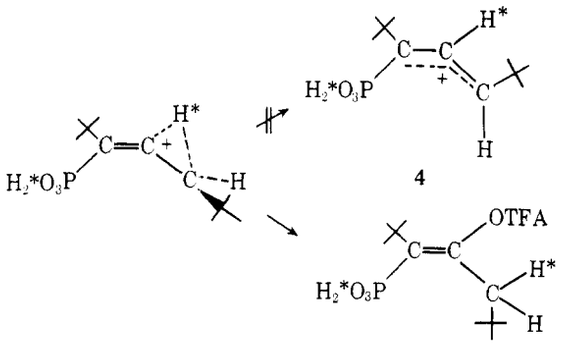
tion barrier for the twist must exceed the barrier for trifluoroacetate addition to the central carbon atom.



4

Experimental Section

The instrumentation used in this work has been previously described.[2,3,7]

Preparation of 3. A 303-mg sample of phosphonic acid **1a**[7] in 5.8 mL of TFA was heated to 75 °C for 5 days, after which ^{1}H NMR indicated no starting material and ~85% pure **3**.[5] The burgandy colored solution was rotary evaporated, dissolved in 5 mL of benzene, then rotary evaporated again. The dark semisolid residue was recrystallized four times from minimum benzene to give 137 mg (42%) of colorless **3**, mp 167–168 °C. Its ^{1}H NMR spectrum is given in the text: IR (KBr) 1720 cm^{-1}; MS (20 eV) *m/e* (rel absorbance) 250 (13), 179 (12), 152 (97), 137 (100), 122 (47), 99 (52), 57 (48).

Anal. Calcd for $C_{11}H_{23}O_4P$: C, 52.78; H, 9.26. Found: C, 52.76; H, 9.20.

Kinetics measurements were done by ^{1}H NMR integration of the intensity of the doublet in **1a** compared to the doublet in **3**. In the case of TFA-d_1, ^{1}H NMR peak heights in the *tert*-butyl region were used.

Registry No.—**1a**, 42087-76-3; **3**, 63088-99-3; TFA, 76-05-1.

References and Notes

(1) (a) T. L. Jacobs and R. C. Kammerer, *J. Am. Chem. Soc.*, **96**, 6213 (1974); (b) M. C. Findlay, W. L. Waters, and M. C. Caserio, *J. Org. Chem.*, **36**, 275 (1971); (c) R. D. Bach, *J. Am. Chem. Soc.*, **91**, 1771 (1969); (d) see, for example, T. L. Jacobs, and R. N. Johnson, *ibid.*, **82**, 6397 (1960); (e) A. V. Fedorova and A. A. Petrov, *J. Gen. Chem. USSR*, **32**, 1740 (1962); (f) allene itself undergoes terminal protonation in the gas phase: D. H. Aue, W. R. Davidson, and M. T. Bowers, *J. Am. Chem. Soc.*, **98**, 6700 (1976).

(2) R. S. Macomber and E. R. Kennedy, *J. Org. Chem.*, **41**, 3191 (1976), and references cited therein.

(3) R. S. Macomber, *J. Am. Chem. Soc.*, **99**, 3072 (1977).

(4) MCB reagent, used without further drying.

(5) Although <15% of other products were indicated by ^{1}H NMR (weak singlets at δ 0.99 and 1.41), the reaction mixture became burgandy colored during the reaction due to a small component of acid-catalyzed polymerization.

(6) The excess OH integration is due to adventitious water in the TFA-d_1.

(7) R. C. Elder, L. R. Florian, E. R. Kennedy, and R. S. Macomber, *J. Org. Chem.*, **38**, 4177 (1973).

(8) Precision estimated to be ±10%.

(9) As the doublet at δ 5.62 decayed, due both to exchange and conversion to **3**, another weak multiplet appeared at δ 5.74. No such absorptions were observed in the TFA–OH reaction.[10]

(10) TFA containing 9% (w/w) water shows a slightly increased rate of coloring,[5] but the rate of hydration is depressed by 75%. When TFA containing 42% (w/w) trifluoroacetic anhydride is used, **1a** (δ 5.62, d, J = 14 Hz) is rapidly converted at 25 °C to a closely related compound (presumably the mixed anhydride) with δ 5.73, d, J = 15.5 Hz.[9] This solution gives no **3** (or its anhydide) after 3 days at 75 °C, nor does it show any coloring.[5]

Micellar Effects on the Monohalogenation of *n*-Pentyl Phenyl Ether

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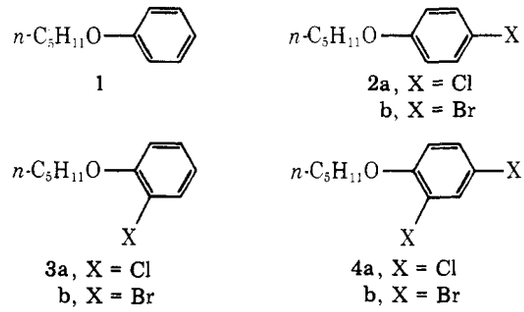
Micellar catalysis of organic reactions has been studied with numerous and diverse systems.[1] However, the synthetic application of micellar catalysis has received limited attention,[2] although stereochemical control has been the subject of several investigations.[3] If a substrate with several potential reaction sites is solubilized by a micelle in a specific manner, it is conceivable that some control of regioselectivity might accompany micellar catalysis of a given reaction.

We have examined the ability of micellar catalysis to influence the regioselectivity of two electrophilic aromatic substitution reactions of *n*-pentyl phenyl ether (**1**).[4] Ether **1**



1 2a, X = Cl; b, X = Br

3a, X = Cl; b, X = Br 4a, X = Cl; b, X = Br

was monochlorinated with chlorine and hypochlorous acid in aqueous micellar sodium lauryl sulfate (NaLS) and was monobrominated with bromine in aqueous micellar NaLS, sodium laurate (NaL), and cetyltrimethylammonium bromide (CTABr), and the ratios of para (**2**) to ortho (**3**) products were determined.[5] For each run, the concentration of **1**, halogenating agent, and micelle was 2.0×10^{-4} M. After the reaction period, the ether product mixture was isolated by one of two methods. In the first, the micellar solution was eluted through a column of ion-exchange resin (Dowex 2-X8 for NaLS and Bio-Rex 70 for CTABr runs). The surfactant and organic material both were retained by the column, and the latter was recovered by elution with methanol and ether. In the second method, organic material was extracted into hexane as surfactant was precipitated by the slow addition of calcium chloride (for NaLS and NaL runs) or sodium perchlorate (for CTABr runs) to a vigorously stirred mixture of micellar solution and hexane. Recoveries by the two methods were comparable, but the latter was quicker and therefore preferred.

The isolated product mixtures were analyzed by GLC after the addition of a hydrocarbon internal standard. For each run where recovery based on starting material was <90%, a control demonstrated that para (**2**) and ortho (**3**) products do not fractionate on isolation.

Ether **1** also was monohalogenated with chlorine and bromine in water. For these runs the concentration of **1** was 6.7×10^{-5} M (saturated solution) and that of halogenating agent 4.0×10^{-5} M, and standard extraction procedures were used for isolation of products, which were analyzed by GLC. The results of all halogenation runs are given in Table I. For any run, no more than a trace, if any, of 2,4-disubstituted product **4** was detected.

Ultraviolet (UV) spectroscopy was used to assess the microenvironments of chlorine, bromine, and **1** in micellar media. A comparison of the UV spectra of chlorine and bromine in micellar NaLS with those in water and heptane led to the conclusion that in micellar NaLS chlorine and bromine do not reside in the micelle hydrocarbon core, but rather in an aqueous environment; the same is assumed for hypochlorous acid. It is further assumed that in micellar NaL and CTABr bromine resides in an aqueous environment. An analogous comparison of the spectra of **1** in micellar NaLS, NaL, and CTABr with those in water, heptane, and 40:60 (v/v) water–dioxane led only to the conclusion that in the micellar media the phenoxy group of **1** does not reside in the bulk aqueous phase. Furthermore, by UV spectroscopy it was demonstrated

Table I. Results of Monohalogenation of *n*-Pentyl Phenyl Ether (1) at 22 ± 3 °C

Run[a]	Solvent[b]	Halogenating agent[c]	Reaction time, h	% recovery of 1 + 2 + 3[d,e]	% yield of 2 + 3[d,f]	*p*/*o* ratio[g] (2/3)
1	aq NaLS	Cl_2	90	95	93	3.1
2	aq NaLS	Cl_2	90	94	94	3.1
3	aq NaLS	HOCl	68	98	98	2.6
4	aq NaLS	HOCl	90	74	71	2.5
5	H_2O	Cl_2	20		15	1.6
6	H_2O	Cl_2	20		10	1.7
7	aq NaLS	Br_2	40	80	79	114
8	aq NaLS	Br_2	40	70	70	108
9	aq NaL	Br_2	68	98	92	24
10	aq NaL	Br_2	68	86	80	22
11	aq CTABr	Br_2	68	70	65	31
12	aq CTABr	Br_2	68	78	73	30
13	H_2O	Br_2	5		16	20
14	H_2O	Br_2	5		21	21

[a] Concentration of 1 was 6.7×10^{-5} M for runs in H_2O and 2.0×10^{-4} M for all other runs. [b] Aqueous micellar solutions were 2.0×10^{-4} M in micelles. [c] Concentration was 4.0×10^{-5} M for runs in H_2O and 2.0×10^{-4} M for all other runs. [d] For runs in micellar media, based on original amount of 1 and determined by GLC analysis using an internal standard. [e] Not determined for runs in H_2O. [f] For runs in H_2O, based on GLC analysis of recovered mixture of **1**, **2**, and **3**. [g] Determined by GLC analysis.

that 1 was completely solubilized in the runs in micellar media.

The results of Table I clearly indicate that micellar catalysis can affect the regioselectivity of monohalogenation. For **1** with chlorine in water, the para/ortho ratio (**2a/3a**) was 1.6 (runs 5 and 6), and that in micellar NaLS was 3.1 (runs 1 and 2). Likewise, with hypochlorous acid the para/ortho ratio of 2.6 in micellar NaLS (runs 3 and 4) is higher than the ratio of 1.41[6a] for anisole in water.[7]

For runs with bromine an effect on the para/ortho ratio (**2b/3b**) was observed with two of the three micellar media used. The para/ortho ratio of 111 (runs 7 and 8) obtained in NaLS is much greater than the ratio of 20 (runs 13 and 14) in water. In micellar NaL and CTABr ratios of 23 (runs 9 and 10) and 30 (runs 11 and 12), respectively, were obtained. The para/ortho ratio for each run in NaLS and CTABr is a minimum value for micellar-catalyzed monohalogenation, since some of the reaction undoubtedly proceeds in the bulk aqueous phase where the para/ortho ratio is lower.

On solubilization of 1 by a micelle, the phenoxy group most likely resides near the micelle surface, and the lipophilic *n*-pentyl chain extends into the hydrocarbon core. With this orientation for **1**, the ortho positions relative to the para position might be sterically shielded from the halogenating agent. As a result, for 1 solubilized by a micelle the fraction of substitution at the para position would be greater than that for 1 in water. The results of Table I are consistent with shielding of the ortho positions at the reactive sites for halogenation in NaLS and CTABr micelles, but not at that site in a NaL micelle. Alternatively, the results in micellar NaL are consistent with bromination which occurs almost totally in the bulk aqueous phase, but this is unlikely. In addition to those outlined above, the results must reflect additional medium and electrostatic factors,[9] but their effects are difficult to assess.

The results indicate that micellar catalysis has a potential application in the control of regioselectivity in organic synthesis, and we are pursuing this further.

Experimental Section

All melting and boiling points are uncorrected. Routine GLC analyses and preparative separations were performed on two columns: column A, 5 ft × ¼ in. stainless steel packed with 3% SE-30 on 100–120 mesh Varaport 30; and column B, 4.5 ft × ¼ in. aluminum packed with 3% SE-30 on 80–100 mesh Chromosorb W. The GLC analyses of product mixtures from the runs of Table I were performed on column C, 8 ft × ¼ in. aluminum packed with 8% SE-30 on 60–80 mesh Chromosorb W AW DMCS. Column oven temperatures of 150 and 180 °C, respectively, were used for chlorination and bromination product analyses. Ultraviolet spectra were obtained with a Beckman DB ultraviolet spectrophotometer and quartz 1-cm cuvettes and with a Cary 14 recording spectrophotometer and quartz 1-cm cuvettes or 10-cm cylindrical cells. Critical micelle concentrations (cmc) were determined by the ring method with a Cahn RM-2 electrobalance and surface tension accessory. Spectral grade dioxane and heptane (Mallinckrodt) were used for UV spectra, and tetrahydrofuran (THF) was distilled from lithium hydride before use. Combustion analyses were performed by Huffman Laboratories, Wheatridge, Colo., and by Galbraith Labororatories, Knoxville, Tenn.

Sodium Lauryl Sulfate (NaLS). Attempts to purify several commerical samples of NaLS were unsuccessful. The cmc of purified commercial material was $\leq 5 \times 10^{-3}$ M with serious hysteresis (lit.[10a] 8.1×10^{-3} M). Therefore NaLS was prepared as follows.

In standard fashion with methanol and sulfuric acid as catalyst lauric acid (Aldrich) was converted to methyl laurate, bp 93–95 °C (0.5 mm). By GLC analysis (column A) the ester was 99.8% pure, and it was reduced in THF with $LiAlH_4$ to give lauryl alcohol, bp 98–100 °C (0.03 mm), mp 24–25 °C. By GLC analysis (column B) this material was homogeneous, and with the procedure of Sandler and Karo,[11] 24.7 g (0.133 mol) of it was converted to laurylsulfuric acid with 11.2 g (0.140 mol) of SO_3 (Sulfan, Baker). Then the crude acid was added to an ice-cold solution of 5.6 g (0.14 mol) of NaOH in 130 mL of water followed by 500 mL of ice-cold methanol. The resultant solid was collected by filtration and recrystallized from methanol. Then a methanol solution of this material was decolorized three times with Norit and evaporated to leave NaLS with a cmc of 5.5×10^{-3} M with serious hysteresis. This NaLS was dissolved in a minimum amount of water at 25 °C, and the solution was cooled to 8 °C. The material which crystallized had a cmc of 6.3×10^{-3} M with only slight hysteresis, and it was combined with NaLS of similar purity from two parallel preparations starting with a total of 316 g of lauryl alcohol. The combined material was recrystallized from water and then from absolute ethanol to yield 107 g (20%) of NaLS with a cmc of 7.1×10^{-3} M with no hysteresis (lit.[10a] 8.1×10^{-3} M).

Sodium Laurate (NaL). A total of 300 g (1.50 mol) of lauric acid (Aldrich) was converted to its sodium salt following an established procedure.[12] The resulting crude material was recrystallized from methanol three times to give NaL with a cmc of 1×10^{-2} M (lit.[13] 2.4×10^{-2} M). This material was slurried twice in ether and once in hexane to give 86.0 g (26%) of NaL with a cmc of 2.1×10^{-2} M with slight hysteresis.

Cetyltrimethylammonium Bromide (CTABr). A 75.0-g portion of CTABr (Aldrich) was washed with hexane and recrystallized from methanol. Two crops were collected, 39.5 g total, and each had a cmc of 9.1×10^{-4} M with no hysteresis (lit.[10b] 9.2×10^{-4} M).

***n*-Pentyl Phenyl Ether (1) and Substituted *n*-Pentyl Phenyl Ethers (2, 3, and 4).** Each of the ethers was prepared by a standard Williamson procedure[14] using the appropriate combination of *n*-pentyl bromide and phenol or substituted phenol. In each preparation fractional distillation gave purified material which was homogeneous

Table II.[a] Physical Properties of Ethers 1, 2, 3, and 4

Ether	Registry no.	Bp, °C
1[b]	2050-04-6	94–96 (23 mm)
2a[c]	51241-40-8	113–115 (0.5 mm)
2b[a]	30752-18-2	81–83 (0.05 mm)
3a[d]	51241-39-5	78–80 (0.1 mm)
3b[a]	60376-60-8	85–87 (0.1 mm)
4a[a]	63076-61-9	118–120 (0.1 mm)
4b[e]	63076-62-0	106–108 (0.01 mm)

[a] Satisfactory analytical data (±0.3% for C and H) were reported for all new compounds listed in the table. [b] Reference 4. [c] B. Jones, *J. Chem. Soc.*, 1831 (1935). [d] E. M. Van Duzee and H. Atkins, *J. Am. Chem. Soc.*, **57**, 147 (1935). [e] S. J. Branch and B. Jones, *J. Chem. Soc.*, 2921 (1955).

by GLC analysis (column A). Table II gives the physical data of the ethers prepared.

Halogenation of *n*-Pentyl Phenyl Ether (1) with Chlorine, Hypochlorous Acid, and Bromine in Aqueous Micellar Media (Runs 1–4 and 7–12). Chlorine (Matheson) and bromine (Mallinckrodt) were used as received, and hypochlorous acid was prepared as described by Brauer.[15] Halogenating agents were added to reaction mixtures as aqueous solutions standardized (ca. 0.005 M) with sodium thiosulfate–potassium iodide.[16] For each run the total volume was 500 mL, and the concentration of 1, micelle, and halogenating agent was 2.0×10^{-4} M. The following is the general procedure used.

All glassware to be exposed to micellar solution was cleaned with $Na_2Cr_2O_7$–H_2SO_4 cleaning solution and rinsed in sequence with water, dilute ammonia, and water. To a 1-L Erlenmeyer flask was added 16.4 mg (0.100 mmol) of **1**. Then an amount of surfactant was added in the form of a stock solution, which on subsequent dilution to 500 mL gave a micelle concentration of 2.0×10^{-4} M (see below). The exact volume (ca. 20 mL) of standarized aqueous halogenating solution needed to give a final concentration of 2.0×10^{-4} M was calculated, and the micellar solution was diluted with water to 500 mL minus this volume. After the reaction mixture was swirled to dissolve **1**, the calculated volume of halogenating agent solution was added, and the mixture was swirled again and allowed to sit (in the dark for brominations) at room temperature (22 ± 3 °C). After the appropriate period, products were isolated by one of the two methods described below.

The amount of surfactant necessary to give a micelle concentration of 2.0×10^{-4} M was calculated using the cmc and aggregation number[1c] (62 for NaLS, 56 for NaL, and 61 for CTABr). A micelle concentration of 2.0×10^{-4} M corresponds to concentrations of 1.95×10^{-2}, 2.22×10^{-2}, and 1.31×10^{-2} M for NaLS, NaL, and CTABr, respectively.

Isolation of Products from Micellar Media. Two methods were used. In the first, a 5-in. aqueous bed of ion-exchange resin was prepared in a 1-in. (o.d.) glass column and washed with 550 mL of methanol followed by 1 L of water. Dowex 2-X8 (chloride form, 20–50 mesh) was used for NaLS solutions and Bio-Rex 70 (sodium form, 80–100 mesh) for CTABr solutions. The micellar reaction mixture was passed through the column three to four times until there was no visual residual surface activity. In this process organic material also was retained by the resin, and it was recovered by elution with 200 mL of methanol followed by 100 mL of ether. Rotary evaporation of the combined eluates left an oil which was extracted into hexane. The resulting hexane solution was dried over Na_2SO_4, and rotary evaporation yielded the product mixture.

In the second, extraction of the product mixture into hexane was facilitated by precipitation of the surfactant. The lauryl sulfate ion of NaLS and the laurate ion of NaL were precipitated with $CaCl_2$ and the cetyltrimethylammonium ion of CTABr with $NaClO_4$. To a vigorously stirred mixture of 500 mL of micellar solution and 150 mL of hexane was added a molar equivalent of precipitating agent dissolved in 30 mL of water. Stirring was continued for 10 min, the hexane layer was separated, and the aqueous layer including precipitate was extracted three times in the same manner using 100-mL portions of hexane. The combined hexane extracts were dried over Na_2SO_4, and rotary evaporation yielded the product mixture.

Analysis of Product Mixtures Isolated from Micellar Media. To each product mixture was added a known weight of 1-phenyldecane as internal standard, and analysis was performed by GLC. Appropriate known mixtures of **1**, **2**, **3**, **4**, and 1-phenyldecane were analyzed by GLC, and correction factors for differences in thermal conductivity were calculated relative to the internal standard and used in quantitation of analyses. For integration the cut-and-weigh method was employed with Keuffel and Esser Albanene tracing paper.

The product mixtures isolated from runs in aqueous NaLS contained small amounts of lauryl alcohol. The retention time of **2a** was identical with that of this material, so product mixtures from runs 1, 2, 3, and 4 were treated as follows after the addition of 1-phenyldecane in order to convert lauryl alcohol into lauryl acetate, which did not interfere with the GLC analysis. To a solution of the product mixture and internal standard in 10 mL of THF were added 1 mL each of pyridine and acetyl chloride. The resulting mixture was stirred for 2 h at room temperature and diluted with 10 mL of methanol. After 10 min at room temperature the mixture was concentrated by rotary evaporation and extracted with hexane. The resulting hexane solution was washed with 5 mL of 5% aqueous NaOH followed by 5 mL of water and was then dried over Na_2SO_4 and rotary evaporated to leave the product mixture for analysis.

Product mixtures isolated from runs 9 and 10 in aqueous NaL contained small amounts of lauric acid, which had a retention time identical with that of **3b**. Therefore, after the addition of internal standard, lauric acid was removed by extraction of a hexane solution with 10% aqueous NaOH. Then the solution was washed with water, dried over Na_2SO_4, and rotary evaporated to leave the product mixture for analysis.

For each run where <90% (based on internal standard) of total ether was recovered in form of **1**, **2**, and **3**, a control demonstrated that **2** and **3** do not fractionate during isolation.

Halogenation of *n*-Pentyl Phenyl Ether (1) with Chlorine and Bromine in Water (Runs 5, 6, 13, and 14). A saturated solution of **1** (6.7×10^{-5} M) was prepared by stirring an excess of **1** with water at room temperature for 2 h. The solution was allowed to stand overnight and was then separated from undissolved ether. To a 500-mL portion of this solution was added 2.0×10^{-5} mol of chlorine in the form of 2.27 mL of a 8.82×10^{-3} M aqueous solution, and to another 500-mL portion was added 2.0×10^{-5} mol of bromine in the form of 4.94 mL of a 4.05×10^{-3} M aqueous solution. Each mixture was swirled and allowed to sit at room temperature for the appropriate reaction period. Then it was quenched with Na_2SO_3, saturated with NaCl, and extracted with three 100-mL portions of hexane. The combined extracts were dried over Na_2SO_4 and rotary evaporated to give the product mixture, which was analyzed by GLC. For integration the cut-and-weigh method was used, and correction factors for differences in thermal conductivity were used in quantitation of analyses.

Ultraviolet Spectroscopy of *n*-Pentyl Phenyl Ether (1). The spectrum of a 2.0×10^{-4} M solution of **1** in heptane displayed absorption maxima at 278 (ϵ 1899) and 272 nm (ϵ 2045) and in 40:60 (v/v) water–dioxane at 278 (ϵ 1454) and 272 nm (ϵ 1763).

The spectrum of a 1.05×10^{-4} M solution of **1** in a 1.95×10^{-2} M aqueous solution of NaLS (micelle concentration of 2.0×10^{-4} M) displayed absorption maxima at 278 (ϵ 1231), 272 (ϵ 1550), and 220 nm (ϵ 7406).[17] Then 7.9 mg (0.048 mmol) of **1** was added to 200 mL of the same NaLS solution, and the mixture was shaken periodically for 2 h and allowed to sit overnight. A sample was withdrawn with the exclusion of any undissolved **1** at the surface and its spectrum recorded. The absorbance of the absorption maximum at 272 nm was 0.377 with 1-cm cuvettes, and this corresponds to a concentration of 2.4×10^{-4} M. Therefore, for runs 1–4 it can be concluded that the 16.4-mg (0.100 mmol) portion of **1** was completely dissolved in the 500 mL of 1.95×10^{-2} M aqueous NaLS.

Solutions were prepared in 2.22×10^{-2} M NaL and 1.31×10^{-2} M CTABr with amounts of **1** that would give each a concentration of 2.0×10^{-4} M if all of **1** dissolved, and absorbance values of the maximum at 272 nm with 1-cm cuvettes were 0.304 and 0.327, respectively. If it is assumed that the molar extinction coefficients for **1** at 272 nm in NaL and CTABr are the same as that for **1** in NaLS, then it can be calculated that **1** is almost if not completely solubilized in both solutions. The spectrum of the NaL solution displayed maxima at 278 (ϵ 1236) and 272 nm (ϵ 1523) and that of the CTABr solution maxima at 279 (ϵ 1378) and 272 nm (ϵ 1630).

The spectrum of a 2.56×10^{-5} M solution of **1** in water displayed absorption maxima at 275 (ϵ 985), 268 (ϵ 1204), and 218 nm (ϵ 6337). Then a saturated aqueous solution of **1** was prepared, and a sample was withdrawn with exclusion of undissolved **1** at the surface and its spectrum recorded. The absorbance of the maximum at 268 nm was 0.081 with 1-cm cuvettes, and this corresponds to a concentration of 6.7×10^{-5} M.

Ultraviolet Spectroscopy of Chlorine and Bromine. Spectra were obtained for 5×10^{-3} M solutions of chlorine in water, aqueous NaLS, 40:60 (v/v) water–dioxane, and heptane. The concentration of NaLS was 0.32 M, which corresponds to a micelle concentration

of 5.0×10^{-3} M. The following absorption maxima (nm) were observed: for water, 292 (ε 24); for aqueous NaLS, 290 (ε 37); for aqueous dioxane, 306 (ε 55); and for heptane, 330 (ε 258).

Spectra were obtained for 2.0×10^{-4} M solutions of bromine in water, aqueous NaLS, and heptane. The concentration of NaLS was 1.95×10^{-2} M, which corresponds to a micelle concentration of 2.0×10^{-4} M. The following absorption maxima (nm) were observed: for water, 260 (shoulder, ε 83) and 392 (ε 82); for aqueous NaLS, 260 (shoulder, ε 66) and 392 (ε 76); and for heptane, 417 (ε 157).

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Registry No.—NaLS, 151-21-3; NaL, 629-25-4; CTABr, 57-09-0; lauric acid, 143-07-7; methyl laurate, 111-82-0; lauryl alcohol, 112-53-8; laurylsulfuric acid, 151-41-7.

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(4) J. V. Braun, H. Deutsch, and A. Schmatloch, *Ber.*, **45**, 1246 (1912).

(5) In a related study Breslow and co-workers[6] have examined the influence of cyclodextrins on the regioselectivity of anisole monochlorination in aqueous hypochlorous acid.

(6) R. Breslow and P. Campbell, *J. Am. Chem. Soc.*, **91**, 3085 (1969); (b) R. Breslow and P. Campbell, *Bioorg. Chem.*, **1**, 140 (1971); (c) R. Breslow, H. Kohn, and B. Siegel, *Tetrahedron Lett.*, 1645 (1976).

(7) A comparison with different substrates is being made, but it can be reasonably assumed that in aqueous hypochlorous acid **1** would give a para/ortho ratio very close to that reported for anisole. Monochlorination of **1**, *n*-nonyl phenyl ether, and *n*-dodecyl phenyl ether in 40:60 (v/v) water–dioxane with hypochlorous acid gave para/ortho ratios of 3.2, 3.3, and 3.6, respectively.[8] These results indicate that in a homogeneous nonmicellar medium the para/ortho ratio is influenced only slightly by chain length.

(8) D. A. Jaeger and R. E. Robertson, unpublished results.

(9) For example, the micelle surface pH should increase on going from NaLS to NaL to CTABr.

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Quinazolines and 1,4-Benzodiazepines. 80.[1] 1-Hydroxy-1,3-dihydro-2*H*-1,4-benzodiazepin-2-one, a Hydroxamic Acid via an Amidine *N*-Oxide

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We wish to record the preparation of a novel class of 1,4-benzodiazepines which contain oxygenated nitrogen atoms in position 1. Also of interest was the preparation of the amidine *N*-oxide[2] **2** by peracid oxidation of amidine **1**[3] and the efficient hydrolysis of compound **2** to the hydroxamic acid **3**.

When a solution of 7-chloro-2-amino-5-phenyl-3*H*-1,4-benzodiazepine 4-oxide (**1**)[4] in methylene chloride was treated with a slight excess of *m*-chloroperbenzoic acid at room temperature, oxidation was complete in minutes and the amidine *N*-oxide **2** was readily isolated, as yellow prisms, in 47% yield (Scheme I). Compound **2** was soluble in both dilute aqueous acids and bases, and was very susceptible to hydrolysis. For example, if a solution of **2** in aqueous acetic acid was allowed to stand at room temperature, the insoluble hydroxamic acid **3** precipitated and was obtained in 88% yield. Mild treatment of **2** with anhydrous hydrogen sulfide afforded a complex mixture from which only 5-chloro-3-phenyl-2,1-benzisoxazole[5] (**4**) was isolated (49%). The same degradation product **4** was obtained (87% yield) when the hydroxamic acid **3** was dissolved in 1 N sodium hydroxide at room temperature. An attempt to deoxygenate the 4-oxide function of **3** with triethyl phosphite resulted in a simultaneous reduction of the hydroxamic acid to the lactam–imine, compound **6**,[6] which was isolated in 24% yield. The acidic character of the hydroxamic acid was evident by the smooth O-methylation of **3** with diazomethane to give **8**. When **3** was heated in acetic anhydride, the 1,3-diacetoxy derivative **5** was obtained. Mild alkaline hydrolysis of **5** afforded a mixture of the 1,3-dihydroxy compound **7** and the 2,1-benzisoxaole **4**, which again indicated the destabilizing influence of the 1-hydroxy substituent on the benzodiazepine ring toward cleavage by nucleophiles.

A comparison of the NMR and UV spectra of **2** and **3** indicated that none of the hydroxyamidine tautomer **9** exists in

Scheme I