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Dedicated to Professor Thomas Kappe on the occasion of his 65th birthday

4-Azido-2-oxoquinoline-3-carboxylates and 4-azidocoumarin-3-carboxylates **6**, which were obtained from the corresponding 4-hydroxy derivatives **1** via 4-tosylates **2** or 4-chloro compounds **4**, cyclized upon thermolysis to 3-alkoxyisoxazolo[4,3-*c*]quinolin-4(5*H*)-ones or the corresponding coumarins **8**, whereas at slightly higher temperatures a 3-*O*, 4-*O*-rearrangement took place to give the 4-alkoxy-isoxazolo[4,3-*c*]quinolin-3-ones and the corresponding coumarins **9**. The necessary reaction conditions could be obtained easily with the help of differential scanning calorimetry.

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Organic azides with reactive *ortho* substituents are known to cyclize easily to heterocyclic compounds [2]. Recently we studied successfully the thermal decomposition of 4-azidoquinolones with 3-formyl and 3-acyl substituents and obtained by an electrocyclic process the corresponding isoxazolo[4,3-*c*]quinolines [3]. The use of an ester group as the reactive *ortho* substituent in position 3 of 4-azidoquinolines should lead to isoxazoles having a functional group for further transformations. Additionally we planned also to synthesize the corresponding coumarin derivatives.

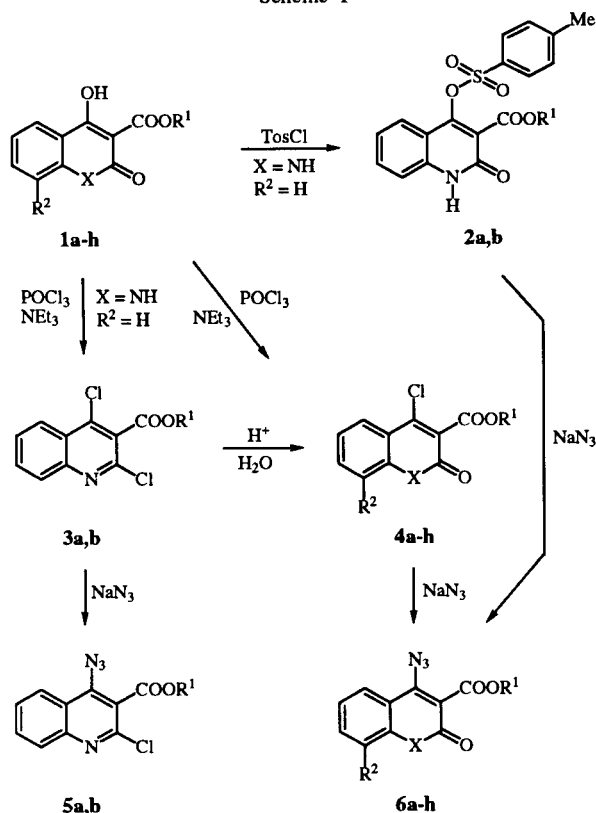
The reaction sequence to 4-azidoquinoline-3-carboxylates and 4-azidocoumarin-3-carboxylates **6** started with the corresponding 4-hydroxy-2-oxoquinoline-3-carboxylates **1**, which were synthesized by improved known procedures. *N*-Unsubstituted 4-hydroxy-2-oxoquinoline-3-carboxylates **1a,b** are described in the literature to be obtained from methyl anthranilate by reaction with dimethyl or diethyl malonate [4-6]. According to reference [4] methyl anthranilate and diethyl malonate in a sealed tube is reported to give methyl 4-hydroxy-2-oxoquinoline-3-carboxylate. The reported melting point, however, corresponds to the ethyl ester. In literature [5] a rather complicated procedure is used, and in literature [6] no exact reaction conditions are described. Therefore we synthesized **1a,b** using our own procedure from the sodium salt of the corresponding dialkyl malonate and methyl anthranilate. The alcohol formed in this reaction was allowed to distill and the solid reaction product heated for a number of hours. To obtain *N*-methyl-4-hydroxy-2-oxoquinoline-3-carboxylates **1c,d**, a known procedure [7] was used starting from *N*-methyl isatoic anhydride and dimethyl or diethylmalonate. Since the availability of *N*-substituted isatoic anhydrides or *N*-substituted anthranilates limited these methods, another method was used to prepare the methylene bridged quinoline derivatives, 1-hydroxy-3-oxo-6,7-dihydrobenzo[*ij*]quinolizinecarboxylates **1e,f**. We reacted 1,2,3,4-tetrahydroquinoline with methanetricarboxylates [9,10] as described for similar reactions in ref

[8]. To avoid byproducts such as di- or triamides of methanetricarboxylic acid, a 1:2 ratio of 1,2,3,4-tetrahydroquinoline:methanetricarboxylate had to be used. Diphenylamine was also reacted with methanetricarboxylates but the yields and the purity of the carboxylates obtained were not sufficient. 4-Hydroxycoumarin-3-carboxylates **1g,h** were prepared from acetylsalicyloyl chloride and dialkyl malonates using a modified literature procedure [11].

As the next step, hydroxy compounds **1** were reacted with phosphoryl chloride to yield either the dichloroquinolines **3** from *N*-unsubstituted quinolones **1a,b**, or 4-chloro compounds **4c-h** from *N*-substituted quinolones and coumarins. All chlorinations were performed at 60-80° in the presence of triethylamine to prevent slow and incomplete reactions caused by hydrogen bonding between the hydroxy group and the ether carbonyl group. Under these reaction conditions no hydrolysis of the esters to carboxylic acids was observed. To obtain the *N*-unsubstituted 4-chloroquinolones **4a,b**, the 2,4-dichloroquinolines **3** were hydrolyzed with 98% methanesulfonic acid in water-ethanol solution. However, the products obtained were rather impure and the purification of **4a,b** was cumbersome. This caused us to synthesize other reactive intermediates, the tosylates **2**, which were prepared from the hydroxy compounds **1a,b** by reaction with toluenesulfonylchloride and *N,N*-dimethylaminopyridine as catalyst. The tosylates **2** were primarily obtained as oils and had to be separated from some byproducts by repeated kinetic controlled crystallization. For synthetic purposes only, the crude solid products could be used, because purification could be done easier after the next preparation step.

The introduction of the azido group into the chloro and tosyloxy compounds **2**, **3** and **4** was performed by nucleophilic exchange of the chlorine or tosylate with sodium azide. To react the dichloroquinolines **3** with sodium azide, a 1:1 molar ratio of **3** and sodium azide in dimethylformamide was heated to 80° to give 4-azido-2-chloroquinoline-3-carboxylates **5** after 20 hours reaction time. A

Scheme 1



R-Key: see Table 1,2

higher reaction temperature - in order to shorten the reaction time - was not possible. The thermoanalytical data of **5** indicated an exothermic reaction starting at about 130-140°, but already at about 100-110° decomposition could be observed at longer reaction times. The chloro group in position 2 of the quinoline nucleus was not exchanged by the azido group under these conditions as we had shown recently [12]. The tosylates **2** and the chloroquinolines **4a-f** were reacted with excess sodium azide at 80° in dimethylformamide with a short reaction time of 45-60 minutes to yield 4-azido-2-oxoquinoline-3-carboxylates **6a-f**. 4-Chlorocoumarin-3-carboxylates **4g,h** were reacted in acetonitrile instead of dimethylformamide to give 4-azidocoumarin-3-carboxylates **6f,g** because otherwise only small yields were obtained caused by the high solubility of **6f,g** in water during the workup. In the case of **4g**, however, the isolated product **6g** was shown to be a complex with acetonitrile with a mp of 96-99°, which had to be dried for an extended period of time at 50° to destroy the complex.

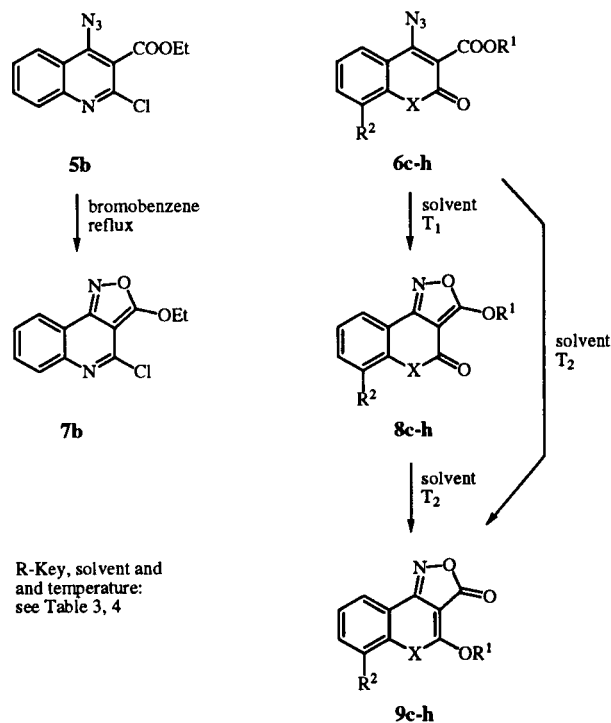
Thermolysis of the 4-azido-2-chloroquinoline-3-carboxylates **5** were performed in high boiling solvents such as bromobenzene or 1,2-dichlorobenzene similar to the reactions of 3-acylquinolines [3] to give isoxazoles *via* an electrocyclic ring closure reaction by decomposition of the azido moiety. This thermal cyclization was successful with

5b, which gave in boiling bromobenzene in good yields 4-chloro-3-ethoxyisoxazolo[4,3-*c*]quinoline (**7b**). The methoxy derivative **7a** could not be obtained in pure form from **5a**, because of the easy decomposition of this compound, which is also visible by differential scanning calorimetry, which shows that after the cyclization immediately a decomposition area follows.

When we did our first cyclization experiments with the azidoquinolines and azidocoumarins **6**, we were unsuccessful because in all cases we obtained two compounds besides some colored byproducts. Only after we had the opportunity to investigate the thermal behavior of compounds **6** by differential scanning calorimetry, we were able to find the correct temperature for the cyclization reaction. When we carried out the thermolysis reactions exactly at these temperatures, we obtained the 3-alkoxy-isoxazolo compounds **8c-h**. The *N*-unsubstituted quinolones **6a,b** also gave useful calorimetric diagrams, but we were not able to isolate pure, stable products of **8a,b**.

The differential scanning calorimetry diagrams of **6c-h**, however, gave additional information (besides the starting temperature of the decomposition of the azido group) as shown as example in Figure 1 (diagram of **6h**): After the exothermic signal of the ring closure reaction to **8** (T_1) in most cases a second exothermic reaction (T_2) is visible at slightly higher temperatures. We were able to carry out this reaction on a preparative scale either by thermolysis of **6c-h** at slightly higher temperatures than the cyclization (as shown by the calorimetric diagrams of **6**), or by

Scheme 2



R-Key, solvent and temperature: see Table 3, 4

thermolysis of **8c-h** at the temperatures shown in the calorimetric diagrams of the alkoxyisoxazoles **8**.

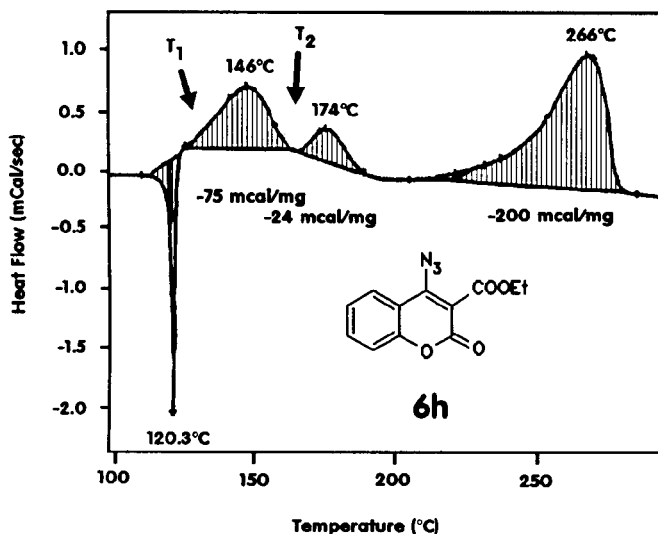


Figure 1. Differential scanning calorimetry plot of **6h**.

In the methyl series, **6c, e, g** the two reaction signals were not well separated, but extrapolation from the ethyl series, **6d, f, h** allowed us to find suitable reaction temperatures. In the thermolysis of **6g** to **8g** and **9g**, however, the difficulty was that the cyclization temperature (T_1) of **6g** to **8g**, diagram of **6g**, is shown to start at 105°, whereas the rearrangement temperature (T_2) from **8g** to **9g**, diagram of **8g**, is lower than the cyclization and starts already at 95°.

In this manner we obtained new products **9c-h**, which gave the same microanalytical data as the precursors **8c-h**. The nmr spectroscopic data of **9c-h** showed only small differences to the precursors **8c-h**, mainly with shifts of about -0.5 ppm for the 3-methoxy or 3-ethoxy group. In the ir spectra of **9c-h** a new carbonyl signal was visible at 1760-1790 cm^{-1} which indicated that a new carbonyl group has been formed in this molecule. From these data the structures of **9** were assigned to isomer 4-alkoxyisoxazolo-4,3-*c*quinolin-3-ones or [1]benzopyran-3-ones, having a 5-ring lactone carbonyl signal in the ir spectra instead of the lactam carbonyl signal at 1665-1680 cm^{-1} caused by migration of the alkyl group from the 3-oxy-substituent at the isoxazole nucleus to the oxo group of the quinoline or the coumarin nucleus. Additionally, the ^{13}C nmr spectra proved this structure, shown by comparison of C-3 and C-5 in the ethoxyisoxazole **8d** having 157 and 172 ppm, whereas C-3 and C-5 in the isoxazolonone **9d** show 164 and 160 ppm. The mechanism for the formation of **9** from **8** is assumed to involve a thermally allowed suprafacial [1,5]-sigmatropic rearrangement resulting in a 10/50-alkyl migration [13].

In the reaction to the isoxazolones **9** it is necessary to take care of the facile decomposition of these compounds. As can be seen from the calorimetric diagrams, decomposition takes place in some cases only 30° above the rearrangement temperature, especially in the ethyl series. In the methyl series the distance to the decomposition temperature is larger, however with the disadvantage above described, that ring closure and rearrangement temperatures are very similar. Here again the calorimetric plots are very helpful. So it is not easy to obtain pure products from **6f** or **8f**, because immediately after the rearrangement to **9f** decomposition took place. Figure 2, which contains the calorimetry diagrams of all three compounds, shows this fact clearly, and also the rather similar cyclization (T_1) and rearrangement temperature (T_2), which allowed us to obtain **9f** without decomposition.

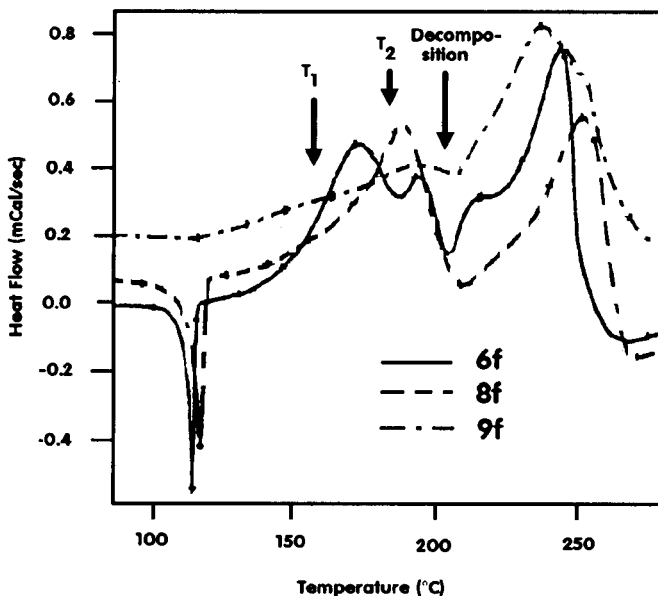


Figure 2. Differential scanning calorimetry plot of **6f**, **8f** and **9f**.

These findings show that only the help of differential scanning calorimetry diagrams gave us the tools to control the reaction conditions in such a manner, that either the primarily formed alkoxyisoxazoles **8** or the rearranged isoxazolones **9** could be obtained, although the differences between ringclosure (T_1) and rearrangement temperature (T_2) range between 10-30°, a difference, which is too small to get useful preparative results by a random choice of the reaction temperature.

EXPERIMENTAL

Melting points were determined on a Gallenkamp Melting Point Apparatus, Model MFB-595 in open capillary tubes. Calorimetric data were obtained on a Rheometric Scientific

Table 1

Experimental, Analytical and Spectroscopic Data of 4-Chloro-2-oxo-1,2-dihydroquinoline-3-carboxylates **4a-d**, 1-Chloro-3-oxo-6,7-dihydro-3*H*,5*H*-benzo[*i,j*]quinolizine-2-carboxylates **4e,f** and 4-Chloro-2-oxo-2*H*-[1]benzopyrane-3-carboxylates **4g,h**

No.	R ¹ R ² X	yield (%) mp (°C) Recrystallization Solvent	Molecular Formula Molecular Mass Appearance	Analysis, %			IR [cm ⁻¹] ¹ H NMR (δ ppm)
				C	H	N	
4a	Me	68	C ₁₁ H ₈ ClNO ₃	55.60	3.39	5.89	3300-2600 w, 1745 m, 1650 s, 1600 m
	H	215 dec	(237.64)	55.41	3.37	5.98	3.95 (t, J = 7 Hz, CH ₃), 7.30-7.50 (m, 2 Ar-H), 7.75 (t, J = 7 Hz, 1 Ar-H), 7.95 (dd, J = 7 + 1.5 Hz, H at C-5), 12.50 (s, NH)
	NH	methanol	light yellow prisms				
4b	Et	74	C ₁₂ H ₁₀ ClNO ₃	57.27	4.01	5.57	3300-2600 m, br, 1745 m, 1650 s, 1600 m
	H	200 dec	251.67	57.60	3.88	5.49	1.30 (t, J = 7 Hz, CH ₃), 4.40 (q, J = 7 Hz, CH ₂), 7.35-7.50 (m, 2 Ar-H), 7.75 (t, J = 7 Hz, 1 Ar-H), 7.95 (dd, J = 7 + 1.5 Hz, H at C-5), 12.50 (s, NH)
	NH	methanol	light yellow prisms				
4c	Me	93	C ₁₂ H ₁₀ ClNO ₃	57.27	4.01	5.57	2950 w, 1740 s, 1640 s, 1615 m, 1590 m
	H	106-107.5	251.67	57.18	3.92	5.50	3.70 (s, N-CH ₃), 3.95 (s, O-CH ₃), 7.45 (t, J = 7 Hz, 1 Ar-H), 7.70 (dd, J = 7 + 1.5 Hz, H at C-8), 7.85 (t, J = 7 Hz, 1 Ar-H), 8.00 (dd, J = 7 + 1.5 Hz, H at C-5)
	N-Me	ligroin	light brown prisms				
4d	Et	89	C ₁₃ H ₁₂ ClNO ₃	58.77	4.55	5.27	2990 w, 1740 s, 1640 s, 1615 m, 1590 m
	H	91.5-92.5	265.70	58.45	4.54	5.26	1.35 (t, J = 7 Hz, ethyl-CH ₃), 3.65 (s, N-CH ₃), 4.40 (q, J = 7 Hz, CH ₂), 7.40 (t, J = 7 Hz, 1 Ar-H), 7.65 (dd, J = 7 + 1.5 Hz, H at C-8), 7.80 (t, J = 7 Hz, 1 Ar-H), 7.95 (dd, J = 7 + 1.5 Hz, H at C-5)
	N-Me	ligroin	light brown microprisms				
4e	Me	92	C ₁₄ H ₁₂ ClNO ₃	60.55	4.36	5.04	2950 w, 1735 m, 1640 s, 1580 m
	-(CH ₂) ₃ -	137.5-142	277.71	60.18	4.19	4.68	1.90-2.15 (m, 6-CH ₂), 3.00 (t, J = 7 Hz, 7-CH ₂), 3.90 (s, CH ₃), 4.10 (t, J = 7 Hz, 5-CH ₂), 7.30 (t, J = 7 Hz, H at C-9), 7.55 (dd, J = 7 + 1.5 Hz, H at C-8), 7.85 (dd, J = 7 + 1.5 Hz, H at C-10)
	-N	methanol	light brown microprisms				
4f	Et	90	C ₁₅ H ₁₄ ClNO ₃	61.76	4.84	4.80	3000-2860 w, 1735 s, 1630 s, 1585 m
	-(CH ₂) ₃ -	125.5-127	291.74	61.84	4.73	4.58	1.35 (t, J = 7 Hz, CH ₃), 1.95-2.10 (m, 6-CH ₂), 2.95 (t, J = 7 Hz, 7-CH ₂), 4.05 (t, J = 7 Hz, 5-CH ₂), 4.40 (q, J = 7 Hz, ethyl-CH ₂), 7.35 (t, J = 7 Hz, H at C-9), 7.55 (dd, J = 7 + 1.5 Hz, H at C-8), 7.85 (dd, J = 7 + 1.5 Hz, H at C-10)
	-N	ethanol	light yellow prisms				
4g	Me	89	C ₁₁ H ₇ ClO ₄	55.37	2.96		2950 w, 1725 s, br, 1610 m, 1570 m
	H	83.5	238.63	55.08	2.86		3.95 (s, CH ₃), 7.50-7.60 (m, 2 Ar-H), 7.85 (t, J = 7 Hz, 1 Ar-H), 8.00 (dd, J = 7 + 1.5 Hz, H at C-5)
	O	ligroin	colorless needles				
4h	Et	94	C ₁₂ H ₉ ClO ₄	57.05	3.59		2990 w, 1745 s, 1725 s, 1610 m, 1605 m, 1570 m
	H	79.5-80	252.7	57.01	3.41		1.35 (t, J = 7 Hz, CH ₃), 4.45 (q, J = 7 Hz, CH ₂), 7.50-7.60 (m, 2 Ar-H), 7.85 (t, J = 7 Hz, 1 Ar-H), 8.00 (dd, J = 7 + 1.5 Hz, H at C-5)
	O	ligroin	colorless prisms				

Table 2

Experimental, Analytical and Spectroscopic Data of 4-Azido-2-oxo-1,2-dihydroquinoline-3-carboxylates (**6a-d**), 1-Azido-3-oxo-6,7-dihydro-3*H*,5*H*-benzo[*i,j*]quinolizine-2-carboxylates (**6e,f**) and 4-Azido-2-oxo-2*H*-[1]benzopyrane-3-carboxylates (**6g,h**)

No.	R ¹ R ² X	yield (%) mp (°C) Recrystallization Solvent	Molecular Formula Molecular Mass Appearance	Analysis, %			IR [cm ⁻¹] ¹ H NMR (δ ppm)	Calorimetric Data: start (°C)/peak max (°C) (ΔH, kcal/mg)
				C	H	N		
6a	Me	80 (A)	C ₁₁ H ₈ N ₄ O ₃	54.10	3.30	22.94	3200-2600 w, 2130 m (N ₃), 1720 m, 1715 m, 1640 s, 1600 m	reaction 175/191 (-137), dec 205/226° (-50)
	H	72 (B)	244.2	54.21	3.09	22.36	3.90 (s, CH ₃), 7.20-7.40 (m, 2 Ar-H), 7.65 (t, J = 7 Hz, 1 Ar-H), 7.85 (dd, J = 7 + 1.5 Hz, H at C-5), 12.20 (s, NH)	
	NH	184.5 dec methanol	pink platelets				[a]	
6b	Et	69 (A)	C ₁₂ H ₁₀ N ₄ O ₃	55.81	3.90	21.70	3060-2600 w, 2150 m (N ₃), 1715 m, 1710 w, 1670 s, 1600 m	reaction 160/177 (-95), dec 203/228 (-30)
	H	81 (B)	258.3	55.93	3.77	21.57	1.35 (t, J = 7 Hz, CH ₃), 4.35 (q, J = 7 Hz, CH ₂), 7.20-7.40 (m, 2 Ar-H), 7.70 (t, J = 7 + 1.5 Hz, 1 Ar-H), 7.85 (dd, J = 7 + 1.5 Hz, H at C-5), 12.15 (s, NH)	
	NH	159.6 dec ligroin	colorless microprisms					

Table 2 (continued)

No.	R ¹ R ² X	yield (%) mp (°C) Recrystallization Solvent	Molecular Formula Molecular Mass Appearance	Analysis, %			IR [cm ⁻¹] ¹ H NMR (δ ppm)	Calorimetric Data: start (°C)/peak max (°C) (ΔH, kcal/mg)
				C	H	N		
6c	Me H N-Me	82 (A) 110-111 cyclohexane	C ₁₂ H ₁₀ N ₄ O ₃ 258.24 light brown prisms	55.81 55.87	3.90 3.75	21.70 21.43	3080 w, 2940 w, 2130 s (N ₃), 1735 m, 1630 s, 1615 m, 1590 m, 1500 w 3.60 (s, N-CH ₃), 3.90 (s, O-CH ₃), 7.25-7.40 (2 dd, J = 7 + 1.5 Hz, 1 Ar-H), 7.55 (dd, J = 7 + 1.5 Hz, H at C-8), 7.70-7.80 (2 dd, J = 7 + 1.5 Hz, 1 Ar-H), 7.90 (dd, J = 7 + 1.5 Hz, H at C-5)	mp 113.1, cyclization 145/171, rearrangement 176 (-215), dec 230/265 (-159)
6d	Et H N-Me	77 (A) 94-95 cyclo- hexane	C ₁₃ H ₁₂ N ₄ O ₃ 272.26 light yellow microprisms	57.35 57.55	4.44 4.48	20.58 20.25	2995 w, 2120 s (N ₃), 1730 s, 1715 m, 1645 s, 1620 m, 1595 m, 1570 m, 1500 m 1.35 (t, J = 7 Hz, ethyl-CH ₃), 3.65 (s, N-CH ₃), 4.35 (q, J = 7 Hz, CH ₂), 7.30-7.40 (2 dd, J = 7 + 1.5 Hz, 1 Ar-H), 7.60 (dd, J = 7 + 1.5 Hz, H at C-8), 7.70-7.80 (2 dd, J = 7 + 1.5 Hz, 1 Ar-H), 7.95 (dd, J = 7 + 1.5 Hz, H at C-5)	mp 99.3, cyclization 143/188, rearrangement 196/226 (-200) mp 251, dec 225/259 (-137)
6e	Me -(CH ₂) ₃ - -N	79 (A) 103-104 ligroin	C ₁₄ H ₁₂ N ₄ O ₃ 284.27 yellow platelets	59.15 59.04	4.25 4.15	19.71 19.19 [a]	2960 w, 2130 m (N ₃), 1735 m, 1620 s, 1590 m 1.90-2.10 (m, 6-CH ₂), 2.95 (t, J = 7 Hz, 7-CH ₂), 3.90 (s, CH ₃), 4.05 (t, J = 7 Hz, 5-CH ₂), 7.15- 7.30 (2 dd, J = 7 + 1.5 Hz, H at C-9), 7.50 (dd, J = 7 + 1.5 Hz, H at C-8), 7.75 (dd, J = 7 + 1.5 Hz, H at C-10)	mp 106.8, cyclization 142/176, rearrangement 177/179 (-183), dec 240/264 (-137)
6f	Et -(CH ₂) ₃ - -N	92 (A) 112.5-113 cyclohexane	C ₁₅ H ₁₄ N ₄ O ₃ 298.30 light yellow microprisms	60.40 60.66	4.73 4.87	18.78 17.81 [a]	3000-2840 w, 2120 m (N ₃), 1715 m, 1625 s, 1590 m 1.35 (t, J = 7 Hz, CH ₃), 1.90-2.15 (m, 6-CH ₂), 2.95 (t, J = 7 Hz, 7-CH ₂), 4.05 (t, J = 7 Hz, 5-CH ₂), 4.35 (q, J = 7 Hz, ethyl-CH ₂), 7.15-7.25 (2 dd, J = 7 + 1.5 Hz, H at C-9), 7.50 (dd, J = 7 + 1.5 Hz, H at C-8), 7.75 (dd, J = 7 + 1.5 Hz, H at C-10).	mp 113.7, cyclization 141/171, rearrangement 180/192 (-145), dec 210/251 (-153)
6g	Me H O	88 (A) 83-87 cyclohexane	C ₁₁ H ₇ N ₃ O ₄ 245.19 orange brown prisms	53.89 54.39	2.88 2.98	17.14 16.53 [a]	2140 w, 2120 m (N ₃), 1740 s, 1705 s, 1605 m, 1560 m 3.90 (s, CH ₃), 7.40-7.55 (m, 2 Ar-H), 7.70-7.85 (2 dd, J = 7 + 1.5 Hz, 1 Ar-H), 7.90 (dd, J = 7 + 1.5 Hz, H at C-5)	mp 86.0, cyclization 105/143, rearrangement 146/150 (-209) dec 220/252 (-178)
6h	Et H O	87 (A) 116.8-118 cyclohexane	C ₁₂ H ₉ N ₃ O ₄ 259.22 orange brown prisms	55.60 55.92	3.50 3.57	16.21 16.02	2990 w, 2920 w, 2125 m (N ₃), 1730 s, 1710 s, 1605 m, 1565 m 1.35 (t, J = 7 Hz, CH ₃), 4.35 (q, J = 7 Hz, CH ₂), 7.40-7.50 (m, J = 7 + 1.5 Hz, 2 Ar-H), 7.70-7.85 (2 dd, J = 7 + 1.5 Hz, 1 Ar-H), 7.90 (dd, J = 7 + 1.5 Hz, H at C-5)	mp 120.3, cyclization 126/146 (-75), rearrangement 166/174 (-24), dec 210/266 (-200)

[a] A correct elemental analysis could not be obtained because of easy decomposition of the azido compound.

DSC-Plus instrument with the differential scanning calorimetry software V5.42. The differential scanning calorimetry plots were recorded between 25-500°, with a heating rate of 2-10°/minute, and 1.5-3 mg compound in sealed aluminium crucibles (11 bar). Infrared spectra were taken on a Perkin-Elmer 298 spectrophotometer or a Galaxy Series FTIR 7000 in potassium bromide pellets. The ¹H nmr spectra were recorded on a Varian Gemini 200 (200 MHz) or a Bruker AM 360 instrument (360 MHz). The ¹³C nmr spectra were recorded on a Bruker AM 360 instrument (90 MHz). The solvent for nmr

spectra was deuteriodimethyl sulfoxide unless otherwise stated. Chemical shifts are reported in ppm from internal tetramethylsilane standard and are given in δ-units. Elemental analyses were performed on a Fisons elemental analyzer, Mod. EA 1108 and are within ±0.4 of the theoretical percentages. All reactions were monitored by thin layer chromatography carried out on 0.2 mm silica gel F-254 (Merck) plates using uv light (254 and 366 nm) for detection. Common reagent-grade chemicals are either commercially available and were used without further purification or prepared by standard literature procedures.

Table 3

Experimental, Analytical and Spectroscopic Data of 3-Alkoxy-isoxazolo[4,3-c]quinolin-4(5*H*)-ones (**8c,d**), 3-Alkoxy-7,8-dihydro-6*H*-isoxazolo[3,4-*b*]benzo[*i,j*]quinolizin-4-ones (**8e,f**) and 3-Alkoxy-isoxazolo[4,3-*c*][1]benzopyran-4-ones (**8g,h**)

No.	R ¹ R ² X	yield (%) mp (°C) Recrystallization Solvent Reaction time Reaction solvent (T ₁ = reflux)	Molecular Formula Molecular Mass Appearance	Analysis, %			IR [cm ⁻¹] ¹ H NMR (δ ppm)	Calorimetric Data: start (°C)/peak max (°C) (Δ <i>H</i> , kcal/mol)
				C	H	N		
8c	Me	71	C ₁₂ H ₁₀ N ₂ O ₃	62.61	4.38	12.17	1665 s, 1635 s, 1610 s	rearrangement 150/183 (-61), dec 240/270 (-155)
	H	260-263 dec	230.21	62.63	4.21	11.88	3.50 (s, N-CH ₃), 4.40 (s, O-CH ₃), 7.35 (t, J = 7 Hz, 1 Ar-H), 7.50 (d, J = 7 Hz, H at C-6), 7.70 (t, J = 7 Hz, 1 Ar-H), 8.00 (dd, J = 7 + 1.5 Hz, H at C-9)	
	N-Me	methanol 30 minutes PhBr	light yellow needles					
8d	Et	81	C ₁₃ H ₁₂ N ₂ O ₃	63.93	4.95	11.47	1665 s, 1630 m, 1610 m	mp 159.4, rearrangement 165/195/200 (-76), dec 210/231 (-108)
	H	151.5-153.5	244.25	63.65	4.90	11.38	1.50 (t, J = 7 Hz, ethyl-CH ₃), 3.50 (s, N-CH ₃), 4.85 (q, J = 7 Hz, CH ₂), 7.30 (2 t, J = 7 Hz, 1 Ar-H), 7.50 (dd, J = 7 + 1.5 Hz, H at C-6), 7.70 (t, J = 7 Hz, 1 Ar-H), 8.00 (dd, J = 7 + 1.5 Hz, H at C-9)	
	N-Me	methanol 30 minutes 1,2-dichloro- benzene	yellow brown prisms					
8e	Me	58	C ₁₄ H ₁₂ N ₂ O ₃	65.62	4.72	10.93	3000 w, 2930 w, 1675 m, 1630 s, 1605 m	rearrangement 150/177 (-54), dec 240/264 (-137)
	-(CH ₂) ₃ -	264-267 dec	256.26	65.40	4.57	10.73	1.90-2.05 (m, 7-CH ₂), 2.90 (t, J = 7 Hz, 8-CH ₂), 4.00 (t, J = 7 Hz, 6-CH ₂), 4.40 (s, OCH ₃), 7.20 (t, J = 7 Hz, H at C-10), 7.45 (d, J = 7 Hz, H at C-9), 7.80 (d, J = 7 Hz, H at C-11)	
	-N	methanol 30 minutes PhBr	light yellow microprisms					
8f	Et	49	C ₁₅ H ₁₄ N ₂ O ₃	66.66	5.22	10.36	2940 w, 2870 w, 1760 w, 1660 s, 1630 s, 1610 s, 1585 m	mp 115.0, rearrangement 138/185 (-59), dec 205/241 (-105)
	-(CH ₂) ₃ -	110-113.6	270.29	66.59	5.17	10.36	1.45 (t, J = 7 Hz, CH ₃), 1.85-2.05 (m, 7-CH ₂), 2.90 (t, J = 7 Hz, 8-CH ₂), 3.95 (t, J = 7 Hz, 6-CH ₂), 4.80 (q, J = 7 Hz, ethyl-CH ₂), 7.20 (t, J = 7 Hz, H at C-10), 7.40 (d, J = 7 Hz, H at C-9), 7.75 (d, J = 7 Hz, H at C-11)	
	-N	methanol 20 minutes 1,2-dichloro- benzene	yellow brown prisms					
8g	Me	59	C ₁₁ H ₇ NO ₄	60.83	3.25	6.45	1795 w, 1750 s, 1620 s, 1575 m,	rearrangement 95/113 (-29), dec 195/218° (-147)
	H	216-218 dec	217.18	61.19	2.89	6.27	1540 m, 1510 m, 4.40 (s, CH ₃), 7.35-7.50 (m, J = 7 Hz, 2 Ar-H), 7.70 (t, J = 7 Hz, 1 Ar-H), 7.95 (d, J = 7 Hz, H at C-9)	
	O	20 minutes PhCl	yellow microprisms					
8h	Et	62	C ₁₂ H ₉ NO ₄	62.34	3.92	6.06	1755, 1620 s, 1575 m, 1540 m	mp 140.5 rearrangement 145/163.0 (-61) dec 200/243 (-129)
	H	137-140	231.2	61.83	3.76	6.14	1.50 (t, J = 7 Hz, CH ₃), 4.85 (q, J = 7 Hz, CH ₂), 7.30-7.55 (m, 2 Ar-H), 7.70 (t, J = 7 Hz, 1 Aryl H), 7.90 (d, J = 7 Hz, H at C-9)	
	O	ethanol 30 minutes PhCl	yellow brown prisms					

[b] ¹³C nmr of **8d** (deuteriochloroform): 14.9, 28.6, 69.8, 87.5 (C-3a), 111.9, 115.4, 122.6, 124.0, 132.1, 140.7 (C-5a), 157.6 (C-3), 158.6 (C-9b), 172.0 (C-4).

Methyl 4-Hydroxy-2-oxo-1,2-dihydroquinoline-3-carboxylate (**1a**).

To a solution of sodium methoxide in methanol prepared from sodium (6.9 g, 0.3 mole) in methanol (225 ml), a mixture of dimethyl malonate (34.5 ml, 0.3 mole) and methyl anthranilate (39.0 ml, 0.3 mole) was added. This mixture was heated to 140-150° and the excess methanol (about 232 ml) removed by distillation using a short Vigreux column. The resulting yellow solid material was heated for 10 hours at 140-150°, cooled to ambient temperature and triturated with diethylether. The insoluble sodium salt was filtered by suction, washed with diethyl ether and dried. Then it was dissolved in water at 50°, filtered from insoluble parts and the filtrate acidified with 2 *M* hydrochloric acid. The light yellow precipitate was filtered, washed

several times with water, dried and then digested with methanol. The yield was 31.18 g (47%), yellowish platelets, mp 223-224° (methanol), lit mp 222-224° [6].

Ethyl 4-Hydroxy-2-oxo-1,2-dihydroquinoline-3-carboxylate (**1b**).

It was prepared according to the procedure used for **1a** using diethyl malonate (46 ml, 0.3 mole); the yield was 27.8 g (40%), light yellow prisms, mp 203-205° (methanol), lit mp 208° [5].

Methyl 4-Hydroxy-1-methyl-2-oxo-1,2-dihydroquinoline-3-carboxylate (**1c**).

It was prepared from dimethyl malonate (6.6 g, 0.05 mol) in dry dimethylformamide (100 ml), sodium hydride (3.5 g, 60% in

Table 4

Experimental, Analytical and Spectroscopic Data of 4-Alkoxyisoxazolo[4,3-c]quinolin-3-ones **9c,d**, 4-Alkoxy-7,8-dihydro-4*H*,6*H*-isoxazolo[3,4-*b*]benzo[*i,j*]quinolin-3-ones **9e,f** and 4-Alkoxyisoxazolo[4,3-*c*][1*H*]benzopyran-3-ones **9g,h**

No	R ¹ R ² X	yield (%) mp (°C) Recrystallization Solvent Reaction time Reaction solvent (T ₂ = reflux or given temperature)	Molecular Formula Molecular Mass Appearance	Analysis, %			IR [cm ⁻¹] ¹ H nmr (δ ppm)	Calorimetric Data: start (°C)/peak max.(°C) (ΔH, kcal/mg)
				C	H	N		
9c	Me	75 (A)	C ₁₂ H ₁₀ N ₂ O ₃	62.61	4.38	12.17	1765 s, br (5-ring lactone-C=O), 1650 s,	dec 230/258 (-150)
	H	78 (B)	230.21	62.49	4.47	11.72	1615 m, 1580 m, 1535 m	
	N-Me	258-262 dec methanol 60 minutes 1,2-dichlorobenzene	brown microprisms				3.35 (s, N-CH ₃), 3.95 (s, O-CH ₃), 7.40 (t, J = 7 Hz, 1 Ar-H), 7.65 (d, J = 7 Hz, 6-H), 7.80 (t, J = 7 Hz, 1 Ar-H), 8.15 (dd, J = 7 + 1.5 Hz, H at C-9)	
9d	Et	88 (A)	C ₁₃ H ₁₂ N ₂ O ₃	63.93	4.95	11.47	1770 s (5-ring lactone-C=O), 1655 s,	dec 205/240 (-112)
	H	91 (B)	244.25	63.83	4.86	11.35	1610 m, 1580 m.	
	N-Me	205-215 dec methanol 90 minutes diphenylether (at 210°)	brown microprisms				1.25 (t, J = 7 Hz, ethyl-CH ₃), 3.60 (s, N-CH ₃), 4.30 (q, J = 7 Hz, CH ₂), 7.40 (t, J = 7 Hz, 1 Ar-H), 7.65 (d, J = 7 Hz, H at C-9), 7.85 (t, J = 7 Hz, 1 Ar-H), 8.10 (d, J = 7 Hz, H at C-6) [b]	
9e	Me	60 (A)	C ₁₄ H ₁₂ N ₂ O ₃	65.62	4.72	10.93	2940 w, 1760 s (5-ring lactone-C=O), 1645 s,	dec 230/252 (-128)
	-(CH ₂) ₃ -	67 (B)	256.26	65.71	4.48	10.67	1610 w, 1585 w	
	-N	246-261 dec methanol 45 minutes diphenylether (200°)	brown microprisms				1.90-2.05 (m, J = 7 Hz, 7-CH ₂), 2.95 (t, J = 7 Hz, 8-CH ₂), 3.90 (s, CH ₃), 4.00 (t, J = 7 Hz, 6-CH ₂), 7.30 (t, J = 7 Hz, H at C-10), 7.60 (d, J = 7 Hz, H at C-9), 7.90 (d, J = 7 Hz, H at C-11)	
9f	Et	40 (A)	C ₁₅ H ₁₄ N ₂ O ₃	66.66	5.22	10.36	2940 w, 1760 s (5-ring lactone-C=O),	dec 182/223 (-98)
	-(CH ₂) ₃ -	47 (B)	270.29	66.21	4.86	10.53	1660 m, 1650 m, 1610 m, 1580 m	
	-N	182-184 dec 2.5 hours 1,2-dichlorobenzene	brown microprisms				1.25 (t, J = 7 Hz, CH ₃), 1.90-2.10 (m, 7-CH ₂), 2.95 (t, J = 7 Hz, 8-CH ₂), 4.05 (t, J = 7 Hz, 6-CH ₂), 4.30 (q, J = 7 Hz, ethyl-CH ₂), 7.30 (t, J = 7 Hz, H at C-10), 7.60 (d, J = 7 Hz, H at C-9), 7.90 (d, J = 7 Hz, H at C-11)	
9g	Me	72 (A)	C ₁₁ H ₇ NO ₄	60.83	3.25	6.45	1790 s (5-ring lactone-C=O),	dec 220/256 (-147)
	H	80 (B)	217.18	60.49	3.13	6.37	1770 m, 1720 m, 1610 w	
	O	226-229 dec methanol 60 minutes 1,2-dichlorobenzene	brown needles				4.10 (s, CH ₃), 7.40-7.60 (m, 2 Ar-H), 7.85 (t, J = 7 Hz, 1 Ar-H), 8.15 (d, J = 7 Hz, H at C-9)	
9h	Et	51 (A)	C ₁₂ H ₉ NO ₄	62.34	3.92	6.06	1790 s (5-ring lactone-C=O), 1715 m,	mp 191.0 dec 195/233 (-160)
	H	56 (B)	231.21	62.47	3.54	5.97	1620 w	
	O	185-192 dec ethanol 3 hours 1,2-dichlorobenzene	yellow brown microprisms				1.40 (t, J = 7 Hz, CH ₃), 4.55 (q, J = 7 Hz, CH ₂), 7.45-7.60 (m, 2 Ar-H), 7.85 (t, J = 7 Hz, 1 Ar-H), 8.15 (d, J = 7 Hz, H at C-9)	

[b] ¹³C nmr of **9d**: 11.5, 28.9, 50.0, 94.1, 108.2, 115.0, 122.4, 124.5, 134.3, 142.2 (C-5a), 156.2 (C-9b), 160.0 (C-4), 164.2 (C-3).

mineral oil, which was washed with cyclohexane) and *N*-methylisatoic anhydride (8.9 g, 0.05 mol) in dry dimethylformamide (75 ml) analogous to the procedure described in ref [7] for **1d**. The yield was 7.07 g (60%), light brownish amorphous powder, mp 166-167° (methanol/water); ir: 1655 s, 1625 s, 1590 m cm⁻¹; ¹H nmr: δ = 3.55 (s, N-CH₃), 3.85 (s, O-CH₃), 7.35 (t, J = 7 Hz, 1 Ar-H), 7.50 (dd, J = 7 + 1.5 Hz, H at C-8), 7.75 (t, J = 7 Hz, 1 Ar-H), 8.05 (dd, J = 7 + 1.5 Hz, H at C-5), 13.00 (s, br, OH).

Anal. Calcd. for C₁₂H₁₁NO₄: C, 61.80; H, 4.75; N, 6.01. Found: C, 61.75; H, 4.72; N, 6.00.

Ethyl 4-Hydroxy-1-methyl-2-oxo-1,2-dihydroquinoline-3-carboxylate (**1d**).

It was prepared according to the procedure described in ref [7] using diethyl malonate (8.5 ml, 0.053 mole); the yield was 8.52 g (69%), light brownish prisms, mp 100-101°, lit mp 100-102° [7].

Methyl 1-Hydroxy-3-oxo-6,7-dihydro-3*H*,5*H*-benzo[*i,j*]quinolizine-2-carboxylate (**1e**).

A mixture of 1,2,3,4-tetrahydroquinoline (2.66 g, 0.02 mole) and trimethyl methanetricarboxylate [9] (7.61 g, 0.04 mole) was

A mixture of 1,2,3,4-tetrahydroquinoline (2.66 g, 0.02 mole) and trimethyl methanetricarboxylate [9] (7.61 g, 0.04 mole) was heated for 15 minutes to 220°. After cooling, the dark brown oil was extracted several times with hot hexane and the yellow solution was collected. This procedure was repeated until the hexane solution was only weak yellowish and the residue oil became solid. The combined hexane solutions were taken to dryness in vacuo and the residue crystallized after standing for some hours. The crystalline residue was collected by suction and dried at 50°. The yield was 0.93 g (18%), yellow needles, mp 146-148.5° (hexane), lit mp 139-142° [8]; ir: 2940 w, 1650 s, 1640 s, 1620 m, 1595 m cm⁻¹; ¹H nmr: δ = 1.90-2.10 (m, 6-CH₂), 2.95 (t, J = 7 Hz, 7-CH₂), 3.90 (s, CH₃), 4.00 (t, J = 7 Hz, 5-CH₂), 7.20 (t, J = 7 Hz, H at C-9), 7.50 (dd, J = 7 + 1.5 Hz, H at C-8), 7.90 (dd, J = 7 + 1.5 Hz, H at C-10).

Anal. Calcd. for C₁₄H₁₃NO₄: C, 64.86; H, 5.05; N, 5.40. Found: C, 64.83; H, 5.13; N, 5.25.

Ethyl 1-Hydroxy-3-oxo-6,7-dihydro-3*H*,5*H*-benzo[*i,j*]quinoline-2-carboxylate (1*f*).

A mixture of 1,2,3,4-tetrahydroquinoline (6.66 g, 0.05 mole) and triethyl methane tricarboxylate [10] (23.22 g, 0.10 mole) was heated to 220° for 40 minutes. After cooling, hexane (100 ml) was added and a yellow product precipitated, which was separated by filtration; the yield was 7.99 g (59%), light yellow prisms, mp 94.5-101°, lit mp 86-90° [8]; ir: 3000-2840 w, 1735 w, 1660-1640 s, 1620 m, 1595 m cm⁻¹; ¹H nmr: δ = 1.30 (t, J = 7 Hz, CH₃), 1.90-2.10 (m, 6-CH₂), 2.95 (t, J = 7 Hz, 7-CH₂), 3.95 (t, J = 7 Hz, 5-CH₂), 4.35 (q, J = 7 Hz, ethyl-CH₂), 7.20 (t, J = 7 Hz, H at C-9), 7.50 (dd, J = 7 + 1.5 Hz, H at C-8), 7.85 (dd, J = 7 + 1.5 Hz, H at C-10).

Anal. Calcd. for C₁₅H₁₅NO₄: C, 65.93; H, 5.53; N, 5.13. Found: C, 66.29; H, 5.72; N, 4.88.

Methyl 4-Hydroxy-2-oxo-2*H*-[1]benzopyrane-3-carboxylate (1*g*).

A mixture of sodium (6.2 g, 0.27 mole) and dimethyl malonate (35.8 g, 0.27 mole) in dry diethyl ether (250 ml) was stirred until all of the sodium had reacted and a colorless voluminous salt had been formed. Then acetylsalicylic chloride (18.0 g, 0.09 mole) was added and the mixture was heated for 16 hours under reflux. After cooling the solid product was filtered by suction, washed with diethyl ether (100 ml) and dissolved in warm water. The insoluble residue was removed by filtration, and the filtrate acidified with concentrated hydrochloric acid to pH = 1. The light yellow precipitate was collected by filtration and washed with water. The yield was 15.8 g (79%), light yellow needles, mp 139-140.5° (methanol); ir: 1725 s, 1650 m, 1630 m, 1610 s cm⁻¹; ¹H nmr: δ = 3.90 (s, CH₃), 7.35-7.45 (m, 2 Ar-H), 7.80 (t, J = 7 Hz, 1 Ar-H), 7.95 (dd, J = 7 and 1.5 Hz, H at C-5).

Anal. Calcd. for C₁₁H₈O₅: C, 60.01; H, 3.66. Found: C, 59.93; H, 3.49.

Ethyl 4-Hydroxy-2-oxo-2*H*-[1]benzopyrane-3-carboxylate (1*h*).

It was prepared using to the procedure of 1*g* from sodium (6.0 g, 0.26 mole), diethyl malonate (41.9 g, 0.26 mole) in dry diethyl ether (250 ml), and acetylsalicyloyl chloride (17.5 g, 0.088 mole); the yield was 9.14 g (44%), colorless prisms, mp 98.5-100° (ethanol); lit mp 101° [11]; ir: 3060 w, 2980 w, 1730 s, 1640 m, 1615 s, 1550 s cm⁻¹; ¹H nmr: δ = 1.35 (t, J = 7 Hz, CH₃), 4.40 (q, J = 7 Hz, CH₂), 7.35-7.45 (m, 2 Ar-H), 7.80 (t, J = 7 Hz, 1 Ar-H), 7.95 (dd, J = 7 + 1.5 Hz, H at C-5).

Anal. Calcd. for C₁₂H₁₀O₅: C, 61.54; H, 4.30. Found: C, 61.64; H, 4.24.

Methyl 4-(4-Methylphenylsulfonyloxy)-2-oxo-1,2-dihydroquinoline-3-carboxylate (2*a*).

A suspension of 1*a* (2.19 g, 0.01 mole), p-toluenesulfonylchloride (2.86 g, 0.015 mole) and 4-*N,N*-dimethylaminopyridine (0.005 g) in dry pyridine (50 ml) was stirred at room temperature for 2 hours. The orange-red solution was poured onto ice/water (500 ml), the oily yellow product was stirred until solidification and then filtered immediately by suction; the yield was 2.02 g (54%), yellow prisms, mp 138-143° (methanol); ir: 3100-2700 w, 1735 m, 1655 s, 1620 m, 1600 m cm⁻¹; ¹H nmr: δ = 2.45 (s, tosyl-CH₃), 3.60 (s, O-CH₃), 7.25 (t, J = 7 Hz, 1 Ar-H), 7.40 (d, J = 7 Hz, 1 Ar-H), 7.50-7.75 (m, 4 Ar-H), 7.85-7.95 (m, 2 Ar-H), 12.50 (s, NH).

Anal. Calcd. for C₁₈H₁₅NO₆S: C, 57.90; H, 4.05; N, 3.75. Found: C, 58.17; H, 3.74; N, 3.64.

Ethyl (4-Methylphenylsulfonyloxy)-2-oxo-1,2-dihydroquinoline-3-carboxylate (2*b*).

It was prepared from 1*b* (2.33 g, 0.01 mole) according to the procedure of 1*a*; the yield was 1.74 g (45%), yellow prisms, mp 171.5-175° (ethanol); ir: 3200-2700 w, 1725 m, 1655 s, br cm⁻¹; ¹H nmr: δ = 1.20 (t, J = 7 Hz, ethyl-CH₃), 2.45 (s, tosyl-CH₃), 4.05 (q, J = 7 Hz, CH₂), 7.20 (t, J = 7 + 1.5 Hz, 1 Ar-H), 7.40 (d, J = 7 Hz, 1 Ar-H), 7.50-7.75 (m, 4 Ar-H), 7.85-7.95 (m, 2 Ar-H), 12.45 (s, NH).

Anal. Calcd. for C₁₉H₁₇NO₆S: C, 58.91; H, 4.42; N, 3.62. Found: C, 58.68; H, 4.38; N, 3.42.

Methyl 2,4-Dichloroquinoline-3-carboxylate (3*a*).

A mixture of 1*a* (6.0 g, 27 mmoles), phosphoryl chloride (40 ml, 440 mmoles) and triethylamine (4 ml) was heated to 60° under stirring for 2 hours. Then the mixture was poured onto crushed ice (400 g) and the obtained mixture of yellow oil and precipitate was stirred until all solidified. The mixture was brought to pH = 5-6 with concentrated sodium hydroxide and the precipitate filtered by suction and washed with water; the yield was 6.62 g (94%), light yellow needles, mp 86-87° (methanol); ir: 3040 w, 2950 w, 1740 s, 1660 w, 1610 w, 1580 m cm⁻¹; ¹H nmr: δ = 4.05 (s, CH₃), 7.85 (t, J = 7 + 1.5 Hz, 1 Ar-H), 7.95-8.10 (m, 2 Ar-H), 8.25 (dd, J = 7 + 1.5 Hz, H at C-5).

Anal. Calcd. for C₁₁H₇Cl₂NO₂: C, 51.59; H, 2.76; N, 5.47. Found: C, 51.56; H, 2.60; N, 5.42.

Ethyl 2,4-Dichloroquinoline-3-carboxylate (3*b*).

It was prepared from 1*b* (3.0 g, 13 mmoles), phosphoryl chloride (20 ml, 218 mmoles) and triethylamine (2 ml) according to the procedure of 3*a*; the yield was 3.44 g (98%), yellow prisms, mp 101-103°; ir: 2995 w, 1735 s, 1615 w, 1575 m cm⁻¹; ¹H nmr: δ = 1.40 (t, J = 7 Hz, CH₃), 4.55 (q, J = 7 Hz, CH₂), 7.85-8.15 (m, 3 Ar-H), 8.25 (dd, J = 7 + 1.5 Hz, H at C-5).

Anal. Calcd. for C₁₂H₉Cl₂NO₂: C, 53.36; H, 3.36; N, 5.19. Found: C, 53.00; H, 3.20; N, 5.12.

General Procedure for the Preparation of 4-Chloro-2-oxo-1,2-dihydroquinoline-3-carboxylates 4*a,b*.

A solution of the corresponding dichloro compound 3*a,b* (10 mmoles) in methanol (30 ml) was treated with 98% methanesulfonic acid (2 ml) and water (1.5 ml), and then heated for 15 hours under reflux. After cooling, the mixture was poured into ice/water

digested with a small amount of methanol and filtered. Experimental, analytical and spectroscopic data are in Table 1.

General Procedure for the Preparation of 4-Chloro-1-methyl-2-oxo-1,2-dihydroquinoline-3-carboxylates **4c,d**, 1-Chloro-3-oxo-6,7-dihydro-3*H*,5*H*-benzo[*i,j*]quinolizine-2-carboxylates **4e,f** and 4-Chloro-2-oxo-2*H*-[1]benzopyrane-3-carboxylates **4g,h**.

A mixture of the corresponding hydroxy compounds **1c-h** (17 mmoles), phosphoryl chloride (20 ml, 218 mmoles) and triethyl amine (2 ml) was heated to 60° and stirred for 1.5-3 hours. Then the mixture was poured onto crushed ice (200 g) to give a brown oil or precipitate; the oil solidified on stirring for 24 hours at room temperature. The mixture was brought to pH = 5-6 with concentrated sodium hydroxide solution, filtered by suction, washed with water and dried. Experimental, analytical and spectroscopic data are in Table 1.

Methyl 4-Azido-2-chloroquinoline-3-carboxylate (**5a**).

To a solution of the dichloroquinoline **3a** (1.50 g, 5.9 mmoles) in dimethylformamide (25 ml), sodium azide (0.39 g, 6.0 mmoles) was added and the mixture heated to 80° for 20 hours with stirring. After cooling the mixture was poured onto ice/water (200 ml) to give a yellow solid. The precipitate was filtered by suction, washed with water and dried at room temperature. The yield was 1.13 g (73%), yellow microprisms, mp 71° dec from methanol; calorimetric data for thermolysis: mp onset 69.1°, maximum 72.0°, cyclization starting at about 127°, maximum 174°, ΔH -262 kcal/mg, decomposition starting at about 207°, maximum 226°, ΔH -41 kcal/mg; ir: 2120 s (N₃), 1735 s, 1610 w, 1570 m cm⁻¹; ¹H nmr: δ = 4.00 (s, CH₃), 7.75 (t, J = 7 Hz, 1 Ar-H), 7.90-8.00 (m, 2 Ar-H), 8.15 (dd, J = 7 + 1.5 Hz, H at C-5).

Anal. Calcd. for C₁₁H₇ClN₄O₂: C, 50.30; H, 2.69; N, 21.33. Found: C, 50.48; H, 2.71; N, 20.57. A correct elemental analysis could not be obtained because of the ease of decomposition of the azido compound.

Ethyl 4-Azido-2-chloroquinoline-3-carboxylate (**5b**).

It was obtained from **3b** (1.50 g, 5.6 mmoles) and sodium azide (0.35 g, 5.4 mmoles) according to the procedure of **5a**; the yield was 1.31g (85%), yellow needles, mp 81-82° dec methanol; calorimetric data for thermolysis: mp onset 80.4°, maximum 84.7°, cyclization starting at about 140°, maximum 181°, ΔH -152 kcal/mg, decomposition starting at about 210°, maximum 241°, ΔH -10 kcal/mg; ir: 3050 w, 2990 w, 2120 s (N₃), 1730 s, 1690 w, 1660 w, 1615 w, 1575 m cm⁻¹; ¹H nmr: δ = 1.45 (t, J = 7 Hz, CH₃), 4.50 (q, J = 7 Hz, CH₂), 7.70-7.80 (m, 1 Ar-H), 7.90-8.00 (m, 2 Ar-H), 8.20 (dd, J = 7 + 1.5 Hz, H at C-5).

Anal. Calcd. for C₁₂H₉ClN₄O₂: C, 52.09; H, 3.28; N, 20.25. Found: C, 52.42; H, 3.16; N, 19.07. A correct elemental analysis could not be obtained because of easy decomposition of the azido compound.

General Procedure for the Preparation of 4-Azido-2-oxo-1,2-dihydroquinoline-3-carboxylates **6a-d**, 1-Azido-3-oxo-6,7-dihydro-3*H*,5*H*-benzo[*i,j*]quinolizine-2-carboxylates **6e,f** and 4-Azido-2-oxo-2*H*-[1]benzopyrane-3-carboxylates **6g,h**.

Method A.

To a solution of the corresponding chloroquinolone **4a-h** (6.0 mmoles) in dimethylformamide (25 ml), sodium azide (0.93 g, 14.3 mmoles) was added. The mixture was stirred at 80° for 1 hour to form a dark brown reaction mixture. This mixture was

poured into ice/water (150 ml) and the dark colored precipitate was filtered by suction and dried at 50°.

Method B. Only for the Preparation of **6a,b**.

To a solution of the corresponding tosylate **2a,b** (2.5 g, 6.7 mmoles) in dimethylformamide (25 ml), sodium azide (1.55 g, 23.8 mmoles) was added and stirred for 45 minutes at 80°. The dark reaction mixture was poured into ice/water (150 ml), and the pink precipitate which formed was filtered with suction, washed with water and dried at 50°.

Experimental, analytical and spectroscopic data are in Table 2.

4-Chloro-3-ethoxyisoxazolo[4,3-*c*]quinoline (**7b**).

A solution of azidoquinoline **5b** (0.5 g, 1.81 mmoles) in bromobenzene (5 ml) was heated for 45 minutes under reflux. The solvent was removed under reduced pressure and the residue digested with cyclohexane. The yellow precipitate was filtered by suction and dried at 50°; the yield was 0.32 g (71%), yellow microprisms, mp 145.5-148° (ligroin); calorimetric data for thermolysis: mp onset 145.8°, maximum 147.1°, decomposition starting at about 153°, maximum 172°, ΔH -62 kcal/mg; ir: 3100-2900, 1790 w, 1735 w, 1625 s, 1615 s, 1570 w cm⁻¹. ¹H nmr: δ = 1.55 (t, J = 7 Hz, CH₃), 4.85 (q, J = 7 Hz, CH₂), 7.60-7.70 (m, 1 Ar-H), 7.75-7.90 (m, 2 Ar-H), 8.15 (dd, J = 7 + 1.5 Hz, H at C-5).

Anal. Calcd. for C₁₂H₉ClN₂O₂: C, 57.96; H, 3.65; N, 11.27. Found: C, 57.58; H, 3.34; N, 11.40.

General Procedure for the Preparation of 3-Alkoxyisoxazolo[4,3-*c*]quinolin-4(5*H*)-ones **8c,d**, 3-Alkoxy-7,8-dihydro-6*H*-isoxazolo[3,4-*b*]benzo[*i,j*]quinolizin-4-ones **8e,f** and 3-Alkoxyisoxazolo[4,3-*c*][1]benzopyran-4-ones **8g,h**.

A solution of the corresponding azido compound **6c-h** (2.0 mmoles) was heated under reflux (5 ml of solvent and time see Table 3). The solvent was removed under reduced pressure and the residue digested with cyclohexane (70 ml). The yellow precipitate was filtered with suction and dried at room temperature. Experimental, analytical and spectroscopic data are in Table 3.

General Procedure for the Preparation of 4-Alkoxyisoxazolo[4,3-*c*]quinolin-3-ones **9c,d**, 4-Alkoxy-7,8-dihydro-4*H*,6*H*-isoxazolo[3,4-*b*]benzo[*i,j*]quinolizin-3-ones **9e,f** and 4-Alkoxyisoxazolo[4,3-*c*][1]benzopyran-3-ones **9g,h**.

Method A.

A solution of the corresponding azide **6c-h** (2.0 mmoles) was heated under reflux (5 ml of solvent, temperature and time see Table 4). The solvent was removed under reduced pressure and the residue digested with cyclohexane (70 ml). The colored precipitate was filtered with suction and dried at 50°.

Method B.

The corresponding isoxazole **8c-h** (2.0 mmoles) was reacted and worked up as described for method A.

Experimental, analytical and spectroscopic data are in Table 4.

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