of the two tautomeric forms, but it is now clear that they were in error in considering that the ortho-quinonoid form would have the lower potential. The present results show that the stable tautomer is the one having the higher reduction potential, and the case thus constitutes a definite exception to the rule. The only suggestion which we can now offer in explanation of the failure of the hydroxyquinone to change over into a thermodynamically more stable tautomer is that there is some steric resistance to such a change.

Summary

A potentiometric study of the benzologues of anthraquinone and phenanthrenequinone has led to the following significant conclusions. (1) The potentials of the benz- and dibenz-anthraquinones lend support to the ortho-quinonoid theory of the structure of anthracene. (2) Hydroxy-chrysenequinone constitutes an exception to the rule that when a quinone can exist in two forms the one of lower potential will predominate.

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[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF THE UNIVERSITY OF BUFFALO]

THE OXIMES OF ALPHA, BETA-UNSATURATED KETONES AND THE BECKMANN REARRANGEMENT

BY A. H. BLATT

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The work of Meisenheimer and others has brought into question the long-accepted assumption that in the Beckmann rearrangement a shift occurs between the oximino hydroxyl group and the hydrocarbon residue spatially adjacent—a *cis* migration—and has given new prominence to the view that the shift is between groups spatially removed—a *trans* migration. The original evidence to this effect was furnished by the ring opening of triphenyl isoxazole;[1] the bulk of the evidence, however, has come from the study of ring closure in appropriately substituted ketoximes.[2]

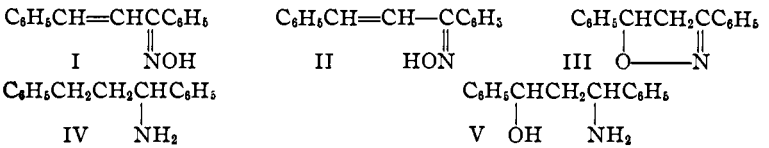
Although the chief evidence for the idea of a *trans* migration has come from the study of ring closure, there is one class of ketoximes, the oximes of α,β-unsaturated ketones, whose behavior seems incompatible with a *trans* migration.[3]

[1] Meisenheimer, *Ber.*, **54**, 3206 (1921).

[2] Meisenheimer and Meis, *ibid.*, **57**, 289 (1924); v. Auwers and Jordan, *ibid.*, **57**, 800 (1924); Brady and Bishop, *J. Chem. Soc.*, **127**, 1357 (1925); Meisenheimer, Zimmermann and Kummer, *Ann.*, **446**, 208 (1926).

[3] Von Auwers has discussed these oximes in a preliminary notice [*Ber.*, **62**, 1320 (1929)] and has outlined a series of researches on the oxime configurations and the relation between configuration, substituents and ease of ring closure. The present work was outlined and started several years ago. It was completed recently without knowl-

Two α,β-unsaturated ketones, benzalacetophenone[4] and dypnone[5] have been studied in some detail. Since the facts are similar in both cases it will be necessary to review only the former. When benzalacetophenone is treated with hydroxylamine hydrochloride, the product is an oxime. To this oxime, which furnishes cinnamanilide when it undergoes the Beckmann rearrangement, Henrich, on the basis of a *cis* migration, assigned the structure (I) and the designation of labile oxime.



When benzalacetophenone is treated with hydroxylamine hydrochloride and an excess of alkali it furnishes, in poor yield and among other products, a substance which Henrich formulated as the isomeric stable oxime (II). This stable oxime, however, is surprisingly unreactive. In contrast to the labile oxime it does not yield an acetyl derivative, nor does it give an addition product with phenyl isocyanate, nor can it be made to undergo a Beckmann rearrangement. In view of its unreactivity Henrich considered an alternative formulation as 3,5-diphenyl isoxazoline (III). This cyclic formula, however, he rejected because he felt it to be inconsistent with the fact that on reduction with sodium and boiling alcohol both the stable and labile oximes give the same product (IV), whereas in Henrich's opinion the isoxazoline should have given the amino alcohol (V). This behavior on reduction has not seemed to the present writer to be sufficient for the rejection of the isoxazoline formula, inasmuch as so little is known of the general behavior on reduction of this type of heterocyclic compounds. And since a decision between the oxime and isoxazoline formulas is a prerequisite for further discussion, our experiments started with this question.

Most of the workers who preceded Henrich had used the isoxazoline formula for the stable oxime and Claus[4c] had shown that this stable oxime could be oxidized to the known 3,5-diphenyl isoxazole—a fact which at least balances Henrich's reduction as structural evidence. To decide definitely between the oxime and isoxazoline formulas we treated the stable oxime with methylmagnesium iodide after the method of Zerewitinoff, believing that no matter how inert the oximino hydroxyl group it

edge of v. Auwers' notice. When the writer's attention was called to the bibliographical omission he informed Professor v. Auwers of this work.

[4] (a) Rupe and Schneider, *Ber.*, **28**, 965 (1895); (b) Goldschmidt, *ibid.*, **28**, 986 (1895); (c) Claus, *J. prakt. Chem.*, [2] **54**, 408 (1896); (d) Fleck, "Dissertation," Leipzig, 1903; the work dealing especially with the rearrangement is by Henrich, (e) *Ann.*, **351**, 171 (1907); (f) *Ber.*, **44**, 1533 (1911).

[5] (a) Henrich and Wirth, *ibid.*, **37**, 732 (1904); (b) *Monatsh.*, **25**, 423 (1904). See also references 4e and 4f.

should certainly evolve methane with this reagent. However, the stable oxime from benzalacetophenone yields no gas; hence it has no active hydrogen and it is to be written, therefore, as the isoxazoline (III).

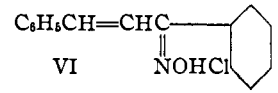
The facts now available are that benzalacetophenone in acid solution yields an oxime, in alkaline solution an isoxazoline. The inferences from these facts are that the true oxime has the *syn* phenyl configuration (I) assigned it by Henrich, that the isomeric oxime is unstable and on formation goes into the isoxazoline (III), and that in the Beckmann rearrangement of the true oxime there is a *cis* shift between the hydroxyl and phenyl groups. A more detailed study for the purpose either of confirming these inferences or of discovering new facts which would bring the rearrangement of α,β-unsaturated ketoximes into line with the other oximes constitutes the balance of this article.

I. The Configuration of the True Oximes

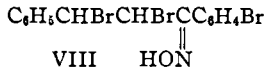
For determining whether the true oximes of α,β-unsaturated ketones possess the *syn* phenyl configuration, corresponding to (I), or the *anti* phenyl configuration, corresponding to (II), benzalacetophenone oxime is unsatisfactory; it is obtained in poor yield, it crystallizes with difficulty, and the cyclic products to be expected from it are symmetrical and give no clue to the way in which ring closure has taken place. Consequently we turned to other unsaturated ketones, benzal-*p*-bromo-acetophenone and benzal-*o*-chloro-acetophenone, and prepared from them the corresponding true oximes—that is, oximes which on rearrangement give substituted anilides of cinnamic acid.

The oxime of benzal-*o*-chloro-acetophenone, if it has the *syn* phenyl structure (VI), corresponding to that assigned by Henrich to the true oxime of benzalacetophenone, might be expected to lose halogen acid when treated with alkali and yield a benzisoxazole. Actually it does not lose halogen acid even on prolonged boiling with alcoholic potash. This fact, while not conclusive, because of the possible inactivity of the chlorine, does make necessary serious consideration of the alternative configuration. Using the more readily available oxime of benzal-*p*-bromo-acetophenone it was possible to secure definite evidence as to configuration by closing the ring on the side toward the double bond. When this oxime is brominated in chloroform solution it takes up two atoms of bromine, yielding a dibromide (VIII), which either by the action of alkali or of heat loses hydrogen bromide and is converted into 3-*p*-bromophenyl-5-phenyl isoxazole (IX). The structure of the isoxazole was shown by its synthesis from the dibromide of benzal-*p*-bromo-acetophenone.[6] This ring closure is explicable only if the oxime has the *anti* phenyl configuration (VII).

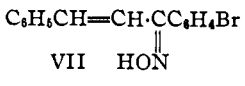
[6] Weygand and Bauer, *Ann.*, **457**, 123 (1927).



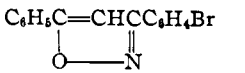
VI



VIII



VII



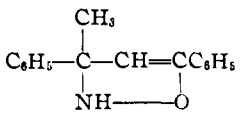
IX

Since the oxime (VII) is the analog of all the oximes of α,β-unsaturated ketones so far examined (it like all the others gives an anilide of cinnamic acid on rearrangement), one must conclude that the true oximes of these α,β-unsaturated ketones have the *anti* phenyl configuration and undergo a *trans* shift in the Beckmann rearrangement.

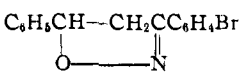
II. The Mechanism of Formation of the Isoxazolines

With the *anti* phenyl configuration assigned to the true α,β-unsaturated ketoximes, it becomes of interest to learn whether these oximes are intermediate steps in the formation of the isoxazolines. We have, therefore, treated the true oximes of dypnone and of benzal-*p*-bromoacetophenone with hydroxylamine hydrochloride and excess alkali (the conditions under which the isoxazolines are formed directly from the ketones) and found that the oximes are unaffected. Neither are they converted into isoxazolines by heating with alcoholic alkali. It would seem then that the oximes are not intermediate in the formation of the isoxazolines.

Since the isoxazolines are formed directly from the ketones only in alkaline solution and since free hydroxylamine is known to add to unsaturated carbonyl compounds,[7] the 1,4-addition of the reagent followed by ring closure immediately suggests itself as a possible mechanism. This mechanism can be tested in the case of dypnone for here the isoxazoline if formed through simple 1,4-addition would have the structure (X), and it would possess an active hydrogen atom. Actually the isoxazoline is inert toward the Grignard reagent.



X



XI

Similarly, if the isoxazoline from benzal-*p*-bromo-acetophenone were formed through 1,4-addition, the nitrogen would be attached to the carbon atom adjacent to the phenyl group. Actually, the nitrogen is attached to the carbon atom adjacent to the *p*-bromophenyl group (XI), as is shown by the oxidation of the isoxazoline to 3-*p*-bromophenyl-5-phenyl isoxazole (IX). Consequently, the simple 1,4-addition of hydroxylamine is eliminated as a mechanism.

[7] Posner, *Ann.*, **389**, 1 (1912).

It appears likely that the isoxazolines are formed as a result of a rather complex process, perhaps involving the addition of a molecule of hydroxylamine to two molecules of unsaturated ketone.[4d] For the present, however, it must suffice to emphasize, in view of the *anti* phenyl configuration assigned to the true oximes, that these oximes are not intermediates in the formation of the isoxazolines.

III. The Sulfuric Acid Rearrangement of the Oximes

Since it has been established that the so-called stable oximes of α,β-unsaturated ketones are in reality isoxazolines, a reaction first noted by Henrich[4e] must be reinterpreted. Henrich showed that the true oximes of benzalacetophenone and dypnone when dissolved in concd. sulfuric acid, heated and then poured on ice gave the stable oximes; restated, the true oximes rearrange to isoxazolines. This is, in effect, a new type of oxime rearrangement. We have confirmed Henrich's observations using dypnone and have further found that in this and other cases simple solution in sulfuric acid followed by pouring on ice suffices to bring about the rearrangement. The reaction is a remarkably clean one. In fact, since the oximes are the sole reaction product using the ketone and hydroxylamine hydrochloride, while the isoxazolines are only one of the many products formed in alkaline solution, it is frequently more satisfactory to prepare the isoxazolines via the oximes and sulfuric acid than from the ketones directly.

It is, of course, hazardous to use this rearrangement as structural evidence but it may be pointed out that the rearrangement is certainly not incompatible with the *anti* phenyl configuration. From appearances at least the rearrangement would seem to involve halochromic salt formation on the part of the oxime, followed by rearrangement of the cation in the strongly acid medium to yield a more basic product.

The expenses of this research have been defrayed by funds privately contributed.

Experimental Part

$C_6H_5CH{=}CHCOC_6H_5$ and $C_6H_5C(CH_3){=}CHCOC_6H_5$

3,5-Diphenyl isoxazoline and 3,5-diphenyl-5-methyl isoxazoline were prepared according to the directions of previous workers.[4c,e] Treated in a Zerewitinoff apparatus with an excess (6 moles) of methylmagnesium iodide in isoamyl ether, there was no evolution of gas even on warming.

When dypnone oxime, prepared according to Henrich's directions,[4e] was boiled with alcoholic sodium hydroxide—2.0 g. of oxime in 150 cc. of alcohol containing 1.5 g. of sodium hydroxide—80% of the oxime was recovered. No isoxazoline could be detected.

Another sample of dypnone oxime was shaken with a small volume of concd. sulfuric acid. There was a noticeable evolution of heat as the oxime dissolved to yield a deep yellow solution. As soon as all the material had gone into solution the reaction mixture was poured onto cracked ice. The precipitated solid melted, after drying, at 75–78°

and a mixture with the pure 3,5-diphenyl-5-methyl isoxazoline (78°) melted at 77–78°. The yield was quantitative.

$C_6H_5CH{=}CHCOC_6H_4Cl\text{-}o$[8]

The unsaturated ketone was made by condensing benzaldehyde and *o*-chloro-acetophenone according to the directions in "Organic Syntheses" for benzalacetophenone.[9] The *o*-chloro-acetophenone was obtained by the hydrolysis of ethyl *o*-chloro-benzoyl acetate.[10] Since the benzal-*o*-chloro-acetophenone, which was obtained in good yield as a yellow oil, could not be induced to crystallize, it was converted directly to the oxime. For this purpose 12.12 g. of unsaturated ketone was dissolved in 100 cc. of alcohol and 7.0 g. of hydroxylamine hydrochloride (100% excess) in 25 cc. of water was added. The resulting solution was boiled for five hours, left overnight, then ether and water were added. The ether layer was worked up in the usual manner and yielded the oxime upon slow evaporation after the addition of petroleum ether. The oxime is reluctant to crystallize and the yield is poor. For analysis the material was twice crystallized from ether and petroleum ether.

Anal. Calcd. for $C_{15}H_{12}ONCl$: C, 69.9; H, 4.7. Found: C, 69.8; H, 4.8.

Benzal-*o*-chloro-acetophenone oxime crystallizes in small cubes. It is very soluble in all the common solvents save petroleum ether. On melting, this oxime shows a peculiar behavior; the most carefully purified material melts over a wide range, 110–124° heating at a rate of 2° per minute, to give a yellow melt; compare the behavior of the oxime of benzal-*p*-bromo-acetophenone below.

Beckmann Rearrangement.—Phosphorus pentachloride in excess was added to 1.0 g. of the oxime dissolved in 10 cc. of absolute ether. The reaction flask was cooled in ice water until the initial precipitate had redissolved, then the solution was poured on ice and the product taken up in ether. On evaporation of the ether, white crystals melting at 134–136° were obtained. These crystals did not depress the melting point of a sample of the *o*-chloro-anilide of cinnamic acid prepared from the acid chloride and *o*-chloro-aniline.

Anal. Calcd. for $C_{15}H_{12}ONCl$: C, 69.9; H, 4.7. Found: C, 69.8; H, 4.8.

The *o*-chloro-anilide of cinnamic acid is quite soluble in acetone and ether. It crystallizes well from methyl and ethyl alcohols in very fine colorless needles when its solutions in these solvents are diluted with hot water. The anilide melts at 136–137°.

Action of Alkali on the Oxime.—To a solution of 2.0 g. of potassium hydroxide in 25 cc. of methyl alcohol there was added 0.761 g. of oxime. The reaction mixture was boiled for five and one-half hours, during which time a red color developed. The solution was then diluted with 125 cc. of water, acidified with dilute nitric acid and left overnight. Next day the precipitate was removed by filtration and the chloride ion in the filtrate determined by a Volhard titration. Only 0.69 cc. of 0.1 *N* silver nitrate solution—corresponding to the removal of 2.3% of the chlorine—was required. The precipitate weighed 0.70 g. and when crystallized slowly from ether and petroleum ether it yielded the characteristic cubes of the original oxime, which was identified by a melting point and a mixed melting point determination.

$C_6H_5CH{=}CHCOC_6H_4Br\text{-}p$

Preparation of the Oxime.—A solution of 0.05 mole of unsaturated ketone was prepared by dissolving 14.35 g. of the ketone in 150 cc. of hot alcohol. After the addition of a drop of hydrochloric acid to neutralize any alkali occluded during the preparation of

[8] The preliminary experiments with this ketone were done by Mr. M. Bovarnick.

[9] "Organic Syntheses," John Wiley and Sons, Inc., New York, **1922**, Vol. II, p. 1.

[10] Thorp and Brunskill, THIS JOURNAL, **37**, 1258 (1915).

the ketone, 5.3 g. (0.075 mole) of hydroxylamine hydrochloride dissolved in 25 cc. of water was added and the reaction mixture boiled for four hours. Hot water was then added to incipient cloudiness. On cooling, the oxime crystallized in fine white needles, which were filtered and dried. The yield was 13.0 g. or 86%. By concentrating the filtrate and adding water another gram of material was obtained. For analysis the oxime was recrystallized from alcohol.

Anal. Calcd. for $C_{15}H_{12}ONBr$: C, 59.6; H, 4.0. Found: C, 59.7; H, 4.0.

Benzal-*p*-bromo-acetophenone oxime (VII) is quite soluble in the common organic solvents; crystallizes well from 95% alcohol or more dilute alcohol in extremely fine needles. These needles—perfectly colorless—melt over a wide range, 138–150°, to a yellow liquid. Repeated crystallization does not affect the melting point and a fractional crystallization accompanied by a microscopic examination of the crystals showed them to be homogeneous. A small sample of the pure oxime was kept at 150° for one-half hour. During this time an odor of benzaldehyde or benzonitrile was noticeable. The yellow melt, on cooling, gave a solid discolored yellow, apparently the oxime accompanied by decomposition products. No isoxazoline could be detected.

Action of Alcoholic Alkali on the Oxime.—Two grams of the oxime was dissolved in 25 cc. of alcohol containing 2.0 g. of potassium hydroxide and the solution was boiled for four hours. It developed a yellow color and an odor indicating that some hydrolysis had taken place. However, by adding water to complete precipitation, 1.75 g. of oxime was recovered and there was no evidence of the formation of isoxazoline.

Action of Hydroxylamine on the Oxime.—When 3.0 g. of the oxime was dissolved in 35 cc. of hot alcohol, a solution of 1.05 g. of hydroxylamine hydrochloride and 2.0 g. of potassium hydroxide in 10 cc. of water added, and the reaction mixture boiled for three hours there was no conversion to the isoxazoline. On working up the products of the reaction 80% of the oxime was recovered.

Beckmann Rearrangement.—Phosphorus pentachloride in excess was added to 2.0 g. of the oxime in 25 cc. of absolute ether. After the initial precipitate had redissolved the reaction mixture was poured onto ice, ether added and the ethereal solution washed with water, sodium carbonate solution and dried. On evaporation of the ether, 1.6 g. of solid, discolored yellow, was obtained. This material was purified by crystallization from alcohol. It then melted at 188–189°. The *p*-bromo-anilide of cinnamic acid was prepared from the acid chloride and *p*-bromo-aniline. It melted at 191° and a mixed melting point with the rearrangement product was 189–190°.

Anal. Calcd. for $C_{15}H_{12}ONBr$: C, 59.6; H, 4.0. Found: C, 59.3; H, 4.1.

Bromination of the Oxime.—When 5.2 g. of the oxime was dissolved in 100 cc. of chloroform and 2.8 g. of bromine in the same solvent was added, a dibromo-oxime (VIII) was formed. The crude material, obtained by pumping off the chloroform, weighed 7.3 g., was discolored red and melted with vigorous decomposition at about 150°. It was purified by crystallization from chloroform and petroleum ether, from which it separates in splendid clusters of fine needles melting, with decomposition, at about 155°.

Anal. Calcd. for $C_{15}H_{12}ONBr_2$: Br, 51.9. Found: Br, 51.3.

The dibromo-oxime is difficultly soluble in the ordinary solvents and if their boiling points are at all elevated it seems either to react with the solvent or to lose hydrogen bromide. With alcoholic alkali the dibromo-oxime eliminates hydrogen bromide to yield 3-*p*-bromophenyl-5-phenyl isoxazole (IX) but the reaction is not clean cut—doubtless because the greater part of the material follows the more complex course recently outlined for α,β-dibromo ketones by Kohler and Addinall.[11] Thus when

[11] Kohler and Addinall, THIS JOURNAL, **52**, 3728 (1930).

0.842 g. of dibromo-oxime was added to 25 cc. of hot methyl alcohol containing 2.0 g. of potassium hydroxide, a brilliant orange solution resulted. Some of the material seemed not to enter into the reaction but to persist as a heavy oil; the oxime is only slightly soluble in methanol. Soon after the addition of the dibromide glistening flat plates of isoxazole began to separate from the solution. After three hours' boiling the reaction mixture was diluted to 150 cc. with distilled water and left overnight. Next day it was acidified with dilute nitric acid, which discharged the color, and filtered. The filtrate in a Volhard titration required 31.75 cc. of 0.1 *N* silver nitrate solution, corresponding to the elimination of 87% of the aliphatic bromine in the dibromide. The precipitate when crystallized from hot ethyl acetate yielded 0.1 g. of 3-*p*-bromophenyl-5-phenyl isoxazole (IX), which was identified by its melting point, 178–179°, and a mixed melting point with a specimen prepared from the dibromide of benzal-*p*-bromo-acetophenone—see below. The ethyl acetate filtrate contained material which gave a copper salt with aqueous copper acetate.

Action of Heat on the Dibromo-oxime (VIII).—Either as the pure solid or in solution the dibromo-oxime when heated loses hydrogen bromide to form the isoxazole (IX). One gram of pure dibromide in a small flask connected to a water pump was heated to 150° until the evolution of hydrogen bromide ceased. The evolved gases reddened litmus paper and produced a yellow precipitate when passed into silver nitrate solution. The dark red melt solidified on cooling. It was crystallized from acetic acid and yielded 0.3 g. of isoxazole. The filtrates deposited an additional small quantity of isoxazole. The isoxazole was identified by its melting point and a mixed melting point. The yield was 50%. The same conversion to the isoxazole can be brought about by heating the dibromo-oxime in glacial acetic acid. Thus 0.5 g. of the dibromooxime in 20 cc. of glacial acetic acid was boiled for thirty minutes. On concentrating and cooling the solution 0.17 g. of isoxazole was obtained.

Synthesis of 3-*p*-bromophenyl-5-phenyl-isoxazole (IX).—To a suspension of 8.9 g. of the dibromide of benzal-*p*-bromo-acetophenone[12] and 2.8 g. of hydroxylamine hydrochloride in 150 cc. of alcohol, there was added 6.6 g. of potassium hydroxide in 15 cc. of water. A yellow color immediately developed and in a few minutes glistening white plates resembling naphthalene began to precipitate. After forty-five minutes the reaction mixture was cooled and filtered, then the precipitate washed thoroughly with water and dried. The yield of crude material, which was practically pure, was 3.6 g. For analysis the isoxazole was crystallized from ethyl acetate.

Anal. Calcd. for $C_{15}H_{10}ONBr$: C, 60.0; H, 3.3. Found: C, 60.0; H, 3.7.

3-*p*-Bromophenyl-5-phenyl isoxazole (IX) is insoluble in cold alcohol and ether, slightly soluble in acetone and chloroform. It crystallizes well from glacial acetic acid, benzene or ethyl acetate. The pure material melts at 178–179°.

Preparation of 3-*p*-Bromophenyl-5-phenyl Isoxazoline (XI). A. From the Ketone.—A solution of 2.1 g. of hydroxylamine hydrochloride (0.03 mole) and 4.0 g. of potassium hydroxide in 20 cc. of water was added to a solution of 5.6 g. of benzal-*p*-bromo-acetophenone (0.02 mole) in 70 cc. of alcohol. After boiling for one and one-half hours, during which time the solution turned orange in color while colorless glistening crystals began separating, the reaction mixture was left overnight. Next day the precipitate of isoxazoline was filtered and dried; yield, 1.9 g. or 30%. The filtrate on dilution with water yielded other products which in view of the known complexity of the alkaline reaction were not studied.

B. From the Oxime.—One gram of benzal-*p*-bromo-acetophenone oxime was shaken with 20 cc. of concd. sulfuric acid. The oxime dissolved giving a yellow solution.

[12] Weygand and Bauer, *Ann.*, **459**, 138 (1927).

After standing overnight the sulfuric acid was poured onto ice and the colorless precipitate filtered and dried. It weighed 0.85 g., melted at 137–139° and caused no depression in the melting point of the isoxazoline prepared directly from the ketone. For analysis the material was crystallized from alcohol.

Anal. Calcd. for $C_{15}H_{12}ONBr$: C, 59.6; H, 4.0. Found: C, 59.7; H, 4.2.

3-*p*-Bromophenyl-5-phenyl-isoxazoline (XI) is moderately soluble in and crystallizes well from the ordinary solvents. In appearance the glistening flat plates of the isoxazoline closely resemble the isoxazole. However, the solubility of the isoxazoline in alcohol is considerably greater than the isoxazole. The pure isoxazoline melts at 138–139°.

Oxidation of the Isoxazoline (XI) to the Isoxazole (IX).—A solution of 2.0 g. of the isoxazoline in 100 cc. of glacial acetic acid was heated to 80° and 1.3 g. (200% excess) of chromic oxide was added. The reaction mixture was stirred for forty-five minutes, then poured into 400 cc. of cold water. The resulting precipitate was filtered and washed with water and a small amount of cold alcohol. It was then boiled with an amount of alcohol insufficient for complete solution. The hot alcoholic solution was separated from the solid residue by filtration. The residue crystallized from ethyl acetate furnished 0.25 g. of pure isoxazole. The first crop of crystals from the alcoholic filtrate was likewise isoxazole and weighed 0.25 g. The identity of these two sets of material was shown by a mixed melting point with the pure isoxazole. The second and third crops of crystals from the alcoholic filtrate weighed 0.6 g. and were slightly impure isoxazoline, as shown by their melting points. The balance of the material apparently had been further oxidized.

Summary

Certain α,β-unsaturated ketones when treated with hydroxylamine hydrochloride yield oximes of the general configuration R—CH=CH—CR′(=NOH). These oximes undergo a *trans* shift in the Beckmann rearrangement and when dissolved in concd. sulfuric acid rearrange in a different manner to yield the isomeric isoxazolines RCHCH₂CR′ (ring closed through O——N, with the N double-bonded to CR′). The so-called stable oximes of these α,β-unsaturated ketones are in reality isoxazolines, and are formed through a process which does not involve either the true oxime as an intermediate or the simple 1,4-addition of hydroxylamine to the ketone.

BUFFALO, NEW YORK