfurazan (17; 'm.p. 137 °C').

In our hands, as we have stated previously,[4] the crude oximation product, prepared by the reported procedure, did not show any carbonyl absorption in the i.r. spectrum, nor was there a CH_2 signal in its ^1H n.m.r. spectrum, as would be expected for compound (17). The presence of low-field signals for OH protons in the n.m.r. spectrum suggested that the crude material was a mixture of (*Z*)- and (*E*)-(12). Suitable chromatography allowed us to obtain both isomers almost pure, while preparative h.p.l.c. (high-performance liquid chromatography) gave analytically pure samples of both isomers. When we investigated the rearrangement reaction in the presence of aqueous potassium hydroxide in ethanol we observed that the (*Z*)-oxime (*Z*)-(12) readily rearranged into the furazan derivative (17; m.p. 61 °C), whereas the (*E*)-oxime (*E*)-(12) remained unaffected. On performing the rearrangement on the crude oximation mixture we obtained a mixture of compound (17) and the unaltered (*E*)-oxime (*E*)-(12) (m.p. 135—137 °C) as expected.

Our opinion is that, on fractional crystallization of the crude oximation material, Ajello [5] isolated the (*E*)-oxime (*E*)-(12) (m.p. 137 °C), which he believed to be the ketone (17), while his so-called isoxazole oxime (m.p. 115 °C) may be a mixture of (*E*)- and (*Z*)-(12). Therefore the rearrangement reaction reported by Ajello yielded a compound (m.p. 137 °C) which was the unchanged (*E*)-oxime and *not* the ketone (17), while the true ketone (17; m.p. 61 °C) was probably lost during his work-up of the reaction mixture.*

3-Benzoyl-5-methylisoxazole (8).—In our hands, oximation of compound (8) gave a mixture of (*Z*)- and (*E*)-(13) which was separated by column chromatography. In a similar way as before, we observed that (*Z*)-(13) smoothly rearranged into

* In a following paper, Ajello and his co-workers [T. Ajello, V. Sprio, and J. Fabra, *Ric. Sci., Parte 2: Sez. B 4*, 1964, 575 (*Chem. Abstr.*, 1965, **62**, 547)] repeated the base-induced rearrangement of 3-benzoyl-5-phenylisoxazole oxime (configuration not stated) prepared as previously reported.[5] In this instance, however, they obtained *only* the 3-phenacyl-4-phenylfurazan (17) (m.p. 63 °C). As to the previously reported 'm.p. 137 °C' for the same compound, they ascribed the discrepancy to an erroneous report. In our opinion, in this last experiment they probably used an oxime sample enriched with the (*Z*)-isomer.



(7),(12),(17) $R^1 = R^2 = Ph$, $R^3 = H$
(8),(13),(18) $R^1 = Me$, $R^2 = Ph$, $R^3 = H$
(9),(14),(19) $R^1 = R^2 = R^3 = Ph$
(10),(15),(20) $R^1 = Ph$, $R^2 = Me$, $R^3 = H$
(11),(16),(21) $R^1 = R^2 = Me$, $R^3 = H$
(22) $R^1 = Me$, $R^2 = Ph$
(23) $R^1 = Ph$, $R^2 = Me$
(24) $R^1 = R^2 = Me$

Scheme 2. *Reagents*: i, $H_2NOH{\cdot}HCl$; ii, OH^-; iii, OH^- [for compound (19) only]

compound (18) when treated with aqueous potassium hydroxide in ethanol, whereas (*E*)-(13) remained unchanged even after being refluxed (2 h) under the same conditions. A previous report [6] has stated that oximation of compound (8) gave one of its oximes (m.p. 133 °C; configuration not stated), together with an oxime of 3-acetonyl-4-phenylfurazan [*i.e.* compound (22)]. The isolated oxime of the isoxazole derivative, now shown to be our (*E*)-oxime (*E*)-(13), was reported (without explanation, however) to remain unchanged when treated with aqueous potassium hydroxide. The formation of an oxime of the furazan derivative may be due to work-up of the oximation mixture. In fact, although Ajello and Cusmano performed the oximation with hydroxylamine hydrochloride, aqueous potassium hydroxide was added *before* the isolation of the reaction products. These experimental conditions left the (*E*)-oxime (*E*)-(13) unchanged but caused rearrangement of the initially formed (*Z*)-(13) into compound (18) which, in turn, underwent further oximation with excess of hydroxylamine. When we repeated the oximation under the previously reported conditions we obtained compound (*E*)-(13) (m.p. 132 °C) together with the two possible rearrangement oximes (*Z*)- and (*E*)-(22).

3-Benzoyl-4,5-diphenylisoxazole (9).—The crude oximation product of 3-benzoyl-4,5-diphenylisoxazole (9) did not exhibit a carbonyl absorption in the i.r. spectrum, but two OH signals (ratio 4 : 1) did occur in the ^1H n.m.r. spectrum, signifying the product to be a mixture of (*Z*)- and (*E*)-(14). This result does not agree with the literature [7] where oximation of compound (9) with hydroxylamine hydrochloride was reported to give the furazan derivative (19; 'm.p. 172 °C') directly. Repeated recrystallization of our oxime mixture from ethanol gave an almost pure sample of (*Z*)-(14) (m.p. 174 °C) as the most abundant component. Assignment of the configuration came from the fact that it readily rearranged to the furazanyl ketone (19; m.p. 118 °C), or to a mixture of compounds (19) and (25), when subjected to aqueous potassium hydroxide. On performing the base-induced rearrangement on the crude oximation material, we recovered the (*E*)-oxime (*E*)-(14) (m.p. 168–170 °C) as the unrearranged isomer, as well as the ketone (19), or/and its hydrolysis product (25). Production of 3-benzoyl-4,5-diphenylisoxazole oxime (m.p. 162 °C; configuration not stated) was reported [7a] by oximation of compound (9) with hydroxylamine hydrochloride in the presence of sodium carbonate. When we repeated this reaction, the (*E*)-oxime (*E*)-(14) was isolated: however, from the reaction mixture we also recovered benzoic acid and 3-benzyl-4-phenylfurazan (25), both compounds arising from rearrangement of the initially formed (*Z*)-(14) into compound (19), followed by hydrolysis of this latter compound under the reaction conditions.

Cusmano and Giambrone [8] claimed that treatment of the previously supposed ketones ('17; m.p. 137 °C') and ('19; m.p. 172 °C') with ethanolic hydrochloric acid gave the 3-acylisoxazoles (7) and (9), respectively, as the reverse reaction to that shown in Scheme 2, *via* open-chain intermediates. As we have now shown, the starting materials used by these authors were not compounds (17) and (19), but instead were the isoxazole oximes (*E*)-(12) and (*Z*)-(14), respectively. Therefore, their results must be viewed as a simple hydrolysis of the oxime group. In our hands, when refluxed (2 h) in ethanolic hydrochloric acid as reported,[8] the true ketones (17) and (19) did not give any rearrangement products and were recovered unchanged.

3-Acetyl-5-phenyl- (10) *and* *3-Acetyl-5-methyl-isoxazole* (11).—Oximation of compounds (10) and (11) with hydroxylamine hydrochloride gave, in our hands, only one isomer from each reagent; these were considered to be compounds (*E*)-(15) and (*E*)-(16), respectively. Although the (*E*)-geometry was not demonstrated, this assignment follows from the absence of any base-induced rearrangement. It was previously reported [6] that oxime (15) remained unchanged when treated under various experimental conditions. Boulton *et al.* reported [2] that oxime (16) did not rearrange when treated with potassium t-butoxide in t-butyl alcohol. In our hands the oximes (15) and (16) did not rearrange in aqueous potassium hydroxide either, *i.e.* under the experimental conditions which were found to be suitable for rearrangement of (*Z*)-oximes. Rearrangement of compound (16) to the furazan (21) was, however, achieved by heating the oxime to its m.p. with copper powder.[2,*]

It was suggested [6] that rearrangement of 3-acylisoxazole oximes carried out with aqueous bases proceeds *via* open-chain intermediates. In our opinion the intermediacy of open-chain species remains an open question. We observed that only (*Z*)-oximes rearrange readily in aqueous base as well as in dipolar aprotic solvents, whereas (*E*)-oximes do not rearrange

* It was also reported that oximes (15) [6] and (16) (T. Ajello and S. Cusmano, *Gazz. Chim. Ital.*, 1939, **69**, 391) directly gave compounds (23) and (24), respectively, when treated with a large excess of hydroxylamine (as the free base). In our opinion, a different course of the rearrangement could be envisaged in this case, *e.g.* proceeding through a prior $E \longrightarrow Z$ isomerization *via* an addition–elimination mechanism, followed by rearrangement to compounds (20, 21), and then oximation of these latter ketones.

under similar conditions. This result could be ascribed to failure of the $E \longrightarrow Z$ isomerization under these conditions. Support of this view may be found in the literature where only a low isomerization rate for oximate anions has been found.[9,*]

Experimental

M.p.s were determined with a Kofler hot-stage apparatus. I.r. spectra (Nujol mulls) were determined with a Perkin-Elmer 257 instrument and ^{1}H n.m.r. spectra (60 MHz) with a Varian EM 360 spectrometer (tetramethylsilane as internal standard). Chromatography on dry columns was performed on Merk silica gel deactivated with water (15%); h.p.l.c. was performed on a Waters apparatus (μ-porasil column). 3-Benzoyl-5-phenyl- (7),[10] 3-benzoyl-5-methyl- (8),[11] 3-benzoyl-4,5-diphenyl- (9),[7b] 3-acetyl-5-phenyl- (10),[12] and 3-acetyl-5-methyl-isoxazole (11) [13] were prepared according to the reported methods. Light petroleum refers to that fraction boiling in the range 40—60 °C.

Oximation Reaction of 3-Benzoylisoxazoles (7)—(9) *with Hydroxylamine Hydrochloride in Ethanol.—General procedure.* To a solution of the ketone (0.01 mol) in ethanol (40 ml) was added aqueous hydroxylamine hydrochloride (0.06 mol) and the mixture was refluxed for 4 h after which t.l.c. indicated that the reaction was complete. After removal of the solvent, water was added to the residue and the mixture was extracted with diethyl ether. The extracts were dried (Na_2SO_4) and evaporated to give the crude oximation material (90%) containing both (*E*)- and (*Z*)-oximes. T.l.c. or h.p.l.c. analysis showed the presence of two components in the crude material, the i.r. spectrum of which did not exhibit a carbonyl absorption, while the n.m.r. spectrum showed the presence of two low-field signals (OH protons).

3-Benzoyl-5-phenylisoxazole (7). (*a*) (E)- *and* (Z)-*Oximes.* The crude oximation mixture as above (3 g) was chromatographed with cyclohexane–ethyl acetate (10 : 1) as eluant. First fractions gave, on being kept for a time, small amounts of the furazan (17) (see below) derived from (*Z*)-(12) and then the (*Z*)-oxime (*Z*)-(12) (0.8 g), m.p. 124—128 °C (from benzene–light petroleum). A pure *sample* was obtained by preparative h.p.l.c. [cyclohexane–ethyl acetate (9 : 1); 1.5 ml min^{-1}], m.p. 129—130 °C (Found: C, 72.8; H, 4.5; N, 10.5; $C_{16}H_{12}N_2O_2$ requires C, 72.71; H, 4.58; N, 10.6%); δ [$(CD_3)_2$SO] 7.35—8.3 (total 11 H, m, 2 × Ph and CH) and 12.35 (1 H, s, OH).

Further elution gave a mixture of both (*Z*)- and (*E*)-oximes (n.m.r.) (0.7 g), and then the (E)-*oxime* (*E*)-(12) (0.7 g), m.p. 135—137 °C (from benzene–light petroleum) (Found: C, 72.6; H, 4.6; N, 10.7; $C_{16}H_{12}N_2O_2$ requires C, 72.71; H, 4.58; N, 10.6%); δ [$(CD_3)_2$SO] 7.35 (1 H, s, CH), 7.4—8.2 (10 H, m, 2 × Ph), and 12.35 (1 H, s, OH).

(*b*) *Rearrangement of oximes* (12) *in the presence of base.* To a solution of the crude oximation product (2 g) in ethanol (60 ml), was added 20% aqueous KOH (8 ml) and the mixture was refluxed for 2 h. [T.l.c. indicated that the rearrangement of the (*Z*)-oxime (*Z*)-(12) was complete within a few minutes, whereas the (*E*)-oxime (*E*)-(12) remained unchanged.] After removal of the solvent, water was added to the residue and the mixture was extracted with diethyl ether. The residue obtained on evaporation of the extract was chromatographed on silica gel (150 g). Elution with cyclohexane–ethyl acetate (20 : 1) gave *3-phenacyl-4-phenylfurazan* (17) (1.2 g), m.p. 61 °C (from light petroleum) (Found: C, 72.65; H, 4.5; N, 10.45; $C_{16}H_{12}N_2O_2$ requires C, 72.71; H, 4.58; N, 10.6%); $\nu_{max.}$ 1 680 cm^{-1} (C=O); δ ($CDCl_3$) 4.65 (2 H, s, CH_2) and 7.3—8.2 (10 H, m, 2 × Ph).

Further elution with cyclohexane–ethyl acetate (10 : 1) gave the unchanged (*E*)-oxime (*E*)-(12) (0.7 g), m.p. 135—137 °C (from benzene–light petroleum). The same result was achieved by using dimethylformamide (DMF) as solvent at room temperature in the presence of KOH.

3-Benzoyl-5-methylisoxazole (8). (*a*) (E)- *and* (Z)-*Oximes.* The crude oximation mixture (3 g) was chromatographed with cyclohexane–ethyl acetate (10 : 1) as eluant. The first compound eluted was the (*Z*)-*oxime* (*Z*)-(13) (1.7 g), m.p. 80—85 °C (from benzene–light petroleum) (Found: C, 65.25; H, 4.9; N, 13.7; $C_{11}H_{10}N_2O_2$ requires C, 65.33; H, 4.98; N, 13.86%); δ ($CDCl_3$) 2.4 (3 H, s, Me), 6.5 (1 H, s, CH), 7.2—7.8 (5 H, m, Ph), and 10.3 (1 H, s, OH).

Further elution gave the (*E*)-oxime (*E*)-(13) (1.1 g), m.p. 132 °C (from benzene–light petroleum) (lit.,[6] 133 °C) (Found: C, 65.3; H, 4.8; N, 13.8; Calc. for $C_{11}H_{10}N_2O_2$: C, 65.33; H, 4.98; N, 13.86%); δ ($CDCl_3$) 2.4 (3 H, s, Me), 6.35 (1 H, s, CH), 7.3—7.7 (5 H, m, Ph), and 9.5 (1 H, s, OH).

(*b*) *Rearrangement of oximes* (13) *in the presence of base.* To a solution of compound (*Z*)-(13) (0.75 g) in ethanol (15 ml) was added 20% aqueous KOH (3 ml). A fast and complete (t.l.c.) rearrangement occurred. Evaporation of the solvent, addition of water to the residue, and filtration gave, on work-up, 3-acetonyl-4-phenylfurazan (18) (0.7 g), m.p. 88—90 °C (from benzene–light petroleum) (lit.,[6] 93 °C) (Found: C, 65.2; H, 4.7; N, 13.6; Calc. for $C_{11}H_{10}N_2O_2$: C, 65.33; H, 4.98; N, 13.86%); $\nu_{max.}$ 1 710 cm^{-1} (C=O); δ ($CDCl_3$) 2.27 (3 H, s, Me), 4.05 (2 H, s, CH_2), and 7.4—7.5 (5 H, m, Ph).

Identical treatment of the (*E*)-oxime (*E*)-(13) refluxing for 2 h gave no reaction.

Oximation of compound (18) with hydroxylamine hydrochloride in ethanol in the presence of sodium acetate at room temperature gave a mixture of (*E*)- and (*Z*)-(22) which was chromatographed with cyclohexane–ethyl acetate (5 : 1) as eluant to afford the (E)-*oxime* (*E*)-(22), m.p. 107 °C (from benzene–light petroleum) (Found: C, 60.7; H, 5.0; N, 19.2; $C_{11}H_{11}N_3O_2$ requires C, 60.82; H, 5.1; N, 19.35%); δ ($CDCl_3$) 1.95 (3 H, s, Me), 3.82 (2 H, s, CH_2), 7.3—7.9 (5 H, m, Ph), and 8.5 (1 H, s, OH), and then (*Z*)-(22) as an *oil* which, when purified by h.p.l.c. [benzene–acetone (98 : 2); 2 ml min^{-1}], showed δ ($CDCl_3$) 1.82 (3 H, s, Me), 4.02 (2 H, s, CH_2), 7.2—7.9 (5 H, m, Ph), and 9.95 (1 H, s, OH). A previously reported [6] oxime of compound (18) (configuration not stated) had m.p. 110 °C.

Oximation of compound (8) by the standard procedure, followed by addition of aqueous KOH [6] and extraction with diethyl ether gave a mixture of (*E*)-(13) (35%), (*E*)-(22) (45%), and (*Z*)-(22) (20%) (by n.m.r.).

3-Benzoyl-4,5-diphenylisoxazole (9). (*a*) (E)- *and* (Z)-*Oximes.* The n.m.r. spectrum of the crude oximation product showed signals for two OH protons for (*Z*)-(14) (80%) and (*E*)-(14) (20%). Repeated recrystallization from ethanol gave the (*Z*)-*isomer* (*Z*)-(14), pure by h.p.l.c. [benzene–acetone (98 : 2); 2 ml min^{-1}] m.p. 174 °C (Found: C, 77.5; H, 4.6; N, 8.15; $C_{22}H_{16}N_2O_2$ requires C, 77.63; H, 4.74; N, 8.23%); δ [$(CD_3)_2$SO] 7.3—7.8 (15 H, m, 3 × Ph) and 12.25 (1 H, s, OH). For details for (*E*)-(14) see below.

(*b*) *Rearrangement of oximes* (14) *in the presence of base.* To a solution of the crude oximation material (2 g) in ethanol

* A similar result is reported for the base-induced rearrangement of 1-methyl-3-acylpyridinium oxime iodides to isoxazole derivatives (S. Tanaka, K. Wachi, and A. Terada, *Chem. Pharm. Bull.*, 1980, **28**, 2083). See also the influence of the geometry of the oxime group in the base-induced ring closure of *o*-halogenophenyl ketone oximes into 1,2-benzisoxazole derivatives (J. Laforest and G. Thuiller, *J. Heterocycl. Chem.*, 1977, **14**, 793).

(50 ml) was added 10% aqueous KOH (9 ml) and the mixture was kept at room temperature for 1 h. After removal of the solvent, water was added to the residue and the mixture was extracted with diethyl ether. Evaporation of the extract, and chromatography of the residue [light petroleum–ethyl acetate (9 : 1) as eluant], yielded 3-benzyl-4-phenylfurazan (25) (0.3 g), m.p. 94—95 °C (from light petroleum) (lit.,[7a] 98 °C) (Found: C, 76.1; H, 5.2; N, 11.7; Calc. for $C_{15}H_{12}N_2O$: C, 76.25; H, 5.12; N, 11.86%); δ [$(CD_3)_2SO$] 4.45 (2 H, s, CH_2) and 7.2—7.9 (10 H, m, 2 × Ph).

Further elution gave the *ketone* (19) (0.7 g), m.p. 118 °C (from ethanol) (Found: C, 77.55; H, 4.8; N, 8.15; $C_{22}H_{16}N_2O_2$ requires C, 77.63; H, 4.74; N, 8.23%); $\nu_{max.}$ 1 670 cm^{-1} (C=O); δ [$(CD_3)_2SO$] 7.1 (1 H, s, CH) and 7.2—8.2 (15 H, m, 3 × Ph).

Finally the (*E*)-oxime (*E*)-(14) (0.25 g), was obtained, m.p. 168—170 °C (from ethanol) (lit.,[7a] 162 °C) (Found: C, 77.7; H, 4.85; N, 8.15; Calc. for $C_{22}H_{16}N_2O_2$: C, 77.63; H, 4.74; N, 8.23%); δ [$(CD_3)_2SO$] 7.3—7.65 (15 H, m, 3 × Ph) and 12.1 (1 H, s, OH).

Acidification of the aqueous mother liquor precipitated benzoic acid. On performing the rearrangement reaction under reflux the ketone (19) was not isolated, but underwent hydrolysis to afford compound (25), while (*E*)-(14) remained unchanged. On performing the rearrangement in DMF as solvent in the presence of solid KOH at room temperature, the yield of compound (19) was increased, but again compound (*E*)-(14) was unchanged.

Oximation of compound (9) (2 g) with hydroxylamine hydrochloride (4.5 g) in ethanol (150 ml) in the presence of Na_2CO_3 (4.5 g) (reflux; 10—12 h) gave, after the usual work-up, compounds (25) (0.7 g), (*E*)-(14) (0.35 g), and benzoic acid.

Oximation of compounds (10) *and* (11). Performing the oximation as in the general procedure gave only one isomer in each case. Compound (15) [from (10)] had m.p. 166 °C (from benzene) (lit.,[6] 170 °C); δ [$(CD_3)_2SO$] 2.25 (3 H, s, Me), 7.3 (1 H, s, CH), 7.5—8.2 (5 H, m, Ph), and 12.0 (1 H, s, OH). Similarly, compound (16) [from (11)] had m.p. 116 °C (from benzene) (lit.,[2,13] 117 °C); δ [$(CD_3)_2SO$] 2.1 and 2.4 (total 6 H, 2 × s, 2 × Me), 6.4 (1 H, s, CH), and 11.75 (1 H, s, OH). Compounds (15) and (16) remained unchanged when refluxed (2 h) with 20% aqueous KOH–ethanol and so we assign the (*E*)-configuration to both the oximes.

References

1 N. Vivona, G. Macaluso, G. Cusmano, and V. Frenna, *J. Chem. Soc., Perkin Trans. 1*, 1982, 165.
2 A. J. Boulton, A. R. Katritzky, and A. M. Hamid, *J. Chem. Soc. C*, 1967, 2005.
3 (*a*) N. Vivona, M. Ruccia, V. Frenna, and D. Spinelli, *J. Heterocycl. Chem.*, 1980, **17**, 401; (*b*) V. Frenna, N. Vivona, D. Spinelli, and G. Consiglio, *ibid.*, p. 861.
4 M. Ruccia, N. Vivona, and D. Spinelli, *Adv. Heterocycl. Chem.*, 1981, **29**, 141.
5 T. Ajello, *Gazz. Chim. Ital.*, 1937, **67**, 779.
6 T. Ajello and S. Cusmano, *Gazz. Chim. Ital.*, 1938, **68**, 792.
7 (*a*) T. Ajello, *Gazz. Chim. Ital.*, 1937, **67**, 55; (*b*) S. Cusmano and S. Giambrone, *ibid.*, 1948, **78**, 630.
8 S. Cusmano and S. Giambrone, *Gazz. Chim. Ital.*, 1951, **82**, 499.
9 (*a*) T. S. Dobashi, D. R. Parker, and E. J. Grubbs, *J. Am. Chem. Soc.*, 1977, **99**, 5382; (*b*) K. J. Dignam and A. F. Hegarty, *J. Chem. Soc., Perkin Trans. 2*, 1979, 1437.
10 T. Sasaki, T. Yoshioka, and Y. Suzuki, *Bull. Chem. Soc. Jpn.*, 1971, **44**, 185.
11 S. Cusmano, *Atti X Congr. Int. Chim.*, 1939, **3**, 110 (*Chem. Abstr.*, 1940, **34**, 102); *Gazz. Chim. Ital.*, 1939, **69**, 214.
12 V. Sprio, E. Ajello, and S. Petruso, *Ann. Chim.* (*Rome*), 1971, **61**, 546 (*Chem. Abstr.*, 1972, **76**, 25019v).
13 T. Ajello and S. Cusmano, *Gazz. Chim. Ital.*, 1939, **69**, 207.

Received 2nd June 1982; *Paper* 2/889