Ring Closure Reactions of 3-Arylhydrazonoalkyl-quinolin-2-ones to 1-Aryl-pyrazolo[4,3-*c*]quinolin-2-ones

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4-Hydroxy-3-arylhydrazonoalkyl-2-quinolones **6** or reactive derivatives such as 3-arylhydrazonoalkyl-4-tosyloxy-2-quinolones **7** or 4-chloro-3-arylhydrazonoalkyl-2-quinolones **14**, which are obtained *via* 3-acyl-4-hydroxyquinolones **4**, **10** or 3-phenylaminomethylene-quinoline-2,4-diones **12**, cyclize in excellent yields to 1-aryl-pyrazolo[4,3-*c*]quinolin-4-ones (**11**). The cyclization conditions were investigated by differential scanning calorimetry (DSC).

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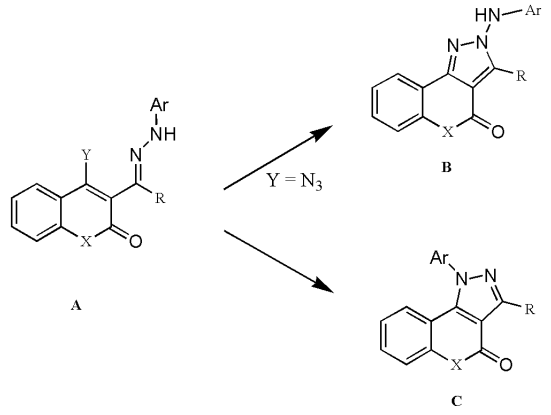
Recently we reported about the thermal electrocyclization of 4-azido-3-hydrazonoalkylquinolones (**A**, Y=N_3) to 2-arylaminopyrazolo[4,3-*c*]quinolones **B** [1]. In the course of the investigation of the precursors of these azidoquinolones we found that in many cases the formation of 1-aryl-pyrazolo[4,3-*c*]quinolin-4-ones **C** was favoured. 1-Aryl-pyrazolo[4,3-*c*]quinolin-4-ones **C** are a class of compounds which have found pharmaceutical interest because of its properties in benzodiazepine receptor affinity and as an immunomodulation drug [2] which prompted us to investigate these cyclization reactions in detail. In the literature there are some syntheses described that start either from 2-aryl-3-pyrazolones [3], 1-aryl-pyrazole-4-carboxylates [2b,4] or 2-hydroxy-3-acetylquinoline-arylhydrazones [3]. Therefore our synthetic pathway promised a new and versatile approach to this class of compounds.

Scheme 1

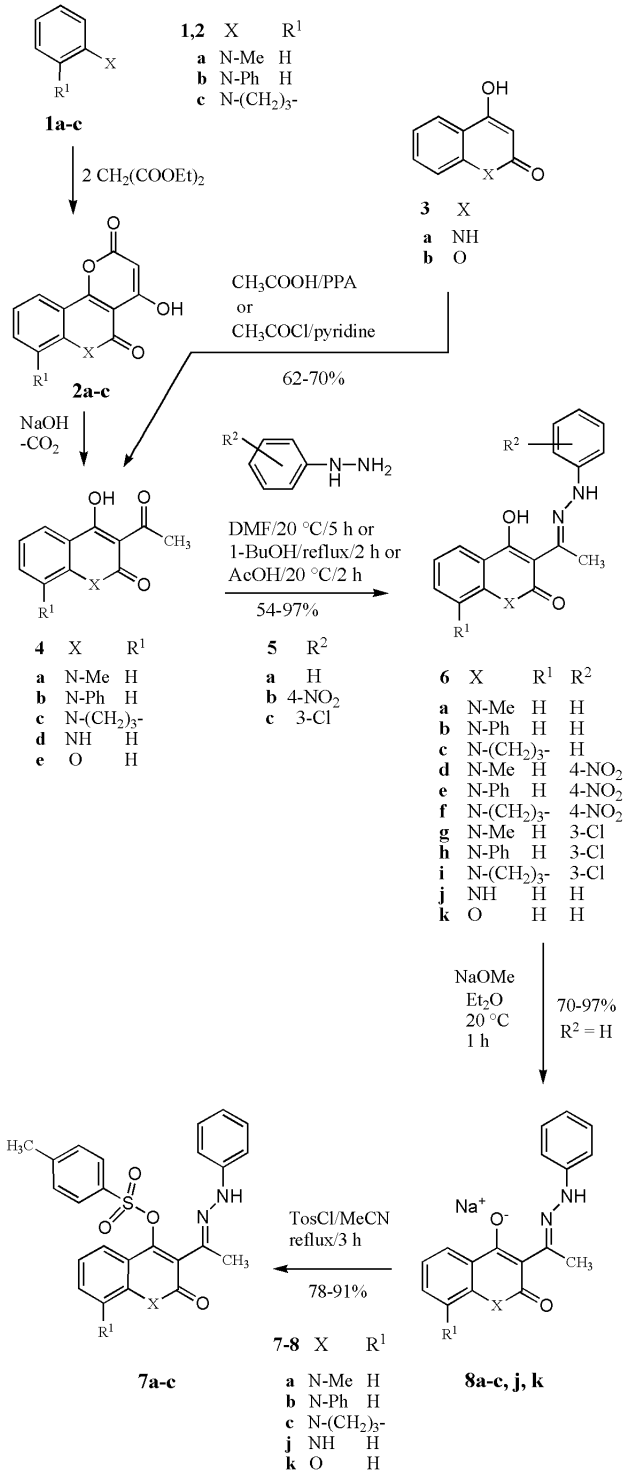


To obtain the key intermediates **A** with R = CH_3 we directed our synthesis using the acetyl hydrazones **6** and **7** with reactive leaving groups Y such as hydroxy, chloro and tosyloxy substituents. As precursors N-substituted 3-acetyl-4-hydroxyquinolones **4a-c** were obtained *via* known methods from either anilines **1** and diethyl malonate via the pyronoquinolones **2a-c** and subsequent ring opening with sodium hydroxide followed by spontaneous decarboxylation [5]. On the other hand, N-unsubstituted 3-acetyl-4-hydroxyquinolone **4d** and 3-acetyl-4-hydroxycoumarin **4e** were synthesized by direct acetylation of 4-hydroxyquinolone **3a** or 4-hydroxycoumarin **3b** with acetic acid/polyphosphoric acid or with acetyl chloride using pyridine as base, adopting the methods described in ref. [6]. The acetylation of **3a,b** as described in ref. [7,8] gave in our hands either very low yields or a mixture of compounds which could not be separated.

Arylhydrazono compounds **6** were obtained by reaction of the acetyl compounds **4** with a small excess of the appropriate arylhydrazines **5** either in dimethylformamide or 1-butanol similar to the method we have reported recently [9]. The solvent and the reaction temperature were dependent on the aryl substituents: phenylhydrazine (**5 a**) reacted already in dimethylformamide solution with acetyl compounds **4** at ambient temperature in good to excellent yields, whereas nitro- and chlorophenylhydrazines **5b,c** required refluxing in 1-butanol to give the corresponding 3-acetylquinolone arylhydrazones **6** in excellent yields. 3-Acetylcoumarin arylhydrazone **6k** was in addition synthesized in refluxing acetic acid according to a method described in ref. [10]. As the next step, we had planned to exchange the hydroxy group of compounds **6** to a chloro substituent in order to obtain a highly reactive intermediate. However, all efforts to introduce the chloro substituent, failed, probably caused by strong hydrogen bondings between the hydrazono moiety and the hydroxy group.

The synthesis of the reactive toluenesulfonyloxy compounds **7** was successful, but had to be performed in a two-step reaction, because the 4-hydroxyquinolone arylhydrazones **6** did again not react directly with toluenesulfonylchloride, even in the presence of strong bases such as triethylamine or 4-dimethylaminopyridine. In the first step, we converted the hydroxy group of **6** to the sodium enolate group of **8** by reaction with sodium methoxide in diethylether. The reaction of sodium salts **8a-c** with toluenesulfonylchloride in dry acetonitrile afforded in excellent yields the desired toluenesulfonyloxy quinolones **7a-c**. Attempts to obtain the toluenesulfonyloxy compounds **7j,k** were not successful, although the sodium salts **8j,k**

Scheme 2



could be isolated in good yields. Probably due to the high reactivity, in both cases after reaction with toluenesulfonyl chloride a mixture of products was obtained, which could not be separated and purified. Investigations of the reaction mixture of **8j** with toluenesulfonylchloride revealed that not only mono-acylation, but also diacylation has taken place.

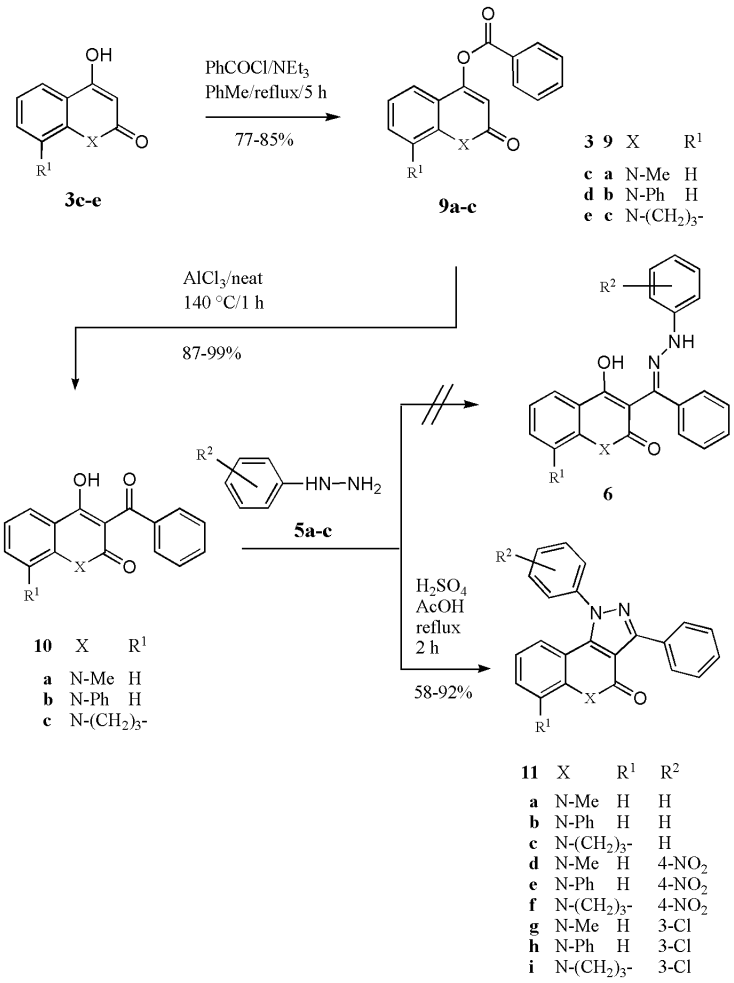
The approach to key intermediates **A** with R = C_6H_5 leads from 4-hydroxy-2-quinolones **3c-e** by acylation with benzoylchloride in the presence of triethylamine to 4-benzoyloxy-2-quinolones **9** adopting a literature method [11]. The Fries rearrangement of **9** with aluminium chloride in the melt gave in excellent yields 3-benzoyl-4-hydroxy-2-quinolones **10a-c**. When hydroxy compounds **10a-c** were treated with phenylhydrazines **5** as described for acetyl compounds **4**, already at room temperature and also at 0 °C, mixtures of compounds were isolated, which contained already cyclized pyrazolo[4,3-*c*]quinolones **11**, and it was not possible to obtain 3-benzoyl-4-hydroxyquinolone arylhydrazones **6** in a pure form.

To obtain pyrazolo[4,3-*c*]quinolones **11** directly from 3-benzoyl-4-hydroxy-2-quinolones **10** pure and in good yields, we adopted a method which we have recently reported [9]. A suspension of 3-benzoyl compounds **10** in acetic acid was treated with some drops of concentrated sulfuric acid to accelerate the reaction rate. Heating for 2 hours afforded the pyrazolo[4,3-*c*]quinolones **11** in good to excellent yields.

A further approach to key intermediates **A** with R = H was intended to proceed *via* 3-formyl derivatives. The synthetic pathway started from 3-phenylaminomethylenequinolinediones **12**, which were obtained from 4-hydroxy-2-quinolones, aniline and triethyl orthoformate, and then converted to 4-chloro-3-formyl-quinolones **13** by a known procedure [12]. The reaction of aldehydes **13** with a small excess of phenylhydrazines **5** in dimethylformamide solution at room temperature or in 1-butanol solution at reflux temperature gave in good to excellent yields the desired 4-chloro-3-arylhydrazonoformyl-quinolinones **14a-e**.

The reactivity of the key intermediates **A**, which were obtained as arylhydrazones with hydroxy groups (compounds **6**), with toluenesulfonyloxy groups (compounds **7**) and chloro substituents (compounds **14**) as leaving groups, was studied by differential scanning calorimetry (DSC). This method is well suited for the determination of thermal reaction conditions [13] showing both the reaction temperature and the reaction enthalpy. Both data are valuable for the planning of thermolysis reactions. The DSC experiments of hydroxy derivatives **6** revealed that after the melting area an exothermic reaction follows starting at 215-235 °C with a broad signal having a maximum at about 250 °C. The reaction enthalpy is rather low (about -20 mcal/mg). In contrast, the more reactive tosyloxy intermediates **7** do not show a melting area, and the reaction signal is sharper and appears at significantly lower temperatures (about 140 °C), with reaction enthalpies having about double the value (about -45 mcal/mg). Similar properties can be observed with the chloro compounds **14**, which have again no melting area and sharp reaction

Scheme 3



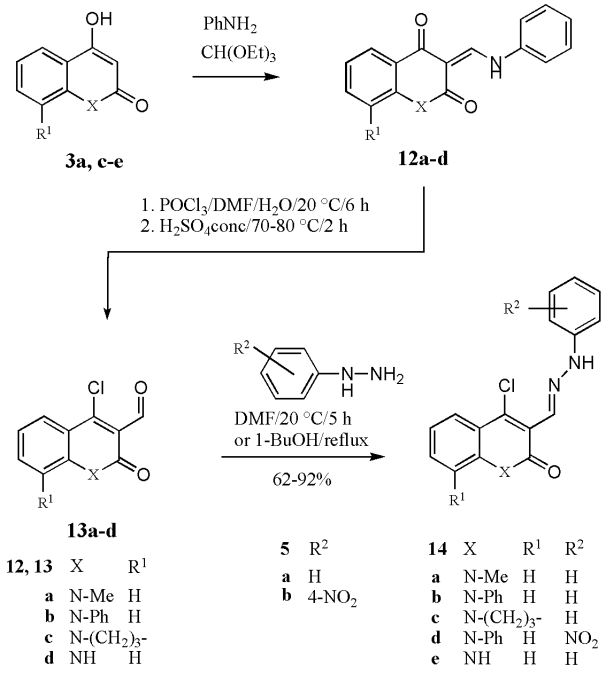
signals, however at significantly higher values (188 and 268 °C), but with rather high reaction enthalpies (about -60 mcal/mg). Generally, the reaction temperature gave us a first hint on the temperature where a thermal cyclization reaction should be performed, and the reaction enthalpy can be used both as a hint on the reactivity and for safety aspects on scale-up.

Experiments to synthesize pyrazolo[4,3-*c*]quinolin-4-ones **11** by thermolysis of 4-hydroxy-3-acetylquinolone arylhydrazones **6** according to the DSC data in solvents such as diphenylether gave only poor results, because a number of by-products were formed. These results can already be deducted from DSC data, especially from the broad peak form ranging over 50 °C, probably caused by additional decomposition reactions. Therefore milder conditions using catalysts were needed. The best results have been obtained when the reaction was performed in acidic medium using acetic acid as solvent and some drops of concentrated sulfuric acid as strong acidic catalyst. In a similar way 4-hydroxy-3-acetyl-2-chromone arylhydrazone (**6k**) gave 3-methyl-1-phenylchromeno[4,3-*c*]pyrazol-4-one (**11t**).

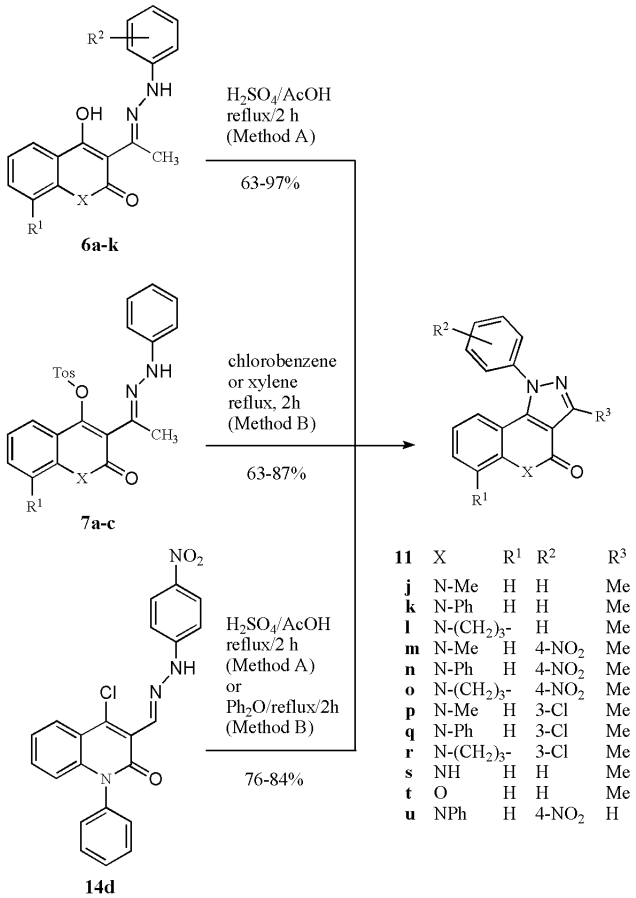
The synthesis of pyrazolo[4,3-*c*]quinolin-4-ones **11** by thermolysis of 3-acetyl-4-tosyloxyquinolone arylhydrazones **7** should give better results according to the DSC data: the reaction temperatures of **7** are about 100 °C lower than of the hydroxy compounds **6** and the reaction signals are sharp without any hints on decomposition reactions. Actually, tosyloxy compounds **7** gave on thermolysis in refluxing xylene or chlorobenzene (the appropriate solvent could be obtained from the DSC data) in excellent yields pyrazolo[4,3-*c*]quinolin-4-ones **11**.

The DSC data of 4-chloroquinoline-3-aldehyde arylhydrazones **14** show on the one hand rather high reaction temperatures on the other hand a sharp signal without decomposition signals. We carried out the thermolysis of **14d** in diphenylether as solvent, to reach these high temperatures, and obtained pure pyrazolo[4,3-*c*]quinolin-4-one **11u** in excellent yields without formation of any by-products. Attempts to use lower-boiling solvents such as N-methylpyrrolidone or dimethylformamide brought no results: only starting material could be isolated. Similar results were obtained when some drops of sulfuric acid

Scheme 4



Scheme 5



were added in order to lower the reaction temperature by acidic catalysis. On the other hand, however, when we used the cyclization method developed for the hydroxy compounds in refluxing acetic acid with the addition of sulfuric acid, again pyrazolo[4,3-*c*]quinolin-4-one **11u** could be obtained in good yields.

The results of this investigation show again that differential scanning calorimetry offers a valuable tool for the planning of synthetic reaction conditions. The diagrams indicate not only the thermolysis temperatures, but give also hints for the search of alternative reaction conditions [13]. The investigated routes to pyrazolo[4,3-*c*]quinolin-4-ones **11** could be shown to allow a diversity generating synthesis in all four ring parts: at the benzo ring (R^1), at the aryl substituent (R^2), at the pyrazole heterocycle (H, methyl or phenyl) and at the pyridine or benzopyran heterocycle (X).

EXPERIMENTAL

Melting points were determined on a Gallenkamp Melting Point Apparatus, Mod. MFB-595 in open capillary tubes. Calorimetric data were obtained on a Rheometric Scientific DSC-Plus instrument with the differential scanning calorimetry software Orchestrator V6.5.8. The differential scanning calorimetry plots were recorded between 25 - 400 °C, with a heating rate of 2-10 °C/min, and 1.5-3 mg compound in sealed aluminium crucibles (11 bar). The ^{1}H nmr spectra were recorded on a Bruker AM 360 instrument (360 MHz). Chemical shifts are reported in ppm from internal tetramethylsilane standard and are given in δ-units. The solvent for NMR spectra was DMSO-d_6 unless otherwise stated. Elemental analyses were performed on a Fisons elemental analyzer Mod. EA 1108, and are within ±0.4 of the theoretical percentages. Infrared spectra were taken on a Galaxy Series FTIR 7000 in potassium bromide pellets. Common reagent-grade chemicals are either commercially available and were used without further purification or prepared by standard literature procedures. All reactions were monitored by thin layer chromatography, carried out on 0.2 mm silica gel 60 F-254 (Merck) plates using uv light (254 and 366 nm) for detection. 3-Acetyl-4-hydroxyquinolin-2(1*H*)-ones **4a-c** were obtained according to ref. [5].

3-Acetyl-4-hydroxyquinolin-2(1*H*)-one (**4d**).

A mixture of glacial acetic acid (30 mL), polyposphoric acid (200 mL) and 4-hydroxyquinolone **3a** (10.00 g, 62 mmol) was heated for 3 hours on a steam-bath. After cooling the resulting oil was poured onto ice/water (500 mL). After 12 hours a precipitate was formed, which was filtered and washed with water until neutral. The yield was 9.50 g (70%), mp 258-260 °C (ethanol), lit. mp 242-256 °C [7].

3-Acetyl-4-hydroxychroman-2-one (**4e**).

A solution of 4-hydroxycoumarin **3b** (30.00 g, 0.19 mol) in dry pyridine (240 mL) and piperidine (0.1 mL) was cooled to 0-5 °C. Then acetylchloride (21.79 g, 0.28 mol) was added and the mixture stirred for 48 h at 20 °C. The dark red reaction mixture was then poured onto ice/water (700 mL) and the product brought to pH 1-2 with 2 *M* hydrochloric acid. The precipitate was filtered

by suction, washed with water until neutral and dried. The yield was 23.51 g (62%), light yellow microprisms, mp 133-135 °C (ethanol/water); lit. mp 134-136 °C [6].

4-Hydroxy-1-methyl-3-[1-(phenylhydrazono)ethyl]-quinolin-2(1*H*)-one (**6a**).

Method A: To a solution of 3-acetylquinolone **4a** (5.00g, 23 mmol) in dimethylformamide (100 mL) 85% phenylhydrazine (**5a**) (2.99 g, 27.6 mmol) was added. The reaction mixture was stirred at 20 °C for 5 hours and poured onto ice/water (700 mL). The mixture was stirred until crystallization took place and the resulting precipitate was filtered and washed with water. The yield was 3.81 g (54%), yellow microprisms, mp 210 °C (ethanol); lit. mp: 211-212 °C [9]; calorimetric data for the thermolysis: mp at 213.5 °C onset, 217.7 °C maximum, ΔH = 34 mcal/mg; cyclization at 214.6 °C onset, 244.0 °C maximum, ΔH = -27 mcal/mg.

4-Hydroxy-1-phenyl-3-[1-(phenylhydrazono)ethyl]-quinolin-2(1*H*)-one (**6b**).

The compound was obtained from 3-acetylquinolone **4b** (5.00 g, 17.9 mmol) and 85% phenylhydrazine (**5a**) (2.20 g, 20.5 mmol) using method A as described for **6a**. The yield was 5.23 g (79%), yellow microprisms, mp 249-251 °C (ethanol); lit. mp: 224-225 °C [14]; calorimetric data for the thermolysis: mp at 229.6 °C onset, 236.0 °C maximum, ΔH = 8 mcal/mg; cyclization at 235.6 °C onset, 254.5 °C maximum, ΔH = -20 mcal/mg.

1-Hydroxy-2-[1-(phenylhydrazono)ethyl]- 6,7-dihydro-5*H*-benzo-[*ij*]quinolizin-3-one (**6c**).

The compound was obtained from 2-acetylbenzo[*ij*]quinolizinone **4c** (5.00 g, 20.6 mol) and 85% phenylhydrazine (**5a**) (2.67 g, 24.7 mmol) using method A as described for **6a**. The yield was 5.10 g (74%), yellow microprisms, mp 202-204 °C (ethanol); lit. mp: 205-208 °C [9]; calorimetric data for the thermolysis: mp at 191.6 °C onset, 198.0 °C maximum, ΔH = 31 mcal/mg; cyclization at 215.1 °C onset, 240.8 °C maximum, ΔH = -19 mcal/mg.

4-Hydroxy-1-methyl-3-[1-(4-nitrophenylhydrazono)ethyl]-quinolin-2(1*H*)-one (**6d**).

Method B: To a suspension of 3-acetylquinolone **4a** (5.00 g, 23.0 mmol) in 1-butanol (30 mL) 4-nitrophenylhydrazine (**5b**) (4.23 g, 27.6 mmol) was added and then heated for 2 hours under reflux. After cooling the precipitate was filtered by suction and washed with a small amount of cold ethanol. The yield was 7.66 g (95%), yellow microprisms, mp 280 °C (ethanol); ir: 3310 m, 1640 s, 1610 s cm^{-1}; ^1H nmr: δ 2.60 (s, CH_3), 3.60 (s, N-CH_3), 7.20 (dd, J = 7 + 1.5 Hz, 2 ArH), 7.30 (t, J = 7 Hz, 1 ArH), 7.55 (dd, J = 7 + 1.5 Hz, 1 ArH), 7.60-7.85 (m, 1 ArH), 8.10 (dd, J = 7 + 1.5 Hz, 8-H), 8.20 (dd, J = 7 + 1.5 Hz, 2 ArH), 10.40 (s, br, NH), 14.05 (s, br, OH).

Anal. Calcd. for $C_{18}H_{16}N_4O_4$: C, 61.36; H 4.58; N, 15.90. Found: C, 61.41; H, 4.44; N, 15.58.

4-Hydroxy-3-[1-(4-nitrophenylhydrazono)-ethyl]-1-phenyl-quinolin-2(1*H*)-one (**6e**).

This compound was obtained from 3-acetylquinolone **4b** (5.00 g, 17.9 mmol) and 4-nitrophenylhydrazine (**5b**) (3.29 g, 21.5 mmol) in 1-butanol (30 mL) using method B as described for **6d**. The yield was 6.89 g (93%), yellow microprisms, mp 281 °C (ethanol); ir: 3240 m, 1600 s cm^{-1}; ^1H nmr: δ 2,55 (s, CH_3), 6.50 (dd, J = 1.5 + 7 Hz, 1 ArH), 7.15-7.40 (m, 5 ArH), 7.45-7.70 (m, 4 ArH), 8.05-8.30 (m, 3 ArH), 10.35 (s, 1 NH), 14.70 (s, br, OH).

Anal. Calcd. for $C_{23}H_{18}N_4O_4$: C, 66.66; H, 4.38; N, 13.52. Found: C, 66.48; H, 4.33; N, 13.28.

1-Hydroxy-2-[1-(4-nitrophenylhydrazono)ethyl]-6,7-dihydro-5*H*-benzo[*ij*]quinolizin-3-one (**6f**).

This compound was obtained from 2-acetylbenzo[*ij*]quinolizinone **4c** (5.00 g, 20.6 mmol) and 4-nitrophenylhydrazine (**5b**) (3.78 g, 24.7 mmol) in 1-butanol (30 mL) using method B as described for **6d**. The yield was 7.10 g (91%) orange microprisms, mp 283 °C (ethanol); ir: 3260 m, 1590 s cm^{-1}; ^1H nmr: δ 1.95-2.05 (m, CH_2), 2.60 (s, CH_3), 3.65-3.70 (m, Ar-CH_2), 4.95-4.05 (m, N-CH_2), 7.15-7.25 (m, 3 ArH), 7.45 (dd, J = 7 + 1.5 Hz, 1 ArH), 7.90 (dd, J = 7 + 1.5 Hz, 1 ArH), 8.20 (dd, J = 7 + 1.5 Hz, 2 ArH), 10.30 (s, br, NH), 14.00 (s, br, OH).

Anal. Calcd. for $C_{20}H_{18}N_4O_4$: C, 63.49; H, 4.79; N, 14.81. Found: C, 63.43; H, 4.78; N, 14.64.

3-[1-(3-Chlorophenylhydrazono)ethyl]-4-hydroxy-1-methyl-quinolin-2(1*H*)-one (**6g**).

This compound was obtained from 3-acetylquinolone **4a** (3.00 g, 13.8 mmol) and 3-chlorophenylhydrazine (**5c**) (2.16 g, 15.2 mmol) in 1-butanol (25 mL) using method B as described for **6d**. The yield was 3.91 g (83%), yellow microprisms, mp 216-218 °C (1-butanol); ir: 3290 m, 1615 s, 1600 s, 1580 s cm^{-1}; ^1H nmr: δ 2.60 (s, CH_3), 3.60 (s, N-CH_3), 6.90 (dd, J = 7 + 1 Hz, 1 ArH), 7.95-7.05 (m, 1 ArH), 7.20-7.40 (m, 2 ArH), 7.50 (dd, J = 7 + 1.5 Hz, 1 ArH), 7.60-7.70 (m, 1 ArH), 8.05 (dd, J = 7 + 1.5 Hz, 8-H), 9.80 (s, NH), 15.10 (s, OH).

Anal. Calcd. for $C_{18}H_{16}ClN_3O_2$: C, 63.25; H, 4.72; N, 12.29. Found: C, 63.04; H, 4.68; N, 12.02.

3-[1-(3-Chlorophenylhydrazono)ethyl]-4-hydroxy-1-phenyl-quinolin-2(1*H*)-one (**6h**).

This compound was obtained from 3-acetylquinolone **4b** (3.00 g, 10.7 mmol) and 3-chlorophenylhydrazine (**5c**) (1.68 g, 11.8 mmol) in 1-butanol (25 mL) using method B as described for **6d**. The yield was 3.78 g (87%), yellow microprisms, mp 256-258 °C (1-butanol); ir: 3295 m, 1610 s, 1600 s cm^{-1}; ^1H nmr: δ 2.60 (s, CH_3), 6.50 (dd, J = 7 + 1.5 Hz, 1 ArH), 6.95 (dd, J = 7 + 1.5 Hz, 1 ArH), 7.00-7.10 (m, 2 ArH), 7.20-7.50 (m, 5 ArH), 7.55-7.70 (m, 3 ArH), 8.15 (dd, J = 7 + 1.5 Hz, 8-H), 9.60 (s, NH).

Anal. Calcd. for $C_{23}H_{18}ClN_3O_2$: C, 68.40; H, 4.49; N, 10.40. Found: C, 68.02; H, 4.47; N, 10.30.

2-[1-(3-Chlorophenylhydrazono)ethyl]-1-hydroxy-6,7-dihydro-5*H*-benzo[*ij*]quinolizin-3-one (**6i**).

This compound was obtained from 2-acetylbenzo[*ij*]quinolizinone **4c** (3.00 g, 12.3 mmol) and 4-chlorophenylhydrazine (**5c**) (1.93 g, 13.5 mmol) in 1-butanol (30 mL) using method B as described for **6d**. The yield was 3.98 g (88%) yellow microprisms, mp 208-210 °C (1-butanol); ir: 3250 m, 2950 w, 1620 s, 1595 s cm^{-1}; ^1H nmr: δ 1.95-2.05 (m, CH_2), 2.60 (s, CH_3), 2.85-2.95 (m, Ar-CH_2), 3.95-4.05 (m, N-CH_2), 6.90 (dd, J = 7 + 1.5 Hz, 1 ArH), 7.00-7.20 (m, 3 ArH), 7.30-7.40 (m, 2 ArH), 7.90 (dd, J = 7 + 1.5 Hz, 1 ArH), 9.60 (s, NH), 15.10 (s, OH).

Anal. Calcd. for $C_{20}H_{18}ClN_3O_2$: C, 65.31; H, 4.93; N, 11.42. Found: C, 65.38; H, 4.80; N, 11.22.

4-Hydroxy-3-[1-(phenylhydrazono)ethyl]-quinolin-2(1*H*)-one (**6j**).

This compound was obtained from 3-acetylquinolone **4d** (3.00 g, 14.8 mmol) and 85% phenylhydrazine (**5a**) (1.92 g, 17.7 mmol) in dimethylformamide (80 mL) according to method A described for **6a**. The yield was 4.00 g (92%), yellow microprisms, mp 237-239 °C dec. (1-butanol); calorimetric data for the thermolysis: mp at 213.6 ° C onset, 223.2 °C maximum, ΔH = 11 mcal/mg; cyclization at 222.5 °C onset, 241.2 °C maximum, ΔH = - 21 mcal/mg; ir: 3300-2780 m, 1630 s, 1600 s cm^{-1}; ^1H nmr: δ 2.70 (s, CH_3), 6.90 (t, J = 7 Hz, 1 ArH), 7.00 (dd, J = 7 + 1.5 Hz, 1 ArH), 7.10-7.40 (m, 5 ArH), 7.50 (t, J = 7 Hz, 1 ArH), 8.00 (dd, J = 7 + 1.5 Hz, 8-H), 9.30 (s, =N-NH), 11.2 (s, 1-NH), 14.90 (s, br, OH).

Anal. Calcd. for $C_{17}H_{15}N_3O_2$: C, 69.61; H 5.15; N, 14.33. Found: C, 69.67; H, 5.14; N, 14.06.

4-Hydroxy-3-[1-(phenylhydrazono)ethyl]-chroman-2-one (**6k**).

This compound was obtained from 3-acetylcoumarin **4e** (1.00 g, 4.9 mmol) in dimethylformamide (30 mL) and 85% phenylhydrazine (**5a**) (0.64 g, 5.9 mmol) according to method A described for **6a**. The yield was 1.26 g (87%), yellowish crystals, mp 184-185 °C.

Method C: A suspension of 3-acetylcoumarin **4e** (8.00 g, 39.2 mmol) and phenylhydrazine (**5a**) (5.08 g, 47 mmol) in glacial acetic acid (150 mL) was heated under reflux for 2 hours, cooled to room temperature and poured onto ice/water (500 mL). The resulting precipitate was filtered by suction and washed with water until neutral. The yield was 10.60 g (97%), yellowish crystals, mp 183-185 °C (glacial acetic acid); ir: 3300-3060 w, 1620 m, 1590 m cm^{-1}; ^1H nmr: δ 2.15 (s, CH_3), 6.92 (t, J = 7 Hz, 2 ArH), 7.30-7.60 (m, 5 ArH), 7.95 (dd, J = 1.5 Hz, 2 ArH), 9.70 (s, br, NH), 15.05 (s, br, OH).

Anal. Calcd. for $C_{17}H_{14}N_2O_3$: C, 69.38; H 4.79; N, 9.52. Found: C, 69.34; H, 4.74; N, 9.44.

1-Methyl-2-oxo-3-[1-(phenylhydrazono)ethyl]-1,2-dihydroquinolin-4-yl 4-Methylbenzenesulfonate (**7a**).

A) Sodium 1-methyl-2-oxo-3-[1-(phenylhydrazono)ethyl]-1,2-dihydroquinolin-4-olate (**8a**): A suspension of 3-acetylquinolone phenylhydrazone **6a** (2.00 g, 6.5 mmol) in dry diethylether (50 mL) was combined with sodium methanolate, prepared from sodium (0.18 g, 7.8 mmol) and dry methanol (5 mL). The mixture was stirred at room temperature for 2 hours, the precipitated sodium salt filtered by suction and dried at 40 °C. The yield was 2.04 g (95%).

B) A suspension of the dried sodium salt **8a** (2.04 g, 6.2 mmol) in dry acetonitril (25 mL) was combined with 4-toluenesulfonylchloride (1.30 g, 6.8 mmol) and heated under reflux for 3 hours. After cooling to room temperature the reaction mixture was poured onto ice/water (200 mL) and stirred until crystallization took place. The solid was collected by suction filtration, washed with water and dried at 40 °C. The yield was 2.59 g (91%), brownish microprisms, mp 172.173 °C (ethanol); calorimetric data for the thermolysis: cyclization at 136.5 ° C onset, 141.9 °C maximum, ΔH = -50 mcal/mg; ir: 3310 s, 1640 s, 1595 s cm^1; ^1H nmr: δ 195 (s, CH_3), 2.25 (s, Ph-CH_3), 3.70 (s, N-CH_3), 6.75 (t, J = 7 Hz, 1 ArH), 7.00 (dd, J = 1.5 + 7 Hz, 2 ArH), 7.10-7.25 (m, 4 ArH), 7.35 (t, J = 7 Hz, 1 ArH), 7.60-7.80 (m, 5 ArH), 9.10 (s, NH).

Anal. Calcd. for $C_{25}H_{23}N_3O_4S$: C, 65.06; H, 5.02; N, 9.10. Found: C, 64.76; H, 4.94; N, 9.13.

2-Oxo-1-phenyl-3-[1-(phenylhydrazono)ethyl]-1,2-dihydroquinolin-4-yl 4-Methylbenzenesulfonate (**7b**).

A) Sodium 2-oxo-1-phenyl-3-[1-(phenylhydrazono)ethyl]-1,2-dihydroquinolin-4-olate (**8b**): 3-acetylquinolone phenylhydrazone **6b** (1.00 g, 2.7 mmol), diethylether (50 mL), sodium (0.08 g, 3.5 mmol) and methanol (3 mL) were brought to reaction and worked up as described for **8a**. The yield was 0.96 g (91%).

B) The dried sodium salt **8b** (0.96 g, 2.5 mmol) in dry acetonitril (10 mL) was brought to reaction with 4-toluenesulfonylchloride (0.56 g, 2.9 mmol) and worked up as described for **7a**. The yield was 1.14 g (87%) yellow microprisms, mp. 180.0 °C dec. (dimethylformamide); calorimetric data for the thermolysis: cyclization at 129.7 °C onset, 136.7 °C maximum, ΔH = -43 mcal/mg; ir: 3290 m, 1640 m, 1595 m cm^{-1}; ^1H nmr: δ 1.90 (s, CH_3), 2.25 (s, Ph-CH_3), 6.60 (dd, J = 1.5 + 7 Hz, 1 ArH), 6.75 (t, J = 7 Hz, 2 ArH), 7.00 (dd, J = 1.5 + 7 Hz, 3 ArH), 7.10-7.90 (m, 12 ArH), 9.10 (s, NH).

Anal. Calcd. for $C_{30}H_{25}N_3O_4S$: C, 68.82; H, 4.81; N, 8.02; S, 6.12. Found: C, 68.44; H, 5.14; N, 7.96; S, 6.29.

3-Oxo-2-[1-(phenylhydrazono)ethyl]-6,7-dihydro-5*H*-benzo[*ij*]quinolizin-1-yl 4-Methylbenzenesulfonate (**7c**).

A) Sodium 3-oxo-2-[1-(phenylhydrazono)ethyl]-6,7-dihydro-5*H*-benzo[*ij*]quinolizin-2-olate (**8c**): 2-acetylbenzo[*ij*]-quinolizinone phenylhydrazone **6c** (2.00 g, 6.0 mmol), diethylether (50 mL), sodium (0.21 g, 9 mmol) and methanol (5 mL) were brought to reaction and worked up as described for **8a**. The yield was 2.07 g (97%).

B) The dried sodium salt **8c** (2.07 g, 5.8 mmol) in dry acetonitril (20 mL) was brought to reaction with 4-toluenesulfonylchloride (1.33 g, 7.0 mmol) and worked up as described for **7a**. The yield was 2.20 g (78%) brown microprisms, mp. 165.0 °C dec. (dimethylformamide); calorimetric data for the thermolysis: cyclization at 140.3 °C onset, 146.4 °C maximum, ΔH = -41 mcal/mg; ir: 3240-3300 w, 2820-2950 w, 1640 s, 1585 s cm^{-1}; ^1H nmr: δ 1.95 (s, CH_3), 2.00-2.05 (m, CH_2), 2.25 (s, Ph-CH_3), 2.95 (t, J = 7 Hz, Ar-CH_2), 4.1 (t, N-CH_2), 6.70 (t, J = 7 Hz, 1 ArH), 7.00 (dd, J = 1.5 + 7 Hz, 2 ArH), 7.10-7.25 (m, 6 ArH), 7.45 (dd, J = 1.5 + 7 Hz, 1 ArH), 7.60 (dd, J = 1.5 + 7 Hz, 1 ArH), 7.70 (dd, J = 1.5 + 7 Hz, 1 ArH), 9.05 (s, NH).

Anal. Calcd. for $C_{27}H_{25}N_3O_4S$: C, 66.51; H, 5.17; N, 8.62; S, 6.58. Found: C, 66.90; H, 5.47; N, 8.22; S, 6.19.

1-Methyl-2-oxo-1,2-dihydroquinolin-4-yl benzoate (**9a**).

This compound was obtained from 4-hydroxyquinolone **3c** according to ref. [11].

2-Oxo-1-phenyl-1,2-dihydroquinolin-4-yl benzoate (**9b**).

To a suspension of 4-hydroxyquinolone **3d** (47.45 g, 0.2 mol) [5] in dry toluene (500 mL) benzoylchloride (33.74 g, 0.24 mol) and dry triethylamine (20.24 g, 0.2 mol) were added and heated under reflux for 5 hours. The solution was cooled to room temperature and then dichloromethane (400 mL) was added. This mixture was extracted with 3x250 mL 2 *M* hydrochloric acid. The organic layer was dried with sodium sulfate and the solvent was removed to dryness under reduced pressure. The yield was 40.92 g (60%), yellowish microprisms, mp 150-151 °C (ethanol); ir: 1740 s, 1660 sh, 1645 s, 1600 m cm^{-1}; ^1H nmr: δ 6.60 (dd, J =

7 + 1.5 Hz, 1 ArH), 6.85 (s, 3-H), 7.20-7.45 (m, 3 ArH), 7.45-7.90 (m, 8 ArH), 8.25 (dd, J = 7 + 1.5 Hz, 2 ArH).

Anal. Calcd. for $C_{22}H_{15}NO_3$: C, 77.41; H, 4.43, N, 4.10. Found: C, 77.45; H 4.37; N 4.07.

3-Oxo-6,7-dihydro-3*H*,5*H*-benzo[*ij*]quinolizin-1-yl benzoate (**9c**).

1-Hydroxybenzo[*ij*]quinolizinone **3e** (40.25 g, 0.2 mol) and benzoylchloride (33.74 g, 0.24 mol) were brought to reaction and worked up as described for **9b**. The yield was 47.20 g (77%), colorless microprisms, mp 159-161 °C (1-butanol); lit. mp. 151 °C [15]; ir: 1740 m, 1655 s, 1590 m cm^{-1}; ^1H nmr: δ 2.05-2.15 (m, CH_2), 2.95-3.05 (m, 1 Ar-CH_2), 4.05-4.15 (m, N-CH_2), 6.70 (s, 2-H), 7.20 (t, J = 7 Hz, 1 ArH), 7.45-7.55 (m, 2 ArH), 7.70 (t, J = 7 Hz, 2 ArH), 7.80 (t, J = 7 Hz, 1 ArH), 8.25 (dd, J = 1.5 + 7 Hz, 2 ArH).

Anal. Calcd. for $C_{19}H_{15}NO_3$: C, 74.74; H, 4.95; N 4.59. Found C, 74.49; H 4.88; N 4.50.

3-Benzoyl-4-hydroxy-1-methylquinolin-2(1*H*)-one (**10a**).

This compound was obtained from 4-benzoyloxyquinolone **9a** according to ref. [11].

3-Benzoyl-4-hydroxy-1-phenylquinolin-2(1*H*)-one (**10b**).

An intimate mixture of 4-benzoyloxyquinolone **9b** (40.92 g, 0.12 mol) and anhydrous aluminium chloride were heated to 140 °C for 1 hour. Then the reaction mixture was cooled to room temperature and taken up into 1 *M* hydrochloric acid (500 mL). The resulting precipitate was collected by suction filtration and washed with water until neutral. The yield was 40.67 g (99%), light yellow microprisms, mp 205-207 °C (1-butanol); ir: 1660 s, 1615 s cm^{-1}; ^1H nmr: δ 6.60 (dd, J = 1.5 + 7 Hz, 1 ArH), 7.25-7.35 (m, 3 ArH), 7.40-7.70 (m, 7 ArH), 7.85 (dd, J = 7+1.5 Hz, 2 ArH), 8.15 (dd, J =1.5 + 7 Hz, 1 ArH).

Anal. Calcd. for $C_{22}H_{15}NO_3$: C, 77.41; H 4.43; N 4.10. Found: C, 77.16; H 4.28; N 4.03.

2-Benzoyl-1-hydroxy-6,7-dihydro-5*H*benzo[*ij*]quinolizin-3-one (**10c**).

1-Benzoyloxybenzo[*ij*]quinolizinone **9c** (18.00 g, 59 mmol) and anhydrous aluminium chloride (15.72 g, 118 mmol) were brought to reaction and worked up as described for **10b**. The yield was 15.69 g (87%), yellow microprisms, mp 155-157 °C (1-butanol); ir: 1640 m, 1595 m cm^{-1}; ^1H nmr: δ 1.95-2.05 (m, CH_2), 2.90-3.00 (m, Ar-CH_2), 3.95-4.05 (m, N-CH_2), 7.35 (t, J = 7 Hz, 2 ArH), 7.45-7.55 (m, 2 ArH), 7.55-7.65 (m, 1 ArH), 7.80 (dd, J =1.5 + 7 Hz, 2 ArH), 7.90 (dd, J =1.5 + 7 Hz, 1 ArH).

Anal. Calcd. for $C_{19}H_{15}NO_3$: C, 74.74; H, 4.95; N, 4.59. Found: C 74.55; H 5.14; N 4.49.

5-Methyl-1,3-diphenyl-1*H*-pyrazolo[4,3-*c*]quinolin-4(5*H*)-one (**11a**).

A suspension of 3-benzoylquinolone **10a** (2.00 g, 7.2 mmol) and 85% phenylhydrazine (**5a**) (0.93 g, 8.6 mmol) in glacial acetic acid (30 mL) was treated with a few drops of concentrated sulfuric acid and heated under reflux for 2 hours. After cooling to 20 °C the reaction mixture was poured onto ice/water (150 mL) and stirred until crystallization took place. The resulting precipitate was collected by suction filtration, washed with water until neutral and dried. The yield was 1.81 g (72%) colorless microprisms, mp 200-202 °C (ligroin); ir: 1650 s, 1615 w, 1595 w cm^{-1}; ^1H nmr: δ 3.70 (s, NCH_3), 7.05-7.15 (m, 2 ArH), 7.45-7.55 (m, 3 ArH), 7.55-7.65 (m, 2 ArH), 7.70-7.75 (m, 5 ArH), 8.10-8.20 (m , 2 ArH).

Anal. Calcd. for $C_{23}H_{17}N_3O$: C, 78.61; H, 4.88; N, 11.96. Found: C, 78.23; H, 4.60; N, 11.87.

1,3,5-Triphenyl-1*H*-pyrazolo[4,3-*c*]quinolin-4(5*H*)-one (**11b**).

A mixture of 3-benzoylquinolone **10b** (1.00 g, 2.9 mmol) and 85% phenylhydrazine (**5a**) (0.38 g, 3.5 mmol) was brought to reaction and worked up as described for **11a**. The yield was 0.81 g (68%) light yellow microprisms, mp 315 °C dec (ligroin); ir: 3100-2990 w, 1675 s, 1615 m, 1595 m cm^{-1}; ^1H nmr: δ 6.60 (dd, J= 1.5+7 Hz, 1 ArH), 7.00-7.20 (m, 2 ArH), 7.35 -7.50 (m, 6 ArH), 7.55-7.70 (m, 3 ArH), 7.75-7.80 (m, 5 ArH), 8.20-8.30 (m, 2 ArH).

Anal. Calcd. for $C_{28}H_{19}N_3O$: C, 81.34; H, 4.63; N, 10.16. Found: C, 80.95; H, 4.47; N, 9.92.

9,11-Diphenyl-5,6-dihydro-4*H*-benzo[*ij*]pyrazolo[3,4-*b*]quinolizin-8-one (**11c**).

A mixture of 2-benzoylbenzo[*ij*]quinolizinone **10c** (2.00 g, 6.6 mmol) and 85% phenylhydrazine (**5a**) (0.85 g, 7.9 mmol) was brought to reaction and worked up as described for **11a**. The yield was 2.29 g (92%) light yellow microprisms, mp 232-234 °C (ligroin); ir: 1645 s, 1595 s cm^{-1}; ^1H nmr: δ 2.05-2.15 (m, CH_2), 2.95-3.05 (m, Ar-CH_2), 4.15-4.25 (m, N-CH_2), 6.95 (dd, J = 1.5 + 7 Hz, 2 ArH), 7.35 (t, J = 7 Hz, 1 ArH), 7.45-7.55 (m, 3 ArH), 7.65-7.75 (m, 5 ArH), 8.15-8.25 (m, 2 ArH).

Anal. Calcd. for $C_{25}H_{19}N_3O$: C, 79.55; H, 5.07; N, 11.13. Found: C, 79.40; H, 4.96; N, 10.83.

5-Methyl-1-(4-nitrophenyl)-3-phenyl-1*H*-pyrazolo[4,3-*c*]quinolin-4(5*H*)-one (**11d**).

A mixture of 3-benzoylquinolone **10a** (3.00 g, 10.7 mmol) and 4-nitrophenylhydrazine (**5b**) (1.97 g, 12.9 mmol) was brought to reaction and worked up as described for **11a**. The yield was 3.59 g (85%), yellow-brownish microprisms, mp 261 °C dec. (toluene); ir: 3300-3200 w, 1660 s, 1610 m, 1600 m cm^{-1}; ^1H nmr: δ 3.70 (s, N-CH_3), 6.75 (dd, J = 1.5 + 7 Hz, 2 ArH), 7.50 (dd, J = 1.5 + 7 Hz, 3 ArH), 7.65-7.75 (m, 2 ArH), 8.00-8.20 (m, 4 ArH), 8.55 (dd, J = 1.5 + 7 Hz, 2 ArH).

Anal. Calcd. for $C_{23}H_{16}N_4O_3$: C, 69.69; H, 4.07; N, 14.13. Found: C, 69.41; H, 4.08; N, 14.18.

1-(4-Nitrophenyl)-3,5-diphenyl-1*H*-pyrazolo[4,3-*c*]quinolin-4(5*H*)-one (**11e**).

A mixture of 3-benzoylquinolone **10b** (3.00 g, 8.9 mmol) and 4-nitrophenylhydrazine (**5b**) (1.61 g, 10.5 mmol) was brought to reaction and worked up as described for **11a**. The yield was 3.88 g (95%), yellow-brownish prisms, mp 301 °C dec. (toluene); ir: 3080 - 3020 w, 1660 m, 1610 w, 1600 m cm^{-1}; ^1H nmr: δ 6.65 (dd, J = 1.5 + 7 Hz, 1 ArH), 7.05-7.50 (m, 9 ArH), 7.50-7.75 (m, 3 ArH), 8.10-8.20 (m, 3 ArH), 8.60 (dd, J = 1.5 + 7 Hz, 2 ArH).

Anal. Calcd. for $C_{28}H_{18}N_4O_3$: C, 73.35; H, 3.96 N, 12.22. Found: C, 75.30; H, 4.30; N, 11.82.

11-(4-Nitrophenyl)-9-phenyl-5,6-dihydro-4*H*-benzo[*ij*]pyrazolo[3,4-*b*]quinolizin-8-one (**11f**).

A mixture of 2-benzoylbenzo[*ij*]quinolizinone **10c** (3.00 g, 9.8mmol) and 4-nitrophenylhydrazine (**5b**) (1.81 g, 11.8 mmol) was brought to reaction and worked up as described for **11a**. The yield was 3.98 g (96%), yellow microprisms, mp 249-251 °C

(toluene); ir: 3030-3020 w, 1650 m, 1610 m, 1600 cm^{-1}; ^1H nmr: δ 2.10 (m, CH_2), 3.00 (m, Ar-CH_2), 4.20 (m, N-CH_2), 7.00-7.20 (m, 2 ArH), 7.40-7.60 (m, 4 ArH), 8.00-8.10 (dd, J = 1.5 + 7 Hz, 2 ArH), 8.15-8.25 (m, 2 ArH), 8.50 (dd, J= 1.5 + 7 Hz, 2 ArH).

Anal. Calcd. for $C_{25}H_{18}N_4O_3$: C, 71.08; H, 4.29; N, 13.26. Found: C, 71.40; H, 4.38; N, 12.99.

1-(3-Chlorophenyl)-5-methyl-3-phenyl-1*H*-pyrazolo[4,3-*c*]-quinolin-4(5*H*)-one (**11g**).

A mixture of 3-benzoylquinolone **10a** (3.00 g, 10.7 mmol) and 3-chlorophenylhydrazine hydrochloride (**5c**.HCl) (2.31 g, 12.9 mmol) was brought to reaction and worked up as described for **11a**. The yield was 2.18 g (52%) brown microprisms, mp 185 °C dec (toluene); ir: 1660 m, 1615 w, 1595 w cm^{-1}; ^1H nmr: δ 3.75 (s, CH_3), 7.15-7.25 (m, 2 ArH), 7.45-7.55 (m, 3 ArH), 7.65-7.75 (m, 2 ArH), 7.75-7.85 (m, 3 ArH), 8.00 (m, 1 ArH), 8.15-8.25 (m, 2 ArH).

Anal. Calcd. for $C_{23}H_{16}ClN_3O$: C, 71.60; H, 4.18; N, 10.89. Found: C, 71.19; H, 4.50; N, 10.10.

1-(3-Chlorophenyl)-3,5-diphenyl-1*H*-pyrazolo[4,3-*c*]quinolin-4(5*H*)-one (**11h**).

A mixture of 3-benzoylquinolone **10b** (3.00 g, 8.9 mmol) and 3-chlorophenylhydrazine hydrochloride (**5c**.HCl) (1.89 g, 10.5 mmol) was brought to reaction and worked up as described for **11a**. The yield was 3.92 g (98%) yellow microprisms, mp 291-293 °C (toluene); ir: 1680 m, 1615 w, 1590 w cm^{-1}; ^1H nmr: δ 6.60 (dd, J = 1.5 + 7 Hz, 1 ArH), 7.10-7.25 (m, 3 ArH), 7.30-7.50 (m, 5 ArH), 7.60-7.75 (m, 3 ArH), 7.75-7.90 (m, 3 ArH), 8.00 (s, 1 ArH), 8.20 (dd, J = 1.5 + 7 Hz, 2 ArH).

Anal. Calcd. for $C_{28}H_{18}ClN_3O$: C, 75.08; H, 4.05; N, 9.38. Found: C, 75.39; H, 4.19; N, 8.98.

11-(3-Chlorophenyl)-9-phenyl-5,6-dihydro-4*H*,11*H*-benzo[*ij*]-pyrazolo[3,4-*b*]quinolizin-8-one (**11i**).

A mixture of 2-benzoylbenzo[*ij*]quinolizinone **10c** (3.00 g, 9.8 mmol) and 3-chlorophenylhydrazine hydrochloride (**5c**.HCl) (2.11 g, 11.8 mmol) was brought to reaction and worked up as described for **11a**. The yield was 3.61 g (89%), brown microprisms, mp 226-228 °C (toluene); ir: 3060 m, 1645 m, 1590 m cm^{-1}; ^1H nmr: δ 2.05 (m, CH_2), 3.00 (m, $ArCH_2$), 4.20 (m, NCH_2), 7.00 (dd, J = 1.5 + 7 Hz, 2 ArH), 7.40 (t, J = 7 Hz, 1 ArH), 7.45-7.55 (m, 3 ArH), 7.70-7.85 (m, 3 ArH), 7.90 (s, 1 ArH), 8.15-8.25 (m, 2 ArH).

Anal. Calcd. for $C_{25}H_{18}ClN_3O$: C, 72.90; H, 4.40; N, 10.20. Found: C, 73.28; H, 4.35; N, 9.94.

3,5-Dimethyl-1-phenyl-1*H*-pyrazolo[4,3-*c*]quinolin-4(5*H*)-one (**11j**).

Method A: A suspension of of 3-acetylquinolone phenylhydrazone **6a** (0.50 g, 1.6 mmol) in glacial acetic acid (15 mL) was treated with some drops of conc. sulfuric acid and then heated for 2 hours under reflux. After cooling the mixture was poured onto ice/water (100 mL), stirred until crystallization was complete and the precipitate collected by suction filtration, washed with water until neutral and dried at 40 °C. The yield was 0.33 g (72%), colorless microprisms, mp 192-194 °C (ligroin).

Method B: A suspension of 3-acetyl-4-tosyloxyquinolone phenylhydrazone **7a** (0.50 g, 1.1 mmol) in chlorobenzene (20 mL) was heated under reflux for 2 hours. After cooling to room temperature the solvent was removed *in vacuo* and the remaining oil triturated with water. The crystals so formed were collected by suction filtration and dried at 40 °C. The yield was 0.25 g (79%), colorless microprisms, mp 190-193 °C (ligroin); lit. mp 181-183 °C (ethanol/water) [2c]; ir: 1655 s, 1615 w, 1595 w cm^{-1}; ^1H nmr: δ 2.60 (s, CH_3), 3.70 (s, N-CH_3), 7.10-7.15 (m, 2 ArH), 7.55-7.75 (m, 7 ArH).

Anal. Calcd. for $C_{18}H_{15}N_3O$: C, 74.72; H, 5.23; N, 14.52. Found: C, 74.91; H, 4.98; N, 14.37.

3-Methyl-1,5-diphenyl-1*H*-pyrazolo[4,3-*c*]quinolin-4(5*H*)-one (**11k**).

3-Acetylquinolone phenylhydrazone **6b** (0.50 g, 1.4 mmol) in glacial acetic acid (15 mL) was brought to reaction and worked up according to method A as described for **11j**. The yield was 0.35 g (71%), colorless microprisms, mp 277-278 °C (ligroin).

3-Acetyl-4-tosyloxyquinolone phenylhydrazone **7b**)(1.50 g, 2.9 mmol) in chlorobenzene (20 mL) was brought to reaction and worked up according to method B as described for **11j** (trituration with ethanol). The yield was 0.89 g (87%), colorless microprisms, mp 277-278 °C (ethanol); ir: 3050 w, 1670 m, 1615 w, 1595 w cm^{-1}; ^1H nmr: δ 2.60 (s, CH_3), 6.60 (dd, J = 1.5 + 7 Hz, 1 ArH), 7.00-7.20 (m, 2 ArH), 7.35 (m, 3 ArH), 7.55-7.80 (m, 8 ArH).

Anal. Calcd. for $C_{23}H_{17}N_3O$: C, 78.61; H, 4.88; N, 11.96. Found: C, 78.40; H, 4.61; N, 11.81.

9-Methyl-11-phenyl-5,6-dihydro-4*H*,11*H*-benzo[*ij*]pyrazolo[3,4-*b*]-quinolizin-8-one (**11l**).

2-Acetylbenzo[*ij*]quinolizinone phenylhydrazone **6c** (0.50 g, 1.5 mmol) in glacial acetic acid (10 mL) was brought to reaction and worked up according to method A as described for **11j**. The yield was 0.30 g (63%), colorless microprisms, mp 204-207 °C.

2-Acetyl-1-tosyloxybenzo[*ij*]quinolizinone phenylhydrazone **7c** (0.50 g, 1.0 mmol) in xylene (20 mL) was brought to reaction and worked up according to method B as described for **11j** (trituration with water). The yield was 0.21 g (67%) colorless prisms, mp 204-207 °C; lit. mp 204-207 °C (ligroin) [9].

3,5-Dimethyl-1-(4-nitrophenyl)-1*H*-pyrazolo[4,3-*c*]quinolin-4(5*H*)-one (**11m**).

3-Acetylquinolone 4-nitrophenylhydrazone **6d** (2.99 g, 5.7 mmol) in glacial acetic acid (30 mL) was brought to reaction and worked up as described for **11j** (method A). The yield was 1.68 g (88%), brown microprisms, mp 248-250 °C dec (ligroin); ir: 1660 s, 1615 m, 1595 s cm^{-1}; ^1H nmr: δ 2.60 (s, 3-CH_3), 3.70 (s, N-CH_3), 7.05-7.15 (m, 1 ArH), 7.30 (dd, J = 1.5 + 7 Hz, 1 ArH), 7.60 (d, J = 7 Hz, 2 ArH), 7.95 (dd, J = 1.5 + 7 Hz, 2 ArH), 8.50 (dd, J = 1.5 + 7 Hz, 2 ArH).

Anal. Calcd. for $C_{18}H_{14}N_4O_3$: C, 64.67; H, 4.22; N, 16.76. Found: C 64.70; H 3.96; N 16.23.

3-Methyl-1-(4-nitrophenyl)-5-phenyl-1*H*-pyrazolo[4,3-*c*]quinolin-4(5*H*)-one (**11n**).

3-Acetylquinolone 4-nitrophenylhydrazone **6e** (0.50 g, 1.2 mmol) **11d** in glacial acetic acid (15 mL) was brought to reaction and worked up as described for **11j** (method A). The yield was 0.40 g (84 %), brown microprisms, mp 305-307 °C (ligroin); ir: 3060 w, 1685 s, 1610 m, 1600 m cm^{-1}; ^1H nmr: δ 2.60 (s, 3-CH_3), 6.60 (dd, J = 1.5 + 7 Hz, 1 ArH), 7.10 (t, J = 7 Hz, 1 ArH), 7.30-7.50 (m, 4 ArH), 7.60-7.75 (m, 3 ArH), 8.00 (dd, J = 1.5 + 7 Hz, 2 ArH), 8.50 (dd, J = 1.5 + 7 Hz, 2 ArH).

Anal. Calcd. for $C_{23}H_{16}N_4O_3$: C, 69.69; H, 4.07; N, 14.13. Found: C, 69.12; H, 3.90; N, 13.76.

9-Methyl-11-(4-nitrophenyl)-5,6-dihydro-4*H*,11*H*-benzo[*ij*]-pyrazolo[3,4-*b*]quinolizin-8-one (**11o**).

1-Acetylbenzo[*ij*]quinolizinone 4-nitrophenylhydrazone **6f** (2.00 g, 5.3 mmol) in glacial acetic acid (30 mL) was brought to reaction and worked up as described for **11j** (method A). The yield was 1.62 g (85 %), light yellow microprisms, mp 296-298 °C dec. (ligroin); ir: 1655 s, 1600 m cm^{-1}; ^1H nmr: δ 1.95-2.05 (m, CH_2), 2.60 (s, 3-CH_3), 2.95-3.05 (m, Ar-CH_2), 4.10-4.20 (m, N-CH_2), 7.00 (dd, J = 1.5 + 7 Hz, 1 ArH), 7.10 (d, 1 ArH), 7.40 (dd, J = 1.5 + 7 Hz, 1 ArH), 7.95 (dd, J = 1.5 + 7 Hz, 2 ArH), 8.50 (dd, J = 1.5 + 7 Hz, 2 ArH).

Anal. Calcd. for $C_{20}H_{16}N_4O_3$: C, 66.66; H, 4.48; N, 15.55. Found: C, 66.27; H, 4.24; N, 15.01.

1-(3-Chlorophenyl)-3,5-dimethyl-1*H*-pyrazolo[4,3-*c*]quinolin-4(5*H*)-one (**11p**).

3-Acetylquinolone 3-chlorophenylhydrazone **6g** (1.00 g, 2.9 mmol) in glacial acetic acid (15 mL) was brought to reaction and worked up as described for **11j** (method A). The yield was 0.90 g (96 %), colorless microprisms, mp 187-189 °C (ligroin); ir: 3050 m, 2830-2960 w, 1665 s, 1595 m cm^{-1}; ^1H nmr: δ 2.60 (s, 3-CH_3), 3.70 (s, N-CH_3), 7.10-7.20 (m, 2 ArH), 7.60-7.85 (m, 6 ArH).

Anal. Calcd. for $C_{18}H_{14}ClN_3O$: C, 66.77; H, 4.36; N, 12.98. Found: C, 66.38; H, 4.75; N, 12.60.

1-(3-Chlorophenyl)-3-methyl-5-phenyl-1*H*-pyrazolo[4,3-*c*]-quinolin-4(5*H*)-one (**11q**).

3-Acetylquinolone 3-chlorophenylhydrazone **6h** (1.00 g, 2.5 mmol) in glacial acetic acid (15 ml) was brought to reaction and worked up as described for **11j** (method A). The yield was 0.94 g (97 %), colorless microprisms, mp 235-237°C (bromobenzene); ir: 1670 s, 1590 m cm^{-1}; ^1H nmr: δ 2.60 (s, 3-CH_3), 6.60 (dd, J = 1.5 + 7 Hz, 1 ArH), 7.05-7.20 (m, 2 ArH), 7.30-7.45 (m, 3 ArH), 7.60-7.80 (m, 6 ArH), 7.90 (s, 1 ArH).

Anal. Calcd. for $C_{23}H_{16}ClN_3O$: C, 71.60; H, 4.18; N, 10.89. Found: C, 71.69; H, 4.00; N, 10.86.

11-(3-Chlorophenyl)-9-methyl-5,6-dihydro-4*H*,11*H*-benzo[*ij*]-pyrazolo[3,4-*b*]quinolizin-8-one (**11r**).

2-Acetylbenzo[*ij*]quinolizinone 3-chlorophenylhydrazone **6i** (0.89 g, 2.5 mmol) in glacial acetic acid (15 mL) was brought to reaction and worked up as described for **11j** (method A). The yield was 0.89 g (94 %), yellow microprisms, mp 162-164 °C (ligroin). ir: 2800-3100 w, 1655 s, 1595 m cm^{-1}; ^1H nmr: δ 1.95-2.05 (m, CH_2), 3.60 (s, 3-CH_3), 2.90-3.00 (m, Ar-CH_2), 4.10-4.20 (m, N-CH_2), 6.95-7.05 (m, 2 ArH), 7.30-7.40 (m, 1 ArH), 7.55-7.80 (m, 4 ArH).

Anal. Calcd. for $C_{20}H_{16}ClN_3O$: C, 68.67; H, 4.61; N, 12.01. Found: C, 68.80; H, 4.64; N, 11.80.

3-Methyl-1-phenyl-1*H*-pyrazolo[4,3-*c*]quinolin-4(5*H*)-one (**11s**).

3-Acetylquinolone phenylhydrazone **6j** (0.70 g, 2.4 mmol) in glacial acetic acid (15 mL) was brought to reaction and worked up as described for **11j** (method A). The yield was 0.50 g (76 %), yellow microprisms, mp 280-282 °C dec (bromobenzene); ir: 2700-3200 w, 1660 s, 1595 m cm^{-1}; ^1H nmr: δ 2.60 (s, 3-CH_3), 7.00 (d, J = 7 Hz, 2 ArH), 7.35-7.45 (m, 2 ArH), 7.50-7.70 (m, 5 ArH), 11.45 (s, N-H).

Anal. Calcd. for $C_{17}H_{13}N_3O$: C, 74.17; H, 4.76; N, 15.26. Found: C, 73.78; H, 4.38; N, 15.03.

3-Methyl-1-phenyl-1*H*-chromeno[4,3-*c*]pyrazol-4-one (**11t**).

3-Acetylcoumarin phenylhydrazone **6k** (1.00 g, 3.4 mmol) in glacial acetic acid (20 mL) was brought to reaction and worked up as described for **11j** (method A). A further purification was performed by dry-flash-column chromatography (silica gel 60, Merck 1.09385, 0.040-0.063 μm, eluant acetone/chloroform 7:3). The yield was 0.90 g (95 %), yellow microprisms, mp 188-190 °C (acetone/chloroform); ir: 3060-3080 w, 2920 w, 1730 sh, 1620 s, 1595 sh cm^{-1}; ^1H nmr: δ 1.90 (s, CH_3), 6.75-6.85 (m, 2 ArH), 7.10 (dd, J = 1.5 + 7 Hz, 1 ArH), 7.25-7.35 (m, 3 Aryl-H), 7.55-7.65 (m, 1 ArH), 8.00 (dd, J = 1.5 + 7Hz, 2 ArH).

Anal. Calcd. for $C_{17}H_{12}N_2O_2$: C, 73.90; H, 4.38; N, 10.14. Found: C, 73.52; H, 4.75; N, 9.94.

1-(4-Nitrophenyl)-5-phenyl-1*H*-pyrazolo[4,3-*c*]quinolin-4(5*H*)-one (**11u**).

Quinoline-3-carbaldehyde 4-nitrophenylhydrazone **14d** (0.80 g, 1.9 mmol) in glacial acetic acid (15 mL) was brought to reaction and worked up as described for **11j** (method A). The yield was 0.55 g (76 %), brown microprisms, mp 266-68 °C dec (ligroin).

Method B: A suspension of quinoline-3-carbaldehyde 4-nitrophenylhydrazone **14d** (0.80 g, 1.9 mmol) in diphenylether (15 mL) was heated under reflux for 2 hours. After cooling to 20 °C the resulting precipitate was filtered and washed with cyclohexane. The yield was 0.61 g (84 %), brown microprisms, mp 267 °C dec (ligroin); ir: 3000-3120 w, 1660 s, 1595 m cm^{-1}; ^1H nmr: δ 6.60 (dd, J = 1.5 + 7 Hz, 1 ArH), 7.10 (t, J = 7 Hz, 1 ArH), 7.25-7.50 (m, 5 ArH), 7.50-7.80 (m, 3 ArH), 8.05 (dd, J = 1.5 + 7 Hz, 2 ArH), 8.55 (dd, J = 1.5 + 7 Hz, 2 ArH).

Anal. Calcd. for $C_{22}H_{14}N_4O_3$: C, 69.11; H, 3.69; N, 14.65. Found: C, 69.50; H, 3.51; N 14.28.

3-Phenylaminomethylene-quinoline-2,4(1*H*,3*H*)-diones (**12a-d**) and 4-Chloro-2-oxo-1,2-dihydro-quinoline-3-carbaldehydes (**13a-d**).

These compounds were obtained according to ref. [12].

4-Chloro-1-methyl-3-(phenylhydrazono)methyl-quinolin-2(1*H*)-one (**14a**).

A suspension of quinoline-3-carbaldehyde **13a** (1.00 g, 4.5 mmol) and 85% phenylhydrazine (**5a**) (0.54 g, 5.0 mmol) in 1-butanol (15 mL) was heated under reflux for 90 minutes. Then the mixture was cooled to room temperature and the yellow precipitate collected by suction filtration, washed with a small amount of cold acetone and dried *in vacuo* at 40 °C. The yield was 1.18 g (84%), yellow microprisms, mp 211 °C (toluene); ir: 3240 m, 1630 s, 1600 s, 1570 s, 1530 w cm^{-1}; ^1H nmr: δ 3.70 (s, N-CH_3), 6.70-7.75 (m, 8 Aryl-H), 8.15 (dd, J = 1.5 + 7 Hz, 5-H), 8.25 (s, CH=N), 10.85 (s, N-H).

Anal. Calcd. for $C_{17}H_{14}ClN_3O$: C, 65.49; H, 4.53; N, 13.48. Found: C, 65.62; H, 4.70; N, 13.26.

4-Chloro-1-phenyl-3-(phenylhydrazono)methyl-quinolin-2(1*H*)-one (**14b**).

Quinoline-3-carbaldehyde **13b** (1.00 g, 3.5 mmol) and 85% phenylhydrazine (**5a**) (0.46 g, 4.2 mmol) in 1-butanol (15 mL) were brought to reaction and worked up as described for **14a**. The yield was 0.81 g (62 %), yellow microprisms, mp 209 °C (toluene); ir: 3260 m, 1635 s, 1600 s cm^{-1}; ^1H nmr: δ 6.50 (dd, J

= 1.5 + 7 Hz, 1 ArH), 6.80 (t, J = 7 Hz, 1 ArH), 7.10 (dd, J = 1.5 + 7 Hz, 1 ArH), 7.20-7.50 (m, 10 ArH), 8.15-8.25 (m, 1 ArH, CH=N), 10.90 (s, NH).

Anal. Calcd. for $C_{22}H_{16}ClN_3O$: C, 70.68; H, 4.31; N, 11.24. Found: C, 71.05; H, 4.39; N, 11.09.

1-Chloro-2-(phenylhydrazono)methyl-6,7-dihydro-5*H*-benzo[*ij*]quinolizin-3-one (**14c**).

A solution of benzo[*ij*]quinolizine-2-carbaldehyde **13c** (0.50 g, 2.0 mmol) and 85% phenylhydrazine (**5a**) (0.26 g, 2.4 mmol) in dimethylformamide (10 mL) was stirred for 5 hours at room temperature. Then the reaction mixture was poured into ice/water (200 mL) and stirred until cystallization took place. The precipitate was collected by suction filtration and washed with water. The yield was 0.60 g (89 %), yellow microprisms, mp 215 °C dec (toluene); calorimetric data for thermolysis: cyclization at 173.0 °C onset, 188.3 °C maximum, ΔH = - 46 mcal/mg; ir: 3260 m, 1620 s, 1600s, 1585 s cm^{-1}; ^1H nmr: δ 1.95-2.05 (m, CH_2), 2.95-3.05 (m, Ar-CH_2), 4.10 (t, J = 7 Hz, N-CH_2), 6.65-6.75 (m, 1 ArH), 7.10-7.60 (m, 6 ArH), 7.95-8.05 (m, 1 ArH), 8.30 (s, N=CH), 10.90 (s, N-H).

Anal. Calcd. for $C_{19}H_{16}ClN_3O$: C, 67.56; H, 4.77; N, 12.44 Found: C, 67.17; H, 4.80; N, 12.08.

4-Chloro-3-(4-nitrophenylhydrazono)methyl-1-phenylquinolin-2(1*H*)-one (**14d**).

Quinoline-3-carbaldehyde **13b** (2.00 g, 7.0 mmol) and 4-nitrophenylhydrazine (**5b**) (1.30 g, 8.5 mmol) in 1-butanol (25 mL) were brought to reaction as described for **14a**. After cooling a precipitate was formed, which was washed with a small amount of ethanol and dried *in vacuo* at 40 °C. The yield was 2.68 g (91 %), brown microprisms, mp 277-279 °C dec (bromobenzene); calorimetric data for thermolysis: cyclization at 260.9 °C onset, 268.5 °C maximum, ΔH = -81 mcal/mg; ir: 3240 m, 1630 s, 1600 s cm^{-1}; ^1H nmr: δ 6.60 (dd, J = 1.5 + 7 Hz, 1 ArH), 7.20 (dd, J = 1.5 + 7 Hz, 2 ArH), 7.35-7.80 (m, 8 ArH), 8.20 (dd, J = 1.5 + 7 Hz, 2 ArH), 8.40 (s, N=CH), 11.70 (s, N-H).

Anal. Calcd. for $C_{22}H_{15}ClN_4O_3$: C, 63.09; H, 3.61; N, 13.38. Found: C, 63.16; H, 3.46; N, 13.06.

4-Chloro-3-(phenylhydrazono)methylquinolin-2(1*H*)-one (**14e**).

Quinoline-3-carbaldehyde **13d** (1.00 g, 4.8 mmol) and 85% phenylhydrazine (**5a**) (0.60 g, 5.5 mmol) in dimethylformamide (10 mL) were brought to reaction and worked up as described for **14c**. The yield was 1.31 g (92%), yellow prisms, mp 232 °C dec (dioxane); ir: 3285 w, 2860 m, 1660 s, 1600 m, 1570 m cm^{-1}; ^1H nmr: δ 6.70-6.80 (m, 1 ArH), 7.20-7.45 (m, 6 ArH), 7.60 (dd, J = 1.5 + 7 Hz, 1 ArH), 8.05 (dd, J = 1.5 + 7 Hz, 5-H), 8.25 (s, N=CH), 10.80 (s, NH), 12.15 (s, 1-NH).

Anal. Calcd. for $C_{16}H_{12}ClN_3O$**:** C, 64.54; H, 4.06; N, 14.11. Found: C, 64.89; H, 4.15; N, 13.72.

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