of potassium carbonate to the chloroform prevented the reaction. Treatment of II (0.853 g., 1.11 mmoles) with 0.452 g. (3.5 mmoles) of tetracyanoethylene in 40 ml. of tetrahydrofuran containing a crystal of potassium carbonate for 10 hr. under a nitrogen atmosphere gave a yellow-orange solution from which evaporation of the tetrahydrofuran and trituration with ethanol gave 0.530 g. (1.11 mmoles, 95%) of crude triazole VII, m.p. 244–256°. Recrystallization from tetrahydrofuran–petroleum ether (b.p. 30–60°) gave 0.15 g. of product with m.p. 255–257°. This sample showed the same characteristic sublimation behavior on a microscope hot stage and a mixture with VII prepared from the acetic acid reaction above showed no melting point depression. When the triphenylmethylaminotriazole VII (0.5 g.) was warmed for a few minutes on a steam bath with 60% sulfuric acid and the mixture poured into 50 ml. of ice–water there was obtained after recrystallization from ethanol 0.33 g. of triphenylcarbinol, m.p. 162–163°, identified by its melting point when mixed with an authentic sample and by the identity of the infrared spectra.

The structure of the triazole VII was confirmed by heating 0.096 g. (0.20 mmole) with 0.2 ml. of benzoyl chloride for 5 min. just below the boiling point. Concentrated aqueous ammonia was added to convert excess benzoyl chloride to benzamide and the 8% aqueous sodium hydroxide was added and the solution extracted with ether. A solid fraction (0.040 g.) insoluble in both the ether and base layers was filtered and found to be unchanged starting material, m.p. 255–257°. The clear aqueous alkaline solution was neutralized with aqueous hydrochloric acid to give, after digestion with 5 ml. of ether to remove a small amount of benzoic acid, 0.01 g. (15% or 26% based on unrecovered starting material) of 1-benzoylamino-4,5-diphenyltriazole, m.p. 250–252° dec., (lit.,[12] needles from ethanol, m.p. 248°, soluble in dilute base). Recrystallization from ethanol gave fine needles, m.p. 255.5–257°. The infrared spectrum showed absorption at 3440 (NH) and 1670 cm.$^{-1}$ (C=O).

Anal. Calcd. for $C_{38}H_{26}N_4$: C, 82.8; H, 5.5; N, 11.7; mol. wt., 479. Found: C, 82.8, 82.4; H, 5.7, 6.3; N, 10.6, 11.5; mol. wt., 416.

Trapping of Benzonitrile Oxide (XIII) in the Reaction of the Silver Salt I with Triphenylmethyl Chloride. 3,5-Diphenylisoxazole. (XII).—A suspension of 13.4 g. (0.05 mole) of the silver salt I in 50 ml. of toluene at −20° was treated with 13.9 g. (0.05 mole) of triphenylmethyl chloride in 100 ml. of toluene. The silver chloride which formed was filtered with a pre-cooled funnel and aliquots of the solution which had been stored for 2 days at −80° was added 1.0 ml. of phenylacetylene and the solution was then allowed to stand in a refrigerator overnight. The resulting yellow solution was evaporated under reduced pressure to give a yellow semisolid which on trituration was petroleum ether became a brownish yellow solid (0.251 g.), m.p. 95–135°. Recrystallization from benzene–ethanol yielded 20.9 mg. of white crystalline isoxazole XII, m.p. 141–146°. The infrared and ultraviolet spectra were nearly identical with those of the authentic sample, m.p. 142.5–143.5°, prepared by the method of Posner[24] (lit.,[24] m.p. 141–142°). An additional fraction of 22.3 mg., m.p. 142–143°, crystallized from the filtrate remaining above. The total amount was 5% of the theoretical.

Anal. Calcd. for $C_{15}H_{11}NO$: C, 81.4; H, 5.0; N, 6.3. Found: C, 81.7; H, 5.0; N, 5.6.

A 20-ml. aliquot treated as a control with no added interception agent gave 0.219 g. (8%) of bisazoethylene II, with melting point and infrared spectrum identical to that described previously. An aliquot treated with 3.5 g. of aniline gave an immediate white precipitate of a product which was not identified. Formation of the red product II was completely prevented, however. The formation of the red product II was also prevented or seemed to be greatly reduced by the addition of bicyclo[2.2.1]hept-2-ene (2.0 g. in 5 ml. of toluene) of 3.0 g. of maleic anhydride, in each case to 20-ml. aliquots of the cold reaction mixture, but the products of these reactions were not investigated.

(24) T. Posner, *Ber.*, **34**, 3985 (1901).

Synthesis and Characterization of Isomeric Methylphenylisoxazole-4-carboxylic Acids

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Various methods of synthesis of 5-methyl-3-phenylisoxazole-4-carboxylic acid (IIa) and 3-methyl-5-phenylisoxazole-4-carboxylic acid (IIIa) are described. On the basis of chemical synthesis and absorption spectra data, unambiguous structures are assigned to the isomers.

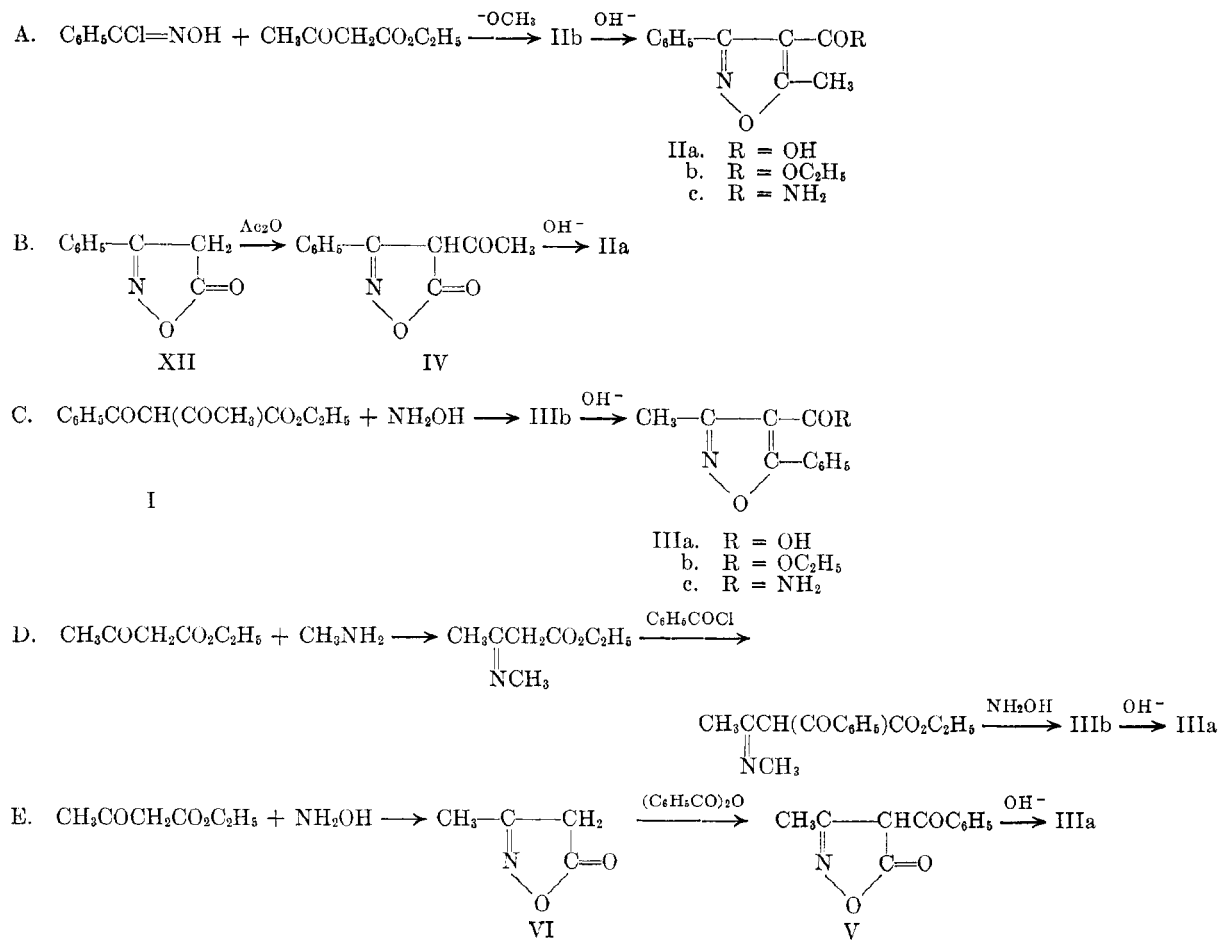
The literature concerned with the isoxazole acids IIa and IIIa prepared as illustrated in reaction schemes A and C of the chart fails to present convincing evidence for the assignment of isomeric structure IIIa rather than IIa to the product of reaction C.[2–4] The ambiguity is largely a consequence of the remarkable similarity of melting points of the isomeric isoxazole esters IIb (m.p. 44–46°) and IIIb (m.p. 54–55°), the acids IIa (m.p. 189°) and IIIa (m.p. 189°), and their respective amides IIc (m.p. 206–208°) and IIIc (m.p. 205–207°).

On the basis of crystal structure differences, Quilico[3] concluded that the isoxazole acid prepared by Betti[4] from ethyl benzoylacetoacetate (I) by reaction series C, is isomeric with the acid prepared from α-chlorobenzaldehyde oxime by reaction series A.

The tenuous nature of this conclusion was exemplified by the similarity of crystalline form of the isomeric amides, their failure to exhibit mixed melting point depression,[3] and by the designation

(1) The author to whom communications should be directed.
(2) U. P. Basu and S. P. Dhar, *J. Indian Chem. Soc.*, **23**, 189 (1946).
(3) A. Quilico and R. Fusco, *Gazz. chim. ital.*, **67**, 589 (1937).
(4) M. Betti and S. Berlingozzi, *ibid.*, **51**, II, 229 (1921); *Chem. Abstr.*, **16**, 9324 (1922).

CHART I



at a later date by Basu and Dhar[2] of a compound melting at 140–142° as one of the isoxazole acid isomers.

We were confronted recently in this laboratory with the problem of determining the correct structure for the isoxazole acid obtained from ethyl benzoylacetoacetate by reaction scheme C. Usually, the reaction of hydroxylamine with unsymmetrical 1,3-diketones to form isoxazoles produces two isomeric structures.[5] For example, ethyl benzoylacetoacetate might be expected and has been reported[2] by Basu and Dhar to yield both isoxazole esters IIb and IIIb on reaction with hydroxylamine. Loss of ethanol by ester I in this reaction to form the two isomeric isoxazolones IV and V might also be anticipated, but has yet to be demonstrated experimentally.[3]

However, when the reaction of I with hydroxylamine hydrochloride in 75% ethanol was conducted in this laboratory following the method of Basu and Dhar[2] (reaction series C of the chart), only one acidic compound, m.p. 189° was isolated, in 90% yield. The isomeric acid reported[2] as melting at 140–142° was not obtained from the reaction mixture. Our result is in agreement with the earlier work of Betti,[4] who similarly obtained only one compound, m.p. 189°, from this reaction.[6]

With the analytical techniques now available, it has been possible to ascertain that the isoxazole acid obtained from reaction series C has structure IIIa and is isomeric with the isoxazole acid IIa, m.p. 189°, prepared unequivocally from α-chlorobenzaldoxime[7] by reaction series A.[2]

In order to establish the structures assigned to the products of reactions A,[3] B,[8] C,[2] D,[9] and E[10] of the chart, physical comparisons were made with the isoxazole acids.

The infrared, ultraviolet, and nuclear magnetic resonance spectra of the two acids prepared by

(5) R. A. Barnes, "Heterocyclic Compounds," Vol. 5, R. C. Elderfield, ed., J. Wiley & Sons, Inc., New York, N. Y., 1957, p. 454.

(6) The low melting compound isolated by Basu and Dhar may have been isoxazolone IV, m.p. 140–141°, prepared recently by Korte and Storiko.[8] The alternative isoxazolone isomer V, m.p. 157°,[10] was found to be insoluble in acid and soluble in weak base. On treatment with thionyl chloride it formed the 5-chloro derivative which yielded the imide on treatment with ammonia. It is likely that IV would react similarly and possibly duplicate the same series of reactions performed by Basu and Dhar with their low-melting compound.

(7) A. Werner and H. Buss, *Ber.*, **27**, 2193 (1894).

(8) F. Korte and K. Storiko, *ibid.*, **94**, 1956 (1961).

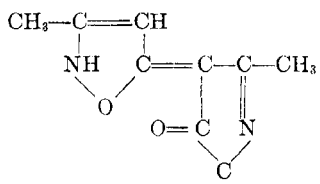
(9) F. Doyle and J. Nayler, U. S. Patent 2,996,501 (1961); *Chem. Abstr.*, **56**, 5971h (1962).

(10) The base-catalyzed rearrangement of the last step in this reaction series has been utilized by G. Speroni and E. Giachetti, *Gazz. chim. ital.*, **83**, 192 (1953).

series A and C show that they are different but closely related. The proton absorption frequencies and shifts in the n.m.r. spectra show that the acids are isomeric. Since the product from A is known to be 5-methyl-3-phenylisoxazole-4-carboxylic acid (IIa), that from C must be 3-methyl-5-phenylisoxazole-4-carboxylic acid (IIIa). The spectrochemical data on the acids obtained from D and E show these products to be identical with that from C. Pathway D is unequivocal, so that substantiation for structure IIIa is thereby provided. Since the products from A and B are identical, pathway B also yields 5-methyl-3-phenylisoxazole-4-carboxylic acid (IIa).

Efforts to prepare 3-methyl-5-phenylisoxazole-4-carboxylic acid (IIIa) from α-chloracetaldoxime in a fashion similar to reaction series A were unfruitful. We were unable to prepare α-chloroacetaldoxime by the method given in the literature[11] and attempts to use the crude α-chloroxime reaction mixture in further reaction with the sodium salt of ethyl benzoylacetate failed to give the anticipated isoxazole ester IIIb.

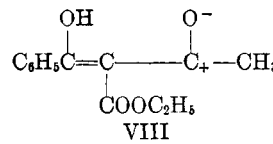
Synthetic path E was attempted, in spite of indications that 3-methyl-5-isoxazolone (VI) could not be prepared. Donleavy and Gilbert had determined[12] that the compound, m.p. 169°, prepared by Hantzsch[13] (and others[14] by other methods) by reaction of hydroxylamine with ethyl acetoacetate in basic solution was not 3-methyl-5-isoxazolone (VI), but rather a "dimethyl-diisoxazolone" of structure VII.



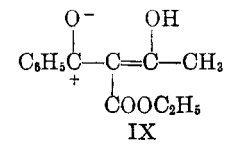
VII

We have been able to prepare 3-methyl-5-isoxazolone (VI) simply by allowing hydroxylamine hydrochloride to react with ethyl acetoacetate in 75% methanol. This compound was then used to prepare 3-methyl-5-phenylisoxazole-4-carboxylic acid (IIIa) as indicated in reaction series E.

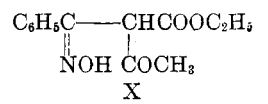
In order to explain why only one isoxazole acid (IIIa) was obtained from reaction scheme C, it seems evident that ethyl benzoylacetoacetate (I) must exist predominantly in the one enol form VIII, since reaction with hydroxylamine hydrochloride yields ethyl 3-methyl-5-phenylisoxazole-4-carboxylate (IIIb) as the sole product. In this case, resonance stabilization of the enol by conjugation with the phenyl ring as illustrated in structure VIII must completely overshadow the opposed electron-withdrawing and inductive effects of phenyl and methyl in the possible enol isomer IX, in which the carbon adjacent to the phenyl group would be most susceptible to nucleophilic attack by hydroxylamine.[15]



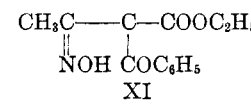
VIII



IX



X



XI

Even if enol IX were present to some extent in the reaction mixture, formation of an isoxazole ring from the intermediate oxime X would be quite difficult. This is due to the greatly increased steric interaction which would be induced between phenyl and the carbethoxy group during and after ring closure to form ester IIb as opposed to formation of ester IIIb from oxime XI. Steric interaction between substituent groups in isoxazole ester IIIb is much diminished in comparison with isomer IIb as is clearly evident from models of the structures.

As indicated by the spectral data given in the table, it is evident that steric interaction between phenyl and the carboxyl group in acid IIa must be of such magnitude that the phenyl ring can no longer freely assume a planar-conjugated relationship with the isoxazole ring. At 264 mμ, the molar extinction coefficient, ϵ, of 5-methyl-3-phenylisoxazole-4-carboxylic acid (IIa) is only 541, while the major absorption peak, ϵ 11,150 lies at 230 mμ. These values contrast markedly with the molar extinction coefficient of ϵ 13,950 at 268 mμ found for 3-methyl-5-phenylisoxazole-4-carboxylic acid (IIIa).

Pertinent correlations can be drawn from the well known *o*-substituted biphenyl derivatives which show diminution of intensity and hypsochromic shifts in the absorption peaks of their ultraviolet spectra as compared with the parent compound, biphenyl.[16]

When the C-4 carboxyl group is absent, as in 3-methyl-5-phenylisoxazole (ϵ 19,500 at 265 mμ) and 5-methyl-3-phenylisoxazole (ϵ 14,850 at 240 mμ),[17] both isomers are strongly ultraviolet-absorbing, which rules out large differences in ϵ in compounds IIa and IIIa or IIb and IIIb resulting simply from structural isomerism.

On esterification of the C-4 carboxyl group of isoxazole acid IIa, freedom of the phenyl ring to assume a lapnar-conjugated relationship with the

(11) H. Wieland, *Ber.*, **40**, 1676 (1907).

(12) J. S. Donleavy and E. E. Gilbert, *J. Am. Chem. Soc.*, **59**, 1072 (1937).

(13) A. Hantzsch, *Ber.*, **24**, 495 (1891).

(14) References to other papers concerning formation of compound VII by various methods and a discussion of results can be found in ref. 12.

(15) For a discussion of oxime formation with various diketones see R. P. Barnes and J. L. Snead, *J. Am. Chem. Soc.*, **67**, 138 (1945).

(16) For leading reference, *cf.* R. A. Friedel and M. Orchin, "Ultraviolet Spectra of Aromatic Compounds," John Wiley & Sons, Inc. New York, N. Y., 1951, pp. 21–23.

(17) B. Eistert and E. Merkel, *Ber.*, **86**, 895 (1953).

TABLE I

MAJOR ABSORPTION WAVE LENGTHS AND CHEMICAL SHIFTS OF ISOMERIC METHYLPHENYLISOXAZOLE-4-CARBOXYLIC ACIDS AND ETHYL ESTERS

Reaction series[a]	Infrared[b] carbonyl (μ)	Ultraviolet[b] $\lambda m\mu$	ϵ	N.m.r. chemical shifts in τ values[c]	
A (Acid IIa)	5.91	264	541	5-CH_3	7.25 (s)
		230	11,150	3-Ph	2.53 (m)
B (Acid IIa)	5.91	265	589	5-CH_3	7.24 (s)
		230	12,750	3-Ph	2.53 (m)
C (Acid IIIa)	5.80	268	13,950	3-CH_3	7.46 (s)
				5-Ph	2.44 (m)[d]
				5-Ph	2.08 (m)[e]
D (Acid IIIa)	5.80	268	15,440	3-CH_3	7.46 (s)
				5-Ph	2.45 (m)[d]
				5-Ph	2.13 (m)[e]
E (Acid IIIa)	5.80	268	15,250	3-CH_3	7.45 (s)
				5-Ph	2.45 (m)[d]
				5-Ph	2.12 (m)[e]
A (Ester IIb)	5.82	266	416	3-Ph	2.57 (m)
				4-Et(CH_2)	8.83 (t,7)
				4-Et(CH_2)	5.73 (q,7)
				5-CH_3	7.33 (s)
C (Ester IIIb)	5.85	265	13,120	3-CH_3	7.47 (s)
				4-Et(CH_3)	8.70 (t,7)
				4-Et(CH_2)	5.67 (q,7)
				5-Ph	2.44 (m)[d]
				5-Ph	2.08 (m)[e]

[a] Refer to chart. [b] Infrared spectra taken in Nujol mull. Ultraviolet spectra were determined in methanol solution. [c] Values in parentheses—no. of peaks: s—singlet, t—triplet, q—quartet, m—multiplet; the coupling constant J in c.p.s. [d] Phenyl protons 3, 4, 5. [e] Phenyl protons 2, 6.

isoxazole ring (ester IIb) is so drastically hindered that no strong absorption band remains in the ultraviolet spectrum (ϵ 416 at 266 mμ). It is probable that some rotation of the phenyl ring still exists. However, the major ultraviolet absorption peak must now lie below 220 mμ. Such strong steric interaction is lacking in isoxazole ester IIIb, ϵ 13,120 at 265 mμ.

This interpretation is further substantiated by the n.m.r. spectra of the isomeric esters IIb and IIIb. An anisotropic downfield shift is evident in the —CH_3 absorption of the ethyl group in compound IIIb. The shift of 0.13 p.p.m. lower τ value is a result of reduced shielding from the phenyl ring π-electron clouds (see table).

Experimental[18]

Reaction Series A. 5-Methyl-3-phenylisoxazole-4-carboxylic Acid (IIa).—The over-all mole yield of the acid (IIa) prepared from benzaldehyde as shown in Series A was 38% of a solid, m.p. 182–186°. Recrystallization with little loss from methanol gave a colorless solid, m.p. 190–191° (lit.,[3] m.p. 189–190°).

Anal. Calcd. for $C_{11}H_9O_3N$: C, 65.0; H, 4.47; N, 6.90. Found: C, 64.7; H, 4.99; N, 6.84.

Reaction Series B. 3-Phenyl-5-isoxazolone (XII). 1. From Ethyl Benzoylacetoacetate.— A mixture of 10.2 g. (0.04 mole) of ethyl benzoylacetoacetate, 7.5 g. (0.11 mole) of hydroxylamine hydrochloride, 17.6 g. of sodium acetate, and 34 ml. of 75% methanol was stirred at 25° for 18 hr. After removal of insoluble solids by filtration, the filtrate was diluted with 200 ml. of water and chilled. The crystalline solid (XII) so obtained weighed 4.25 g. (60.8%), m.p. 151–152°; λ_{max}^{Nujol} 5.56 μ (carbonyl); n.m.r. 3-phenyl (multiplet) τ 2.47, 4-methylene (singlet) τ 6.21.

Anal. Calcd. for $C_9H_7O_2N$: C, 67.1; H, 4.38; N, 8.70. Found: C, 66.9; H, 4.52; N, 8.59.

2. From Ethyl Benzoylacetate.—When 8.45 g. (0.04 mole) of ethyl benzoylacetoacetate was substituted for ethyl benzoylacetoacetate, there was obtained 6.34 g. (90.5%) of isoxazolone XII, m.p. 153–155°; λ_{max}^{Nujol} 5.56 μ (carbonyl).

5-Methyl-3-phenylisoxazole-4-carboxylic Acid (IIa).—The acid (IIa) was prepared from 3-phenyl-4-isoxazolone (XII) by the method described in the literature[8] in an over-all mole yield of 71%, m.p. 188–189° (lit.,[8] m.p. 190°).

Anal. Calcd. for $C_{11}H_9O_3N$: C, 65.0; H, 4.47; N, 6.90. Found: C, 65.2; H, 4.57; N, 7.06.

Reaction Series C. Ethyl Benzoylacetoacetate (I).—The ester was prepared by the method given by R. L. Shriner, A. G. Schmidt, and L. J. Roll[19] except that sodium hydride was used in place of sodium metal, and the reaction temperature was reduced from reflux to 25–30°. The yield was 79% of an oil, b.p. 112°/0.5 mm.; λ_{max}^{film} 5.84, 6.05, 8.07, 9.36, 11.13, 13.07, 14.42 μ.

Ethyl 3-Methyl-5-phenylisoxazole-4-carboxylate (IIIb).—Following the procedure of Basu and Dhar,[2] there was obtained in several experiments a solid, m.p. 55–56°, 91 mole %.

Anal. Calcd. for $C_{13}H_{13}O_3N$: C, 67.6; H, 5.67; N, 6.06. Found: C, 67.8; H, 5.90; N, 6.43.

3-Methyl-5-phenylisoxazole-4-carboxylic Acid (IIIa).—Basic hydrolysis of ester IIIb gave a 99% yield of the acid IIIa, m.p. 189–191° (lit.[2] m.p. 188–189°).

Anal. Calcd. for $C_{11}H_9O_3N$: C, 65.0; H, 4.47; N, 6.90. Found: C, 65.0; H, 4.57; N, 7.08.

Reaction Series D. 3-Methyl-5-phenylisoxazole-4-carboxylic Acid (IIIa).—The acid was obtained by the method given in the literature[9] in an over-all mole yield of 24%, m.p. 188–189° (lit.,[9] m.p. 193–195°).

Anal. Calcd. for $C_{11}H_9O_3N$: C, 65.0; H, 4.47; N, 6.90. Found: C, 65.2; H, 4.62; N, 6.67.

Reaction Series E. 3-Methyl-5-isoxazolone (VI).—A mixture of 32.5 g. (0.25 mole) of ethyl acetoacetate and 34.7

(18) Melting points were determined by the capillary method and are uncorrected.

(19) R. L. Shriner, A. G. Schmidt, and L. J. Roll, "Organic Syntheses," Coll. Vol. II, J. Wiley and Sons, Inc., New York, N. Y., 1943, p. 266.

g. (0.50 mole) of hydroxylamine hydrochloride in 135 ml. of 75% methanol was stirred at 25° for 2 hr. After removal of methanol under vacuum, the concentrated aqueous mixture was filtered to remove excess hydroxylamine hydrochloride, then extracted with two 100-ml. portions of chloroform. After drying over anhydrous magnesium sulfate, the chloroform solution was concentrated to a residue. The oil was taken up in 200 ml. of ether, from which a small amount of insoluble material separated. The ethereal solution was concentrated to an oil weighing 17.0 g. (68.6 mole %) b.p. 78°/0.25 mm. (dec.); λ_{max}^{film} 5.54 μ (carbonyl); n.m.r.—3-methyl (triplet) τ 7.84, 4-methylene (quartet) τ 6.58.

Anal. Calcd. for $C_4H_5O_2N$: C, 48.5; H, 5.05; N, 14.1. Found: C, 48.3; H, 5.28; N, 13.8.

3-Methyl-5-phenylisoxazole-4-carboxylic Acid (IIIa).—A mixture of 9.9 g. (0.1 mole) of 3-methyl-5-isoxazolone (VI), 113 g. (0.5 mole) benzoic anhydride and 20 g. of sodium benzoate was stirred at 95–100° for 1 hr. The mixture was cooled, then slurried with 500 ml. of water. The aqueous mixture was filtered to remove insoluble solids, then treated with 200 g. of solid sodium hydroxide. The resulting strongly basic solution was heated at 95–100° for 4 hr., cooled and made acidic (pH 2) with concentrated hydrochloric acid. A crude solid, weighing 12 g., m.p. 110°, separated, which was found to be a mixture of isoxazole acid IIIa and benzoic acid. After two recrystallizations from methanol, there was obtained 3.5 g. (17.2%) of isoxazole acid (IIIa), m.p. 189–190° (lit.,[10] m.p. 189°).

Anal. Calcd. for $C_{11}H_9O_3N$: C, 65.0; 4.47; N, 6.90. Found: C, 65.1; H, 4.41; N, 6.80.

N.m.r. Spectra.—The nuclear magnetic resonance adsorption spectra were determined with a Varian Model A-60 spectrometer. Deuteriochloroform was used as the solvent and the chemical shifts were determined relative to tetramethylsilane as an internal standard. The field was scanned at a rate equivalent to 2 c.p.s. per second over a chart width of 50 cm. The chemical shift was estimated to ±0.5 c.p.s. or a τ value of ±0.01 p.p.m.

Acknowledgment.—We are indebted to Dr. Allen I. Cohen of The Squibb Institute for the determination and interpretation of the n.m.r. data, and to Dr. N. H. Coy and associates for determination and discussions concerning the ultraviolet and infrared absorption spectra. Our appreciation is also extended to Mr. Joseph F. Alicino and his associates for determination of the microanalytical values reported.

Rates of *syn–anti* Isomerization of Phenyl 2-Pyridyl Ketoxime[1]

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Received June 18, 1962

A precise method for analyzing mixtures of *syn*- and *anti*-phenyl 2-pyridyl ketoxime for *syn* content was developed using the ability of the *syn* form to form a tris complex with Fe(II). This method is somewhat general and may be used for many other (slow to rearrange) α-amine oximes. The *anti/syn* ratio in the freshly prepared phenyl 2-pyridyl ketoxime is 0.30, which is considerably lower than the equilibrium value showing that the product ratio is determined by the kinetics rather than by the equilibrium constant. In 1 *M* acid or base at 25° the rate of isomerization is slow ($t_{1/2} > 4000$ min.). In the molten state (175°) and in cyclohexanol (161 and 144°) both forms come to equilibrium following a first-order expression ($t_{1/2}$ = 1–30 min.) but k_F/k_R evaluated in this way does not equal K_{eq} suggesting a complex mechanism involving the solvent. The equilibrium *anti/syn* ratio decreased with increasing temperature reflecting the decreased stability of the intramolecular hydrogen bond.

One of the dominant factors in the kinetics of formation of nickel(II) complexes of aliphatic α-amine oximes appears to be the *syn–anti* isomerization rate of the oxime group.[3] In order to evaluate this effect, studies on the kinetic behavior of the *syn–anti* conversion were initiated.

The *syn* and *anti* forms of aliphatic aldo and ketoximes have been shown to exist by Phillips[4a] and by Lustig[4b] using n.m.r. but they have seldom been isolated.[4a,5,6] The rates of isomerism have never been studied but generally the rearrangement is thought to be very fast.

In order to study the rates of isomerism, the pure geometrical forms were needed and an accurate method of analysis had to be developed. The geometrical forms of aromatic oximes had been described and appeared to have rates of rearrangement of a measureable magnitude. Thus an aromatic system was initially investigated as a background for the aliphatic system.

The geometrical forms of an aromatic α-amine oxime, phenyl 2-pyridyl ketoxime, were chosen for study because the *syn*-phenyl form gives a colored Fe(II) complex which may be used for analysis. The lower melting isomer of this oxime was first observed by Tschugaeff[7] and the correct assignment of configuration was made by Huntress and Walker[8]: the lower melting point form (150.5–151.5°) being the *syn*[9] form, the *anti* form melting at 165–167°.

Several studies have shown that concentrated acids and bases, at elevated temperatures, are

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(9) The designation *syn* refers to *syn*-phenyl and *anti* to *anti*-phenyl.