The Reactions of Some *ortho*-Substituted Anilines With Various α,β-Acetylenic Ketones. A Route to Substituted Quinolines

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The reactions of some *ortho*-substituted anilines with various α,β-acetylenic ketones were investigated as a route to 4-alkyl-, 4-aryl-, 4-hydroxy-, and 4-amino-3-quinolyl ketones. The anilines examined were 2-aminoacetophenone (**1**), 2-aminobenzophenone (**2**), anthranilonitrile (**3**), methyl anthranilate (**4**), and ethyl anthranilate (**5**). The acetylenic ketones used were 1,4-diphenyl-2-butyne-1,4-dione (**6**), 3-butyn-2-one (**7**), 1,3-diphenyl-2-propyn-1-one (**8**), and 4-phenyl-3-butyn-2-one (**9**). The acetylenic ketones typically reacted with the anilines to give enamines; however, exceptions were found. Acetylene **6** reacts with **3** to give the enamine (**13**) along with a small amount of 2,3-dibenzoyl-4-quinolamine (**14**). The reactions of **1** or **2** with **6** give the respective quinoline derivatives directly. Acetylene **8** reacts with **2** to give 3-benzoyl-2,4-diphenylquinoline (**22**) directly, whereas no reaction occurs between **8** and **1** or **3**. Acetylene **9** does not react with **1**, **2**, or **3**. The enamines exist as the intramolecularly hydrogen bonded isomers and usually undergo cyclization with 5 molar equivalents of methanolic sodium methoxide to give quinoline derivatives. The 4-quinolinols exist predominantly as the 4-quinolinone tautomer.

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The addition of multifunctional nitrogenous nucleophiles to carbon-carbon triple bonds conjugated with electron withdrawing groups such as COR [2], COAr [3], COOR [4], CN [5], and SOOR [6] has been employed as a route to a wide variety of heterocyclic compounds. The types of heterocyclic compounds prepared in this manner include indolizines [7], pyrimidines [8], pyrroles [9], and quinolines [10]. The reactions of acetylenic esters have been investigated extensively. However, analogous reactions of acetylenic ketones have only recently been examined as routes to pyrazoles [11-13], pyrroles [14,15], isoxazoles [13], pyrimidines [16], pyridones [17], perimidines [15], and quinolines [18,19]. An extensive examination of the use of activated acetylenes as a route to numerous heterocyclic compounds may be found in several reviews [20-23].

The reactions between multifunctional nucleophiles and acetylenic ketones or esters generally have been postulated to proceed initially *via* nucleophilic addition to an acetylenic bond to form Michael-type adducts. Cyclization of the adducts to give heterocyclic products usually occurs by one of two possible modes. One mode involves the intramolecular addition of a second functional group from the nucleophile to an ester or ketone carbonyl group that

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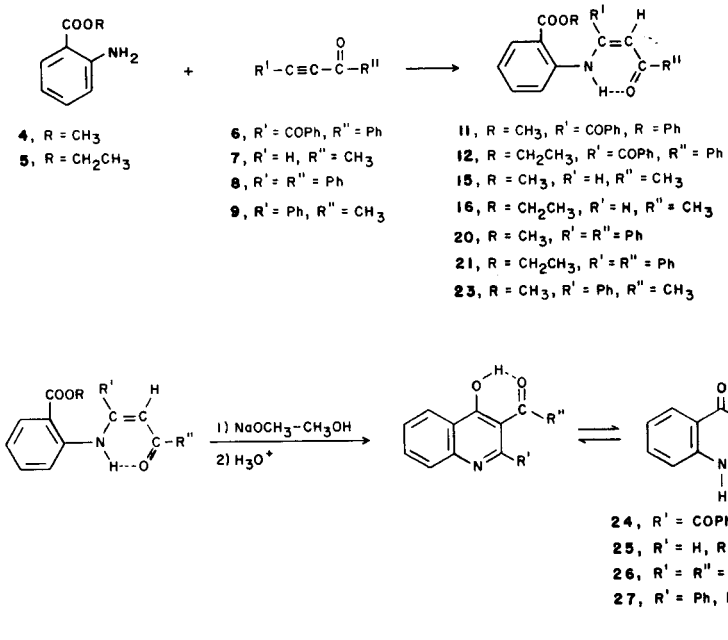


originated from the activated acetylenes. Condensation at the carbonyl group in the case of the acetylenic esters results in the loss of an alkoxide leaving group. However, no leaving group is present in the case of the acetylenic ketones and subsequent protonation of the oxygen followed by loss of water or displacement of the resulting hydroxy group may occur. Alternatively, cyclization may occur *via* condensation between the remaining functional group of the nucleophile and the anionic carbon alpha to the site of the initial nucleophilic addition. Cyclization may occur either spontaneously, upon heating, or upon acid or base treatment of the Michael adduct obtained from the initial reaction between the nucleophile and the acetylenic electrophile [10,19].

The addition reactions of *ortho*-substituted anilines to activated acetylenes as a route to quinoline derivatives have not been extensively investigated. Taylor and Heindel [10] have shown that the addition of 2-aminoacetophenone (**1**) to dimethyl acetylenedicarboxylate yields an enamine which on treatment with methanolic sodium methoxide cyclizes to dimethyl 4-methylquinoline-2,3-dicarboxylate. However, the addition of 2-aminobenzophenone (**2**) to dimethyl acetylenedicarboxylate gives a 4-phenylquinoline derivative directly. Potts and Elliot [19] have reported that the addition of **1** to 1,4-diphenyl-2-butyne-1,4-dione (dibenzoylacetylene) (**6**) gives an uncharacterized enamine which on acid-catalyzed cyclization yields 2,3-dibenzoyl-4-methylquinoline (**30**).

In this paper, we report the addition of various *ortho*-substituted anilines to four α,β-acetylenic ketones as a route to 3-quinolyl ketones containing 4-alkyl, 4-aryl, 4-hydroxy, and 4-amino substituents. In order to determine the utility of this route, four acetylenic ketones were chosen on the basis of their varied reactivity towards nucleophilic attack. The relative electrophilicity of the acetylenic ketones as a function of the variation of substituents on the triple bond had previously been determined [24,25]. The acetylenic ketones utilized in decreasing order of reactivity were: 1,4-diphenyl-2-butyne-1,4-dione (**6**), 3-butyn-2-one (**7**), 1,3-diphenyl-2-propyn-1-one (**8**), and 4-phenyl-3-butyn-2-one (**9**).

Three types of *ortho*-substituted anilines were employed in this study. Methyl anthranilate (**4**) and ethyl anthranilate (**5**) were expected to provide a route to 4-hydroxy-3-quinolyl ketones probably as the more stable 4-quinolinone tautomer. The ketones, 2-aminoacetophenone (**1**) and 2-aminobenzophenone (**2**), were expected to lead to 4-methyl- and 4-phenyl-3-quinolyl ketones, respectively. It was anticipated that the reaction between anthranilonitrile (**3**) and the acetylenic ketones would provide a route to 4-amino-3-quinolyl ketones.

The addition of *ortho*-substituted anilines to the acetylenic ketones was accomplished by reacting equimolar quantities of these reagents in methanol, except in the case of ethyl anthranilate, until thin-layer chromatography (tlc) showed the disappearance of one of the starting materials from the reaction mixtures. In most cases, the reaction mixtures were heated under reflux. However, the addition of the anilines to 3-butyn-2-one (**7**) was usually performed at room temperature since 3-butyn-2-one formed intractable mixtures when heated in the presence of base.

In general, the aromatic amines (**1-5**) underwent Michael-type addition to the acetylenic ketones (**6-9**) to give either enamines or quinoline derivatives, the latter being derived presumably from enamine intermediates. However, in a number of cases, reactions between certain substituted anilines and acetylenic ketones did not occur. Enamines which were obtained were isolated in yields ranging from 94% when using 1,4-diphenyl-2-butyne-1,4-dione (**6**) to 35% when employing 3-butyn-2-one (**7**). Some physical data for enamines prepared in this study are shown in Table 1.

Spectral evidence supports the structural assignment of the enamines as the intramolecularly hydrogen bonded *Z* isomer. These compounds, which may be considered as vinylogous amides, each exhibit a weak series of absorptions from 3200 cm^{-1} to 3000 cm^{-1} characteristic of the NH stretch in strongly hydrogen bonded amides in the solid state. A carbonyl stretch occurs in the range from 1653 cm^{-1} to 1570 cm^{-1}, characteristic of intramolecularly hydrogen bonded carbonyls. Enamines prepared from 1,4-diphenyl-3-butyne-1,4-dione (**6**) exhibit a second carbonyl absorption between 1685 and 1660 cm^{-1}, whereas enamines prepared from the alkyl anthranilates each exhibit an ester carbonyl absorption at approximately 1710 cm^{-1}. The ^{1}H-nmr spectrum for each of the enamines exhibits a broad signal for the intramolecularly hydrogen bonded amino proton at about δ 14.0 which collapses rapidly on deuteration. A signal for the olefinic proton occurs between δ 5.37 and δ 6.70. In the case of enamines prepared from 3-butyn-2-one (**7**), this signal appears as a doublet as does a second olefinic signal which occurs between δ 7.93 and δ 8.71 ($J = 9$ Hz). The observed coupling constant is consistent with those reported values for *cis* olefinic protons [26]. The enamines exhibit bands near 332 nm and 258 nm in the ultraviolet. A third band in the range from 382 nm to 350 nm is believed to result from a π to π^* transition in the β-aminoenone system [27]. This band appears at about 382 nm for enamines prepared from 1,4-diphenyl-2-butyne-1,4-dione (**6**), which is consistent with the absorptions found by Lahiri and coworkers [15] for the *Z* isomer of analogous enamines. The absence of β-aroyl or β-aryl substituents or the change from a phenyl to a methyl substituent attached at the carbonyl group on the enone moiety lowers the absorption by approximately 30 nm. This bathochromic shift is consistent with those values previously reported for similar compounds [15,24].

SCHEME 2

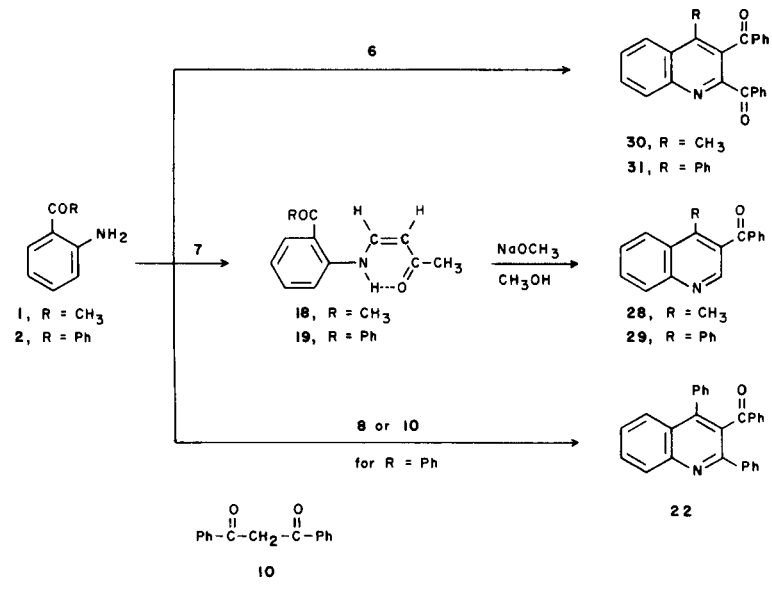
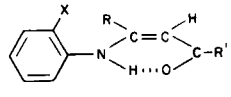


Table 1

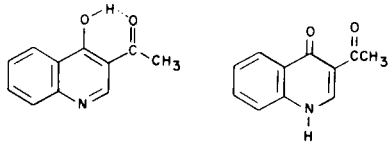
Physical Data for Enamines



Compound	X	R	R'	Yield %	Mp °C (Recrystallization Solvent)	Formula	Analysis % Calcd./Found C	H	N
11	CO_2CH_3	COPh	Ph	94	120-122 (methanol)	$C_{24}H_{19}NO_4$	74.79 74.67	4.97 5.01	3.63 3.59
12	$CO_2CH_2CH_3$	COPh	Ph	83	132-134 (acetone-petroleum ether)	$C_{25}H_{21}NO_4$	75.17 74.94	5.30 5.37	3.51 3.48
13	CN	COPh	Ph	65	157.5-159 (methanol)	$C_{23}H_{16}N_2O_2$	78.39 78.28	4.58 4.61	7.95 7.92
15	CO_2CH_3	H	CH_3	40	110-112 (benzene-petroleum ether)	$C_{12}H_{13}NO_3$	65.74 65.73	5.98 6.01	6.39 6.38
16	$CO_2CH_2CH_3$	H	CH_3	35	59.5-61.5 (benzene-petroleum ether)	$C_{13}H_{15}NO_3$	66.94 66.89	6.48 6.53	6.00 6.00
17	CN	H	CH_3	39	105-107.5 (methanol)	$C_{11}H_{10}N_2O$	70.95 70.92	5.41 5.46	15.04 15.04
18	$COCH_3$	H	CH_3	35	85-87.5 (cyclohexane)	$C_{12}H_{13}NO_2$	70.92 70.87	6.45 6.48	6.89 6.88
19	COPh	H	CH_3	36	106.5-108 (cyclohexane)	$C_{17}H_{15}NO_2$	76.96 77.01	5.70 5.74	5.30 5.22
20	CO_2CH_3	Ph	Ph	82	108-109.5 (tetrahydrofuran-petroleum ether)	$C_{23}H_{19}NO_3$	77.29 77.21	5.36 5.39	3.92 3.91
21	$CO_2CH_2CH_3$	Ph	Ph	80	101-102 (tetrahydrofuran-petroleum ether)	$C_{24}H_{21}NO_3$	77.61 77.54	5.70 5.71	3.77 3.77
23	CO_2CH_3	Ph	CH_3	51	157-159.5 (methanol)	$C_{18}H_{17}NO_3$	73.20 73.37	5.80 5.81	4.74 4.70
32	$COCH_3$	COPh	Ph	20	120-121.5 (cyclohexane)	$C_{24}H_{19}NO_3$	78.03 77.87	5.18 5.21	3.79 3.74

The intramolecularly hydrogen bonded enamines formed by addition of the alkyl anthranilates to each of the acetylenic ketones upon treatment with 5 molar equivalents of sodium methoxide in methanol undergo cyclization to yield 4-quinolinols (Scheme 1). Physical data for the 4-quinolinols and other quinoline derivatives obtained in this study are shown in Table 2.

The spectral characteristics of the 4-quinolinols provide evidence that these compounds exist primarily as the 4-quinolinone tautomer. In solid state, the 4-quinolinones (**24-27**) exhibit a weak to medium absorption for the amide NH stretch at about 3250 cm^{-1} and an amide carbonyl absorption at about 1626 cm^{-1} in the infrared, which is consistent with the observations of Staskun [28] for analogous 4-quinolinones. However, 3-acetyl-4-quinolinol (**25**) exhibits an absorption at 3434 cm^{-1}, characteristic of the weak hydrogen bonding of OH or NH protons, and a broad absorption at 2680 cm^{-1} which may be due to a strong intramolecularly hydrogen bonded OH group in the 4-quinolinol tautomer. A strong absorption at 1646 cm^{-1} implies strong intramolecular hydrogen bonding at the acetyl group (**25a**). A weaker absorption at 1660 cm^{-1} may be due to the non-hydrogen bonded carbonyl absorption of the acetyl group in the 4-quinolinone tautomer (**25b**). An amide type carbonyl absorption band appears at 1623 cm^{-1}

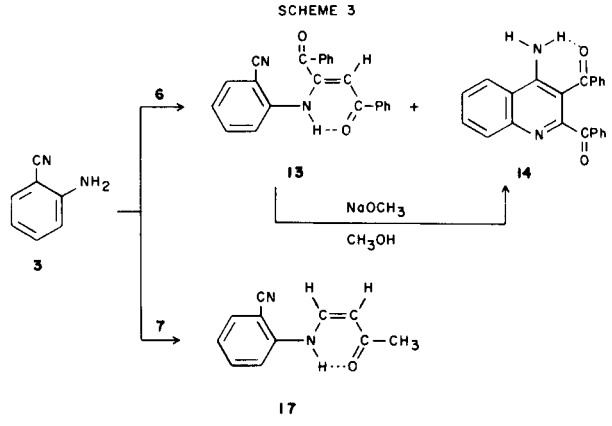


25a 25b

and is weaker than the analogous absorptions in the spectra of **24**, **26**, and **27**. These spectral characteristics imply that **25** may exist as a mixture of the 4-quinolinol and 4-quinolinone tautomers in the solid state. Due to the insolubility of the 4-quinolinones in appropriate solvents, solution infrared spectra for these compounds could not be obtained. Each of the 4-quinolinones in this study exhibits two absorptions at around 322 nm and 249 nm in the ultraviolet, consistent with the absorptions reported at 325 nm and 249 nm for 1-methyl-4-quinolinone [29].

Several of the 4-quinolinols reported in this study have been prepared previously by less direct methods. For example, Mapara and Desai [30] have shown that heating ethyl 2-acetyl-3-(phenylamino)propenoate in a mixture of acetic anhydride and sulfuric acid gives 3-acetyl-4-quinolinol (**25**) in 50% yield. In a modification, Staskun [28] reported that heating 3-amino-2-(*N*-phenylacetimidoyl)crotonoate in polyphosphoric acid gives 3-acetyl-2-phenyl-4-quinolinol (**27**) in 60-80% yield. Although these investigators did not report yields for the starting esters, their preparation requires several steps reducing the overall yields for the 4-quinolinols. Kollenz, Igel and Zeigler [31] have

SCHEME 3

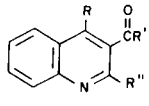


reported the formation of 3-benzoyl-2-phenyl-4-quinolinol (**26**) in 61% yield from the enamine, 1,3-diphenyl-3-(phenylamino)-2-propen-1-one, obtained from the condensation between aniline and 1,3-diphenylpropane-1,3-dione (**10**). Martin and coworkers [32] previously prepared this enamine in 38% yield and Kollenz, Igel, and Ziegler [31] found that it reacted with oxalyl chloride to yield a pyrrole-2,3-dione which gives the quinoline derivative on pyrolysis, presumably *via* an acylcumulene intermediate. In our study, the two-step preparation of **26** from commercially available methyl anthranilate (**4**) and the easily prepared 1,3-diphenyl-2-propyn-1-one (**8**) gives the quinoline derivative in 62% overall yield.

The reactions of 2-aminoacetophenone (**1**) and 2-aminobenzophenone (**2**) with 1,4-diphenyl-2-butyne-1,4-dione (**6**) were recently examined by Bass and Bowles [18] and were found to give 2,3-dibenzoyl-4-methylquinoline (**30**) or 2,3-dibenzoyl-4-phenylquinoline (**31**), respectively. On reexamining the reaction between **1** and **6**, we were unable to isolate the crude enamine intermediate reported by Potts and Elliot [19] when the reaction was carried out in methanol at reflux for 30 minutes. However, quinoline **30** was obtained in 79% yield. The intermediate enamine (**32**) was obtained when **1** and **6** were allowed to react in tetrahydrofuran at room temperature for 20 hours. It was found to cyclize slowly to the quinoline derivative (**30**) in methanol at room temperature. No enamine intermediate was indicated by tlc on the reaction mixture from 2-aminobenzophenone (**2**) and 1,4-diphenyl-2-butyne-1,4-dione (**6**). The analogous reaction of **2** with 1,3-diphenyl-2-propyn-1-one (**8**) gave 3-benzoyl-2,4-diphenylquinoline (**22**) directly (Scheme 2). However, the reactions of **1** and **2** with 3-butyn-2-one (**7**) gave the enamines **18** and **19**, respectively. Treatment of these enamines with methanolic sodium methoxide gave 3-acetyl-4-methylquinoline (**28**) or 3-acetyl-4-phenylquinoline (**29**), respectively (Scheme 2). Mills and Schofield [33] have reported the preparation of **29** in 14% overall yield in five steps starting with the annelation of ethyl malonate and 2-aminobenzophenone (**2**). In our

Table 2

Physical Data for Quinoline Derivatives



Compound	R	R′	R″	Yield %	Mp °C (Recrystallization Solvent)	Formula	Analysis % Calcd./Found C	H	N
14	NH_2	Ph	COPh	63 [a], 14 [b]	194.5-195.5 (ethanol)	$C_{23}H_{16}N_2O_2$	78.39 78.12	4.58 4.61	7.95 7.87
22	Ph	Ph	Ph	52 [c]	146-147.5 [d] (acetone-petroleum ether)	$C_{28}H_{19}NO$	87.25 87.10	4.97 5.01	3.63 3.59
24 [e]	OH	Ph	COPh	86	250-251.5 (acetone-petroleum ether)	$C_{23}H_{15}NO_3$	78.18 77.99	4.28 4.32	3.96 3.96
25 [e]	OH	CH_3	H	71	240-244 [f] (acetone)	$C_{11}H_9NO_2$	70.58 70.37	4.84 4.90	7.48 7.43
26 [e]	OH	Ph	Ph	75	287-289 [g] (acetone)	$C_{25}H_{15}NO_2$	81.21 81.11	4.65 4.76	4.30 4.27
27 [e]	OH	CH_3	Ph	80	248-249 [h] (acetone)	$C_{17}H_{13}NO_2$	77.55 77.59	4.98 5.03	5.32 5.30
28	CH_3	CH_3	H	87	93-94 (petroleum ether)	$C_{12}H_{11}NO$	77.81 77.82	5.98 6.01	7.56 7.53
29	Ph	CH_3	H	78	69-71 [i] (carbon tetrachloride-petroleum ether)	$C_{17}H_{13}NO$	85.57 82.61	5.30 5.35	5.66 5.61
30	CH_3	Ph	COPh	79	205-206.5 [j] (acetone)	$C_{24}H_{17}NO_2$	82.03 82.36	4.88 5.11	3.99 3.96
31	Ph	Ph	COPh	81	203-205 (acetone)	$C_{29}H_{19}NO_2$	84.24 84.34	4.63 4.82	3.39 3.38

[a] From **13**. [b] Isolated directly from reaction between **3** and **6**. [c] Isolated directly from reaction between **2** and **8**. [d] Lit [35] mp 146-147°. [e] Exists predominantly as 4-quinolinone tautomer. [f] Appears to decompose, Lit [30] mp 244°. [g] Lit [31] mp 280°. [h] Lit [28] mp 250-251°. [i] Lit [33] mp 76-78°. [j] Lit [19] mp 204-205°.

method, the two-step sequence starting with 2-aminobenzophenone (**2**) and 3-butyn-2-one (**7**) gave the quinoline derivative, **29**, in 28% overall yield. The addition of either **1** or **2** to 4-phenyl-3-butyn-2-one (**9**) or of **1** to 1,3-diphenyl-2-propyn-1-one (**8**) did not appear to occur. No evidence (tlc) was found for the formation of enamines or quinolines in either of these cases. In the attempted reactions employing **2** with **9**, over 80% of the starting amine was recovered after heating the reactants in refluxing methanol for 12 days.

The reaction of anthranilonitrile (**3**) with 3-butyn-2-one (**7**) gave the enamine **17**. However, attempts to cyclize **17** with methanolic sodium methoxide gave complex mixtures which were not characterized. Reactions between anthranilonitrile (**3**) and either 1,3-diphenyl-2-propyn-1-one (**8**) or 4-phenyl-3-butyn-2-one (**9**) did not appear to occur (tlc). The addition of **3** to the most reactive acetylene, 1,4-diphenyl-2-butyne-1,4-dione (**6**) gave the enamine **13** as the major product along with a small amount of 2,3-dibenzoyl-4-quinolinamine (**14**). The conversion of **13** to **14** was effected by heating the enamine with 5 molar equivalents of sodium methoxide in refluxing methanol for 3 days under a nitrogen atmosphere (Scheme 3).

Quinolinamine **14** exhibited two amino proton signals, a sharp concentration dependent signal at δ 1.87 for the non-hydrogen bonded amino proton and a broad signal at δ 6.73 for the intramolecularly hydrogen bonded amino proton in its H-nmr spectrum. Upon deuteration, the signal at δ 1.87 collapses immediately, whereas the signal at δ 6.73 is shifted to δ 6.88. The low field amino proton signal appears to exchange very slowly with deuterium. This observation for the behavior of the **14** upon deuteration is consistent with the initial mono-deuteration of the amino group. The infrared spectrum for **14** exhibited three weak NH absorptions at 3462, 3355, and 3252 cm^{-1}, probably as a result of both the asymmetric and symmetric stretching modes of the intramolecularly and intermolecularly hydrogen bonded protons.

In those cases in which 2-aminoacetophenone (**1**), 2-aminobenzophenone (**2**), or anthranilonitrile (**3**) were found unreactive toward a particular acetylenic ketone, a variety of conditions were employed in an attempt to promote these reactions. No products were observed (tlc) when the reactants were heated in refluxing 2-methoxyethanol (bp 124°) for up to 12 days. The use of *N*-methylmorpholine as a catalyst in the addition of amines to activated acetylenes

has previously been reported [34]. However, heating the reactants for 12 days in refluxing 1,2-dimethoxyethane (bp 83°) containing a molar equivalent of *N*-methylmorpholine did not produce either enamines or quinoline derivatives.

Although no kinetic studies were done, the time necessary for reactions between the *ortho*-substituted anilines and the acetylenic ketones to reach completion (tlc) was found to depend primarily on the structure of the acetylenic ketones. Reactions of 1,4-diphenyl-2-butyne-1,4-dione (**6**) generally were complete to 30 minutes. Addition of the anilines to the next most reactive acetylene, 3-butyn-2-one (**7**), required 20 hours at room temperature in order to reach completion. The reactions of 1,3-diphenyl-2-propyn-1-one (**8**) went to completion in about 12 days. These observations are consistent with the reported relative reactivities of the acetylenic ketones used in this study [24,25].

Enamines obtained from the reactions of 1,3-diphenyl-2-propyn-1-one (**8**) with the alkyl anthranilates were also obtained by heating these aromatic amines with 1,3-diphenylpropane-1,3-dione (**10**) for 3 days with azeotropic removal of water in refluxing benzene containing a small amount of *p*-toluenesulfonic acid. Both 2-aminoacetophenone (**1**) and anthranilonitrile (**3**) were unreactive towards **10** under these conditions. The use of 2-aminobenzophenone (**2**) in this reaction led directly to 3-benzoyl-2,4-diphenylquinoline (**22**). Fehnel [35] had previously prepared **22** in 59% yield by heating the same reactants in glacial acetic acid.

The addition of *ortho*-substituted anilines to acetylenic ketones provides a route to various 4-substituted-3-quinolyl ketones in certain cases. However, reactivity in the initial Michael-type addition is dependent on the structure of both the amines and the acetylenes, limiting the preparative value of the method. Generally, the enamines which were obtained were found to readily cyclize with sodium methoxide to give good yields of the respective quinoline derivatives. The *ortho*-substituted anilines readily react with 1,4-diphenyl-2-butyne-1,4-dione (**6**) to give good yields of the enamine or quinoline derivatives. However, addition of the substituted anilines to 3-butyn-2-one (**7**) gives complex reaction mixtures from which low yields of enamines are obtained after column chromatography. Products obtained from the less reactive 1,3-diphenyl-2-propyn-1-one (**8**) are more conveniently prepared from 1,3-diphenylpropane-1,3-dione (**10**), although neither substrate appears to be reactive towards 2-aminoacetophenone (**1**) or anthranilonitrile (**3**) under the conditions employed. The least reactive acetylene, 4-phenyl-3-butyn-2-one (**9**), reacts with only the alkyl anthranilates to give enamine adducts.

EXPERIMENTAL

Proton magnetic resonance spectra (^{1}H-nmr) were recorded on a Varian T-60 spectrometer. Chemical shifts are expressed in parts per million downfield from internal tetramethylsilane. The ^{1}H-nmr signals are designated as follows: s, singlet; d, doublet; t, triplet; q, quartet; m, multiplet; br, broad singlet. Unisol-d, a mixed nmr solvent, was obtained from Norell, Incorporated, Landisville, New Jersey. Infrared (ir) spectra were obtained on a Perkin-Elmer 283 spectrophotometer as potassium bromide disks. Infrared signals are designated as follows: w, weak; m, medium; s, strong; vs, very strong. Ultraviolet (uv) spectra were obtained on a Beckman Acta VII spectrophotometer, results are expressed as λ max in nanometers.

All melting points were determined on a Thomas Hoover melting point apparatus and are uncorrected. Elemental analyses were performed by Atlantic Microlabs, Inc., Atlanta, Georgia and were within ± 0.3% of the theoretical values.

Column chromatographic separations were performed on activated silica gel, mesh size 60-200, Davison Chemical Corp., Baltimore, Maryland, with a column length of 45.0 cm, inner diameter of 2.5 cm, containing 250 g silica gel. Thin-layer chromatography (tlc) was performed to monitor the progress of each reaction, using silica gel pre-coated poly(ethylene terephthalate) plates, thickness 100 microns, Eastman Kodak, Rochester, New York. Solvents used for chromatographic methods were reagent grade. Visualization of products on thin-layer chromatographs was accomplished by uv absorbance, followed by development in an iodine chamber.

The 1,4-diphenyl-2-butyne-1,4-dione (**6**) was prepared acccording to the method of Lutz and Smithey [36] and the 1,3-diphenyl-2-propyn-1-one (**8**) was a gift of the late Professor R. E. Lutz, University of Virginia, and was recrystallized from petroleum ether prior to use. The 2-aminobenzophenone (**2**), obtained from commercial sources, was recrystallized from 95% ethanol prior to use. Methanol used as a reaction solvent was stored over molecular sieves, type 4A, Davidson Chemical, Baltimore, Maryland, prior to use. All other starting materials were obtained from commercial sources and were used without additional purification. In those cases where reaction products were obtained by different methods, their identities were confirmed by mixture melting point and matching ir spectra.

1,4-Diphenyl-2-[(2-carbomethoxyphenyl)amino]-2-butene-1,4-dione (**11**).

Methyl anthranilate (**4**) (1.52 g, 0.01 mole) and 1,4-diphenyl-2-butyne-1,4-dione (**6**) (2.3 g, 0.01 mole) were dissolved in hot methanol (20 ml). The reaction mixture was heated at reflux for 30 minutes to afford a clear, yellow solution. Upon standing in the freezer (−30°) for several hours, crude **11** was obtained. Recrystallization of the crude product from methanol gave 3.6 g (94%) of **11**, mp 120-122°, R_f = 0.59 (19:1 benzene-diethyl ether); ir: 3300-3000 cm^{-1} (N-H, w), 3063, 2958 cm^{-1} (C-H, m), 1726 cm^{-1} (ester C=O, s), 1663 cm^{-1} (C^1=O, vs), 1570 cm^{-1} (C^4=O, vs), 1618, 1599, 1550, 1456 cm^{-1} (C=C, aromatic C=C), 1260 cm^{-1} (C-O, vs); ^{1}H-nmr (deuteriochloroform): δ 14.2 (1 H, br, N-H), δ 8.78-7.12 (14 H, m, Ar-H), δ 6.70 (1 H, s, H-3), δ 4.30 (3 H, s, ester CH_3); uv (methanol): λ max 382 nm (ε 25700), 332 nm (ε 10000), 258 nm (ε 16100).

1,4-Diphenyl-2-[(2-carbethoxyphenyl)amino]-2-butene-1,4-dione (**12**).

Ethyl anthranilate (**5**) (1.6 g, 0.01 mole) and 1,4-diphenyl-2-butyne-1,4-dione (**6**) (2.3 g, 0.01 mole) were reacted in 95% ethanol (20 ml), following the procedure employed for the preparation of **11**. The addition of a few drops of water to the cooled reaction mixture aided the crystallization of **12**. Recrystallization of the crude product from acetone-petroleum ether gave 3.2 g (83%) of **12**, mp 132-134°, R_f = 0.66 (19:1 benzene-diethyl ether); ir: 3300-3000 cm^{-1} (N-H, m), 3068, 2980 cm^{-1} (C-H, m), 1717 cm^{-1} (ester C=O, vs), 1685 cm^{-1} (C^1=O, vs), 1580 cm^{-1} (C^4=O, s), 1622, 1601, 1556, 1456 cm^{-1} (C=C, aromatic C=C), 1260 cm^{-1} (C-O, vs); ^{1}H-nmr (deuteriochloroform): δ 14.2 (1 H, br, N-H), δ 8.70-7.14 (14 H, m, Ar-H), δ 6.72 (1 H, s, H-3), δ 4.68 (2 H, q, J = 8 Hz, ester CH_2), δ 1.55 (3 H, t, J = 8 Hz, ester CH_3); uv (95% ethanol): λ max 391 nm (ε 14200), 322 nm (ε 8040), 259 nm (ε 14100).

1,4-Diphenyl-2-[(2-cyanophenyl)amino]-2-butene-1,4-dione (**13**) and 2,3-Dibenzoyl-4-quinolinamine (**14**).

Anthranilonitrile (**3**) (1.2 g, 0.01 mole) and 1,4-diphenyl-2-butyne-1,4-dione (**6**) (2.3 g, 0.01 mole) were dissolved in hot methanol (20 ml). The reaction mixture was heated at reflux for 30 minutes to afford an orange solution in which crystals were observed. Upon standing at −30° for one hour, crude **13** was obtained. Recrystallization of the crude product from methanol gave 2.3 g (65%) of **13** as bright orange crystals, mp 157.5-159°, R_f = 0.67 (19:1 benzene-diethyl ether); ir: 3240-3000 cm^{-1} (N-H, w), 3038 cm^{-1} (C-H, m), 2212 cm^{-1} (C≡N, m), 1670 cm^{-1} (C^1=O, vs), 1580 cm^{-1} (C^4=O, vs), 1612, 1599, 1563 cm^{-1} (C=C, aromatic C=C); ^{1}H-nmr (deuteriochloroform): δ 12.9 (1 H, br, N-H), δ 8.4-7.0 (14 H, m, Ar-H), δ 6.43 (1 H, s, H-3); uv (methanol): λ max 372 nm (ε 8610), 308 nm (ε 4570), 258 nm (ε 9270).

After removal of **13**, the mother liquor was concentrated to 5 ml on a steam bath. Upon standing in the freezer (−30°) for two days, crude **14** was obtained. The crude product was dissolved in dichloromethane (5 ml) and was stirred vigorously for 15 minutes with 15% aqueous hydrochloric acid (5 ml). The hydrochloride salt which formed was collected by filtration and washed with water (10 ml) followed by acetone (10 ml). The salt was then suspended in 25% aqueous sodium hydroxide (5 ml), the mixture was extracted twice with dichloromethane (5 ml), and the combined dichloromethane extracts were dried over anhydrous sodium sulfate. The dichloromethane solution was reduced to 2.0 ml on a steam bath, and petroleum ether was added until cloudy. Upon standing at −30° for several hours, **14** was obtained as pale yellow crystals. Recrystallization of crude **14** from dichloromethane-petroleum ether gave 0.49 g (14%) of **14**, mp 194.5-195.5, R_f = 0.10 (19:1 benzene-diethyl ether); ir: 3462, 3355, 3252 cm^{-1} (N-H, w), 3063 cm^{-1} (Ar-H, w), 1660 cm^{-1} (C=O, vs), 1641 cm^{-1} (H-bonded C=O, vs), 1619 cm^{-1} (aromatic C=N, m), 1500, 1590, 1580, 1551, 1457 cm^{-1} (aromatic C=C), 1378 cm^{-1} (C-N, s); ^{1}H-nmr (deuteriochloroform): δ 8.31-7.38 (14 H, m, Ar-H), δ 6.73 (1 H, br, N-H), δ 1.87 (1 H, s, N-H); uv (methanol): λ max 276 nm (ε 21300), 249 nm (ε 31900).

2,3-Dibenzoyl-4-quinolinamine (**14**).

Compound **13** (1.0 g, 2.8 mmoles) was dissolved in freshly prepared methanolic sodium methoxide (20 ml) from methanol (20 ml) and sodium (0.32 g, 0.014 mole). The solution was heated at reflux under nitrogen for 3 days, then poured onto cracked ice (50 g). The precipitate was collected by filtration and washed with water (20 ml). Compound **14** was purified as described in the preparation of **13** and **14** above. The intermediate hydrochloride salt was recrystallized from a minimum amount of methanol before neutralization. Recrystallization of the free amine from 95% ethanol gave 0.63 g (63%) of **14**, mp 194-195°.

4-[(2-Carbomethoxyphenyl)amino]-3-buten-2-one (**15**).

Methyl anthranilate (**4**) (3.8 g, 0.025 mole) and 3-butyn-2-one (**7**) (1.7 g, 0.025 mole) were dissolved in methanol (20 ml), the temperature being maintained below 20°. The solution was then allowed to warm to room temperature and was left to stand in a tightly stoppered flask for 20 hours. Dropwise addition of water and cooling gave bright yellow plates of **15**. Compound **15** was dissolved in a minimum amount of benzene and purified by column chromatography (45.0 cm column, 250 g silica gel), with 9:1 benzene-diethyl ether as the eluent. The solution containing **15** was evaporated *in vacuo* and the oil obtained was crystallized from benzene-petroleum ether to afford 2.2 g (40%) of **15** as a white crystals, mp 110-112°, R_f = 0.19 (19:1 benzene-diethyl ether); ir: 3300-3000 cm^{-1} (N-H, m), 3074, 3024, 2953 cm^{-1} (C-H, m), 1705 cm^{-1} (ester C=O, vs), 1653 cm^{-1} (C=O, vs), 1595, 1576, 1589, 1445 cm^{-1} (C=C, aromatic C=C), 1264 cm^{-1} (C-O, vs); ^{1}H-nmr (deuteriochloroform): δ 14.0 (1 H, br, N-H), δ 8.65 (1 H, d, J = 9 Hz, H-4), δ 8.30-7.31 (4 H, m, Ar-H), δ 5.82 (1 H, d, J = 9 Hz, H-3), δ 4.33 (3 H, s, ester CH_3), δ 2.38 (3 H, s, enone CH_3); uv (methanol): λ max 350 nm (ε 23200), 333 nm (ε 15100), 232 nm (ε 9340).

4-[(2-Carbethoxyphenyl)amino]-3-buten-2-one (**16**).

Ethyl anthranilate (**5**) (4.1 g, 0.025 mole) and 3-butyn-2-one (**7**) (1.7 g, 0.025 mole) were reacted in 95% ethanol (20 ml), using the procedure employed in the preparation of **15**. After 20 hours at room temperature the ethanol was removed *in vacuo* and the resultant oil was dissolved in a minimum amount of benzene. The benzene solution was subjected to column separation (45.0 cm column, 250 g silica gel), first with benzene to elute starting material, followed by elution with 17:3 benzene-diethyl ether to elute **16**. The solution containing **16** was evaporated *in vacuo*, and the resultant oil was crystallized from benzene-petroleum ether to afford white crystals of **16**, 2.0 g (35%), mp 59.5-61.5°, R_f = 0.20 (19:1 benzene-diethyl ether); ir: 3300-3040 cm^{-1} (N-H, m) 3078, 2981, 2934, 2096 cm^{-1} (C-H, m), 1691 cm^{-1} (ester C=O, s), 1653 cm^{-1} (C=O, vs), 1610, 1584, 1570, 1461 cm^{-1} (C=C, aromatic C=C), 1246 cm^{-1} (C-O, s); ^{1}H-nmr (deuteriochloroform) δ 14.1 (1 H, br, N-H), δ 8.71 (1 H, d, J = 9 Hz, H-4), δ 8.33-7.37 (4H, m, Ar-H), δ 5.89 (1 H, d, J = 9 Hz, H-3), δ 4.87 (2 H, q, J = 8 Hz, ester CH_2), δ 2.37 (3 H, s, enone CH_3), δ 1.53 (3 H, t, J = 8 Hz, ester CH_3); uv (95% ethanol): λ max 351 nm (ε 25300), 332 nm (ε 18100), 234 nm (ε 9760).

4-[(2-Cyanophenyl)amino]-3-buten-2-one (**17**).

Anthranilonitrile (**3**) (3.0 g, 0.025 mole) and 3-butyn-2-one (**7**) (1.7 g, 0.025 mole) were reacted in methanol (20 ml), following the procedure employed for the preparation of **15**. After 20 hours, the reaction mixture was evaporated to 5 ml on a steam bath. Upon standing at −30° for 12 hours, crude **17** was obtained. The precipitate was recrystallized from methanol to afford pale yellow crystals of **17**, 1.8 g (39%), mp 105-107.5°, R_f = 0.22 (19:1 benzene-diethyl ether); ir: 3220-3000 cm^{-1} (N-H, vw), 3070 cm^{-1} (C-H, w), 2217 cm^{-1} (C≡N, s), 1646 cm^{-1} (C=O, vs), 1613, 1586, 1575, 1461 cm^{-1} (C=C, aromatic C=C); ^{1}H-nmr (detueriochloroform): δ 8.33-7.37 (6 H, m, H-4 and Ar-H), δ 5.89 (1H, d, J = 9 Hz, H-3), δ 2.33 (3 H, s, CH_3); uv (methanol): λ max 338 nm (ε 23400), 228 nm (ε 10700).

4-[(2-Acetylphenyl)amino]-3-buten-2-one (**18**).

2-Aminoacetophenone (**1**) (3.4 g, 0.025 mole) and 3-butyn-2-one (**7**) (1.7 g, 0.025 mole) were reacted in methanol (20 ml), following the procedure employed for the preparation of **15**. After 20 hours at room temperature, the methanol was removed *in vacuo*, and the resultant oil was dissolved in a minimum amount of benzene. The benzene solution was subjected to column separation (45.0 cm column, 250 g silica gel), first with 17:3 benzene-diethyl ether to elute unreacted 2-aminoacetophenone (**1**), followed by elution with 3:2 benzene-diethyl ether to elute **18**. The solvent was removed *in vacuo* and the bright yellow oil was crystallized from cyclohexane to afford pale yellow feathery crystals of crude **18**, 1.8 g (35%), mp 65-75°. Repeated recrystallization from cyclohexane gave pure **18**, mp 85-87.5°, R_f = 0.07 (19:1 benzene-diethyl ether); ir: 3200-3000 cm^{-1} (C=O, vs), 1570, 1560, 1451 cm^{-1} (C=C, C=C aromatic); ^{1}H-nmr (deuteriochloroform): δ 14.5 (1 H, br, N-H), δ 8.49 (1 H, d, J = 9 Hz, H-4), δ 7.35-7.28 (4 H, m, Ar-H), δ 5.82 (1 H, d, J = 9 Hz, H-3), δ 2.85 (3 H, s, CH_3), δ 2.36 (3 H, s, enone CH_3); uv (methanol): λ max 364 nm (ε 20100), 324 nm (ε 16700), 240 nm (ε 11600).

4-[(2-Benzoylphenyl)amino]-3-buten-2-one (**19**).

3-Butyn-2-one (**7**) (1.7 g, 0.025 mole) in methanol (10 ml) was added dropwise over a 30 minute period to a solution of 2-aminobenzophenone (**2**) (4.9 g, 0.025 mole) in refluxing methanol (25 ml). The solution was heated at reflux for an additional 15 minutes, then the solvent was removed *in vacuo*. The residue was dissolved in a minimum amount of benzene and subjected to column separation (45.0 cm column, 250 g, silica gel), first with 1:1 benzene-petroleum ether to elute unreacted starting material, followed by elution with 19:19:2 benzene-petroleum ether-diethyl ether to elute **19**. The solution containing **19** was evaporated *in vacuo* and the resultant yellow oil was crystallized from cyclohexane to afford bright yellow needles of **19**, 2.4 g (36%), mp 106.5-108°, R_f 0.15 (19:1 benzene-diethyl ether); ir: 3260-3000 cm^{-1} (N-H, w), 3084, 2926 cm^{-1} (C-H, w), 1661 cm^{-1} (C=O, vs), 1655 cm^{-1} (C=O, vs), 1590, 1560, 1452 cm^{-1} (C=C, aromatic C=C); ^{1}H-nmr (deuteriochloroform): δ 12.9 (1 H, br, N-H), δ 7.93-6.73 (9 H, m, H-4 and Ar-H), δ 5.37 (1 H, d, J = 9 Hz, H-3), δ 2.15 (3 H, s, CH_3); uv (methanol): λ max 364 nm (ε 17600), 327 nm (ε 21000), 248 nm (ε 20100).

1,3-Diphenyl-3-[(2-carbomethoxyphenyl)amino]-2-propen-1-one (**20**).

Method A.

Methyl anthranilate (**4**) (0.73 g, 4.8 mmoles) and 1,3-diphenyl-2-propyn-1-one (**8**) (1.0 g, 4.8 mmoles) were dissolved in methanol (20 ml) and heated at reflux for 9 days to afford a clear, yellow solution. After cooling in an ice bath, water was added dropwise to the reaction mixture until cloudy. Upon standing at 0° for 30 minutes, crude **20** was obtained as yellow crystals. The precipitate was air dried overnight and then dissolved in a minimal amount of benzene. The benzene solution was subjected to column separation (45.0 cm column, 250 g silica gel), first with benzene to elute unreacted starting material, followed by elution with 3:2 benzene-dichloromethane to elute **20**. The solution containing **20** was evaporated *in vacuo* to afford a yellow, semi-crystalline residue. Crystallization of the residue from tetrahydrofuran-petroleum ether gave 1.4 g (82%) of **20** as bright yellow crystals, mp 108-109.5°, R_f = 0.54 (19:1 benzene-diethyl ether); ir: 3270-3000 cm^{-1} (N-H, w), 3079, 2959 cm^{-1} (C-H, w), 1714 cm^{-1} (ester C=O, vs), 1626 cm^{-1} (C=O, vs), 1607, 1588, 1573, 1558, 1463, 1447 cm^{-1} (C=C, aromatic C=C), 1358 cm^{-1} (C-N, s), 1261 cm^{-1} (C-O, vs); ^{1}H-nmr (deuteriochloroform): δ 14.1 (1 H, br, N-H), δ 8.61-6.50 (14 H, m, Ar-H), δ 6.43 (1 H, s, H-2), δ 4.03 (3 H, s, CH_3); uv (methanol): λ max 382 nm (ϵ 25700), 332 nm (ϵ 10000), 258 nm (ϵ 16100).

Method B.

Methyl anthranilate (**4**) (0.45 g, 3.0 mmoles) and 1,3-diphenylpropane-1,3-dione (**10**) (0.67 g, 3.0 mmoles) were dissolved in benzene (25 ml) containing a few crystals of *p*-toluenesulfonic acid. The reaction mixture was heated at reflux for 3 days using a Dean-Stark trap to remove water. The volume of the reaction mixture was then reduced to 5 ml on a steam bath. Compound **20** was isolated as a yellow oil by employing a column separation as in Method A. Unreacted 1,3-diphenylpropane-1,3-dione (**10**) was eluted with benzene. Crystallization of the yellow oil from tetrahydrofuran-petroleum ether gave 0.62 g (56%) of **20**, mp 108-109.5°.

1,3-Diphenyl-3-[(2-carbethoxyphenyl)amino]-2-propen-1-one (**21**).

Method A.

Ethyl anthranilate (**5**) (0.79 g, 4.8 mmoles) and 1,3-diphenyl-2-propyn-1-one (**8**) (1.0 g, 4.8 mmoles) were reacted in 95% ethanol (20 ml) as in Method A for the preparation of **20**. Recrystallization from tetrahydrofuran-petroleum ether of the crude product obtained from the reaction mixture gave 1.43 g (80%) of **21** as bright yellow crystals, mp 101-102°, R_f = 0.62 (19:1 benzene-diethyl ether); ir: 3300-3000 cm^{-1} (N-H, w), 3073, 2983, 2906 cm^{-1} (C-H, w), 1701 cm^{-1} (ester C=O, vs), 1607 cm^{-1} (C=O, vs), 1598, 1584, 1575, 1555, 1464, 1416 cm^{-1} (C=C, aromatic C=C), 1356 cm^{-1} (C-N, s), 1257 cm^{-1} (C-O, vs); ^{1}H-nmr (deuteriochloroform): δ 14.1 (1 H, br, N-H), δ 8.62-6.57 (14 H, m, Ar-H), δ 6.48 (1 H, s, H-2), δ 4. 68 (2 H, q, J = 8 Hz, ester CH_2), δ 1.50 (3H, t, J = 8 Hz, ester CH_3); uv (95% ethanol): λ max 382 nm (ϵ 26300), 332 nm (ϵ 10100), 258 nm (ϵ 16300).

Method B.

Ethyl anthranilate (**5**) (0.50 g, 3.0 mmoles) and 1,3-diphenylpropane-1,3-dione (**10**) (0.67 g, 3.0 mmoles) were dissolved in benzene (25 ml) containing a few crystals of *p*-toluenesulfonic acid. The reaction mixture was heated at reflux for 3 days using a Dean-Stark trap to remove water. The volume of the reaction mixture was reduced to 5 ml on a steam bath and the concentrated reaction mixture was then subjected to column separation (45.0 cm column, 250 g silica gel), first with benzene to elute unreacted 1,3-diphenylpropane-1,3-dione (**10**), followed by elution with 3:2 benzene-dichloromethane to elute **21**. The solution containing **21** was evaporated *in vacuo* to afford a yellow oil. Crystallization of the yellow oil from tetrahydrofuran-petroleum ether gave 0.55 g (47%) of **21**, mp 100.5-101.5°.

3-Benzoyl-2,4-diphenylquinoline (**22**).

Method A.

2-Aminobenzophenone (**2**) (0.95 g, 4.8 mmoles) and 1,3-diphenyl-2-propyn-1-one (**8**) (1.0 g, 4.8 mmoles) were dissolved in hot methanol (20 ml). The solution was heated at reflux on an oil bath for 11 days. After cooling in an ice bath, water was added dropwise to the reaction mixture until cloudy. Upon standing at 0° for 30 minutes, crude **22** was obtained. The precipitate was air dried overnight. Recrystallization from acetone-petroleum ether gave 1.0 g (52%) of **22** as white crystals, mp 146-147.5° (lit [35] mp 146-147°), R_f = 0.59 (19:1 benzene-diethyl ether); ir: 3063 cm^{-1} (Ar-H, w), 1670 cm^{-1} (C=C, vs), 1614 cm^{-1} (aromatic C=N, m), 1564, 1549, 1485, 1450 cm^{-1} (aromatic C=C); ^{1}H-nmr (deuteriochloroform): δ 9.10-7.54 (m, Ar-H); uv (methanol): λ max 290 nm (ϵ 12700), 252 nm (ϵ 38000).

Method B.

2-Aminobenzophenone (**2**) (0.59 g, 3.0 mmoles) and 1,3-diphenylpropane-1,3-dione (**10**) (0.67 g, 3.0 mmoles) were dissolved in hot benzene (25 ml) containing a few crystals of *p*-toluenesulfonic acid. The solution was heated at reflux for 3 days using a Dean-Stark trap to remove water. The solution was extracted with 20% sodium hydroxide (10 ml), then water (10 ml). The benzene solution was dried over anhydrous sodium sulfate and the solvent removed *in vacuo*. Crystallization of the crude product from methanol-water gave white plates of **22**, mp 142-146°. An additional recrystallization from acetone-petroleum ether gave 0.54 g (43%) of pure **22**, mp 146-147.5°.

4-Phenyl-4-[(2-carbomethoxyphenyl)amino]-3-buten-2-one (**23**).

Methyl anthranilate (**4**) (3.8 g, 0.025 mole) and 4-phenyl-3-butyn-2-one (**9**) (3.6 g, 0.025 mole) were dissolved in methanol (20 ml). Heating at reflux for 12 days gave a yellow solution in which crystals were observed. Upon standing at −30° for several hours, crude **23** was obtained. Recrystallization of crude **23** from methanol gave 3.8 g (51%) of pure **23** as bright yellow crystals, mp 157-159.5°, R_f = 0.24 (19:1 benzene-diethyl ether); ir: 3270-3000 cm^{-1} (N-H, w), 3081, 3035, 3009, 2955 cm^{-1} (C-H, w), 1710 cm^{-1} (ester C=O, vs), 1607, 1585, 1565, 1454 cm^{-1} (C=C, aromatic C=C), 1627 cm^{-1} (C=O, vs), 1358 cm^{-1} (C-N, s), 1257 cm^{-1} (C-O, vs); ^{1}H-nmr (deuteriochloroform): δ 13.9 (1 H, br, N-H), δ 8.76-6.63 (9 H, m, Ar-H), δ 5.97 (1 H, s, H-3), δ 4.32 (3 H, s, ester CH_3), δ 2.40 (d 3H, s, enone CH_3); uv (methanol): λ max 350 nm (ϵ 9380), 302 nm (ϵ 9660), 228 nm (ϵ 10700).

2,3-Dibenzoyl-4-quinolinol (**24**).

Compound **11** (1.0 g, 2.5 mmoles) was dissoloved in freshly prepared methanolic sodium methoxide (20 ml) from methanol (20 ml) and sodium (0.29 g, 12.5 mmoles). The reaction mixture was refluxed for 10 minutes, then poured into cold water (70 ml), extracted twice with dichloromethane (15 ml), acidified with dilute sulfuric acid, and then cooled to complete crystallization. The crude precipitate was collected by filtration, washed with water (15 ml), then air dried overnight. Recrystallization from acetone-petroleum ether gave 0.86 g (86%) of **24** as white crystals, mp 250-251.5°; ir: 3261 cm^{-1} (N-H, w), 3090, 3067 cm^{-1} (Ar-H or N-H, w), 1681 cm^{-1} (ketone C=O, vs), 1663 cm^{-1} (H-bonded C=O, vs), 1626 cm^{-1} (amide C=O, vs), 1600, 1582, 1545, 1520, 1475, 1451 cm^{-1} (C=C, aromatic C=C); ^{1}H-nmr (Unisol-d): δ 12.6 (s, br N-H), δ 9.09-7.60 (m, Ar-H); uv (methanol): λ max 322 nm (ϵ 9900), 247 nm (ϵ 30500).

3-Acetyl-4-quinolinol (**25**).

Compound **15** (0.50 g, 2.3 mmoles) was cyclized in methanolic sodium methoxide (20 ml) prepared from methanol (20 ml) and sodium (0.26 g, 11 mmoles), using the method employed for the preparation of **24**. Recrystallization from acetone of the crude precipitate obtained from the reaction mixture gave feathery, white needles of **25**, 0.35 g (71%), mp 240-244° dec (lit [30] mp 244°); ir: 3434 cm^{-1} (N-H, or OH, m), 3100 cm^{-1} (Ar-H, or N-H, w), 2987, 2944 cm^{-1} (C-H, m), 1660 cm^{-1} (C=O, vs), 1646 cm^{-1} (H-bonded C=O, m), 1626 cm^{-1} (amide C=O, m), 1603, 1572, 1549 cm^{-1} (C=C, aromatic C=C); ^{1}H-nmr (Unisol-d): δ 8.38-7.22 (5 H, m, Ar-H), δ 8.60 (1H, s, H-2), δ 2.67 (3H, s, CH_3); uv (methanol): λ max 314 nm (ϵ 11400), 245 nm (ϵ 9890).

3-Benzoyl-2-phenyl-4-quinolinol (**26**).

Compound **20** (0.50 g, 1.5 mmoles) was cyclized in methanolic sodium

methoxide (20 ml) prepared from methanol (20 ml) and sodium (0.17 g, 7.5 mmoles), using the method employed for the preparation of **24**. The crude precipitate was dissolved in a minimum amount of refluxing 95% ethanol. The solution was then cooled and its volume reduced to a few milliliters under an air stream to afford 0.38 g (75%) of **26** as white plates, mp 287-289°(lit [31] mp 280°); ir: 3260, 3065 cm^{-1} (N-H, w), 3020 cm^{-1} (Ar-H, w), 1670 cm^{-1} (C=O, vs), 1626 cm^{-1} (amide C=O), 1607, 1573, 1543, 1512, 1475 cm^{-1} (C=C, aromatic C=C); ^{1}H-nmr (Unisol-d): δ 11.9 (s, br, N-H), δ 9.02-7.67 (m, Ar-H); uv (methanol): λ max 321 nm (ε 14400), 248 nm (ε 38300).

3-Acetyl-2-phenyl-4-quinolinol (**27**).

Compound **23** (0.50 g, 1.7 mmoles) was cyclized in sodium methoxide (20 ml) prepared from methanol (20 ml) and sodium (0.20 g, 8.5 mmoles), using the method employed for the preparation of **24**. Recrystallization from acetone of the crude precipitate obtained from the reaction mixture gave **27** as white crystals, 0.40 g (80%), mp 248-249° (lit [28] mp 250-251°); ir: 3105 cm^{-1} (N-H, w), 3066 cm^{-1} (Ar-H, or N-H, w), 2987, 2944 cm^{-1} (C-H, m), 1696 cm^{-1} (C=O, vs), 1628 cm^{-1} (amide C=O, s), 1603, 1572, 1549 cm^{-1} (C=C, aromatic C=C); ^{1}H-nmr (Unisol-d): δ 11.8 (1 H, br, NH), δ 8.39-7.14 (9 H, m, Ar-H), δ 2.43 (3 H, s, CH_3); uv (methanol): λ max 322 nm (ε 10900), 253 nm (ε 22000).

3-Acetyl-4-methylquinoline (**28**).

Compound **18** (0.50 g, 2.7 mmoles) was dissolved in freshly prepared methanolic sodium methoxide (15 ml) from methanol (15 ml) and sodium (0.32 g, 13.5 mmoles). The reaction mixture was heated at reflux for 10 minutes, cooled, poured into diethyl ether (30 ml), and then extracted with water (75 ml). The aqueous layer was extracted twice with diethyl ether (20 ml), and the combined ether extracts were then washed with water (25 ml) and dried over anhydrous sodium sulfate. Removal of the solvent *in vacuo* afforde crude **28**. Recrystallization of the crude product from petroleum ether gave 0.44 g (87%) of pure **28** as white crystals, mp 93-94°, R_f = 0.10 (19:1 benzene-diethyl ether); ir: 3072 cm^{-1} (Ar-H, w), 2965, 2928 cm^{-1} (C-H, w), 1679 cm^{-1} (C=O, vs), 1582, 1565, 1504 cm^{-1} (aromatic C=C); ^{1}H-nmr (deuteriochloroform): δ 10.0 (1 H, s, H-2), δ 8.28-7.35 (5 H, m, Ar-H), δ 2.79 (3 H, s, acetyl CH_3), δ 2.67 (3 H, s, CH_3); uv (methanol): λ max 324 nm (ε 6420), 252 nm (ε 18000).

3-Acetyl-4-phenylquinoline (**29**).

Compound **19** (0.50 g, 1.9 mmoles) was cyclized in methanolic sodium methoxide (20 ml) prepared from methanol (20 ml) and sodium (0.22 g, 9.5 mmoles), using the method employed for the preparation of **28**. Recrystallization from carbon tetrachloride-petroleum ether gave 0.39 g (78%) of **29** as soft, pale yellow crystals, mp 69-71° (lit [33] mp 76-78°); R_f = 0.14 (19:1 benzene-diethyl ether); ir: 3064 cm^{-1} (Ar-H, w), 2933 cm^{-1} (C-H, w), 1697 cm^{-1} (C=O, vs), 1611 cm^{-1} (aromatic C=N, w), 1573, 1553, 1503, 1488 cm^{-1} (aromatic C=C); ^{1}H-nmr (deuteriochloroform): δ 9.06 (1 H, s, H-2), δ 8.31-7.18 (10 H, m, Ar-H), δ 2.97 (3 H, s, CH_3); uv (methanol): λ max 290 nm (ε 6900), 241 nm (ε 24100).

2,3-Dibenzoyl-4-methylquinoline (**30**).

2-Aminoacetophenone (**1**) (0.25 g, 1.8 mmoles) and 1,4-diphenyl-2-butyne-1,4-dione (**6**) (0.43 g, 1.8 mmoles) were dissolved in hot methanol (10 ml). The reaction mixture was heated at reflux for 30 minutes to afford a yellow solution in which crystals were observed. Upon standing at −30° for one hour, crude **30** was obtained as pale yellow crystals. Recrystallization of the crude product from acetone gave 0.51 g (79%) of **30** as white crystals, mp 205-206.5° (lit [19] mp 204-205°), R_f = 0.46 (19:1 benzene-diethyl ether); ir: 3069, 3059 cm^{-1} (Ar-H, w), 2999 cm^{-1} (C-H, w), 1664, 1650 cm^{-1} (C=O, vs), 1619 cm^{-1} (aromatic C=N, w), 1597, 1582, 1568, 1499, 1459, 1452 cm^{-1} (aromatic C=C); ^{1}H-nmr (deuteriochloroform): δ 8.35-7.26 (14 H, m, Ar-H), δ 2.57 (3 H, s, CH_3); uv (methanol): λ max 252 nm (ε 4300).

2,3-Dibenzoyl-4-phenylquinoline (**31**).

2-Aminobenzophenone (**2**) (0.35 g, 1.8 mmoles) and 1,4-diphenyl-2-butyne-1,4-dione (**6**) (0.43 g, 1.8 mmoles) were reacted in methanol (10 ml), following the procedure employed for the preparation of **30**. Recrystallization of the crude product from acetone gave 0.62 g (81%) of **31** as white crystals, mp 203-205°; R_f = 0.64 (19:1 benzene-diethyl ether); ir: 3060 cm^{-1} (Ar-H, w), 1674, 1658 cm^{-1} (C=O, vs), 1599, 1578, 1565, 1487, 1451 cm^{-1} (aromatic C=C); ^{1}H-nmr (deuteriochloroform): δ 8.43-6.97 (19 H, m, Ar-H); uv (methanol): λ max 265 nm (ε 2410).

1,4-Diphenyl-2-[(2-acetylphenyl)amino]-2-butene-1,4-dione (**32**).

2-Aminoactophenone (**1**) (0.25 g, 1.8 mmoles) and 1,4-diphenyl-2-butyne-1,4-dione (**6**) (0.43 g, 1.8 mmoles) were dissolved in tetrahydrofuran (10 ml), the temperature being maintained below 25°. The solution was then allowed to warm to room temperature and was left to stand in an unstoppered flask for 24 hours. The resultant oil was crystallized from tetrahydrofuran-petroleum ether to give 0.32 g (47%) of crude **32**. The crude product was dissolved in a minimal amount of refluxing cyclohexane and the hot solution was clarified by filtration. On cooling to room temperature, 0.14 g (20%) of **32** was obtained as bright yellow crystals, mp 120-121.5°, R_f = 0.32 (19:1 benzene-diethyl ether); ir: 3057 cm^{-1} (C-H, w), 1666 cm^{-1} (C^1=O, s), 1573 cm^{-1} (C^4=O, vs), 1615, 1596, 1552, 1503, 1447 cm^{-1} (C=C, aromatic C=C); ^{1}H-nmr (deuteriochloroform): δ 13.5 (1 H, br, N-H), δ 7.98-6.86 (14 H, m, Ar-H), δ 6.31 (1 H, s, H-2), δ 2.65 (3 H, s, CH_3); uv (methanol): λ max 402 nm (ε 1950), 327 nm (ε 1530), 265 nm (ε 1800).

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