used, small amounts of **3** were present as a contaminant in the sample of **2**, as indicated by the ir spectroscopy.
(15) For a review, see E. S. Wallis and J. F. Lane, *Org. React.*, **3**, 267 (1946).
(16) The use of dioxane as a cosolvent in Hofmann reactions was reported: E. Magnien and R. Baltzly, *J. Org. Chem.*, **23**, 2029 (1958).
(17) Originally, Mr. M. Yamamoto of these laboratories found that treatment of **28** with aqueous potassium hypobromite without the addition of tetrahydrofuran gave a trace amount of **11a** with recovery of most of unreacted **28**.
(18) K. Ishizumi, S. Inaba, and H. Yamamoto, *J. Org. Chem.*, **39**, 2587 (1974).
(19) After the completion of this work, the conversion of 5-chloro-3-(*o*-fluorophenyl)indole-2-carboxamide to the corresponding oxindole-3-carboxamide by reaction with *tert*-butyl hypochlorite was reported: A. Walser, J. F. Blount, and R. I. Fryer, *J. Org. Chem.*, **38**, 3077 (1973).
(20) Unpublished studies of Mr. M. Yamamoto and Mr. M. Koshiba.
(21) J. M. Bruce and F. K. Sutcliffe, *J. Chem. Soc.*, 4789 (1957).
(22) The product was identified with an authentic sample by comparison of the infrared spectra.
(23) L. H. Sternbach, R. I. Fryer, W. Metlesics, G. Sach, and A. Stempel, *J. Org. Chem.*, **27**, 3781 (1962).
(24) F. B. Mallory, "Organic Syntheses," Collect. Vol. IV, Wiley, New York, N. Y., 1963, p 74.

Quinazolines. III.[1] Curtius and Hofmann Reactions of 2′-Benzoyloxanilic Acids. Novel Syntheses of Quinazolinones

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N-Substituted 2′-benzoyloxaniloyl chlorides **2**, prepared from the reaction of the corresponding 2-aminobenzophenones **1** and oxalyl chloride, were converted through their azides **3** to quinazolinones **6** in good yields by treatment with aqueous sodium azide. N-Unsubstituted derivative **2e** gave the azide intermediate **3e**, which was shown to be identical with the product of chromic acid oxidation of the corresponding indole-2-carboxylic acid azide. For the Hofmann reaction, *N*-(2-benzoylphenyl)oxamides **7a,b,f** were prepared from the corresponding chlorides **2** by treatment with ammonia. Similar reaction of nitro compound **2c** with ammonia led to a mixture of quinazolinone **6c** and 2-hydroxyquinazoline **8**. The desired oxamide **7c**, however, was obtained by chromic acid oxidation of indole-2-carboxamide **10**. *N*-Alkyl-substituted oxamides **7a–c** were converted to the corresponding quinazolinones **6** in satisfactory yields either by treatment with aqueous sodium hypobromite in tetrahydrofuran, or with methanolic sodium hypobromite in methanol.

In an accompanying paper,[1] it was shown that 2′-benzoyloxaniloyl azides and their rearranged isocyanates were intermediates in the oxidative ring enlargement of indole-2-carboxylic acid azides and 2-isocyanatoindoles to quinazolinones. We wish to report now on the Curtius (sodium azide method)[2a] and Hofmann reactions[2b] of 2′-benzoyloxanilic acids. Although oxaniloyl azides have been reported to undergo the Curtius rearrangement in the presence of amines to give biurets,[2d] the Hofmann reaction of oxamides, which is expected to give ureas, has not been investigated.

Curtius Reaction of 2′-Benzoyloxaniloyl Chlorides 2. The required oxaniloyl chlorides **2** (Scheme I) were readily prepared from the corresponding 2-aminobenzophenones **1** by treatment with oxalyl chloride, and utilized in the next step without further purification. When a solution of N-substituted derivatives **2** in acetone was treated with aqueous sodium azide (wet method), the expected quinazolinones **6** were precipitated[3] in high yields, as shown in Table I. This was, however, preceded by the formation of another compound as could be established by thin layer chromatography. In the case of **2a**, this intermediate, urea **5a** could be isolated by carrying out the reaction at low temperature and quenching with water. However, the urea **5a** could not be purified owing to its great tendency to cyclize, although analysis of the crude product agreed with that of the assigned structure. The crude product was cyclized completely to **6a** by refluxing in toluene. The isolation of **5a** indicates that hydrolysis of the isocyanate intermediate **4** occurs prior to cyclization to **6**.

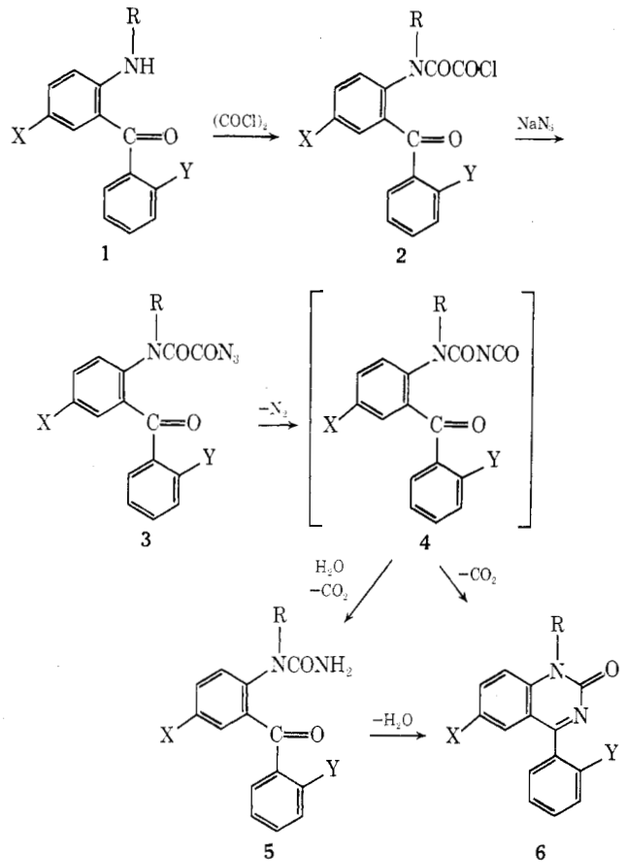
The conversion of **2a** to **6a** was also achieved, although in lower yield, by heating a solution of **2a** in toluene with powdered sodium azide[4] (dry method), a method practicable only for reactive chlorides.[2a] Under these anhydrous conditions, the formation of **6** must involve direct cyclization of **4** with elimination of carbon dioxide to give **6**.

Table I
Reactions of 2′-Benzoyloxaniloyl Chlorides with Sodium Azide

No.	Compd	R	X	Y	Method	Temp, °C	Time, hr	Product	Yield,[a] %	Mp,[b] °C	Lit. mp, °C
1	**2a**	CH_3	Cl	H	Wet	*c*	4.5	**6a**	90	224–224.5	222–223[d]
2	**2a**	CH_3	Cl	H	Dry	100	4	**6a**	36	223–224	222–223[d]
3	**2b**	CH_2-c-C_3H_5	Cl	H	Wet	*c*	4	**6b**	86	173–174	175–176[e]
4	**2c**	CH_3	NO_2	H	Wet	60[f]	3	**6c**	77	269–270	261–262[g]
5	**2d**	$(CH_2)_2OCOCH_3$	NO_2	H	Wet	60[f]	1	**6d**	73[h]	154.5–155.5[h]	155–156[i]
6	**2e**	H	Cl	F	Wet	*c*	0.5	**3e**	*j*		
7	**2e**	H	Cl	F	Dry	112	1.5	**3e** **6e**	19 4	104–106 >300	105–106[k] >300[l]

[a] Overall yield from the corresponding 2-aminobenzophenone and based on product precipitated from the reaction mixture unless otherwise stated. [b] The melting points were taken without recrystallization unless otherwise stated. [c] Room temperature. [d] Reference 5c. [e] Reference 5b. [f] Before heating, the reaction temperature was maintained at room temperature with a reaction time of 1–2 hr. [g] Reference 6. [h] Yield and melting point of the sample recrystallized once from ethanol. [i] Reference 7. [j] The ir spectrum of the reaction product indicated the presence of **3e**. [k] Reference 1. [l] K. Ishizumi, S. Inaba, and H. Yamamoto, *J. Org. Chem.*, **38**, 2617 (1973).

Scheme I



a, X = Cl; Y = H; R = CH_3
b, X = Cl; Y = H; R = CH_2-c-C_3H_5
c, X = NO_2; Y = H; R = CH_3
d, X = NO_2; Y = H; R = $(CH_2)_2OCOCH_3$
e, X = Cl; Y = F; R = H

Reaction of N-unsubstituted oxaniloyl chloride **2e** with aqueous sodium azide gave an intractable mixture containing the azide intermediate **3e.** Under anhydrous conditions, **3e** was actually isolated together with **6c** (Table I). This compound was in every respect identical with the product of chromic acid oxidation of 5-chloro-3-(*o*-fluorophenyl)indole-2-carboxylic acid azide.[1]

The use of the sequence **1** → **2** → **6** to prepare 1-substituted quinazolinones in good yield is particularly interesting, since alkylation of 1-unsubstituted quinazolinones, especially with bulky alkyl halides, results in a mixture of N- and O-alkylated products.[5] The same conversion (**1** → **6**) has previously been achieved in one operation by cyclization with derivatives of carbamic acid, such as urea, urethane, and potassium cyanate–acetic acid. However, these condensation reactions require severe reaction conditions and give relatively low yields of **6**.[5,6] Furthermore, we were unsuccessful in converting **1d** to **6d**[7] by the urethane condensation method, probably the only method applicable for the ring closure of nitro compounds.[5c,6] Consequently, the present method appears to offer major advantages for the preparation of 1-substituted quinazolinones from the corresponding 2-aminobenzophenones.

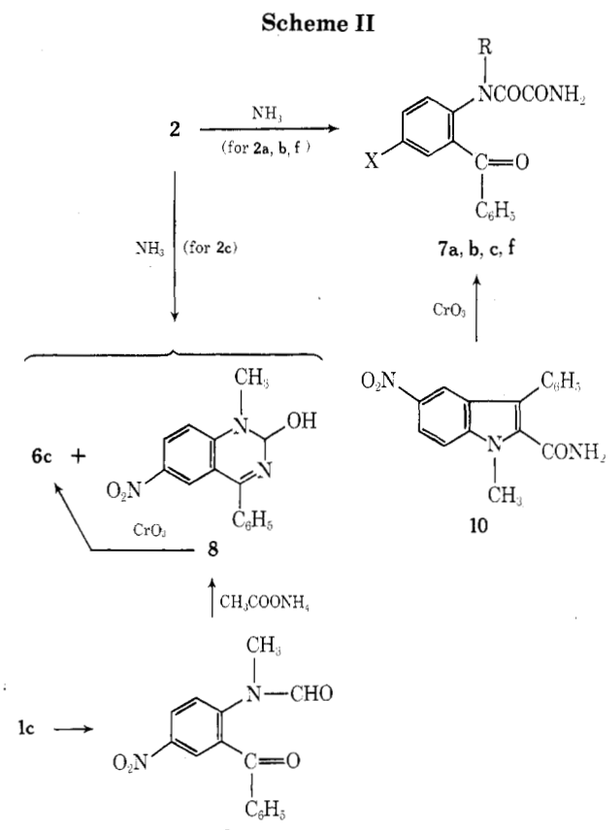
Hofmann Reaction of *N*-(2-Benzoylphenyl)oxamides (7). The chloro oxamides **7a,b,f** (Scheme II) were prepared by treatment of the corresponding oxaniloyl chlorides **2** with ammonia in 79–92% overall yields from **1.** The same treatment of the nitro compound **2c,** however, led to a mixture of quinazolinone **6c** and 2-hydroxyquinazoline **8** instead of the expected oxamide **7c.** The structure of **8** was confirmed both by oxidation to **6c** with chromic acid and by an independent preparation from 2′-benzoyl-*N*-methyl-4′-nitroformanilide (**9**) and ammonium acetate.[8] Compound **9** did not react with ammonia in tetrahydrofuran, conditions under which **2c** gave **8,** thus indicating that **9** is not an intermediate in the conversion of **2c** to **8.** The required oxamide **7c** was, however, obtained in 60% yield by oxidation of 1-methyl-5-nitro-3-phenylindole-2-carboxamide[9] (**10**) with chromic acid.

As expected, the Hofmann reaction of oxamides **7** gave the corresponding quinazolinones **6** with the results summarized in Table II. Although **6a** was obtained by heating **7a** with aqueous sodium hypobromite, a standard procedure for the Hofmann reaction, the yield was improved considerably when **7a** was added as a solution in tetrahydrofuran[1] to the same reagent, presumably because the increase of solubility of **7a** permits a lower reaction temperature. Comparison of runs 2 and 3 indicates the advantage of using hypobromite, contrary to the fact that better results are generally achieved with hypochlorite rather than hypobromite.[2b]

In analogy with the Curtius reaction of **2** using aqueous sodium azide, the Hofmann reaction of **7** to give **6** under aqueous conditions probably involves hydrolysis of the rearranged isocyanate intermediate **4** to **5,** followed by cyclization of **5** to **6,** although **5** could not be isolated.

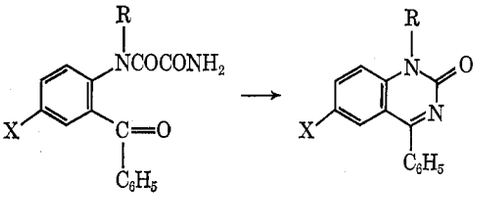
The Jeffreys modification of the Hofmann reaction was also applicable to conversion of **7** to **6.** Thus, heating of **7** with sodium methoxide and bromine in methanol directly precipitated **6** with no observable formation of the expected methyl allophanate (**11**).[10] The conversion of **7** to **6** in methanol seems to be explained simply by direct cycliza-

Scheme II



a, X = Cl; R = CH_3
b, X = Cl; R = CH_2-c-C_3H_5
c, X = NO_2; R = CH_3
f, X = Cl; R = H

Table II
Hofmann Reactions of *N*-(2-Benzoylphenyl)oxamides

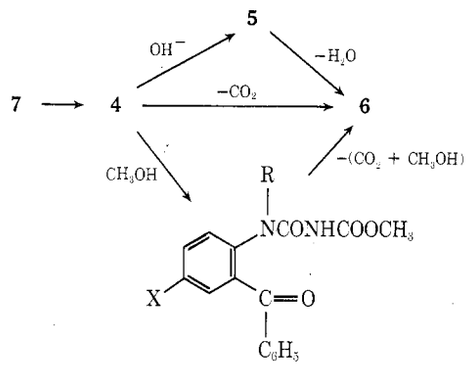


7 6

No.	Compd	R	X	Reagent	Temp, °C	Time, hr	Yield, %
1	**7a**	CH_3	Cl	NaOBr	60	1.3	39
2	**7a**	CH_3	Cl	NaOBr (THF)	−5 to −3	2	74
3	**7a**	CH_3	Cl	NaOCl (THF)	−5 to 0	2	35
4	**7a**	CH_3	Cl	NaOBr (CH_3OH)	Reflux	2	67
5	**7b**	CH_2-c-C_3H_5	Cl	NaOBr (THF)	−5 to −4	0.8	82
6	**7c**	CH_3	NO_2	NaOBr (THF)	−5 to 0	4	8
7	**7c**	CH_3	NO_2	NaOBr (CH_3OH)	Reflux	2	50
8	**7f**	H	Cl	NaOBr (THF)	Reflux	1	
9	**7f**	H	Cl	NaOBr (CH_3OH)	Reflux	2	7

tion of the isocyanate intermediate **4** to **6** with elimination of carbon dioxide. However, the formation of methyl allophanate (**11**) as a precursor of **6** cannot be rigorously excluded since **11a**, on heating with sodium methoxide in methanol, gave **6a** (Scheme III).

Scheme III



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The Hofmann reaction of oxamides **7** to give **6** appears to be quite general, although it requires a substituent at the anilino nitrogen to obtain a satisfactory yield of **6**.

Experimental Section

Melting points were determined on a Thomas-Hoover capillary melting point apparatus and are uncorrected. Infrared spectra (Nujol mulls) were measured on a Hitachi Model EPI-G3 spectrophotometer and nmr spectra on a Varian T-60 instrument using tetramethylsilane as an internal standard. Mass spectra were taken on a Shimadzu LKB instrument with the direct sample inlet system and ionizing potential at 70 eV. All solutions were dried over anhydrous sodium sulfate and solvents were evaporated under water-aspirator pressure. The identity of compounds was established by a comparison of spectral properties.

Preparation of 2-Aminobenzophenones (1). All 2-aminobenzophenones except **1d** have been characterized previously. Compounds **1a**,[11a] **1b**,[5b] and **1c**[11b] were prepared by acid hydrolysis of the corresponding 1,3-dihydro-5-phenyl-2*H*- 1,4-benzodiazepin-2-ones[12according] to the procedure described by Sternbach, *et al.*[11b] Compounds **1e** and **1f** were prepared by the Friedel–Crafts reaction following the procedure described by Sternbach, *et al.*[11a]

2-(2-Acetoxyethyl)amino-5-nitrobenzophenone (1d) was prepared by heating 4.0 g of 2-(2-hydroxyethyl)amino-5-nitrobenzophenone[13] in 40 ml of acetic anhydride containing 4.0 g of sodium acetate at 50–55° for 1 hr. The cooled solution was made basic with aqueous ammonia. The resulting precipitate was collected by filtration, washed with water and ether, and dried. Recrystallization from ethanol gave 3.79 g (82.9%) of **1d**, mp 102.5–103.5°.

Anal. Calcd for $C_{17}H_{16}N_2O_5$: C, 62.19; H, 4.91; N, 8.53. Found: C, 62.42; H, 4.75; N, 8.55.

Reaction of 2′-Benzoyloxaniloyl Chlorides (2) with Aqueous Sodium Azide. Wet Method. The wet procedure may be exemplified by preparation of quinazolinone **6a** (run 1). To 2.5 g of oxalyl chloride was added 1.0 g (4.1 mmol) of **1a** with stirring and cooling in an ice bath, and stirring was continued for 1 hr at room temperature. Excess oxalyl chloride was evaporated and the residual oil, oxaniloyl chloride **2a** was dissolved in 10 ml of acetone. The cold solution was added in one portion to a stirred solution of 0.60 g (9.2 mmol) of sodium azide in 2 ml of water cooled to −5°. An exothermic reaction occurred (the temperature rose to 10°). The mixture was stirred at room temperature for 4.5 hr and then cooled in an ice bath. The precipitate was collected by filtration, washed with water, and dried to give 0.96 g of **6a**, mp 224–224.5°. From the filtrates, an additional 35 mg of product, mp 220–221.5°, was obtained for a combined yield of 995 mg (90.3%).

Similar procedures were used for the preparation of **6b**, **6c**, and **6d** (runs 3, 4, and 5). The acetone-soluble quinazolinone **6d** was isolated by concentrating the reaction mixture, extracting with chloroform, and removing the solvent. The residue was crystallized from ether and recrystallized from ethanol to yield pure product. The results are summarized in Table I.

In the alternative procedure, the addition of aqueous sodium azide solution to the oxaniloyl chloride **2** in acetone solution, the yields of **6** were decreased by 10–25%, probably owing to the increase of hydrolysis reaction which occurs prior to reaction with sodium azide.

Reaction of 2a with Aqueous Sodium Azide at Low Temperature. Isolation of *N*-(2-Benzoyl-4-chlorophenyl)-*N*-methylurea (5a). The urea intermediate **5a** was obtained in the crystalline state only one time. Oxaniloyl chloride **2a**, from reaction of 2.0 g (8.1 mmol) of **1a** and oxalyl chloride, was dissolved in 30 ml of acetone and cooled in an ice bath. To the stirred solution was added in one portion a cold solution of 1.2 g (18.4 mmol) of sodium azide in 4 ml of water. The mixture was stirred under cooling for 2 hr and then 50 ml of ice water was slowly added. On further stirring crystallization occurred. The crystals were collected by filtration and washed with water and 50% aqueous acetone to give 1.81 g (77.0%) of **5a**, which decomposed at 125–128° without melting and melted at 216–220°. Thin layer chromatography indicated that the sample was contaminated with a small amount of **6a** and, after melting at 220°, converted completely to **6a**: ir 3270, 3170 (shoulder), 1643 cm^{-1}.

Anal. Calcd for $C_{15}H_{13}ClN_2O_2$: C, 62.40; H, 4.54; Cl, 12.28; N, 9.70. Found: C, 62.67; H, 4.27; Cl, 12.07; N, 9.39.

From the filtrates 0.14 g (6.4%) of **6a**, mp 223–224.5°, was obtained.

The urea **5a** (0.50 g) was cyclized completely by heating in 5 ml of refluxing toluene for 2.5 hr. The mixture was cooled and the precipitate was collected by filtration to give 0.42 g (89.6%) of **6a**, mp 221–223°.

Attempts to repeat the crystallization of the urea intermediate failed. The reactions behaved the same: apparently the urea formed (tlc), but failed to crystallize from the gummy material after dilution of the reaction mixture with water. The gummy material was converted directly to **6a** during the work-up procedure.

Reaction of 2a with Dry Sodium Azide. Dry Method (Run 2). To a solution of **2a** [from 0.50 g (2.0 mmol) of **1a**] in 10 ml of toluene was added 0.30 g (4.6 mmol) of powdered sodium azide,[4] and the mixture was stirred and heated at 100° for 4 hr. After cooling, the precipitate was collected by filtration, washed with water, and dried to yield 0.16 g of **6a,** mp 223–224°. From the filtrates an additional 0.04 g of product, mp 220.5–221.5°, was obtained for a combined yield of 0.20 g (36.3%).

4′-Chloro-2′-(*o*-fluorobenzoyl)oxaniloyl Chloride (2e). To 4.0 g of oxalyl chloride was added 1.0 g of **1e** with stirring and cooling. The solid mass formed immediately. Toluene (5 ml) was added and stirring was continued at room temperature for 30 min. The solvent and excess oxalyl chloride was evaporated to dryness to yield 1.34 g (98.4%) of **2e:** mp 127.5–130°; ir 3200, 1770, 1728, 1630, 1612 cm^{-1}.

Anal. Calcd for $C_{15}H_8Cl_2FNO_3$: C, 52.96; H, 2.37; N, 4.12. Found: C, 54.82; H, 2.71; N, 4.59.

The analysis indicates that it is perhaps contaminated with a small amount of **2′,2″-bis(*o*-fluorobenzoyl)-4′,4″-dichlorooxanilide (12e).**[14]

When the reaction was carried out by adding oxalyl chloride to **1e,** the oxanilide **12e** was obtained as the major product. After recrystallization from dimethylformamide, colorless needles were obtained: mp > 300°; ir 3170, 1710, 1655, 1620 cm^{-1}.

Anal. Calcd for $C_{28}H_{16}Cl_2F_2N_2O_4$: C, 60.78; H, 2.91; cl, 12.81; N, 5.06. Found: C, 60.76; H, 2.98; Cl, 12.43; N, 5.05.

4′-Chloro-2′-(*o*-fluorobenzoyl)oxaniloyl Azide (3e). Run 7. To a suspension of 0.67 g (2.0 mmol) of **2e** in 10 ml of toluene was added 0.30 g (4.6 mmol) of powdered sodium azide. The mixture was stirred and refluxed for 1.5 hr. Filtration of the cooled mixture and washing with water gave 0.10 g of a solid, which was shown by infrared spectrum to be a mixture of **12e** and **3e.** From the combined filtrations, 0.13 g (18.7%) of **3e,** mp 104–106°, was obtained after removal of the initially precipitated, impure product **3e** (0.19 g) by filtration. The infrared spectrum indicated that the sample was essentially pure and identical with an authentic sample.[1]

The filtrates obtained after removal of **3e** were separated and extracted with ether. The organic layers were combined, washed with water, dried, and evaporated to give 23 mg (4.2%) of **6e,** mp >300°.

When the reaction was carried out with aqueous sodium azide according to the general procedure, the azide **3e** contaminated with unknown compounds was mainly obtained with a small amount of **12e** (run 6).

Attempted Condensation of 1d with Urethane. A mixture of 100 mg of **1d,** 30 mg of zinc chloride, and 150 mg of urethane was stirred and heated at 180–190° for 4 hr. The cooled reaction mixture was dissolved in chloroform and filtered to remove the insoluble material. The filtrate was washed with 5% sodium hydroxide solution and water, dried, and evaporated. An examination of the oily residue (40 mg) by thin layer chromatography indicated the presence of four products, but none of these corresponded to authentic samples of **1d** and **6d.**

***N*-(2-Benzoyl-4-chlorophenyl)-*N*-methyloxamide (7a).** Oxaniloyl chloride **2a** (from 10.0 g of **1a**) was dissolved in 100 ml of tetrahydrofuran and stirred in an ice bath. Ammonia was bubbled in slowly for 30 min and the reaction mixtre was filtered. The insoluble material was washed thoroughly with tetrahydrofuran and the combined filtrates were evaporated. The oily residue was crystallized from ether to give 11.9 g (92.3% overall yield) of **7a,** mp 144–146°. Recrystallization from a mixture of tetrahydrofuran and ether afforded yellow prisms: mp 144–146.5°; ir 3430, 3200, 3055, 1715, 1672, 1662 cm^{-1}; nmr ($CDCl_3$) δ 3.22 and 3.55 (9:2, s, 3, CH_3), 5.90 and 7.10 (1:1, broad s, 2, D_2O exchangeable, NH_2), 7.20–7.93 (m, 8, aromatic H); mass spectrum *m/e* 316 (M^+), 272 (M − $CONH_2$), 258, 230.

Anal. Calcd for $C_{16}H_{13}ClN_2O_3$: C, 60.67; H, 4.14; Cl, 11.19; N, 8.84. Found: C, 60.84; H, 4.14; Cl, 11.19; N, 8.92.

***N*-(2-Benzoyl-4-chlorophenyl)-*N*-cyclopropylmethyloxamide (7b)** was prepared similarly from **1b** in 86.8% yield. Recrystallization from tetrahydrofuran gave pale yellow prisms, mp 143.5–144.5°.

Anal. Calcd for $C_{19}H_{17}ClN_2O_3$: C, 63.96; H, 4.80; Cl, 9.94; N, 7.85. Found: C, 63.66; H, 4.95; Cl, 9.84; N, 7.79.

(2-Benzoyl-4-chlorophenyl)oxamide (7f) was prepared similarly in 79.1% overall yield. Recrystallization from tetrahydrofuran afforded colorless prisms, mp 209–210° (lit.[15] mp 209–211°).

Anal. Calcd for $C_{15}H_{11}ClN_2O_3$: C, 59.59; H, 3.36; Cl, 11.71; N, 9.25. Found: C, 59.53; H, 3.70; Cl, 11.38; N, 9.22.

1,2-Dihydro-1-methyl-6-nitro-4-phenylquinazolin-2-ol (8). A. From 2c. Ammonia was bubbled through a stirred solution of **2c** (from 5.0 g of **1c**) in 100 ml of tetrahydrofuran in an ice bath for 20 min. The reaction mixture was filtered. The insoluble material was dissolved in tetrahydrofuran by warming and filtered. The residue, left on concentration of the combined filtrates, was washed with ether and recrystallized from 550 ml of tetrahydrofuran to give 0.86 g (15.6%) of **8,** mp 188–192°. Further recrystallization from tetrahydrofuran afforded yellow needles: mp 195–200°; ir 3070 (broad), 1630, 1615 cm^{-1} (shoulder).

Anal. Calcd for $C_{15}H_{13}N_3O_3$: C, 63.59; H, 4.63; N, 14.83. Found: C, 63.35; H, 4.53; N, 14.42.

The original mother liquor was concentrated and the residue was recrystallized from tetrahydrofuran to give 0.88 g (16.0%) of **6c,** mp 254–260°.

B. From 2′-Benzoyl-*N*-methyl-4′-nitroformanilide (9). A mixture of 5.0 g of **1c,** 4.0 g of sodium formate, and 40 ml of formic acid was heated at 135–140° for 26.5 hr, during which time solution occurred. The formic acid was evaporated and the residue was dissolved in methylene chloride. The solution was washed with dilute sodium hydroxide solution and water, dried, and concentrated to dryness. The residue was chromatographed over 200 g of silica gel with chloroform to give 2.67 g of starting material (53.4% recovered **1c**) and 2.14 g of a brown oil as a second fraction. The oil was crystallized from hexane to yield 2.07 g (37.3%) of **9,** mp 80–84°. Recrystallization from ether afforded slightly yellow plates, mp 85–88°.

Anal. Calcd for $C_{15}H_{12}N_2O_4$: C, 63.38; H, 4.26; N, 9.86. Found: C, 63.41; H, 4.54; N, 9.80.

A mixture of 1.0 g of **9,** 2.4 g of ammonium acetate, and 2.7 g of pyridine in 25 ml of dimethyl sulfoxide was stirred and heated at 75–85° for 1.5 hr. The reaction mixture was then poured into ice water. The precipitate that obtained by filtration was chromatographed over 30 g of silica gel. Elution with ethyl acetate yielded 0.33 g (36.6%) of **1c** as a first fraction and 5 mg (0.5%) of **6c,** mp 258–262°, as a second fraction. Continued elution with ethyl acetate gave 0.61 g of a yellow oil, which was crystallized from ether to yield 0.15 g (15.1%) of **8,** mp 194–198°.

When the reaction was carried out by treating a solution of 0.50 g of **9** in 30 ml of tetrahydrofuran with a stream of ammonia and then refluxing the reaction mixture, 0.48 g (96%) of starting material was recovered unchanged.

Chromic Acid Oxidation of 8 to 6c. To a stirred solution of 0.30 g of **8** in 3.5 ml of acetic acid was added a solution of 0.43 g of chromic anhydride in 0.35 ml of water, and the mixture was stirred at room temperature for 3.5 hr. The reaction mixture was then diluted with ice water. The resulting precipitate was collected by filtration, washed with water, and dried to give 0.28 g (94.0%) of **6c,** mp 265–269°.

***N*-(2-Benzoyl-4-nitrophenyl)-*N*-methyloxamide (7c).** To a stirred suspension of 10.0 g of indole-2-carboxamide **10**[9] in 68 ml of acetic acid was added a solution of 10.2 g of chromic anhydride in 10 ml of water below 20°. After stirring at room temperature for 1.5 hr, the mixture was diluted with 500 ml of water and filtered. The solid so obtained was washed with water and dissolved in methylene chloride. The solution was washed with water, dried, and evaporated. The residue was crystallized from methylene chloride and ether to give 6.44 g of **7c,** mp 152–157°. Concentration of the filtrate and crystallization from ether gave an additional 0.23 g of product for a combined yield of 6.67 g (60.2%). After recrystallization from ethanol, yellow needles were obtained: mp 156–158°; ir 3430, 3345, 3190, 3052, 1720, 1702, 1670, 1652 cm^{-1} (shoulder); mass spectrum *m/e* 327 (M^+), 283 (M − $CONH_2$).

Anal. Calcd for $C_{16}H_{13}N_3O_5$: C, 58.71; H, 4.00; N, 12.84. Found: C, 58.65; H, 3.96; N, 12.81.

Reaction of 7a with Sodium Hypobromite. A. In Water (Run 1). Bromine (1.0 g, 12.5 mmol) was added dropwise to a solution of 1.2 g (30 mmol) of sodium hydroxide in 10 ml of water cooled to 0°. To the clear yellow solution was added immediately 0.50 g (1.6 mmol) of **7a.** The mixture was stirred at room temperature for 1 hr and at 60° for 1.3 hr. After cooling, the precipitate was collected by filtration, washed with water, and dried to give 0.23 g of crude **6a,** mp 205–213°. Recrystallization from isopropyl alcohol afforded 165 mg (38.6%) of pure **6a,** mp 223.5–224.5°.

B. In Water–Tetrahydrofuran (Run 2). Bromine (1.92 g, 24 mmol) was added dropwise to a cooled solution of 2.4 g (60 mmol)

of sodium hydroxide in 20 ml of water. To the hypobromite solution was added immediately a cold solution of 1.0 g (3.2 mmol) of **7a** in 20 ml of tetrahydrofuran, and the mixture was stirred at −5 to −3° for 2 hr. The insoluble material was filtered and washed with water to give 0.23 g of **6a**, mp 222.5–224°. The filtrates were separated and the aqueous layer was washed with ether. The combined organic layers were dried and evaporated. Trituration of the residue with ether gave an additional 0.40 g of **6a**, mp 220–224°, for a combined yield of 0.63 g (73.7%).

Similar procedures were used for the preparation of **6b** and **6c** (runs 5 and 6). Compound **7f** was unreactive to the reagent even under reflux, as indicated by thin layer chromatography (run 8).

In another experiment (run 3) 5 ml of 1.8 *N* sodium hypochlorite solution[1] was used in rearrangement of 0.50 g of **7a** in 8 ml of tetrahydrofuran. A similar work-up as above gave 0.15 g (35.1%) of crude **6a**. The results are summarized in Table II.

C. In Methanol (Run 4). Compound **7a** (1.0 g, 3.2 mmol) was added to a solution of 0.23 g (10 mmol) of sodium in 20 ml of methanol cooled to −7. To the solution was added 0.8 g (10 mmol) of bromine. The mixture was stirred at room temperature for 1 hr and then heated under reflux for 2 hr. The solid that separated on cooling was collected by filtration to yield 0.45 g of **6a**, mp 221.5–222.5°. The filtrates were concentrated to about one-third volume and diluted with water. Filtration of the resulting precipitate and washing with ether afforded an additional 0.12 g of **6a**, mp 219–222°, for a combined yield of 0.57 g (66.7%).

Compound **6c**, prepared from similar rearrangement of **7c**, was recrystallized from tetrahydrofuran to give a 49.7% yield of pure product, mp 267–267.5° (run 7).

Compound **6f**[16] was obtained in 6.8% yield by first treating 1.0 g of **7f** and 0.3 g of sodium in 20 ml of methanol with 0.8 g of bromine at −8° for 30 min and at room temperature for 1 hr, and then refluxing the mixture for 2 hr. The insoluble material was removed by filtration, and the filtrate was concentrated to about one-third of the original volume and diluted with water. The red oil that separated, on standing, gradually crystallized. The yellow crystals were collected by filtration, heated in refluxing toluene, cooled, and filtered to yield 55 mg of product, mp >300° (run 9).

Cyclization of Methyl 4-(4-Chloro-2-benzoylphenyl)-4-methylallophanate (11a) to 6a. A solution of 100 mg of crude **11a**[1] in 2 ml of methanol was refluxed for 2 hr, during which time no reaction occurred as indicated by thin layer chromatography. To the solution was added a small piece of sodium, and refluxing was continued for 30 min. After cooling, the precipitate was collected by filtration and washed with water to give 13 mg of **6a**, mp 222–224°. From the filtrates, an additional 10 mg of product was obtained for a combined yield of 23 mg (29.5%).

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Registry No.—**1c**, 51806-03-2; **1d**, 51806-04-3; **1e**, 784-38-3; **2a**, 51806-05-4; **2b**, 51806-06-5; **2c**, 51806-07-6; **2d**, 51806-08-7; **2e**, 51806-09-8; **3e**, 51806-10-1; **5a**, 51806-11-2; **6a**, 20927-53-1; **6b**, 33453-19-9; **6c**, 26953-46-8; **6d**, 49830-84-4; **6e**, 40069-75-8; **6f**, 4797-43-7; **7a**, 51806-12-3; **7b**, 51806-13-4; **7c**, 51806-14-5; **7f**, 19144-18-4; **8**, 51806-15-6; **9**, 51806-16-7; **10**, 30008-50-5; **11a**, 51806-17-8; **12e**, 51806-18-9; 2-(2-hydroxyethyl)amino-5-nitrobenzophenone, 37554-73-7; sodium azide, 12136-89-9.

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Substituent Constants for the 4,6-Dimethyl-*s*-triazinyl Group from Ionization and Fluorine Nuclear Magnetic Resonance Data[1]

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The *m*- and *p*-(4,6-dimethyl-*s*-triazin-2-yl)benzoic acids (**6a** and **6b**) have been synthesized and their pK_a's in 50% aqueous ethanol (v/v) have been determined as 5.15 and 4.94, respectively. The substituent constants calculated from the pK_a data for the 4,6-dimethyl-*s*-triazinyl substituent (**1**) are σ_m +0.25, σ_p +0.39, and σ_I +0.15. The corresponding dimethyl-*s*-triazinyl substituted fluorobenzenes (**3c** and **3d**) have also been synthesized and their ^{19}F chemical shifts have been determined relative to fluorobenzene in carbon tetrachloride, methanol, and dimethyl sulfoxide. The substituent constants for **1** based upon the chemical shifts in methanol are σ_I +0.18 and $\bar{\sigma}_R^P$ +0.19. The substituent constants are discussed.

In view of the rather limited number of heterocyclic substituents for which substituent constants have been evaluated,[2] and also the potential insights which such constants might afford, the determination of the substituent constants for the 4,6-dimethyl-*s*-triazin-2-yl substituent (**1**) was undertaken. This substituent was chosen be-