of the C(2) methyl group were noted. More $Eu(FOD)_3$ was added, and the spectrum was again recorded. This addition-recording sequence was performed a total of five times. The maximum mole ratio (σ) of $Eu(FOD)_3$ to **4** (or **5**) was 0.02. Plots of chemical shift differences ($\Delta\delta$, in ppm) against mole ratio (σ) were linear ($\Delta\delta = a + \rho\sigma$) and had correlation coefficients ≥0.999. The plots are shown in Figures 1, 2, and 3 of the supplementary material for the C(6) proton, the C(2) proton, and the C(2) methyl group protons, respectively. Compounds **4** and **5** showed a similar downfield shift of the signal due to the proton at C(6) (ρ = 1810 for **4** and ρ = 1904 for **5**). The extent of the shift was typical of a proton syn to the oxygen atom. Moreover, the signals of the proton at C(2) of **5** (ρ = 1516) and the methyl group protons at C(2) of **4** (ρ = 1090) showed a similar, but more pronounced, shift than those of the proton at C(2) of **4** (ρ = 845) and the methyl group protons at C(2) of **5** (ρ = 594). These data demonstrated that the two isomers were epimeric at C(2). In the major isomer **4** a syn relationship existed between the oxygen atom and the C(2) methyl group, whereas in the minor isomer **5** an anti relationship existed between these substituents. ASIS studies gave similar results.

Supplementary Material Available: Figures 1, 2, and 3 and tables of IR, MS, ^1H NMR ($CDCl_3$), and ^{13}C NMR ($CDCl_3$) spectroscopic data for *trans*- and *cis*-thiopyran *S*-oxides (5 pages). Ordering information is given on any current masthead page.

$S_{RN}1$-Based Methodology for Synthesis of Naphthylquinolines and Naphthylisoquinolines[1]

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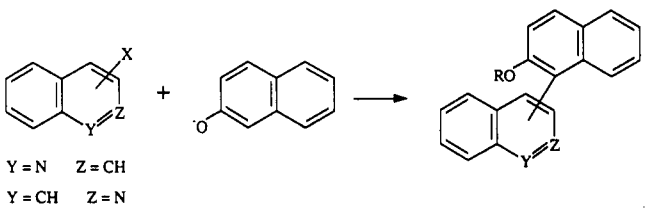
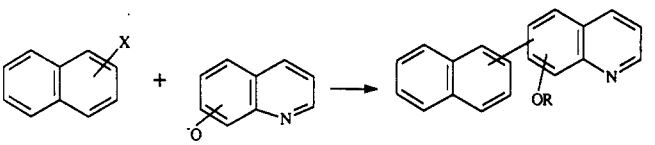
A versatile $S_{RN}1$ methodology allows straightforward access to title compounds via two strategies: (A) cross-coupling reactions of halobenzopyridine derivatives with anions from 2-naphthol or conversely of iodonaphthalene with anions from hydroxyquinoline and (B) total synthesis from either acetylchloropyridines in which the acetyl and chloro groups are ortho to each other or *o*-bromobenzamide treated with anions from acetonaphthone.

A research project in the field of bioorganic chemistry led us some time ago to devise a $S_{RN}1$ methodology[2] for synthesis of unsymmetrically substituted 2,2′-binaphthalene derivatives.[3a,b] To the best of our knowledge, no general method for synthesizing their aza analogues naphthylbenzopyridine derivatives (Figure 1) has been reported. The naphthylisoquinoline alkaloids encountered in Ancistrocladaceae have not been synthesized by direct methods like the classical Ullmann reaction, which has afforded only trace amounts of the mixed coupling product.[4] Moreover, there are only scattered reports in the literature on the preparation of this class of compounds.[5]

Scheme I



Scheme II



The synthesis of the related phenylpyridine derivatives[6-8a,b] could possibly be adapted to our purpose, but we considered that $S_{RN}1$ chemistry might provide easy and versatile access to naphthylquinoline and naphthylisoquinoline derivatives. Indeed, two direct routes appeared feasible: (A) regiospecific cross coupling between naphthyl and benzopyridyl moieties and (B) total synthesis from

(1) $S_{RN}1$ Studies. 26. Previous reports include the following: (a) Amatore, C.; Beugelmans, R.; Bois-Choussy, M.; Combellas, C.; Thiebault, A. *J. Org. Chem.* **1989**, *54*, 5688. (b) Symons, M. C. R.; Beugelmans, R.; Bowman, W. R.; Lechevallier, A. *Tetrahedron Lett.* **1989**, *30*, 5949. (c) Part 25: ref 3.

(2) Aromatic nucleophilic substitution reactions via chain radical mechanism ($S_{RN}1$) were discovered in 1970 by J. F. Bunnett and were investigated by his group and others since then. Those reactions require no strong activating groups, are compatible with many electron-withdrawing or -releasing substituents, and are regiospecific. An account was given by J. F. Bunnett (Acc. *Chem. Res.* **1978**, *11*, 413) and a general treatment by R. A. Rossi and R. H. de Rossi (*Aromatic Substitution by the $S_{RN}1$ Mechanism*; ACS Monograph 178; American Chemical Society: Washington, DC, 1983). For a review of synthetic extensions, see: Beugelmans, R. *Bull. Soc. Chim. Belg.* **1984**, *93*, 547.

(3) (a) Beugelmans, R.; Bois-Choussy, M.; Tang, Q. *J. Org. Chem.* **1987**, *52*, 3880. (b) Beugelmans, R.; Bois-Choussy, M.; Tang, Q. *Tetrahedron* **1989**, *45*, 4302.

(4) Bringman, G.; Jansen, J. R. *Tetrahedron Lett.* **1984**, *25*, 2537. For a review, see: Bringman, G. The Naphthylisoquinoline Alkaloids. In *The Alkaloids*; Brossi, A., Ed.; Academic Press: New York, 1986; Vol. 29, Chapter 3, p 141. Photochemical mixed aryl coupling of the two molecular moieties prelinked by a benzyl ether bridge was the key step of the nonbiomimetic total synthesis of naphthylisoquinoline alkaloids (pp 173-181).

(5) Nelson, N. A.; Paquette, L. A. *J. Org. Chem.* **1962**, *27*, 964. Reacting 6-methoxy-2-tetralone with (6-ethoxy-2-pyridyl)lithium was the key step of the mixed coupling reaction.

(6) Akiba, K.-Y.; Yseki, Y.; Wada, M. *Tetrahedron Lett*, **1982**, *23*, 429 and references cited therein. The authors have found that $PhCuBF_3$ in THF was superior to other organometallic reagents for synthesis of 4-phenylpyridine from *N*-(ethoxycarbonyl)pyridinium chloride.

(7) Thompson, W. J.; Gaudino, J. *J. Org. Chem.* **1984**, *49*, 5237 and references cited therein. The authors report that arylboronic acids were found to couple efficiently with 5-bromonicotinates to yield 5-arylnicotinates, but that the reaction was sensitive to steric inhibition in the arylboronic acid component.

(8) (a) Sharp, M. J.; Cheng, W.; Snieckus, V. *Tetrahedron Lett.* **1987**, *28*, 5093. (b) Cheng, W.; Snieckus, V. *Tetrahedron Lett.* **1987**, *28*, 5097. 2-Arylpyridines and heteroterphenyl were obtained by Pd^0-catalyzed cross coupling of arylboronic acids with aryl bromides.

0022-3263/91/1956-2518$02.50/0

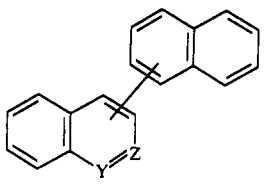
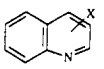
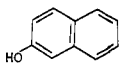
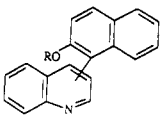
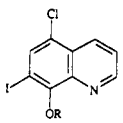
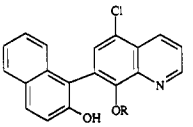
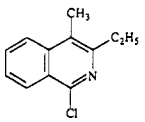
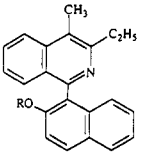
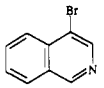
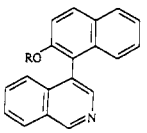


Figure 1.

Table I. $S_{RN}1$ Cross-Coupling Products from Haloquinolines 1–4 or Haloisoquinolines 7 and 8 with Nucleophiles Derived from 2-Naphthol (Approach A1)

substrate	nucleophile from	product (yield, %)[a]
		
1, 2-Cl 2, 3-Br 3, 4-Cl	5 5 5	**6a** (70) **6b** (85) **6c** (70)
		
4	**5**	**6d** (50)
		
7	**5**	**9a** (50)
		
8	**5**	**9b** (74)

[a] Yields are given for R = $CH(CH_3)_2$ (ref 15).

acetylhalopyridines in which the acetyl and halo groups are ortho to each other or *o*-halobenzamide and acetonaphthone enolate anions.

Results and Discussion

A. Cross-Coupling Reactions. Azabinaphthyl compounds can be obtained by $S_{RN}1$ cross-coupling reactions between either benzopyridine substrates bearing a leaving group (X = I, Br, Cl) and naphthol-derived nucleophiles (approach A1) or halonaphthalenes and nucleophiles derived from hydroxyquinoline or hydroxyisoquinolines (approach A2).

Approach A1. This approach (Scheme I) requires naphthol-derived nucleophiles—reported recently to react with substituted aryl halides[9-11]—and haloquinolines which belong to a well-documented class of substrates for $S_{RN}1$ reactions.[12-14] However, cross-coupling reactions leading to naphthylquinoline or isoquinoline derivatives had not yet been performed.

Photostimulated reactions of 2-, 3-, or 4-haloquinolines with the anion obtained from 2-naphthol (**5**) by t-C_4H_9OK in dimethyl sulfoxide led exclusively to the corresponding (hydroxynaphthyl)quinolines **6a–c** in good yields[15] (Table I). The more highly substituted 5-chloro-7-iodo-8-isopropoxyquinoline (**4**) was known from previous studies[14] to generate a radical at position 7 after selective extrusion of I^- as a leaving group; with the 2-naphthoate anion this latter substrate led to **6d**, which carries not only hydroxyl group on the naphthyl subunit but also hydroxyl and chlorine substituents on the quinolyl moiety.

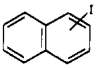
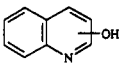
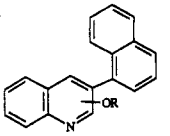
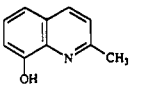
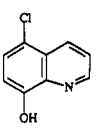
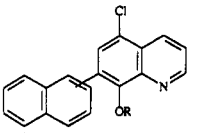
Reactions of the 2-naphthoate anion with a 1-chloroisoquinoline such as **7** or with 4-bromoisoquinoline (**8**)—the sole haloisoquinoline reported to behave as a substrate for $S_{RN}1$ reactions[16]—yielded the corresponding (2-hydroxynaphthyl)isoquinolines **9a,b** (Table I).

$S_{RN}1$ reactions of the 1-naphthoate anion were known from our previous studies[9,10] to afford mixtures of 2-aryl-, 4-aryl-, and 2,4-diaryl-1-naphthol derivatives, and therefore this nucleophile was not used in the present investigation.

Approach A2. The second access, depicted in Scheme II, is based upon reactions between halonaphthalenes—a well-known group of substrates for $S_{RN}1$ reactions[10,11,13,17a-c]—and anions derived from hydroxyquinoline or hydroxyisoquinoline which had not been mentioned in the literature as potential nucleophiles.

Reaction of iodonaphthalene **10** with anions from 2- or 4-hydroxyquinoline (**11** or **12**) afforded naphthylhydroxyquinolines resulting from selective attack of the 1-naphthyl radical on position 3, which was the sole car-

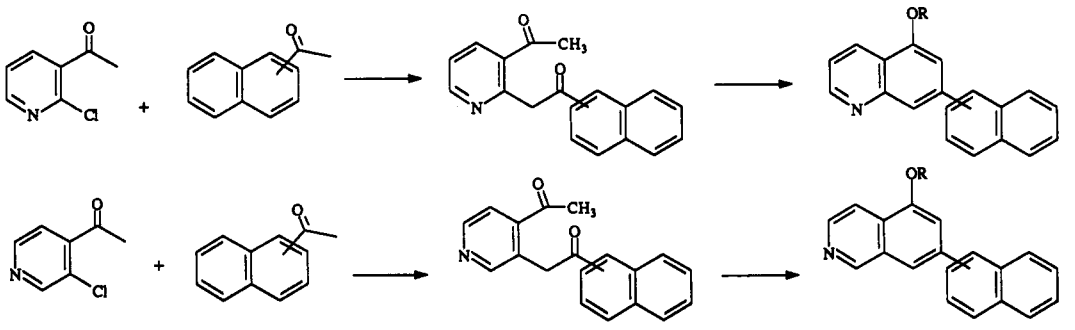
Table II. $S_{RN}1$ Cross-Coupling Products from 1- or 2-Iodonaphthalene with Nucleophiles Derived from Hydroxyquinolines 11–14 (Approach A2)

substrate	nucleophile from	product (yield, %)[a]
		
10, 1-I 10	11, 2-OH 12, 4-OH	15a (20) 15b (15)
		
10	13	15c (50)[b]
		
10 16, 2-I	14 14	15d (51) 17 (40)

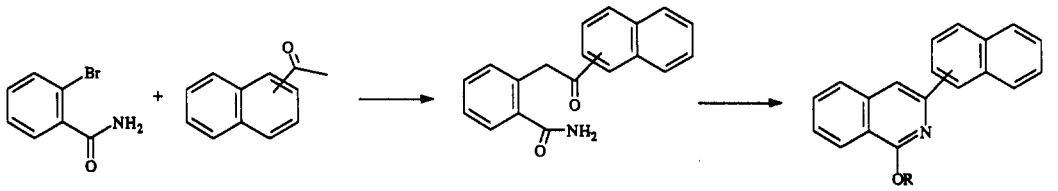
[a] Yields are given for R = $CH(CH_3)_2$ (ref 15). [b] Mixture of 8-isopropoxy-5-(1-naphthyl)-, -7-(1-naphthyl)-, and -5,7-bis(1-naphthyl)quinoline.

(9) Beugelmans, R.; Bois-Choussy, M. *Tetrahedron Lett.* **1988**, *29*, 1289.
(10) Beugelmans, R.; Bois-Choussy, M.; Tang, Q. *Tetrahedron Lett.* **1988**, *29*, 1705.
(11) Pierini, A. B.; Baumgartner, M. T.; Rossi, R. A. *Tetrahedron Lett.* **1988**, *29*, 3429.
(12) Hay, J. V.; Wolfe, J. F. *J. Am. Chem. Soc.* **1975**, *97*, 3702.
(13) Rossi, R. A.; Palacios, S. M. *J. Org. Chem.* **1981**, *46*, 5300.
(14) Beugelmans, R.; Bois-Choussy, M.; Gayral, P.; Rigothier, M. C. *Eur. J. Med. Chem.* **1988**, *23*, 539.
(15) Primary $S_{RN}1$ products bearing a free hydroxyl function are generally poorly soluble except in dipolar aprotic solvents such as DMSO or DMF and were purified in the form of isopropyl ethers, deprotection of which was not effected.
(16) Zoltewicz, J. A.; Oestreich, T. M. *J. Am. Chem. Soc.* **1973**, *95*, 6683.
(17) (a) Bunnett, J. F.; Sundberg, J. E. *Chem. Pharm. Bull.* **1975**, *23*, 2620. (b) Rossi, R. A.; de Rossi, R. H.; Lopez, A. F. *J. Am. Chem. Soc.* **1976**, *98*, 1252. (c) Beugelmans, R.; Ginsburg, H. *Tetrahedron Lett.* **1987**, *28*, 413.

Scheme III



Scheme IV



banionic site available. Derivatives **15a** or **15b** were thus obtained in rather low yield because of efficient reduction of the 1-naphthyl radical, which led to large amounts of naphthalene. This competitive reaction is a well-documented chain-termination step in the $S_{RN}1$ process.[2,18a,b]

2-Methyl-8-hydroxyquinoline (**13**) has carbanionic sites available on positions 5 and 7 so that reaction with **10** led to an intractable mixture **15c** resulting from attack of the 1-naphthyl radical on each or on both positions. In contrast, a clean reaction took place with **14**, which had only one carbanionic site available on position 7, position 5 being substituted by an inert chlorine atom. Likewise, **17** was the sole product from the reaction of **14** with 2-iodonaphthalene (**16**) (Table II).

Because yields of reactions with nucleophiles derived from hydroxyquinolines were low to moderate, we have not extended further this study to nucleophiles derived from hydroxyisoquinolines.

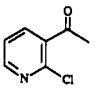
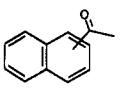
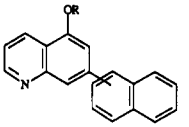
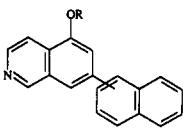
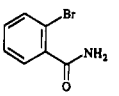
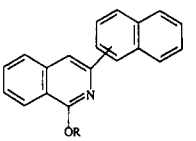
B. Total Synthesis. The strategy for total synthesis derived from that developed in our laboratory for preparing unsymmetrically substituted binaphthyl derivatives,[2,3] involves $S_{RN}1$ reactions of 1- or 2-acetonaphthone-derived enolates as nucleophiles with appropriate substrates: acetylhalopyridines in which the acetyl and halo groups are ortho to each other which have a built-in heterocycle (approach B1, Scheme III) or *o*-halobenzamides bringing in the heteroatom to become ultimately incorporated in the heterocycle (approach B2, Scheme IV).

Approach B1. In the former approach (Scheme III), 3-acetyl-2-chloropyridine (**18**) was reacted with the anion derived from 1- or 2-acetonaphthone (**19** or **20**) to afford 5-hydroxy-7-(1- or 2-naphthyl)quinoline (**21a** or **21b**) in good yield. The deoxybenzoin was the $S_{RN}1$ product resulting from attack of the corresponding acetylpyridyl radical on the carbanion, and it underwent cyclization in the medium to give the quinolyl moiety of the naphthylquinoline target molecule. The isomeric 4-acetyl-3-chloropyridine (**22**) behaved similarly and led to 5-hydroxy-7-(1- or 2-naphthyl)isoquinoline (**23a** or **23b**).

Approach B2. The second approach, B2, depicted in Scheme IV, was exemplified by the reactions of *o*-bromobenzamide (**24**) with enolate anions derived from acetonaphthones **19** and **20**. Heterocyclization involving the amide and carbonyl groups occurred in the medium as already observed[19,20] to form the isoquinoline subunit of the target molecules.

Results of approaches B1 and B2 are summarized in Table III.

Table III. $S_{RN}1$ Total Synthesis of Naphthylquinolines 21a,b and Naphthylisoquinolines 21c–f by Approaches B1 and B2

substrate	nucleophile from	product (yield, %)[a]
		
18	**19**, 1-$COCH_3$ **20**, 2-$COCH_3$	**21a** (87) **21b** (75)
		
22	**19**, 1-$COCH_3$ **20**, 2-$COCH_3$	**23a** (70) **23b** (63)
		
24	**19**, 1-$COCH_3$ **20**, 2-$COCH_3$	**25a** (70) **25b** (60)

[a] Yields are given for R = $CH(CH_3)_2$ (ref 15).

Results of approaches B1 and B2 are summarized in Table III.

Mechanism. Anions derived from hydroxyquinolines **11–14** had not been used before as nucleophiles in $S_{RN}1$ chemistry, and therefore control experiments between the anion from 5-chloro-8-hydroxyquinoline (**14**) and the substrate 1-iodonaphthalene (**10**) were carried out. The reaction did not take place in the dark, indicating that photostimulation was necessary to trigger the first two steps (eqs 1 and 2) leading to the radical $Ar^{\bullet}$ via the radical anion $ArX^{\bullet-}$. Addition of a catalytic amount of galvinoxyl (10 mol %) to the photostimulated reaction medium re-

(18) (a) Bunnett, J. F.; Sundberg, J. E. *J. Org. Chem.* **1976**, *41*, 1702. (b) Semmelhack, M. F.; Bargar, T. M. *J. Org. Chem.* **1977**, *42*, 1481.

(19) Beugelmans, R.; Bois-Choussy, M. *Synthesis* **1981**, 729.

(20) Beugelmans, R.; Ginsburg, H.; Bois-Choussy, M. *J. Chem. Soc., Perkin Trans. 1* **1982**, 1149.

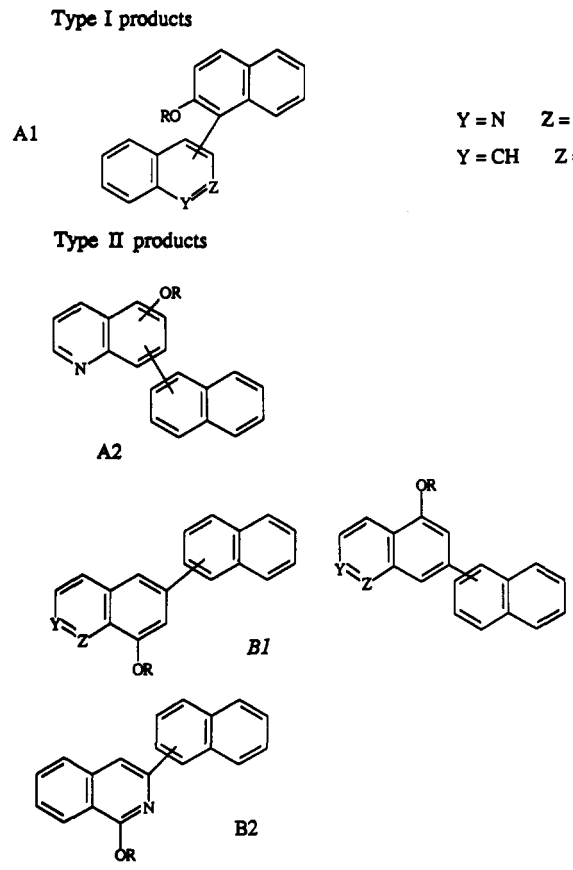
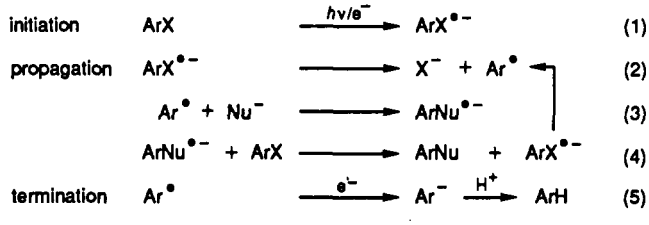


Figure 2.

duced the yield of the substitution product **15a** to 10%. This fact indicated that trapping of the intermediate radical Ar• had interrupted the chain propagation sequence (eqs 3 and 4).



The termination step (eq 5) was responsible for low yields, formation of naphthalene, and sluggishness of the reactions between the substrate **10** and the nucleophiles derived from **11** or **12**, due to competitive reduction of the radical Ar•. All these observations are consistent with the well-established $S_{RN}1$ mechanism.[2,18a,b]

Scope and Limitation

Cross-coupling reactions A1 and A2 together with total synthesis via approaches B1 and B2 give access to two types of products (Figure 2).

Type I products, obtained via A1, have a 2-hydroxynaphthalene subunit linked to the quinolyl or isoquinolyl moiety at the site previously occupied by the leaving group.

Type II products, obtained via approaches A2, B1, or B2, bear a hydroxyl group on various positions of the quinoline or isoquinoline moiety. Pathway A2 gives rise to products resulting from linkage of the 1- or 2-naphthalene component to the carbanionic site located ortho or para to the hydroxyl function and offers thus a large array of possibilities.

Total synthesis according to B1 is less versatile in that the 1- or 2-naphthalene moiety can be attached to the quinoline or isoquinoline subunit only on two positions, namely, 6 or 7, depending upon the substitution pattern of the acylhalopyridine in which the acyl and halo groups are ortho to each other. Pathway B2 leads to compounds where the 1- or 2-naphthalene moiety is attached to the isoquinoline in position 3.

In all cases, substrates and nucleophiles can bear functionalities such as OR, CO_2R, NH_2, etc. known to be compatible with the $S_{RN}1$ mechanism.[2] Thus, a great number of variously substituted naphthyl–heteroaryl compounds, in addition to those reported here, are obtainable by an appropriate choice of adequately substituted partners to be combined according to methods A1, A2, B1, or B2.

Experimental Section

Melting points are uncorrected. ^1H NMR spectra were recorded in $CDCl_3$. Purification of products was achieved by preparative thin-layer chromatography or by column chromatography on silica gel.

Materials. 1-Chloro-3-ethyl-4-methylisoquinoline (**7**) was prepared from the corresponding isocarbostyril[19] (0.500 g) dissolved in $POCl_3$ (5 mL) and refluxed under a nitrogen atmosphere for 1 h. $POCl_3$ was evaporated and 6 N HCl (10 mL) was added. After 15 min at room temperature, standard workup gave **7** (0.516 g, 96%) as crystals: mp 62–64 °C; ^1H NMR δ 1.33 (t, J = 7 Hz, 3 H) 2.50 (s, 3 H), 2.93, (q, J = 7 Hz, 2 H), 7.3–7.9 (m, 3 H), 8.05 (dd, 1 H): MS, m/z 207, 205 (M^+) 192, 190, 179, 177.

3-Acetyl-2-chloropyridine (**18**) was prepared from 3-acetylpyridine according to the literature.[21]

4-Acetyl-3-chloropyridine (**22**)[23] was prepared from 4-cyanopyridine.[22]

General Procedure for $S_{RN}1$ Reactions. To dry dimethyl sulfoxide (20 mL) under argon in a 100-mL Pyrex tube fitted with a septum were introduced 2-hydroxynaphthalene, hydroxyquinolines, or 1- or 2-acetonaphthone (4 mmol) and freshly sublimed t-C_4H_9OK (4 mmol). After complete dissolution, the substrate (1 mmol) was added and the flask was illuminated by a Hanovia 450-W high-pressure mercury lamp. The reaction was monitored by TLC aliquots and was quenched after consumption of the substrate by addition of NH_4Cl and water. The excess of the less polar substances (hydroxynaphthalene, acetonaphthone) was extracted to a large extent with heptane, leaving the crude $S_{RN}1$ product, which was extracted by ethyl acetate after acidification to pH 2. The crude residue ((hydroxynaphthyl)quinoline or -isoquinoline) left after solvent evaporation was heated at 80 °C for 3 h in DMF with 2-bromopropane and K_2CO_3. Standard extraction afforded isopropyl ethers, purified by preparative TLC on silica gel.

2-(2-Isopropoxy-1-naphthyl)quinoline (6a): irradiation time, 120 min; yield, 70%; oil; ^1H NMR δ 1.14 (d, J = 6 Hz, 6 H), 4.50 (sept, J = 6 Hz, 1 H), 7.34 (m, 2 H), 7.60 (m, 2 H), 7.70–8.10 (m, 6 H), 8.27 (m, 2 H); MS, m/z 313 (M^+), 270, 254; exact mass calcd for $C_{22}H_{19}NO$ 313.1466, found 313.1450.

3-(2-Isopropoxy-1-naphthyl)quinoline (6b): irradiation time, 30 min; yield, 85%; mp 30–34 °C; ^1H NMR δ 1.15 (d, J = 6 Hz, 6 H), 4.43 (sept, J = 6 Hz, 1 H), 7.15 (m, 3 H), 7.35 (m, 2 H), 7.63 (m, 4 H), 7.99 (d + s, 2 H), 8.73 (s, 1 H); MS, m/z 313 (M^+), 270, 254. Anal. Calcd for $C_{22}H_{19}NO$: C, 84.36; H, 6.06. Found: C, 84.06; H, 6.27.

4-(2-Isopropoxy-1-naphthyl)quinoline (6c): irradiation time, 120 min; yield, 70%; oil; ^1H NMR δ 0.97 (d, J = 6 Hz, 3 H), 1.07 (d, J = 6 Hz, 3 H), 4.50 (sept, J = 6 Hz, 1 H), 7.1 (d, 1 H), 7.16–7.43 (m 6 H), 7.67 (dd, 1 H), 7.83 (d, J = 7 Hz, 1 H), 7.97 (d, J = 7 Hz, 1 H), 8.23 (d, J = 7 Hz, 1 H), 9.03 (d, J = 4 Hz, 1 H); MS, m/z 313 (M^+), 270; exact mass calcd for $C_{22}H_{19}NO$ 313.1466, found 313.1437.

5-Chloro-7-(2-hydroxy-1-naphthyl)-8-isopropoxyquinoline (6d): irradiation time, 120 min; yield, 50%; mp 206–210 °C; ^1H NMR δ 0.9 (d, J = 6 Hz, 3 H), 1.23 (d, J = 6 Hz, 3 H), 4.60 (sept,

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(22) Rokach, J.; Girard, Y. *J. Heterocycl. Chem.* **1978**, *15*, 683.
(23) La Mattina, J. L.; Taylor, R. L. *J. Org. Chem.* **1981**, *46*, 4179.

J = 6 Hz, 1 H), 7.40 (m, 3 H), 7.56 (m, 2 H), 7.66 (s, 1 H), 7.83 (d, J = 8 Hz, 2 H), 8.56 (d, J = 8 Hz, 1 H), 8.90 (d, J = 4 Hz, 1 H); MS, m/z 365, 363 (M^+), 321, 304. Anal. Calcd for $C_{22}H_{18}ClNO_2$: C, 72.65; H, 4.95. Found: C, 72.48; H, 4.96.

3-Ethyl-1-(2-isopropoxy-1-naphthyl)-4-methylisoquinoline (9a): irradiation time, 60 min; yield, 50%; oil; ^1H NMR δ 0.97 (d, J = 6 Hz, 3 H), 1.07 (d, J = 6 Hz, 3 H), 1.33 (t, J = 7 Hz, 3 H), 2.70 (s, 3 H), 3.13 (q, J = 7 Hz, 2 H), 4.46 (sept, J = 6 Hz, 1 H), 7.13 (t, J = 8 Hz, 1 H), 7.2–7.35 (m, 3 H), 7.40 (d, J = 8 Hz, 1 H), 7.50 (d, J = 8 Hz, 1 H), 7.63 (t, J = 8 Hz, 1 H), 7.83 (d, J = 8 Hz, 1 H), 7.93 (d, J = 8 Hz, 1 H), 8.05 (d, J = 8 Hz, 1 H); MS, m/z 355 (M^+), 340, 312, 297; exact mass calcd for $C_{25}H_{25}NO$ 355.1936, found 355.1949.

4-(2-Isopropoxy-1-naphthyl)isoquinoline (9b): irradiation time, 60 min; yield, 74%; oil; ^1H NMR δ 0.97 (d, J = 6 Hz, 3 H), 1.03 (d, J = 6 Hz, 3 H), 4.46 (sept, J = 6 Hz, 1 H), 7.16–7.60 (m, 7 H), 7.80–8.10 (m, 3 H), 8.46 (s, 1 H), 9.30 (s, 1 H); MS, m/z 313 (M^+), 271; exact mass calcd for $C_{22}H_{19}NO$ 313.1466, found 313.1471.

2-Isopropoxy-3-(1-naphthyl)quinoline (15a): irradiation time, 240 min; yield, 20%; oil; ^1H NMR δ 1.20 (d, J = 6 Hz, 6 H), 5.63 (sept, J = 6 Hz, 1 H), 7.33–7.70 (m, 7 H), 7.77 (d, 1 H), 7.93 (m, 3 H), 8.0 (s, 1 H); MS, m/z 313 (M^+), 271, 254; exact mass calcd for $C_{22}H_{19}NO$ 313.1466, found 313.1475.

4-Isopropoxy-3-(1-naphthyl)quinoline (15b): irradiation time, 240 min; yield, 15%; oil; ^1H NMR δ 0.80 (d, J = 6 Hz, 3 H), 0.96 (d, J = 6 Hz, 3 H), 3.90 (sept, J = 6 Hz, 1 H), 7.50 (m, 1 H), 7.60 (m 4 H), 7.75 (m, 2 H), 7.96 (m, 2 H), 8.16 (dd, 1 H), 8.36 (dd, 1 H), 8.83 (s, 1 H); MS, m/z 313 (M^+), 271, 254; exact mass calcd for $C_{22}H_{19}NO$ 313.1466, found 313.1455.

5-Chloro-8-isopropoxy-7-(1-naphthyl)quinoline (15d): irradiation time, 180 min; yield, 51%; mp <30 °C; ^1H NMR δ 0.85 (d, J = 6 Hz, 3 H), 0.90 (d, J = 6 Hz, 3 H), 4.35 (sept, J = 6 Hz, 1 H), 7.10–7.50 (m, 7 H), 7.80 (m, 2 H), 8.45 (d, J = 8 Hz, 1 H), 8.90 (d, J = 4 Hz, 1 H); MS, m/z 349, 347 (M^+), 332, 305, 288; exact mass calcd for $C_{22}H_{18}ClNO$ 347.1077, found 347.1070.

5-Chloro-8-isopropoxy-7-(2-naphthyl)quinoline (17): irradiation time, 300 min; yield, 40%; oil; ^1H NMR δ 1.07 (d, J = 6 Hz, 6 H), 4.56 (sept, J = 6 Hz, 1 H), 7.54 (m, 3 H), 7.83 (s, 1 H), 7.92 (m, 4 H), 8.17 (s, 1 H), 8.57 (d, J = 8 Hz, 1 H), 9.03 (d, J = 4 Hz, 1 H); MS, m/z 349, 347 (M^+), 332, 305, 288; exact mass calcd for $C_{22}H_{18}ClNO$ 347.1077, found 347.1065.

5-Isopropoxy-7-(1-naphthyl)quinoline (21a): irradiation time, 30 min; yield, 87%; mp 110–115 °C; ^1H NMR δ 1.43 (d, J = 6 Hz, 6 H), 4.73 (sept, J = 6 Hz, 1 H), 7.0 (s, 1 H), 7.30–7.70 (m, 5 H), 7.80–8.15 (m, 4 H), 8.66 (d, J = 8 Hz, 1 H), 8.97 (d, J = 4 Hz, 1 H); MS, m/z 313 (M^+), 271, 254; exact mass calcd for $C_{22}H_{19}NO$ 313.1466, found 313.1456. Anal. Calcd for $C_{22}H_{19}NO$: C, 84,36; H, 6.06. Found: C, 84.01; H, 6.18.

5-Isopropoxy-7-(2-naphthyl)quinoline (21b): irradiation time, 60 min; yield, 75%; oil; ^1H NMR δ 1.45 (d, J = 6 Hz, 6 H), 4.85 (sept, J = 6 Hz, 1 H), 7.22 (s, 1 H) 7.32 (dd, 1 H), 7.48 (m, 2 H), 7.87 (m, 4 H), 8.05 (s, 1 H), 8.16 (s, 1 H), 8.58 (d, J = 8 Hz, 1 H), 8.90 (d, J = 4 Hz, 1 H); MS, m/z 313 (M^+), 270, 254. Anal. Calcd for $C_{22}H_{19}NO$: C, 84.36; H, 6.06. Found: C, 84.61; H, 6.32.

5-Isopropoxy-7-(1-naphthyl)isoquinoline (23a): irradiation time, 60 min; yield, 70%; oil; ^1H NMR δ 1.46 (d, J = 6 Hz, 6 H), 4.73 (sept, J = 6 Hz, 1 H), 7.16 (s, 1 H), 7.50 (m, 4 H), 7.60 (s, 1 H), 7.94 (m, 3 H), 8.10 (d, J = 6 Hz, 1 H), 8.57 (d, J = 6 Hz, 1 H), 9.20 (s, 1 H); MS, m/z 313 (M^+) 271; exact mass calcd for $C_{22}H_{19}NO$ 313.1466, found 313.1460.

5-Isopropoxy-7-(2-naphthyl)isoquinoline (23b): irradiation time, 60 min; yield, 63%; mp 142–144 °C; ^1H NMR δ 1.51 (d, J = 6 Hz, 6 H), 4.90 (sept, J = 6 Hz, 1 H), 7.41 (s, 1 H), 7.58 (m 2 H), 7.83 (s, 1 H), 7.86 (d, 1 H), 7.90–8.05 (m, 3 H), 8.10 (d, J = 6 Hz, 1 H), 8.17 (s, 1 H), 8.60 (d, J = 6 Hz, 1 H), 9.33 (s, 1 H); MS, m/z 313 (M^+), 271. Anal. Calcd for $C_{22}H_{19}NO$: C, 84.36; H, 6.06. Found: C, 84.10; H, 6.28.

1-Isopropoxy-3-(1-naphthyl)isoquinoline (25a): irradiation time, 120 min; yield, 70%; oil; ^1H NMR δ 1.44 (d, J = 6 Hz, 6 H), 5.63 (sept, J = 6 Hz, 1 H), 7.40–7.60 (m, 6 H), 7.67 (m, 2 H), 7.83 (m, 2 H), 8.30 (m, 2 H); MS, m/z 313 (M^+), 271; exact mass calcd for $C_{22}H_{19}NO$ 313.1466, found 313.1462.

1-Isopropoxy-3-(2-naphthyl)isoquinoline (25b): irradiation time, 60 min; yield, 60%; mp 78 °C; ^1H NMR δ 1.50 (d, J = 6 Hz, 6 H), 5.68 (sept, J = 6 Hz, 1 H), 7.26–7.55 (m, 4 H), 7.55–7.90 (m, 5 H), 8.06 (m, 2 H), 8.41 (s, 1 H); MS, m/z 313 (M^+), 271. Anal. Calcd for $C_{22}H_{19}NO$: C, 84.36; H, 6.06. Found: C, 84.50; H, 6.04.

Supplementary Material Available: ^1H NMR spectra for **6a**, **6c**, **9a**, **9b**, **15a**, **15b**, **15d**, **17**, **23a**, and **25a** (10 pages). Ordering information is given on any current masthead page.