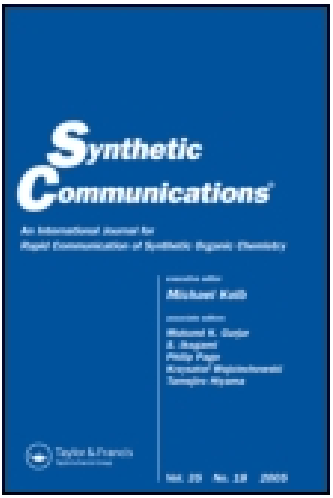

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Further Insight into the Reactivity of Oxazinones Toward Phosphorus Reagents

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Further Insight into the Reactivity of Oxazinones Toward Phosphorus Reagents

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ABSTRACT

A series of quinoline derivates has been obtained from the reaction of 3-phenyl-2,4-benzoxazin-1-one (**1**) with alkylidenephosphoranes. With ester ylides **3a,b**, the reaction affords hydroxyquinolines **8a,b** and new stable phosphorus ylide **9**, whereas with keto ylides **3c,d**, quinolinones **12a,b**, hydroxyindoles **10a,b** and benzoazepines **14a,b** are obtained. **1** reacts with allyl-**4**, methyl-**5a** and ethyltriphenylphosphonium bromides **5b** in the presence of LiH to afford 2-hydrophenyloxazolo[1,2-*a*]-4-hydroxyquinoline (**16**) from the first reaction whereas alkoxyquinolines **21a,b** and hydroxyazepines **22a,b** are obtained from **5a,b**.

Key Words: 2,4-Oxazin-1-one; Quinolines; Azepines; Resonance-stabilized; Unsaturated and active alkylidenephosphoranes; Intramolecular *Wittig* reaction.

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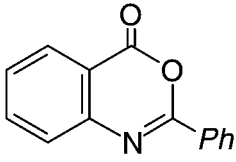
INTRODUCTION

2,4-[1,2], and 2,3-benzoxazinones[3,4] have been shown to be versatile synthons for introducing nucleophilic amine substituent into heterocyclic nucleus and preparing new pyrimidine derivatives. Subsequently, we reported that 4-(4-methylphenyl)-2,3-benzoxazin-1-one (**2**) undergoes an insertion reaction when exposed to phosphonium ylides giving isoquinolines as the major products.[5] In contrast, ring contraction was observed when **2** or the structurally related, 3-phenyl-2,4-benzoxain-1-one **(1)** was allowed to react with trialkyl phosphites, yielding phosphono substituted-isoindoles (or indoles).[6] These intriguing transformations led us to apply ylide chemistry to 2,4-benzoxazinone **1**, available from heating the benzoylanthranilic acid in excess acetic anhydride.[1b] Furthermore, new quinoline-or indole chemistry would be of potential interest to biochemistry and pharmaceutical chemistry.



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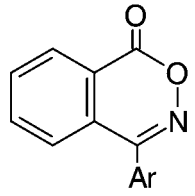


2, Ar = C_6H_4-*Me-p*

$Ph_3P=CHCOR^1$

3a, R^1 = *OMe* ; **3b**, R^1 = *OEt*
3c, R^1 = *Me*; **3d**, R^1 = *Ph*

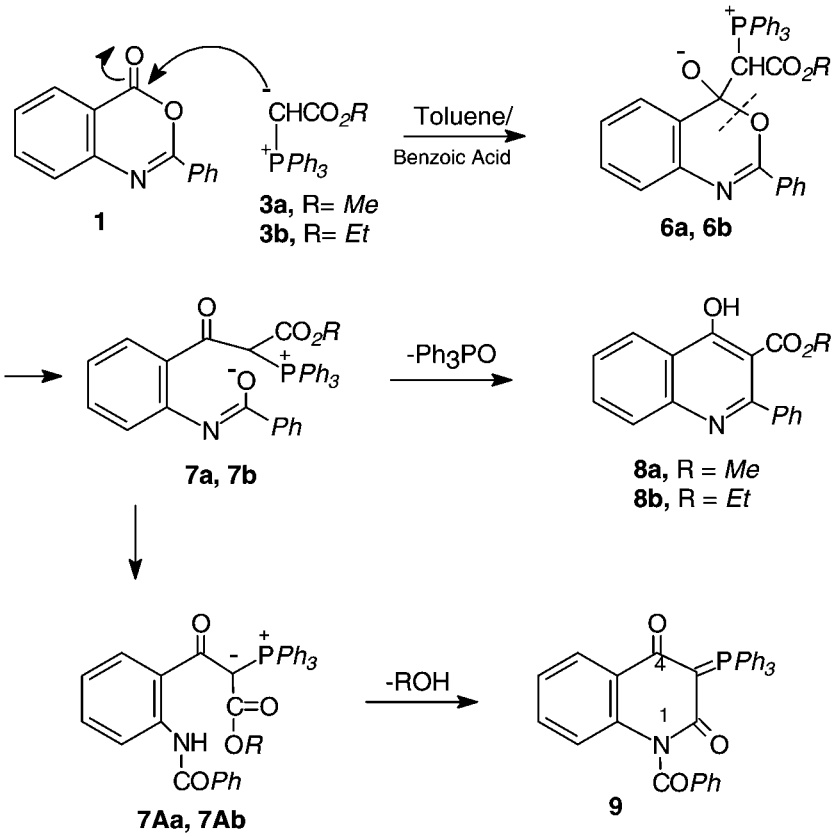
$Ph_3\overset{+}{P}-CH_2R^2\ \bar{Br}$

4, R^2 = -CH=CH_2
5a, R^2 = H; **5b**, R^2 = *Me*

RESULTS AND DISCUSSION

2,4-Benzoxazin-1-one **1** on treatment with one equivalent of methoxycarbonylmethylenetriphenylphosphorane (**3a**) in refluxing toluene, the reaction was very slow and has been accelerated by using a catalytic amount of benzoic acid as a protonating catalyst in the reaction medium. The success of this procedure is attributable to the protonation of the carbonyl group, making it more electrophilic and, therefore, more susceptible to nucleophilic attack by the ylide **3**. The product mixture was then subjected to column chromatography to give methyl 4-hydroxy-2-phenylquinoline-3-carboxylate

(**8a**, 44%) and the phosphonium ylide **9** (28%). Hydroxyquinoline **8a** was identical in all aspects with material previously obtained from the reaction of 2-[(benzylidene)amino]benzonitrile with ester ylide **3a**.[7] A similar treatment of **1** with ethoxy analogue **3b** gave the ylide **9** (24%) together with the known[7,8] hydroxyquinoline **8b** (40%) (Scheme 1). Product **9** exhibited a carbonyl band (C(4)=O) at 1740 cm^{-1} in its IR spectrum, compared to 1680 cm^{-1} for the corresponding band (C(1)=O) in **1**.[2b] Other bands appeared at 1655 cm^{-1}(C(2)=O), 1635 cm^{-1} (N-COPh) and at 1556 cm^{-1} (C=P). Its ^{13}C NMR spectrum displayed a signal, among others, at δ 134.2 attributed to *C*-P-ipso. The phosphonium ylide **9** failed to undergo the *Wittig* reaction with aldehydes and was not affected by refluxing with alcoholic potassium hydroxide solution. This latter behavior is inconsistent



Scheme 1.

with the behavior of phosphonium ylide derived from 2,3-benzoxazinone **2** and benzoylmethylenetriphenylphosphorane (**3d**).[5] This presumably reflects the extra stabilization (compared to **3**) afforded by the other two carbonyl groups and the conjugation possible in the resonance forms.[9] Accordingly, its ^{31}P NMR spectrum has positive chemical shift at $\delta_P = 24.64$ ppm (vs. 85% H_3PO_4), which indicates a high contribution of the zwitterionic phosphorus betaine structure.[10]

A reasonable mechanism of condensation of **1** with ester ylides **3a,b** involves an initial attack[1–5] of the ylide carbon in **3a** or **3b** onto the C(1)═O group, with subsequent ring opening of **1** to afford **7a,b** via the intermediates **6**. Under thermal conditions and in the presence of a protonating agent the zwitterion **7** is presumably formed. Further intramolecular *Wittig* reaction and prototropic rearrangement produce the products **8a,b**, with concomitant elimination of triphenylphosphine oxide. On the other hand, rearrangement of **7a,b** to **7Aa,b** followed by intramolecular cyclization would lead to the final ylide **9** accompanied with the loss of the appropriate alcohol moiety (Scheme 1).

By treatment of **1** with 2 equiv. of acetonyl- (**3c**) or benzoylmethylenetriphenylphosphorane (**3d**) in a way analogous to that described for **3a,b**, a mixture of **10a**, **12a**, and **14a** (or **10b**, **12b**, and **14b**) was obtained. Compounds **10**, **12**, and **14** were obtained in essentially the same ratio regardless whether 1 or 2 equivalents of **3c,d** were used.

The structure of 2-acetyl-3-methyl-5-hydroxy-*N*-benzoylbenzoazepine has been assigned to **14a** (20%) on the base of analytical, IR, ^1H, and ^{13}C NMR and mass spectral data. The seven membered heterocycle is well supported by the presence in the ^{13}C NMR spectrum of the signals 18.9 (3-C-*C*H_3), 26.7 (2-C-CO*C*H_3), 141.5 (2-*C*-COCH$_3$), 158.6 (5-*C*-OH) and 206.3 (*C*(O)Me). Also for *N*-benzoyl-2-methyl-4-oxo-quinoline (**12a**, 32%), and *N*-benzoyl-2-acetyl-3-hydroxyindole (**10a**, 18%) analytical and spectral data are consistent with the given structures (cf. Tables 1–3). Fused substituted-azepines had been previously[5] observed through the reaction of **2** with **3c**. Obviously, the expected zwitterion intermediates **7c,d** initially formed give, by electrocyclic ring closure and proton rearrangement, either to **10a** and **10b** via elimination of triphenylphosphine (Scheme 2, i), or to **12a** and **12b** via extrusion of triphenylphosphine oxide (Scheme 2, ii).[11] On the other hand, the formation of the azepines **14a** and **14b** is readily explained if it is proposed that the anionic intermediates **7c,d** undergo *Wittig* olefination with a second ylide species **3c** (or **3d**) to give **13**, which leads to **14a** (or **14b**) via elimination of Ph_3P and prototropic rearrangement (Scheme 2, iii).

When a mixture of compound **1** and allyltriphenylphosphonium bromide (**4**) in dimethylformamide (DMF) was treated with lithium hydride (LiH), the

Table 1. Physical properties and IR spectra for products **9, 10a,b, 12a,b, 14a,b, 16, 21a,b**, and **22a,b**.

Product/ color	R^1/R^2	Mp (°C)/solvent	Yield (%)	IR (KBr), $\nu\,cm^{-1}$
9/brown	—	>300/AcOEt	~26	1740 (C(4)=O), 1655 (C(2)=O), 1635 (N-C=O), 1556 (C=P).
10a/orange	R^1 = Me	132–134/ $CHCl_3 : CH_2Cl_2$ (1 : 1, *v*/*v*)	18	3350 (OH), 1658 (C(O)Me), 1630 (C(O)Ph).
10b/orange	R^1 = Ph	172–174/acetone	24	3355 (OH), 1660, 1632 (2 × C(O)Ph).
12a/pale yellow	R^1 = Me	109–111/cyclohexane	32	1738 (C(4)=O), 1625 (C(O)Ph).
12b/pale yellow	R^1 = Ph	131–132/CH_2Cl_2	29	1735 (C(4)=O), 1630 (C(O)Ph).
14a/yellow	R^1 = Me	164–166/EtOH	20	3355 (C(5)OH), 1658 (C(O)Me), 1640 (C(O)Ph).
14b/brown	R^1 = Ph	184–186/EtOH	13	3333 (C(5)OH), 1658, 1640 (2 × C(O)Ph).
16/yellow	—	190–192/EtOH	52	3442 (OH).
21a/yellow	R^2 = H	96–98/ether	33	1585 (C=N).
21b/yellow	R^2 = Me	84–86/pentane	37	1585 (C=N).
22a/pale yellow	R^2 = H	170–172/MeCN	36	3448, 3356 (OH and NH).
22b/pale yellow	R^2 = Me	245–247/MeCN	40	3455, 3348 (OH and NH).

[a]See the experimental section for further details.

unexpected 1-hydro-2-phenyloxazolo[1,2-*a*]-6-hydroxyquinoline (**16**) (52%) was isolated according to Scheme 3. As with the reaction between **1** and **3**, addition of allyl ylide at C(1) position of **1** and ring opening followed by cycloelimination sequence affords the product **16**. A similar approach is known[12] for the reaction of isatoic anhydride with carbanions. The mechanism of this reaction as well as further reactions with similar oxazinones is still under consideration.

Table 2. Analytical and MS spectral data for products **9, 10a,b, 12a,b, 14a,b, 16, 21a,b** and **22a,b**.

Cpd	Mol. form. (M.wt.)	Anal. found (calcd) (%)				MS: m/z (%): [M^+] and relevant fragments
		C	H	N	P	
9	$C_{34}H_{24}NO_3P$ (525.54)	77.50 (77.71)	4.42 (4.60)	2.55 (2.67)	5.63 (5.89)	526 (18) [$M^+ + 1$], 525 (22), 497 (72), 469 (55), 427 (22), 421 (100) [M^+-105 (COPh)], 406 (32), 378 (28), 277 (24), 263 (50)[M^+-262 (Ph_3)], 262 (16), 119 (13), 105 (17), 77 (26).
10a	$C_{17}H_{13}NO_3$ (279.3)	73.32 (73.11)	4.45 (4.69)	4.98 (5.02)	—	279 (56) [M^+], 278 (100) [M^+-1], 263 (23), 251 (11), 235 (33), 223 (18), 174 (22), 163 (42), 119 (18), 105 (26), 77 (15).
10b	$C_{22}H_{15}NO_3$ (341.37)	77.71 (77.41)	4.50 (4.43)	3.96 (4.10)	—	341 (67) [M^+], 340 (100), 312 (28), 283 (15), 263 (28), 235 (65), 221 (50), 206 (66), 163 (37), 119 (22), 105 (43), 77 (38).
12a	$C_{17}H_{13}NO_2$ (263.3)	77.43 (77.55)	4.78 (4.98)	4.99 (5.32)	—	263 (100) [M^+], 249 (19), 235 (40), 221 (58), 195 (15), 158 (18), 143 (22), 129 (26), 105 (20), 77 (14).
12b	$C_{22}H_{15}NO_2$ (325.37)	81.11 (81.21)	4.42 (4.65)	4.23 (4.30)	—	325 (100) [M^+], 297 (13), 248 (30), 220 (50), 195 (55), 129 (37), 105 (48), 101 (14), 77 (24).

14a	$C_{20}H_{17}NO_3$ (319.36)	75.19 (75.22)	5.28 (5.37)	4.27 (4.39)	—	319 (40) [M^+], 318 (81), 305 (14), 301 (23), 289 (19), 263 (24), 215 (71), 197 (100) [M^+-121 (OH & COPh)], 122 (18), 119 (23), 105 (11), 93 (20), 77 (17).
14b	$C_{30}H_{21}NO_3$ (443.52)	81.13 (81.25)	4.69 (4.77)	3.05 (3.16)	—	443 (35) [M^+], 442 (56), 425 (42), 415 (13), 366 (23), 348 (37), 337 (51), 324 (77), 321 (100) [M^+-121 (OH & COPh)], 309 (17), 247 (25), 105 (29), 77 (31).
16	$C_{17}H_{13}NO_2$ (263.3)	77.35 (77.55)	4.67 (4.98)	5.12 (5.32)	—	263 (100) [M^+], 262 (75), 261 (64), 245 (30) [M^+-18 (H_2O)], 235 (18) [M^+-28(CO)], 158 (30) [M^+-105 (C_6H_5CO)], 129 (58), 105 (22), 77 (16).
21a	$C_{16}H_{13}NO$ (235.29)	81.52 (81.68)	5.21 (5.57)	6.21 (5.95)	—	235 (25) [M^+], 221 (100)[M^+-14 (CH_2)], 195 (31) [M^+-30 (CH_2O), 157 (23), 135 (37), 129 (51), 101 (41), 77 (25).
21b	$C_{18}H_{17}NO$ (263.34)	81.97 (82.10)	6.34 (6.51)	4.99 (5.32)	—	263 (37) [M^+], 249 (29), 233 (100) [M^+-30 (2Me)], 219 (72), 205 (17), 186 (45), 162 (29), 129 (53), 101 (18), 77 (39).

(*continued*)

Table 2. Continued.

Cpd	Mol. form. (M.wt.)	Anal. found (calcd) (%)				MS: m/z (%): [M^+] and relevant fragments
		C	H	N	P	
22a	$C_{16}H_{13}NO$ (235.29)	81.42 (81.68)	5.44 (5.57)	6.13 (5.95)	—	235 (100)[b] [M^+], 234 (72), 233 (71), 217 (31) [M^+-18 (H_2O)], 205 (13), 134 (21) (C_6H_5-C=CH=CH=COH), 121 (27), 115 (13) (C_6H_5-C=CH=CH), 101 (19), 77 (11).
22b	$C_{18}H_{17}NO$ (263.34)	82.43 (82.1)	6.32 (6.51)	5.00 (5.32)	—	263 (100) [M^+], 262 (88), 261 (64), 247 (16), 245 (51) [M^+-18 (H_2O)], 233 (40) [M^+-30 (2Me)], 217 (35), 177 (25), 172 (12), 148 (29), 144 (19), 119 (20), 101 (25), 77 (36).

[a]See the experimental section for further details.
[b]Similar structures (azepines) showed MS: m/z (%): [M^+, 100].[13]

Table 3. NMR[a] spectral data for products **9, 10a,b, 12a,b, 14a,b, 16, 21a,b** and **22a,b**.

Cmpd	^{1}H NMR ($CDCl_3$), δ (ppm)	^{13}C NMR ($CDCl_3$), δ (ppm)
9[b]	7.12–8.21 (m, *H*-Ph).	121.3, 124.5, 124.7, 126.4, 127.2, 127.9, 129.1, 129.6, 131.5, 132.2 (*C*═*C*, Ph), 134.2 (d, $^1J_{CP}$ = 104, 3-*C*-P, *ipso*), 172.8 (*C*(1)═O), 183.3 (*C*═O, benzoyl).
10a	2.44 (s, 3H, C(O)CH_3), 7.24–7.83 (m, 9H, *H*-Ph), 11.85 (s, 1H, O*H*, D_2O - exchang.).	26.8 (CO*C*H_3), 120.6, 121.5, 122.6, 122.8, 124.3, 124.6, 131.79, 133.2 (*C*═*C*, Ph[c]), 127.9 (*C*-9), 136.3 (2-*C*), 148.9 (8-*C*), 154.5 (3-*C*-OH), 187.2 (*C*(O)Ph), 202.8 (*C*(O)Me).
10b	7.23–8.18 (m, 14H, *H*-Ph), 11.95 (s, 1H, O*H*, D_2O - exchang.).	134.3 (2-*C*), 156.7 (3-*C*), 174.7, 181.3 (2 × *C*(O)Ph).
12a	2.14 (s, 3H, 2-C-CH_3), 6.38 (s, 1H, 3-C*H*), 7.22–8.15 (m, 9H, *H*-Ph).	19.2 (*C*H_3), 133.7 (3-*C*), 143.1 (2-*C*), 172.4 (4-*C*═O)), 176.2 (*C*(O)Ph).
12b	6.27 (s, 1H, 3-C*H*), 7.09–8.19 (m, 14H, *H*-Ph).	131.0 (3-*C*), 147.1 (2-*C*), 168.2 (4-*C*═O), 178.2 (*C*(O)Ph).
14a	2.13, 2.25 (2s, 2 × 3H, 2 × CH_3), 6.18 (s, 1H, 4-C*H*), 7.25–7.88 (m, 9H, *H*-Ph), 14.82 (s (br), 1H, 5-C-O*H*, D_2O - exchang.).	18.9 (3-C-*C*H_3), 26.7 (C(O)*C*H_3), 116.7 (4-*C*), 141.5 (2-*C*), 158.1 (5-*C*-OH), 175.6 (*C*(O)Ph), 206.3 (*C*(O)CH_3).
14b	6.11 (s, 1H, 4-C*H*), 6.97–8.27 (m, 19H, *H*-Ph), 14.82 (s (br), 1H, 5-C-O*H*, D_2O - exchang.).	113.2 (4-*C*), 141.6 (2-*C*), 156.2 (5-*C*-OH), 172.7, 178.8 (2 × *C*(O)Ph).
16	4.22 (2-C-*H*), 6.26 (s, 1H, 4-C*H*), 6.55 (s, 1H, 5-C*H*), 7.27–7.87 (m, 9H, *H*-Ph), 14.82 (s (br), 1H, 6-C-O*H*, D_2O - exchang.).	51.5 (2-*C*′), 114.6 (5-*C*), 120.2, 121.1, 122.4, 122.8, 124.5, 124.2, 133.2, 133.7 (*C*═*C*, Ph), 144.8 (4-*C*′), 153.6 (5′-*C*), 158.6 (6-*C*).
21a	3.72 (s, 3H, OCH_3), 6.31 (s, 1H, 3-C*H*), 7.18–7.82 (m, 9H, *H*-Ph).	54.7 (O*C*H_3), 111.4 (3-*C*), 119.8, 121.2, 122.3, 122.8, 124.6, 126.4, 132.4, 133.4 (*C*═*C*, Ph), 127.6 (10-*C*), 149.4 (9-*C*), 154.7 (2-*C*), 158.3 (4-*C*).

(*continued*)

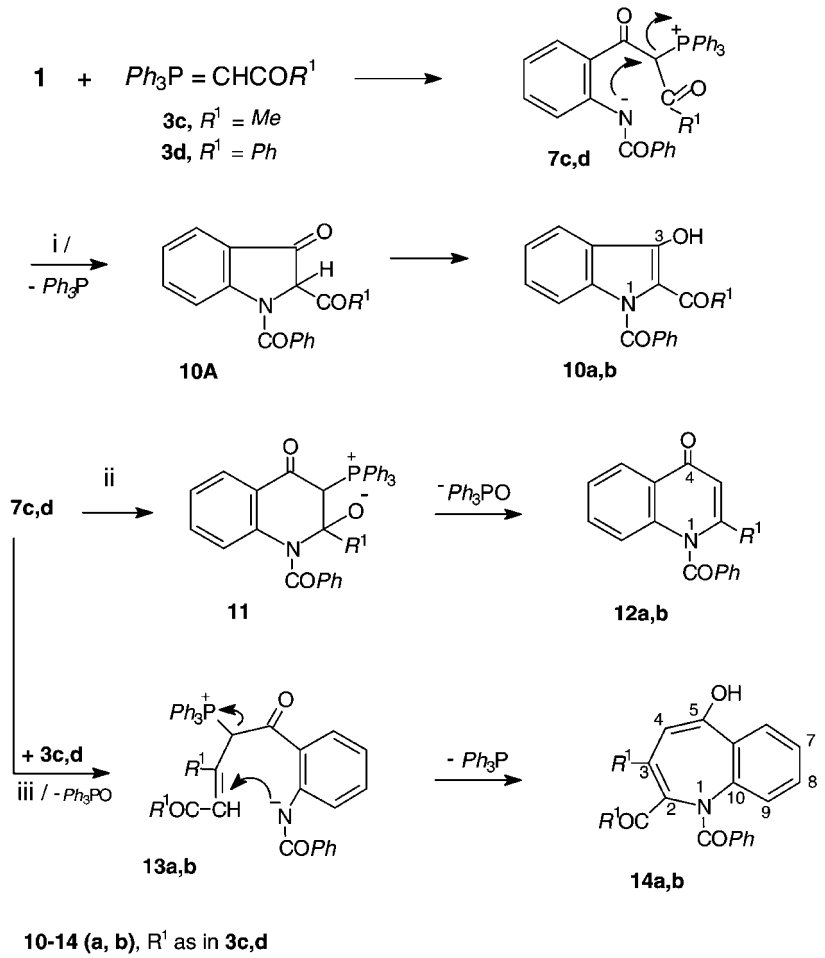
Table 3. Continued.

Cmpd	^{1}H NMR ($CDCl_3$), δ (ppm)	^{13}C NMR ($CDCl_3$), δ (ppm)
21b	0.99 (t, 3H, $J_{HH} = 6.8$, OC.CH_3), 2.16 (s, 3H, 3-C-CH_3), 4.08 (q, 2H, $J_{HH} = 6.8$, OCH_2), 7.24–8.18 (m, 9H, *H*-Ph).	16.7, 18.3 (2 × CH_3), 60.8 (OCH_2), 120.1, 121.1, 122.5, 122.8, 124.6, 126.1, 131.5, 133.4 (*C*═*C*, Ph), 127.9 (10-*C*), 129.1 (3-*C*), 149.2 (9-*C*), 152.6 (2-*C*), 157.2 (4-*C*).
22a	7.36–8.26 (m, 11H, *H*-Ph & *H*-Het), 9.66, 11.89 (2s (br), 2 × 1H, N*H* & O*H*).	110.8 (4-*C*), 118.3 (3-C), 119.7, 120.1, 121.5, 122.2, 124.3, 126.4, 132.5, 133.2 (*C*═*C*, Ph), 127.9 (*C*-11), 135.5 (2-*C*), 139.6 (10-*C*), 158.5 (5-*C*).
22b	1.98, 2.14 (2s, 2 × 3H, 3-C & 4-C-CH_3), 7.27–8.01 (m, 9H, *H*-Ph), 9.66, 11.89 (2s (br), 2 × 1H, N*H* & O*H*, D_2O - exchang.).	14.6, 18.2 (2 × CH_3), 119.9, 120.8, 121.7, 122.4, 124.3, 126.6, 132.58, 133.3 (*C*═*C*, Ph), 128.5 (4-*C*), 131.5 (3-*C*), 135.8 (2-*C*), 139.1 (10-*C*), 156.1 (5-*C*).

[a]See the experimental section for further details.
[b]^{31}P NMR ($CDCl_3$): δ_P 24.64 ppm.
[c]δ_C Compounds **10b, 12a,b**, and **14a,b** showed signals for (*C*═*C*, Ph), almost as compound **10a**.

Finally, the reaction of **1** with 2 equiv. of methyl- (**5a**) and ethyltriphenylphosphonium bromide (**5b**) in DMF containing LiH afforded hydroxybenzoazepines **22a,b** (∼38%) together with alkoxyquinolines **21a,b** (∼35%). *Wittig* olefination of the initially formed **17a** (or **17b**) by a second phosphorus species afforded the ylides **18a** (or **18b**). An electrocyclic ring closure of **18** afforded **19**, which by subsequent formation of an oxirane **20** (and loss of Ph_3P) and proton migration could account for the formation of **21a,b**. A parallel mechanism has been suggested,[5] by one of the referees, for similar alkoxyisoquinoline derivatives were obtained previously by treatment of 2,3-oxazinone **2** with salts **5a,b**. Compounds **22a,b** could reasonably be formed from **18** by a cycloelimination reaction[5] (Scheme 4).

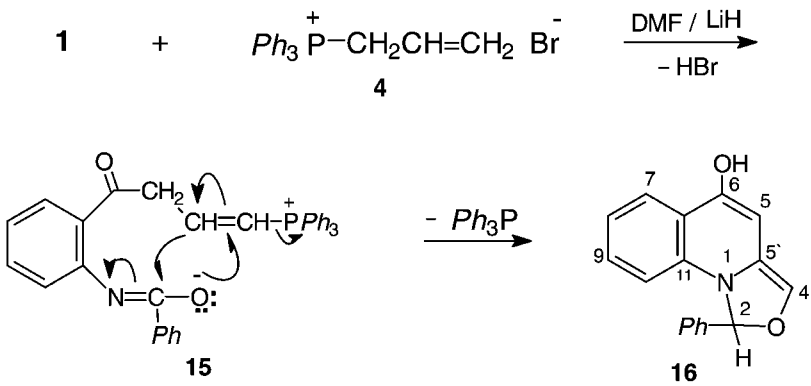
In summary, the present and the previous studies[5,6] have demonstrated a range of reactivity of oxazinones **1** and **2** toward different types of phosphorus ylides **5** as well as toward trialkyl phosphites and dialkyl phosphonates. The divergent pathways have led to the construction of a variety of 5-, 6-, and 7-*N*-heterocycles, related to biologically active compounds based on the known drug skeletons.



Scheme 2.

EXPERIMENTAL

The melting points are uncorrected. The IR spectra were recorded on a Perkin–Elmer spectrophotometer model 297 (Grating) using KBr discs. The ^{1}H and ^{13}C NMR spectra were run in $CDCl_3$ or d_6-DMSO as solvents on a Jeol-270 MHz instrument, using $SiMe_4$ as an internal reference. The ^{31}P NMR spectra were recorded relative to external H_3PO_4 (85%) with a Varian CFT-20 instrument. The mass spectra were performed at 70 eV



Scheme 3.

on a Shimadzu GCS-QP 1000 EX spectrometer provided with a data system. The appropriate precautions in handling moisture-sensitive compounds were observed. Solvents were dried by standard techniques. Light petroleum refers to the fraction 40–60°C.

Reaction of 3-Phenyl-2,4-benzoxazin-1-one (1) with Ester Ylides 3a and 3b

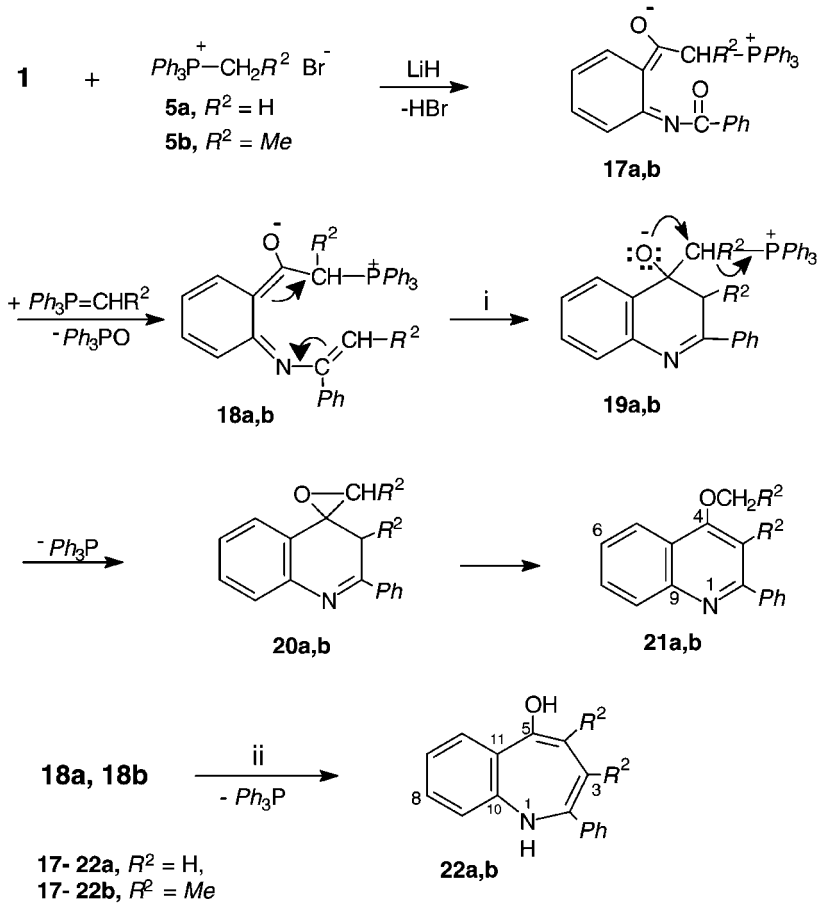
(A) Preparation of Compounds **8a**, **8b**, and **9**

A stirred solution of 1 g (4.48 mmol) of **1** and 5.8 mmol alkoxycarbonylmethylenetriphenylphosphorane **3a** or **3b** in 30 mL toluene containing 0.2 g benzoic acid was heated under reflux for 55 hr. The volatile materials were evaporated under reduced pressure and the residue was separated by column chromatography on silica gel. Elution with *n*-hexane/$CHCl_3$ (4:6, *v*/*v*) yielded 4-hydroxyquinolines **8a** or **8b**.

Methyl 4-hydroxy-2-phenylquinoline-3-carboxylate (8a) was obtained as pale yellow crystals (550 mg, 44%), mp 275–277°C from EtOH (Lit.[7], m.p. 276–278°C).

Ethyl 4-hydroxy-2-phenylquinoline-3-carboxylate (8b) was obtained as pale yellow needles (524 mg, 40%), mp 260–261°C from MeCN (Lit.[7,8], m.p. 260–262°C).

Elution with *n*-hexane/$CHCl_3$ (2:8, *v*/*v*) yielded the phosphonium ylide **9**. Percentage yield, physical, and spectral data are listed in the Tables 1–3.



Scheme 4.

(B) Attempted Reaction of 9 with Aldehydes

The reaction of **9** with benzaldehyde and *p*-chlorobenzaldehyde was investigated in dioxane and ethyl acetate at reflux temperatures for periods as long as 48 hr. In all cases the starting material was recovered.

(C) Attempted Hydrolysis of 9

A mixture of 0.3 g of **9** and 20 mL alcoholic KOH (10%, aqu.) was heated under reflux for 15 hr. The mixture was concentrated to its half, to give 216 mg

(72%) of brown needles, shown to be identical with **9** (TLC, IR, and MS spectra).

Reaction of 1 with Keto Ylides 3c,d

Preparation of Compounds **10a,b, 12a,b**, and **14a,b**

A solution of 8.96 mmol of acetylmethylenetriphenylphosphorane (**3c**) or benzoylmethylenetriphenylphosphorane (**3d**) and 1 g (4.48 mmol) of **1** in 30 mL toluene containing 0.2 g of benzoic acid was refluxed for 3 days. The product mixture was worked up as described for the reactions of **3a,b.** Further separation by column chromatography using *n*-hexane-AcOEt yielded compounds **12a** (or **12b**) (7:3, *v*/*v*), **10a** (or **10b**) (4:6, *v*/*v*), and **14a** (or **14b**) (3:7, *v*/*v*) (cf. Tables 1–3). The reaction between equimolar amounts of **1** and **3c** (or **3d**) under the same reaction conditions again afforded **12a** (or **12b**) (∼20%), **10a** (or **10b**) (∼15%), and **14a** (or **14b**) (∼13%) along with **1** (18%).

Reaction of 1 with Unsaturated Ylide 4

Preparation of Compound **16**

To a slurry of 0.5 g LiH dispersion (60% in mineral oil) in 15 mL DMF was added slowly 1 g (4.48 mmol) of **1** in 20 mL DMF. The reaction mixture was stirred at r.t. until all hydrogen evolution had ceased (∼1 hr), and a solution of 1.7 g (4.5 mmol) of allyltriphenylphosphonium bromide (**4**) in 15 mL DMF was added in one portion. The resulting mixture was stirred at r.t. for 2 hr and then refluxed up. After the consumption of the starting oxazinone (∼16 hr) the reaction mixture was poured onto 400 mL of water and extracted with two 200-mL portions of $CHCl_3$ (2 × 100 mL). The combined organic extracts were backwashed with 100 mL H_2O, dried, and the solvent was removed under reduced pressure. The residue was chromatographed on silica gel, gradient eluting from 20% to 50% AcOEt in *n*-hexane, yielded **16** (1:1, *v*/*v*) (cf. Tables 1–3).

Reaction of 1 with Phosphonium Bromides 5a,b

Preparation of **21a,b**, and **22a,b**

A solution of the appropriate salt **5a** (3 g, 8.96 mmol) or **5b** (3.2 g, 8.96 mmol) and 1 g (4.48 mmol) of **1** in 30 mL DMF was treated with 0.5 g

(12 mmol) LiH in 10 mL DMF for 2 hr at r. t. and then was heated for 18 hr. The mixture was worked up as described for the reaction of **4** and separated by column chromatography using *n*-hexane-AcOEt to give products **21a, 21b** (7:3, *v*/*v*) and **22a, 22b** (4:6, *v*/*v*) (cf. Tables 1–3). The reaction between equimolar amounts of **1** and **5a** (or **5b**) under the same reaction conditions, again afforded **21a** (or **21b**) (∼17%) and **22a** (or **22b**) (∼24%) along with **1** (∼23%).

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